The Institute of Brewing & Distilling

REPORT FROM THE EXAMINERS 2008

General Certificate and Diploma (both Brewing and Distilling)
as well as Master Brewer reports in one handy volume

Board of Examiners and Examination Centres 2008

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The Diploma and Master Brewer Examinations were held in the following world-wide Centres:

UK and Ireland	Aberlour
	Alton
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Cameroon	Douala
Canada	Calgary
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Jamaica	Kingston
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Kenya	Nairobi
Malaysia	Kuala Lumpu
Mexico	Monterrey
Myanmar	Yangon
Netherlands	Zoeterwoude
New Zealand	Auckland
	Christchurch
	Dunedin
Nigeria	Lagos
Papua New Guinea	Boroko
Romania	Brasov
Samoa	Apia
Seychelles	Mahe
St Vincent	Campden Park
South Africa	Cape Town
	Durban
	Johannesburg
	Port Elizabeth
	Pretoria
	Stellenbosch
Tanzania	Dar Es Salaam
Trinidad	Champs Fleurs
Uganda	Kampala
USA	Atlanta
	Colorado
	Davis
	Elkton
	Forth Worth
	Ithaca
	Kansas
	Milwaukee
	San Diego
	Trenton
Zambia	Lusaka
Zimbabwe	Harare

The statistics

Diploma in Brewing, Distilling & Packaging and Master Brewer Examinations.

508 candidates sat all or part of the Institute's Diploma and Master Brewer Examinations (553 in 2007) at 66 centres around the world.
78 candidates sat all or part of the Master Brewer. 11 candidates accumulated passes in all modules.
379 candidates sat all or part of the Diploma in Brewing. 104 accumulated passes in all modules.
32 candidates sat all or part of the Diploma in Distilling. 6 accumulated passes in all modules.
19 candidates sat part of the new Diploma in Packaging.

The number if candidates who sat each module of the Master Brewer and Diploma examinations is shown in the table with the split between candidates in the UK and Ireland and the rest of the world.

Number of candidates who sat each module

Exam	Module	2008	2007
Diploma in Brewing	Module 1	212	233
	Module 2	166	175
	Module 3	170	153
Diploma in Distilling	Module 1	9	16
	Module 2	14	14
	Module 3	14	7
Diploma in Packaging	Module 1	14	NA
	Module 2	NA	NA
	Module 3	5	NA
Master Brewer	Module 1	34	35
	Module 2	24	26
	Module 3	26	22
	Module 4	14	15
	Module 5	20	22

Split between the British Isles and the rest of world

	UK & Ireland	Rest of World
Total Dipl.Brew Candidates	124	255
Total Dipl.Distil Candidates	31	1
Total Dipl.Pack Candidates	10	9
Total M.Brew Candidates	37	41

Report from the Chairman of the Board of Examiners

As in previous years, the results for the 2008 examinations show a continuing increase in candidate numbers registering for the examinations, with the average performance across all of the IBD exams essentially maintained this year. In total this year, there were 11 new Master Brewers qualifying, with 101 candidates achieving the Diploma in Brewing and 6 the Diploma in Distilling. Also 75 candidates obtaining the GCB and 88 the GCP in November 2007, with 119 and 25 passing GCB and GCP respectively in May 2008. In addition, 83 candidates obtained the General Certificates in Distilling. Finally, 15 candidates obtained the new Certificate in the Fundamentals of the Brewing and Packaging of Beer, in April 2008 following a training course held at Durham University.

I should like to congratulate all candidates who have attained qualification, especially those achieving distinctions and awards. In particular, I should like to congratulate Donald Oliver (who attended the UC Davis extension programme) for being awarded the June 2008 JS Ford prize (Dipl. Brew.) and Tracey Whyte (Diageo Global Supply) for attaining the Diploma in Distilling Award presented by the Worshipful Company of Distillers. In addition, Louis Richard De Jager (SAB, South Africa) received the Crisp Malting award (for the best paper in Dipl. Brew. Module 1), Peter Aldred (University of Ballarat, Australia) was awarded the Brewery Engineers Association award (for the highest result in the Process Technology section of Dipl. Brew. Module 3) and Niall Conway (Irish Distillers, Pernod Ricard) attained the Gin and Vodka Association prize (for best paper in Dipl. Distill. Module 2).

Finally, congratulations are extended to Tran Thi Ngoc Loan (Vietnam Brewery Ltd) and Simon Barnett (Coors UK) for obtaining the Worshipful Company of Brewers award for GCB and GCP, respectively, in 2007 and to Cathy Gilbert (Diageo Global Supply) who received the 2007 GCD Scotch Whisky Association award.

As previously, the 2008 General Certificate awards await the results of the November round of examinations.

As ever, I would like to draw attention to the individual examiners' reports following. They are also available via the IBD web site, in the Journal (JIB) or by application to the IBD Examinations Administration team at Clarges Street. Future candidates are strongly encouraged to regard these reports as essential reading in that they contain descriptions of the ideal content of answers, sound advice on examination technique and detailed analysis of the year's papers.

For the Master Brewer examinations, the number of entrants continues to increase year on year. In 2008, overall pass rates and pass performances were similar to last year, with 62% pass (of 34 candidates, compared to 17 candidates in 2007) for module 1, 63% (of 24 candidates) for module 2, 58% pass (of 26) for module 3, 86% (of 14) for module 4 and 65% pass (of 20 candidates) for module 5.

The results for the Diploma in Brewing in 2008 were slightly down on the results for 2007. Of the individual Brewing modules, the pass rates for module 1, (63% of the 212 candidates) and for module 2 (58% of 166 candidates) was less than last year, but maintained for module 3 (68% of 170 candidates).

The high pass rate for candidates sitting the Diploma in Distilling examinations achieved last year was exceeded this year, with a phenomenal 100% pass for all three modules! Congratulations to all 16 candidates for module 1, 14 candidates for module 2 and 7 for module 3.

This year saw the launch of the new Diploma In Beverage Packaging with 10 of 14 candidates passing Module 1 and all 5 candidates entered for Module 3 achieving passes. The formulation of Module 2 has been completed, so that all 3 modules are now available for examination in 2009.

Yet again, all examiners for the written papers for M. Brew. and Diplomas commented on the need for candidates to concentrate their efforts in answering the precise questions asked, by paying particular attention to preparation, organisation and time management. There does appear to be insufficient preparation in some cases.

Some specific comments are:

- Candidates often fail to answer the requisite number of questions or answer their final question very badly. Good time management is as important in the examination room as it is at work.
- Too many candidates fail to read the questions carefully enough and either miss out some parts or misinterpret the question; for example, answering a question about mash conversion systems by describing mash separation systems.

The examiners for Master Brewer comment specifically that some candidates still do not seem to be fully prepared in terms of the technical experience that this high level examination requires. Again, candidates should seek the help of mentors to gain the necessary exposure to all facets of beer production in line with the M. Brew. syllabus. Mentors should be encouraging their pupils to get as wide a range of practical brewing experience as is feasible in their individual situations and to read as widely as possible from textbooks, journals as well as electronic media.

The results for the GCB and GCP exams in November 2007 showed some improvement over previous exams (GCB 51% pass of 148 candidates; GCP 64% pass of 138 candidates), but the May 2008 exam produced a marked increase for GCB (69% pass of 172 candidates), but only 45% pass (of 55 candidates) for GCP; strangely, the lowest pass rate (33%) was for those GCP candidates opting for the Returnable Bottle elective.

The May 2008 GCD exam followed the new syllabus offering the three alternative options of Cereal-, Molasses- and Grape-based distillation, with all papers now set in MCQ (multiple choice questions) format, and achieved a pass rate of 72%, comparable to last year.

With regard to IBD examination developments, as stated above the Diploma In Beverage Packaging (Dipl. Pack.) has been established successfully.

Also the Certificate in the Fundamentals of Brewing and Packaging Beer (FBPB) was set again in January 2008 for In-Bev candidates, being a qualification aimed at non-technical personnel or new entrants to the brewing industry, with an examination set in MCQ format. In April 2008, this qualification was made available to candidates attending the IBD Fundamentals in Brewing course held at Durham University and, with a slightly modified syllabus, is now available to a wider spectrum of interested candidates.

The development of a comparable qualification in the Fundamentals of Distilling is ongoing and the Distilling group has now completed an expanded syllabus for a new Diploma in Distilling (like the new GCD) to include elective options for Molasses- and Grape-based distilled products (in addition to

Cereal distilling); this will be available for examination in June 2009.

In addition, the Master Brewer team is carrying out a full review of the syllabus, the results of which will be published separately in due course.

As previously, all IBD MCQ format examinations will remain as paper-based for the time being, but we continue to investigate the concept of on-line examinations for the future.

This report again indicates a busy, but productive, year for the IBD Board of Examiners and the Examinations Department. As ever, I must express my gratitude to all the examiners and moderators for their important contributions, especially those who have retired or moved on from the Board this year and, to them, I give special thanks for their trojan efforts in recent years. However, as part of the evolutionary process, I give a warm welcome to the new members who have been 'press-ganged' into joining the Board of Examiners this year and for the coming years.

Finally, but by means in the least, many thanks to the Clarges Street based team for their continuing hard work and support. Special thanks to Jessica Baldwin (née Clark) and Andrea Williams for their outstanding contributions in organising and operating the IBD examination system.

To end, good luck to all prospective candidates in the pursuit of IBD qualifications.

David G Taylor

The Institute of Brewing & Distilling Examinations 2008

Question Papers and Examiners' Reports

DIPLOMA IN BREWING EXAMINATION 2008

Module 1 – Materials and Wort

The examination was sat by 212 candidates, compared with 184 candidates in 2007 and 234 in candidates in 2006. The pass rate for the examination this year was 63%. This compares with a pass rate in 2007 of 70% and 2006 of 73%.

The grade distribution was as follows (2007 in parenthesis):
A: 1% (1%)
B: 5% (8%)
C: 18% (30%)
D: 38% (30%)
E: 21% (19%)
F: 12% (11%)
G: 4% (1%)

It is pleasing that very few candidates did not answer six questions; time management is a very important part of doing well. The very best candidates showed an ability to write quickly, legibly and clearly, using diagrams that were accurately labelled to enhance their answers. The skill of thinking quickly and concisely is not just important for examinations, it is a skill required for all aspects of life. Furthermore, the ability to communicate knowledge to others is essential. If you have a passion for producing high quality beer, it is essential that you continue to learn and communicate your knowledge. It is a help to the examiners if you number each question clearly, for example, Q1, Q2 etc, in this way sections or parts of answers will not get mixed up. It is also important for the candidate to clearly mark on the first page of the examination booklet the questions, in order, that they have answered.

Question 1

Discuss the basic principles of the design and operation of one type of malt kiln. [10]

Give an account of the changes, which take place in the malt during kilning, and explain the impact of these changes on malt quality. [10]

This question was attempted by 154 candidates (73%) with 63% achieving the pass mark. The majority of students did very well at this question; however those who failed to identify what happens in kilning did not score as highly as those who wrote properly argued answers. It would also please the examiner if the candidates answered the questions in the manner that they were posed, rather than weaving both questions together.

The principle of kilning is to remove water from green malt by passing a large amount of hot air through green malt. Objectives are to stop further growth, achieve a stable product suitable for storage and transportation, develop colour and flavour, preserve the enzymes developed in steeping and germination and inhibit or reduce the formation of undesirable compounds such as nitrosamines. In design of a kiln one must keep in mind the three phases of kilning (free-drying, forced drying and curing).

The first design consideration is firing, direct or indirect and also the primary source of energy. The second consideration is radial fan flow per ton of malt per hour during the three phases, also the bed loading in terms of mechanics and time as well as the amount of barley per m^2. Proper control in kilning depends on incoming temperature above and below the kiln, temperature of the external air and the re-circulated air, air humidity, operating times of the turner (and type of turner) operating times of the fans and the setting of fresh to re-circulated air. The first stage of kilning is the Free Drying phase. Air on temperature is 50 – 60°C and the green malt moisture drops from 45% to 12% over a period of 10-12 hours.

This stage involves removing water from the grain slowly and transferring it to the exhaust air. It is near the end of this stage that the "breakpoint" is reached, when the band of moisture in the malt reaches the surface. A rapid increase in the exhaust air will be noticed along with a decrease in humidity. In this slow moisture decrease of the barley the enzymes are protected. In the second stage (Forced Drying) the air on is increased to 60°C and the moisture of the grain is reduced slowly to 4-6%. This process takes 3 to 4 hours. In the third stage, Curing, the air on temperature is increased to 80–85°C, and it is at this stage that colour and flavour are developed. In the free drying stage low temperatures and high air volumes can decrease soluble protein formation and consequently decrease malt colour.

High temperatures and low air volumes at this stage could result in "stewing" which increases soluble protein and final malt colour. At curing the time and temperature affects malt quality: high temperatures and longer time reduces the precursor for DMS, reduces enzyme titre and increases malt colour and aroma. Intensive curing will lower wort pH, increase wort viscosity and increase the Kolbach Index.

Question 2

What are the requirements and specifications (with numerical ranges for each parameter) for either Lager malt or Pale ale malt ? [12]

Identify four parameters that help to define the "Degree of Modification" of malt, discuss their relevance and outline their methods of analysis. [8]

This question was attempted by 158 candidates (75%), with 64% achieving the pass mark. This question was generally well answered, with good use of diagrams to illustrate the design and operation of the different processes. Weaker answers tended to concentrate on trivial details at the expense of the bigger picture.

Lager malt, in contrast to Ale malt, usually is produced using barley with higher protein content. Usually it is germinated at lower temperature and kilned at lower temp. Lager malt usually gives lower extract, lower color, but gives significantly higher enzyme levels. In addition, it has a fine mild flavor. Lager malt is used as the basis of most of the world's beers in conjunction with specialty malts for added flavors. Pale Ale malt exhibits higher extract levels, higher color and homogeneity, but records lower enzyme levels. Since it is kilned at higher temperatures than Lager malt, Pale Ale malt gives a slightly toastier malt flavor, which is well suited to production of Pale Ales. Pale Ale malt forms the majority of the grist for a typical UK Pale Ale or Bitter. A well marked answer included the specifications for the barley and the final malt type with the proper units of measure. Those parameters included sizing, homogeneity, extract (fine/coarse), enzymes, colour, protein (total/soluble), KI, Friability, Free amino nitrogen content, wort viscosity, odour, and wort pH. Additional marks were given for those that mentioned other specifications such as storability, free from pests, and free from pesticide or heavy metal residues.

Degree of Modification measurements include: 1) Friability (Originally an IOB method, and it is quantified by using a Friabilimeter). It indicates the easiness of the malt kernel can be crashed into powder or flour. It is an index of modification, particularly, is related to cell walls and protein break down, as well as dead kernels. It generates % friability, % partly germinated grains and % of glassy kernels: 2) Beta-Glucan content (an EBC method). It indicates the degradation of cell wells of barley endosperm: 3) Fine and coarse difference (Term used in EBC method) indicates the difference between coarse and fine grain extracts. The more well-modified the more the smaller the difference. A very rough estimate of modification: 4) Kolbach index. It is the ratio of total soluble N in Laboratory wort produced from the mashing malt by EBC method to the total N of malt. It is calculated as: KI = {% of soluble N /% of total N}×100 It is related to the degree of protein break down in the malt kernels. It is a good indicator for low protein barley malt, but it could mislead the modification of high protein barley malt: 5) Cold water extract: and 6) Acrospire length.

Question 3

Discuss the range of solid adjuncts that can be used in a brewery to provide fermentable extract. [12]

For two different types of cereal adjunct, describe their composition, how they can be used in brewing and their effect on wort and beer quality. [8]

This question, attempted by 157 candidates (74%) with 61% achieving the pass mark, was generally answered well. Many candidates displayed a good basic knowledge of the sources of solid adjuncts and their uses, but several candidates also chose to provide information about liquid adjuncts (which was clearly NOT required)!

There is a wide range of solid adjuncts (principally cereals) available for use in brewing as a source of fermentable extract. Several candidates set about answering the first part of the question in table format, which worked to some extent, but some candidates did not provide sufficient discussion, merely presenting a list of potential materials.

Many candidates chose to sub-divide the range of adjuncts into smaller groups, and this approach tended to be more successful. For example, several cereals can be malted, such as wheat, oats, rye and sorghum. Further many cereals in raw (un-malted) form, including barley, have starch that gelatinises at mashing temperatures and so can be added directly to the mashing vessel. Indeed, starch gelatinisation temperature is a major parameter to be considered regarding use of adjuncts.

Rice, maize and sorghum have starch that gelatinises at temperatures significantly higher than sensible mashing temperatures and so require alternative processing. Some form of pre-treatment is therefore required. This can involve the use of a separate cooking vessel in the brewhouse (as used for rice and maize grits) or the cereals can be pre-cooked separately by flaking, micronisation or torrification and then be added directly with malt.

Some candidates mentioned the use of refined starch from wheat and maize and also solid refined sugar from cane. However, very few answers included discussion on the use of coloured malts ("specialty malts"), derived principally, but not only, from barley, particularly to create speciality beers, although there was some mention of roast barley for stouts.

The second section was not covered anything like as well as the first section; indeed some candidates elected to ignore this section completely! Considering the wide, free choice given here, it was very surprising that several answers only included detailed description of one adjunct. Further, very few answers provided full details on composition and influence on wort and beer quality. The most popular choices of adjuncts, were maize and rice grits followed by wheat malt and roast barley.

Question 4

The following treatment processes may be required for brewery water supplies:

demineralisation; [5]
selective ion removal; [5]
activated carbon treatment; [5]
sterilization. [5]

For each process, explain briefly
(a) why the treatment could be necessary,
(b) how the procedure can be carried out,
(c) its relevance to beer quality.

This question was attempted by only 96 candidates (45%), with just 30% achieving the pass mark. There were very few answers worthy of high marks. It is a continuing source of puzzlement to the examiners that questions on water quality and treatment are not popular and usually not answered well. It clearly indicates that at all levels, not just at Diploma, most candidates are not well prepared on this topic, which reflects a lack of knowledge about the main ingredient of all beers!

Several candidates provided only scant information and many answers did not address all three topics required for all of the four treatment processes. The majority of candidates were unable to distinguish between demineralization and selective ion removal, with far too many answers asserting that reverse osmosis is the ideal process for selective removal of ions! Also, several candidates wrote apparently knowledgably about carbon filtration, but did not describe the sources of carbon available, nor, indeed, how the carbon is activated.

All in all, a very poor and disappointing performance.

Reverse osmosis is, of course, a very effective treatment for producing demineralized water (also removing many organic compounds also). Full demineralization is also achievable by ion exchange processes, involving a combination of strongly acidic (for full cation removal) and strongly basic (for anion removal) exchange resins.

The benefits of demineralised water in brewing relate to giving the brewer total control over the inorganic content, allowing salt additions to be made to formulate the exact composition of brewing liquor necessary for the full range of products required. Also many brewers favour the use of demineralized water for alcohol/ gravity adjustment of high gravity-brewed beers, making the necessary compensatory salt additions in the brewhouse to achieved desired finished beer ionic specifications. In addition, demineralized water is very useful for boiler feed water.

Candidates could have chosen many different examples of selective ion removal procedures:

- classical examples are the various decarbonation treatments, i.e. the removal of alkalinity (bicarbonate), by various procedures, such as heating, addition of lime or inorganic acids, or use of weakly acidic cation exchange resins to replace calcium ions with hydrogen ions, followed by a de-gassing tower. All decarbonation or de-alkalizing systems are designed to produce good quality brewing liquor.
- alternatively, use of a softening ion exchange system (strongly acidic cation resin) to replace calcium and magnesium ions by sodium ions produces "soft" water, ideal for a number of brewery applications as process water.
- nitrate specific weakly basic anion exchange resins are available to reduce nitrate contents in brewing liquor; important because of concerns relating nitrate, nitrite and nitrosamine formation.
- water containing excessive amounts of iron and/or manganese salts can be treated by aeration techniques (direct injection of air or ozone) or by incorporation of manganese dioxide into sand filters, all designed to form and precipitate the insoluble iron and manganese oxides and hydroxides.

Activated carbon filtration is the preferred system for removal of chlorine residues and most organic contaminants, including halogenated compounds. Treatment involves a pressure vessel housing the activated carbon on a gravel bed and water flows down through the carbon bed. Activated carbon consists of porous particles (1 to 3mm) with a high surface area to volume ratio. Key factors affecting performance relate to the type and grade of carbon (such as coconut shell, bituminous coal, lignite or bone, with a combination of coal and coconut shell being favoured for brewing water), plus pore volume and pore size distribution. Coconut shell carbon has mainly small pores (less than 2nm), whereas coal carbon has larger pores (over 5nm). Consequently coconut carbon is more effective for removal of smaller molecules.

Carbon filters can be cleaned by both forward and reverse flow, with hot water used to regenerate the carbon. Plant is usually equipped for direct steam injection at the base to allow for steam sterilization.

The benefit of carbon filtration is that brewing liquor and all other water sources contributing to the finished product (dilution water, additions make-up, jetting during bottling) can be guaranteed free of organic contamination and chlorine residues. Further, chlorine removal ensures that potential flavour taints arising from chlorophenolic compounds, either generated in situ during mashing and/or boiling or generated in hot liquor or even steam residues, can be avoided.

There are many sterilisation techniques available for treating water for all uses in a brewery and the examiner was looking for some detail describing the various chemical processes involved, such as addition of chlorine, chlorine dioxide, bromine (and bromine based biocides), ozone and silver ions, as well physical methods like ultraviolet irradiation and micro-filtration.

Chlorination is still the favoured method for sterilizing untreated water. Water purchased from a municipal supplier will contain sufficient residual active chlorine to ensure safe on-site storage for some time prior to use, whereas own water supply will require chlorination at up to 1.0 mg/l to achieve disinfection during distribution within the brewery. Active chlorine is an effective sterilant by virtue of its strong oxidizing capability and is most usually used as sodium hypochlorite solution. It is very much the method of choice for "raw" water storage because of low cost, but must be removed by carbon filtration prior to on-site usage. For this reason, some brewers favour ozonation as an alternative.

Water used for dilution of high gravity-brewed beer, as well as requiring de-oxygenation, is often sterilised also, especially if added post beer filtration. The favoured methods are UV irradiation (where UV light at 256nm effects the destruction of cellular DNA and RNA) or sterile micro-filtration through very fine absolute filters (at 0.45µ or less).

Chlorine dioxide in solution is increasingly being used for disinfection of process water, finding many applications in brewing, such as vessel and mains sanitising (as a detergent flush) or in packaging operations (especially sterile filling of glass and PET bottles and cans) for non-returnable package rinsing, prior to filling. Chlorine dioxide is a powerful oxidizing agent (2.5 times the oxidizing power of chlorine), but is non-tainting (because its action does not involve the chlorine atom), is non-corrosive and effective in a wide pH range against a wide variety of beer spoilage organisms.

A further use of sterile water is in jetting in sterile filling of bottles, where this water supply is often UV treated and sterile filtered.

Question 5

Starting from the Steeping process, describe in outline, how the enzymatic activities of Malting barley contribute to the production of fermentable wort. [12]

Describe briefly the control factors that the brewer can employ to manipulate these enzymatic reactions to achieve the desired wort composition. [8]

This question was attempted by 175 candidates (83%) with 59% achieving the pass mark. This question was poorly answered and good answers were accompanied with diagrams illustrating barley structure related to enzyme and fermentable formation, and also a diagram describing the starch structure of the barley kernel. One thing that was noted was the number of candidates that did not read the second part of the question carefully, where it was asked "what can the brewer do" and as a result missed 8 points.

In steeping the barley kernel is hydrated from 14 to 45% moisture through the embryo region of the kernel thereby initiating the distribution of gibberelic acid, a plant growth hormone through the aleurone layer. This initiates the synthesis and release of the hydrolytic enzymes which then act upon the starchy endosperm. The breakdown of the cell wall structures by beta-glucanases and pentosases exposes the protein matrix surrounding the starch material. Hydrolysis by various proteases (endo-peptidase,carboxy-peptidases, amino-peptidase, di-peptidases) exposes the starch material and also break down the proteins to amino acids that are essential for proper fermentation. The starch material can then be converted to fermentable sugars through the action of alpha and beta amylases as well as dextrinase.

During mashing for a given malt, the brewer can achieve the desired wort carbohydrate composition by alternating the following factors to control/influence the enzymes' activities:
Milling (Physical state, enzymes titre higher when ground fine), mash temperature, time of mash, pH of mash, mash concentration, thin or thick, (thin favours diastatic action, and thick mash favours proteolytic action), the addition of exogenous enzymes and varying the adjunct level and type.

Question 6

Describe briefly, with the aid of diagrams, the basic principles and operation of the various mills available for commercial brewing [12]
Discuss the relationships between the milling and wort separation systems and their impact on wort composition and brew house efficiency. [8]

This question was attempted by 188 candidates (89%) with 63% achieving the pass mark. Many of the candidates only described 2, 4 or 6 row mills, forgetting about wet milling and hammer mills. Exceptional answers included malt conditioning. Diagrams were a necessity to achieve good final marks.

The purpose of milling is to make the starchy endosperm available for conversion in mashing. Milling effects extraction and extraction yield, contact time/runoff time, clarity/physical stability and flavour stability. For each of the mill types the candidate was expected to detail the mill type as well as how each worked including all operational features (for instance for dry milling, feed rollers, fluting, sieves, screens, rotational screens and grist composition). A description of the mill and the matching separation system as well as a discussion on the reasons for the match (i.e. roller milling and lauter tuns because of the need for husk material) was required for full marks. For each system the candidate was expected to detail the brewhouse and extraction efficiencies as well as the merits of each system in regards to beer flavour (lipids) and physical stability (polyphenols, tannins).

Question 7

Outline the manufacturing processes for hop pellets and extracts.[10]
Discuss briefly the relative quality and economic merits of using processed hop products, rather than whole hops, for adding bitterness and aroma character to beer. [10]

This question was attempted by 165 candidates (78%) with 59% achieving the pass mark. The first section was generally well-answered, with good use of diagrams to illustrate, by flow sheets, the design and operation of the various processes. However many answers tended to gloss over the second section, apparently failing to appreciate that this carried half of the overall marks for the question. Also, several candidates failed even to mention hop oil extracts and the use of the many and various sub-fractions that are now commercially available.

Most candidates provided good outlines of the processes involved in the production of type 90, type 45 (concentrated) and pre-isomerised pellets, with a few noting the manufacture of type 100 (compressed whole hop) pellets. In addition, the examiner was looking for brief descriptions of the manufacture of various extracts using liquid and supercritical CO_2 and ethanol extraction processes, producing both kettle and isomerised extracts, and many candidates achieved good marks here.

Somewhat surprisingly, very few candidates described the production of reduced hop products ("rho-", "tetra-", "hexa-"iso-α-acids) and yet discussed their benefits in the second section.

Finally, many answers failed to include descriptions of hop oil-enriched extracts or fractionated hop oils and essences.

In the main, the discussions in the second section relating to the benefits of using hop products were very limited. Indeed several candidates elected to provide detailed summaries of the isomerisation of alpha acids (complete with chemical formulae) and, in some cases, attempted to draw chemical structures of hop oil components. Unfortunately, no matter how correct these drawings were, since they had no relevance to the question asked, they attracted no marks!

The discussion should have been included the facts that increasing "purification" means less storage space requirements (due to volume reduction), increased stability, improved utilisation or efficiency of use and reduced losses, reduction in chemical (e.g. nitrate) and heavy metal residues, ease of use with the opportunity for automated additions, all of which must be off set by increased costs (directly proportional to degree of processing).

Other "quality" factors should also have been included, such as resistance to light striking and foam enhancement from reduced compounds, increased bittering potential, varying bittering potential from higher cis- to trans- ratios (and implications for reduced loss of bitterness during prolonged storage of packaged beer), measurement problems, need for special dosing equipment, handling precautions, etc.

Finally, discussion was also required of the use of fractionated oil components, use for late kettle hop or dry hop character, separation into multiple fractions and re-blending to make a wide range of bespoke products.

Question 8
Write notes on two of the following;
a) the key chemical reactions that occur during wort boiling; [10]
b) the principal features of aerobic and anaerobic digestion systems for waste water treatment; [10]
c) the principles of Quality Management Systems. [10]

This question was attempted by 162 candidates (76%) with 61% achieving the pass mark. Most candidates chose options (a) and (b) to answer, but most responses to section (c) provided good answers.

Option (a) required candidates to demonstrate knowledge of the chemistry involved in wort boiling, although most included concentration of wort (caused by evaporation of water) and removal of other volatiles; these are, of course, physical factors caused by phase changes.

The true chemical changes include: wort sterilisation; enzyme inactivation; solubilisation of hop acids, with isomerisation of alpha acids and oxidation of beta acids; colour reactions (Maillard reactions leading to formation of melanoidins, sugar caramelisation, polyphenol polymerisation); protein/polypeptide denaturation and precipitation by coagulation, plus precipitation of phosphates and oxalate (principally as calcium salts) leading to reduction in wort pH; formation of DMS, by breakdown of SMM.

Many answers just included lists of some or many of these chemical changes and failed to provide any details, even in outline, of the actual chemical reactions involved. Those answers that did include such details attracted higher marks.

Good answers to option (b) described in some detail the biological treatments carried out under aerobic and anaerobic conditions. The mechanisms of COD removal by aerobic micro organisms involve a two stage process leading to the formation of carbon dioxide and water, as follows:

$COD + O_2 + NH_3$ = new cells + $CO_2 + H_2O$;

Cells + O_2 (auto-oxidation)= $CO_2 + H_2O + NH_3$

Aerobic treatment processes include activated sludge or attached growth designs and tend to produce more sludge and reduce COD levels less than anaerobic systems. Anaerobic systems are also 2 stage, but also produce potentially useful biogas (methane) and good answers again contained the appropriate equations:

acidogenic bacteria + COD = $CH_3COOH + H_2 + CO_2$

methanogenic bacteria + fatty acids = $CH_4 + CO_2$

and $8H^+ + CO_2 = CH_4 + H_2O$

In anaerobic reactors, micro organisms tend to grow more slowly than in aerobic systems, so that there are longer retention times, with higher levels of activity, so that COD removal is higher, with less sludge production.

The better answers also indicated that optimal treatments may be designed as a combination of both systems with an anaerobic reactor, followed by aerobic.

Option (c) of this question, although the least popular, was, in the main, adequately answered with some candidates receiving very good marks for their descriptions of QMS, including the need for fully documented systems, Total Quality approaches, ISO-schemes, World class manufacturing systems, involving GMP, HACCP, COSHH, supplier quality management, Statistical Process control, etc. Marks were awarded for a structured approach as much as for content.

Rob McCaig – July 2008

DIPLOMA IN BREWING EXAMINATION 2008
Module 2 – Yeast and Beer

Overview

In all there were 166 submitted scripts with 97 candidates achieving a pass grade to give a pass rate of 58.4%. This markedly lower than last year (70%), hovering between 2006 (63%) and 2005 (53%). However it is encouraging that like 2007, there were three A grade passes. Otherwise the overall performance was disappointing with 50% of the candidates straddling the grades between a pass (D – 34%) and fail (E – 15.7%). Both the examiner and moderator felt this cohort set out to do the bare minimum to pass this Module. There was no sense of reading around the subject or little in the way of personal comment or insight.

Analysis of questions that were answered and the corresponding pass rate was illuminating. Question 1 was answered by 50% of the candidates with only 30.1% passing. Conversely Q5 was answered by 95% with a pass rate of 67% which was just bettered by Q8 at 71%. Further analysis is presented below.

Table 1: Overall Pass/Fail Rates and Grades

Passed	**97**	**58.4%**
Grade		
A	3	1.8%
B	9	5.4%
C	28	16.9%
D	57	34.3%
Failed	**69**	**41.6%**
Grade		
E	26	15.7%
F	32	19.3%
G	11	6.6%

Table 2: Performance by Question

Question	Answered by	Passed by	Passed %
1	83	25	30.1
2	132	68	51.5
3	84	40	47.6
4	136	85	62.5
5	157	105	66.9
6	154	80	51.9
7	131	61	46.6
8	94	67	71.3

Examination technique

So, as the new boy on the block I came into this eyes wide open. Moderating last years Diploma 2 was a great introduction but being Examiner is a whole new ball game. Put yourself in my shoes. Lots and lots of papers, with mostly six answers per pack which adds up to nearly a thousand answers to be marked. So be gentle dear candidate. Mindful of this and without wishing to be 'Mr Grumpy' there are number of things candidates can do to get your examiner and – when it really matters – your moderator on your side.

We all have our pet favourites. For me top of the list are the 12 candidates of paper 2 who missed 'instruction no 8' to insert the number of questions attempted on the front cover of their answer book'. Of all the possible transgressions this one is guaranteed to win you no favours whatsoever with this examiner!

It's all about engagement. You/me have a relationship, albeit somewhat distant. Me, I'm looking for you to present your knowledge and insight in a way that I can reward with ticks and oohs and aahs of appreciation. What I rather not have is (i) a writing style that requires skilled forensic analysis to understand, (ii) answers that are not continuous and jump illogically around the answer book, (iii) jokes that frankly are not funny and invariably are irrelevant and finally (iv) answers that regurgitate parrot fashion revision/training notes without any insight or personal connection, opinion or engagement whatsoever.

Moderator Tobin Eppard also has concerns about some candidate's use of time. For example there really is no need to write the question down unless it is absolutely necessary on your part to understand the question – just get right on with your response. Similarly writing up the answer on the left hand page and then rewriting it 'neat' doesn't feel like a good use of time.

Finally 14 candidates failed to answer six questions. Only one passed, just with a 'D'. So the message is clear, respond to six questions however briefly. Marks can be picked up from the scantiest response – remember attempting six answers could make the difference between a pass and a fail.

Question 1

Outline the pathways that the yeast cell uses to reduce/oxidise Nicotinamide Adenine Dinucleotide (NAD) during fermentation. [12]
Discuss how the concentrations of the products of these pathways can influence beer flavour. [8]

Yeast metabolism can prove to be tricky particularly here where the candidates understanding, rather than ability to recall and present metabolic pathways, was being tested. Good answers focussed on the reduction and oxidation of NAD and the routes the cell takes to control its redox balance during fermentation. The few 'excellent' papers recognized that pyruvate's involvement in yeast growth results in the potential accumulation of NADH which is remedied through the substantial formation of glycerol. Too many papers dumped all the revised pathways into the answer. As the question specified 'fermentation', no marks were gained for regurgitating the complete Krebs cycle, oxidative phosphorylation or the pentose phosphate pathways.

Part b was looking for the candidates knowledge on the flavour/aroma contribution of the various NADH dependent pathways. Marks were awarded for correct identification of metabolites, insight into their contribution to flavour and/or aroma and typical concentration in beer and flavour threshold. This question was answered by only 50% of the candidates (with a disappointing overall pass rate of 30%) and regrettably – for many of them - was a great example of answering the question they wanted rather than the question that was posed!

Question 2

Explain how the composition of beer and its processing can minimize the threat of microbiological spoilage. [20]

Although some candidates missed the point, this question was arguably pretty straightforward! Firstly the product parameters that contribute to building microbiological robustness. Included here was ABV, iso- α acids/reduced hop materials, nutrient depletion, pH, oxygen control, water and microbiological specifics (where appropriate). Consideration of 'process' factors was somewhat meatier. Basic answers would include CIP, wort boiling, pasteurisation, (sterile) filtration, sampling plan with better responses folding in raw materials, fermenter and yeast management, water quality, prevention of air ingress, process gas hygiene, hygienic design, recovered beer management, draught beer hygiene and operator training. Explanations 'why' these parameters impact on the propensity for microbial spoilage were rewarded where appropriate. Surprisingly some candidates dealt exclusively with either 'product' parameters or 'process' parameters and accordingly were marked down.

Question 3

Describe the formation and implication for beer flavour of sulphur compounds. [20]

This question was looking for a rounded answer that captured the diversity of sulphur compounds and sources together with their impact on beer flavour and aroma. Regrettably for some candidates the sum content of their answer focussed exclusively on DMS/DMSO. Good answers discussed H_2S and SO_2 in terms of source, flavour impact, metabolic pathway and control. The role of SO_2 as an antioxidant and potential antimicrobial was also rewarded as were notes on the contribution/role of sunstruck character/MBT, *Megasphaera, Pectinatus* and mercaptans.

Question 4

Describe in detail the 'additions' that can be made to beer during conditioning/maturation and to bright beer tank. [10]
Explain why these additions are made. [10]

The key to this question was to cover not only the 'what' but the 'why'. Marks were offered for the usual list* with additional marks for 'added value' or insight. Marks were often given as half marks for either what or why. Many candidates rightly presented their answers as a table, with the best fusing 'what' and 'why' into a single cohesive answer.

**The list included sugar/syrups, hop products, gases, caramel/malt extracts, antixodidants, liquor, heading agents, haze prevention, enzymes, finings and yeast.*

Question 5

Consumers are said to 'drink with their eyes'. What steps can be taken to assure the head retention and clarity of a glass of beer. [20]

Marks here were split 50-50 for foam and clarity. For simplicity, head retention was broken down into raw materials/process, negative factors, positive factors, glassware and gases. Marks were given per category with further floating marks for appropriate elaboration, insight or understanding (opposed to bland learning and regurgitating the words). Similarly clarity was fragmented into headlines of microbiology, process/raw materials, haze, on-trade/premise hygiene and product (not all are 'bright'). Again floating marks for 'builds'. Some crossover was inevitable but the same point didn't get twice the marks! What the examiner wasn't looking for (but often got) was mechanisms of formation (foam/haze) or methods of measurement (often in painful, protracted detail).

Question 6

Write notes on the following topics
a) storage of pitching yeast [10]
b) measurement of pitching yeast concentration. [10]

For storage, pretty straightforward, marks for informed comments on time, temperature, headspace gas, stirring (noting reduced shear), ABV, hygienic design, slurry v cone to cone or cake, selection of 'best' yeast, cropping best practice and a floating mark for acid washing/dilution liquor quality or glycogen maintenance. Similarly measurement was vital stains, capacitance, spun solids etc with additional marks around importance. A decent drawing of a storage vessel would grab a mark but trotting-out stuff about vitality or step by step methodology on how to use a haemocytometer failed to garner a mark. Too many candidates missed – or chose to ignore - the key word of 'pitching'. The plethora of laboratory storage methods and their pro's and con's whilst interesting and broadly correct in terms of conclusions was also not rewarded.

Question 7

How, why and when are the following parameters measured during the brewing process.
a) dissolved carbon dioxide [4]
b) dissolved oxygen [4]
c) specific gravity [4]
d) alcohol [4]
e) pH [4]

This broke down neatly into nominally a mark each for 'how', 'why' and 'where' with a floating mark for excellence. In many cases the examiner and moderator resorted to half marks where there was insufficient detail or understanding. The 'why' was frequently poorly answered. Similarly many candidates did not have a good understanding of the "how" – we suggest that future candidates garner a better feeling for laboratory methods as they are key to control of the process. Of the eight questions, only Q1 performed more poorly than this question despite almost 80% of the candidate answering it.

Question 8
Select two of the following topics to answer.
Outline the formulation, application and typical working concentrations of CIP (cleaning-in-place) detergents and sanitizers in the fermentation and beer processing areas. [10]
Describe the application and implementation of Hazard Analysis and Critical Control Points (HACCP) analysis. [10]
The staling of beer flavour and its control. [10]
The best performing question with a pass rate of 71.3%. The CIP question was reasonably formulaic. Noting the importance of CIP earned a mark. The majority of the marks were awarded for knowledge in describing acid and alkali detergent make up together with the principles and diversity of sanitisers. Description of a typical CIP cycle in fermentation and in beer processing would – depending on clarity (diagrams helped here) and depth – gain a mark or two. Bonus marks were awarded for points of detail (sprayball location/performance, total dump v recovery, carbonate conductivity, monitoring/validation).

The HACCP question was surprisingly poorly answered. What was required was a broad understanding of what HACCP is about and where it sits in the QMS, the six or so steps of hazard analysis, its site wide organisation and something about the challenges and approaches to practical implementation. This is again, key to understanding the basis of quality systems and control methodologies that ensure product safety and system reliability. We wholeheartedly suggest that an understanding of HACCP will be a useful investment to maintain the quality of your products.

Staling and control was generally well answered. An overview was appreciated especially if coupled with the Dalgiesh chart detailing the timeline of sensory change. Marks were offered for descriptions/discussion of staling reactions with the remainder of the marks rewarding best practice for minimising flavour instability in process and in package.

David Quain – July 2008

DIPLOMA IN BREWING EXAMINATION 2008
Module 3 – Packaging and Process Technology

The overall pass rates, and details of candidates' performance on individual questions are shown in the tables below.

Table 1: Overall Pass/Fail Rates and Grades
Diploma in Brewing Module 3 - June 2008

Number of Candidates:		170	
Passed		115	67.7%
Grade	A	13	7.7%
	B	22	12.9%
	C	41	24.1%
	D	39	22.9%
Failed		55	32.4%
Grade	E	28	16.5%
	F	17	10.0%
	G	10	5.9%

Table 2: Performance by Question
Diploma in Brewing Module 3 - June 2008

Question	Answered by:	Passed by:	Passed %
1	133	86	65
2	81	58	72
3	63	46	73
4	114	99	87
5	104	79	76
6	158	109	69
7	63	36	57
8	92	51	55
9	55	38	69
10	114	64	56

General Comments:

The pass rate at just below 68% was a little lower than last year (70%). However, there are unfortunately still a number of candidates who are sitting the exam clearly with little or no preparation and this cannot be helpful to a candidate's morale. Ten candidates scored less than 25% and 5 less than 15%. Companies must take some responsibility in making sure, through mentoring and training, that their employees are given the best chance of passing this exam and not to enter candidates until they are capable of making a reasonable attempt.

Candidates are advised to answer six questions and it is of interest that only four candidates passed the exam by answering less than six questions and all four dropped only one question. By comparison, 19 of the 55 failed candidates did not complete six questions.

As in previous years, candidates performed better on the packaging questions (Section A) than on the process technology question (Section B) which contains calculations. Here are a few hints to prospective candidates about answering calculation questions. The Examiner is looking for a clear demonstration of method in working through the calculation. The correct answer at the end of the calculation is welcome but alone does not receive many marks. So doing the calculation on scrap paper, in your head or on the calculator keypad and just giving an answer, will not get good marks, even if it is correct. So an answer could start with writing out the relevant equation – in full, at this stage and then, if relevant, explain why certain terms in the equation can be deleted. For example in a flow question, Bernoulli is an energy balance equation and should be written out in full, with all terms (potential, pressure, kinetic, friction and pump terms) between two points, A and B. Then perhaps some terms can be eliminated or cancel out, for example PA and PB might be cancelled if both dispensing and receiving tanks are at atmospheric pressure so PA = PB. Show all workings, since, even if the arithmetic goes wrong, marks will still be awarded for progressing through the calculation correctly.

And finally, always answer the question and not what you happen to know. If the question says, "draw a diagram", draw a diagram. Don't write out a list or an explanation of items if not asked for. The marks are for the diagram and it is a waste of valuable time providing written material that will not get marks, no matter how good or accurate the information.

And one last thought: if the Exam instructions say – "fill out the numbers of all questions answered, in the order answered, on the front of the first book" – do it! Why should the Examiner have to do it for you?

Question 1
Sketch the flow layout of a flash pasteuriser. Describe features in the design of the pasteuriser and the precautions in its operation and maintenance that need to be taken to guarantee integrity. [8]
Explain the terms "pasteurisation" and "pasteurisation unit", and illustrate, with the use of diagrams, the relationship between time, temperature and lethal rate. [6]
Outline the factors, other than time and temperature, which can affect the survival of organisms. [6]

This was the most popular question on the paper, probably because it is a topic that has appeared many times before and should have been covered in most candidates preparation for the exam. However the pass rate at 65% was disappointing. Sketches of the flow layout were generally good, but still a fair number that were very messy, with not a single straight line and much crossing out and re-drawing. The question was looking for the things in the design, operation and maintenance that could compromise integrity, so a good approach would be to list them under each heading –

design, operation and maintenance. In design, the plate material, pressure rating and back pressure control to prevent gas breakout, a boost pump to raise the pasteurised beer above the unpasteurised beer pressure (and also above the heating and coolant agent pressures) and accurate temperature and pressure probes and their use in control, should all be stated.
In operation, good CIP and sterilisation at start-up, recirculation or shut-down on low temperature and pressure, avoidance of recirculation of beer and continuous membrane sampling are a few of the measures looked for. For maintenance, frequent test procedures for plate integrity and regular calibrations of temperature and pressure sensors are needed.

The second part of the question, after the straightforward definitions of pasteurisation and pasteurisation unit was looking for the Del Vecchio thermal death curve of log time versus temperature indicating the lethal zone for a particular organism. It was encouraging that most candidates were aware of D and Z values and knew what they were and could quote that the typical Z value for brewery organisms was 7°C (actually 12.5°F or 6.944°C)

The final part of this question looked for the factors, other than time and temperature, that could affect organism survival. Most candidates were aware that alcohol, CO_2, low pH, hops and moisture all affected them adversely, whereas cell density, proteins, saturated fats (lipids) and sugars are all said to protect organisms. The age and physiological state of the organisms can also affect survival.

Question 2
Write brief notes, in the context of packaging, on FOUR of the following: [5 marks each]

- **hazard and critical control points (HACCP)**
- **head space air**
- **empty bottle inspection**
- **predicted and actual shelf life**
- **keg contents checking**
- **particulate matter in packaged beer**
- **loss of foam potential**
- **can seam evaluation**

This question was selected by less than half the candidates, despite there being a choice of topics – four from eight.

HACCP – originated by Pilsbury Foods and taken up by NASA for food preparation for astronauts, HACCP is a system for assuring a process. It was the basis for the UK Food Safety Act 1990 which was adopted by the EU in their Directive of 1993. This question was looking for explanation of the seven principles of HACCP.

Head space air – The head space air is one component of total in-package oxygen (TIPO) and it is important to control headspace air if low TIPOs are to be achieved. Bottles can be double evacuated and purged before filling and jetted, vibrated or knocked before crowning so that foam displaces the air in the bottle headspace. Long tube fillers give better results than short tube but are slower. Cans are too weak to be evacuated but can be purged to give a lower air content before filling. The wide surface area of the beer after filling requires blanketing and/or bubble breaking to remove air and under-cover gassing immediately before the can end is applied. Kegs have a low air prior to filling due to being sealed from the atmosphere and purged with steam and CO_2 during the washing and pressurising cycles.

Empty Bottle inspection – essential for both NRB and RB lines for line performance and customer protection. Can be manual or automatic, but the latter is more reliable for modern line speeds. Machines use air pressure, radio frequency, visible light, lasers, ultrasound and physical checks to detect defects. It is important to check the machine/s at least once per shift with test bottles containing typical defects.

PSL and ASL – The actual shelf life (ASL) needs to greater than the declared product shelf life, but quick checks (predicted shelf lifes - PSLs) are needed for product release as a means of gauging likely ASL. Before packaging, beer stability can be assessed by tests such as the Chapon Alcohol Chill Test, and others. Once packaged, accelerated ageing tests by temperature cycling, or forcing by high temperature storage, can be used to estimate shelf life. Retrospective correlation of these PSL tests with actual ASL results are needed to affirm which test has the best fit for your beer.

Keg Contents checking – There are two issues – contents, possibly contaminated, in empty kegs returned from trade, and checking the contents of filled kegs on-line. From trade, pressure testing, weighing and hydrocarbon sniffing are all used to detect problems.

Due to variation in tare weight, filled keg contents cannot be checked by full weighing alone - (except possibly with a brand new population of identical kegs). Tare weighing of the kegs can be done on-line or the kegs can be pre-weighed and bar-coded or fitted with transponders which can be read at the fulls weigher and used to calculate net weight. Hence knowing the beer SG, it is possible to calculate the volume filled and calibrate the beer meters. Otherwise, off-line destructive weighing and emptying of batches of kegs from known filling lines is needed in order to calibrate the meters and fulfil legal weights and measures requirements..

The filling of kegs can be brimful - detecting overflow by conductivity on the fob line - but this can cause high losses and extra duty payment on the extra beer above nominal. Meters are routinely used but their calibration is key to achieving consistent contents.

Particulate matter in packaged beer – most candidates were able to explain the possible causes of particles in beer as either microbiological or non-microbiological. For the former a recheck on cleaning, sterilisation and pasteurisation procedures would be called for, and also the efficacy of bottle washing, and possible contamination of jetting water and rinse waters. Non-microbiological haze can have a number of causes – protein-polyphenol chill haze or permanent haze, denatured fob, filter aids, oxalate, starch, b-glucan (“invisible”) haze and those caused by additives.

Loss of foam potential – Beer has a wealth of foam positive factors, so poor foam is usually the result of foam negative agents coming into contact with the beer. In packaging, lubricants, used on the filler and seamer, need to be carefully controlled to avoid contaminating the packaged product. The empty bottle may have had excessive or misdirected cold-end treatment (inside the bottle) during manufacture. Conveyor lubricants can be fat or oil based and care taken to avoid transfer into the open package. Gross contamination of a bottle washer or keg washer can occur from the contaminated contents of the containers returned from trade – cooking fats, vegetable oil, diesel oil etc.
Beer foaming should be avoided since it can lose carbonation and cause haze. Low carbonation and/or nitrogenation can cause poorer foam than required.

Can seam evaluation – Most candidates were aware that can seam evaluation was essential to check seam integrity and so eliminate leakage and ingress of air. Better answers gave an annotated diagram of the seam cross-section after tear-down with the components and key measurements of a double seam highlighted, such as seam length, countersink and seam thickness. The calculated parameters from the seam measurements, such as actual overlap, tightness rating, body hook butting etc, were mentioned by the best answers.

Question 3
Outline the basic principles of operation of a CIP system for a packaging plant and explain how the pipe work and fittings for a packaging plant, and its associated tanks, are designed for effective CIP [12]
How can the microbiological and chemical cleanliness of a packaging plant be checked? [8]

This was one of the least popular questions but well answered by most candidates who attempted an answer (73% pass rate).
The basic principles of a CIP system needed to cover the following key points: cleaning without dismantling, mechanical and chemical action, time and temperature. For packaging, soil levels are usually lower than other brewery systems and requirements, such as higher cleaning frequency and sterility, are different. So a separate facility is commonplace. CIP can include external cleaning of plant (e.g. foam cleaning) as well as internal. Systems can be total loss or total recovery or a hybrid with a bit of each.

A typical CIP cycle should have been described, with temperatures, concentrations and times and with some, or all, of the following: pre-rinse using recovered final rinse, caustic circulation, acid circulation, final rinse. sterilent circulation and possible re-rinse, or hot water/steam sterilise – depending on the circuit described.

The key features of pipe work and plant design for effective CIP are:

Pipe work – hygienic design, no crevices, dead-legs, polished and laid to falls with no hollows or humps (air pockets). Flow rate on CIP >2m s^{-1}, continuous welded pipe where possible with fewest fittings.

Tanks – effective spray device for size/shape of tank (high pressure/low volume or low pressure/high volume), effective scavenging to avoid pooling, no shadows from coils and fittings, hygienic anti-vac relief (caustic + CO_2 filled tank = flat tank!) and cleanable pressure relief valve, "new" (clean) door rubbers and new dairy sample point rubbers at every clean.

To check the efficacy of CIP, checks could be invasive or non-invasive; the former possibly requiring a re-sterilise afterwards. Simple things to be checked are times, temperatures, flow rates and concentrations of the process just completed. It was pleasing that some candidates suggested a visual inspection for soil, surface wetting and debris – all too frequently forgotten when operators never have to leave the control room.

Most candidates were able to outline swabbing techniques and sampling of final rinse water for testing for chemical and microbiological residues, describing the tests carried out for each. However, far too many candidates just suggested "ATP" without defining on what, how, where or when the test was to take place. After CIP, new in-line membrane sampling or discreet product samples can be taken and checked as assurance that all is well.

Question 4

Sketch a fully labelled layout of either a keg racking line or a bottling line, showing all the main items of equipment. [10]
Describe how this layout facilitates the handling of empty and full containers onto and off the line, accumulation and handling of rejected containers and waste materials. [10]

The highest pass rate of 87% for this popular question is evidence that most candidates knew what a packaging line looked like and could reproduce a diagram of the main plant items without too much difficulty. For their chosen layout – straight-thro, U-shape, comb or arena – better candidates described the advantages, or otherwise, of segregating Fork Lift Trucks (FLTs) from operators and utilisation of the FLTs and operators for full and/or empty containers. Also, empty and full stock segregation, particularly for cask and keg, may be vital to avoid mix-up. For accumulation, most candidates described the V-graph of plant running speeds and better candidates outlined the benefits of dynamic accumulation compared to accumulation tables and other accumulators.

How the layout lends itself to the easy collection and movement of rejected containers, and other waste materials from the line was poorly answered with a lot of candidates saying no more than that they would be amassed somewhere after rejection. There are rejects of empty containers ("foreign", damaged, wrong size/shape, contaminated), full containers (recheck - "good" rejoin line, "bad" – part-full, washer reject, repair, scrap etc) and each needs a route. Other wastes such a bottle washer pulp, broken glass, damaged cases etc. also need to be catered for in the design.

Question 5

What are secondary packaging materials? [4]
Explain the role and the desired properties of a secondary packaging material for ONE of the following primary beer packages:-
- **cans**
- **non-returnable bottles. [10]**

Outline the impact of secondary packaging materials on the environment and how their effect can be minimised. [6]

Whilst just a few candidates confused primary, secondary and tertiary packaging, the majority were able to say that secondary packaging collates, protects and markets the primary packages for the convenience of retailer and customer.

The second part of the question looked to the candidate to expand on the previous answer by defining, for one secondary package alone, its role and its properties that make a good product. Role covers: collate, protect, inform, market and sell and properties: strong, durable, printable, attractive, visual, lightweight, machineable, cheap, available and recyclable.

The environmental issues of packaging materials was well answered by most candidates, and covered the five "R"s in their most beneficial order to the environment – reduce, reuse, recycle, reclaim and recover, or similar combinations of "R" words!

Better answers covered individually the main groupings of secondary packaging materials - cardboard and paper, plastics and wood.

Section B – Process Technology

Question 6

Outline the mechanical design features of a plate heat exchanger. [6]
Explain why most heat exchangers for brewery use will be configured to run counter-current and explain the circumstances when co-current might be the preferred choice. [4]
Explain why hydraulic pressure shocks on the plate pack are to be avoided. [2]
A counter-current wort cooler, is operated under the following set of conditions:
Wort flow rate 5 kg/s
Water flow rate 5.5 kg/s
Wort Inlet 98°C
Water Inlet 8°C
Wort Outlet 14°C
If the exchanger has a surface area of 100 m^2, what is the value of the overall heat transfer coefficient? [8]

Data
Specific Heat (cp) of water = 4.2 kJ kg^{-1}K^{-1}
Specific heat (cp) of wort = 4.0 kJ kg^{-1}K^{-1}

The first part of Question 6 was looking for the mechanical design features of a plate heat exchanger, so a flow diagram was not the required answer. Plate material and thickness, embossing and small flow gap to give high turbulence and very high U value were the sort of information items required.

The co-current and counter-current configurations were well explained and most candidates were aware of the reasons for their selection: counter-current for energy efficiency and best use of the coolant temperature, co-current for situations where freezing would be a real possibility with counter-current.

Hydraulic shocks are to be avoided due to the potential for blowing out gaskets and consequent hazard to operators and visitors from hot fluids, downtime to make repairs and, in extreme situations, irreparable damage to the gasket groove necessitating complete pack replacement. Titanium plates are also susceptible to cracking from flexing leading to leakage or cross contamination.

The calculation of the overall heat transfer coefficient required firstly a calculation of the water outlet temperature at 80.7℃, so that the DTLMTD between the two fluids – wort and water - could be calculated as 10.66℃.

If the average DT of 11.65℃ was used instead of the DTLMTD, a mark was deducted. Similarly, a mark was deducted if the units for U (W m^{-2}K^{-1} or kW m^{-2}K^{-1}) were not given.

Question 7

Outline the properties of austenitic stainless steel and name two commonly used austenitic stainless steels and their compositions. [4]
Explain why they are the preferred material of construction for many items of brewery equipment and give one example of where an alternative grade of stainless steel should be used. [4]
Explain how weld decay of stainless steel can occur and the changes that can be made to the stainless steel composition to improve its resistance. [6]
Describe the process of stress corrosion cracking (SCC) of stainless steel and the factors that compound the potential for SCC attack. [6]

One of the three least popular questions, despite requiring little more than textbook reading of the topic in order to be able to fully answer the question. The pass rate at only 57% indicates that all too few had done so! Austenitic stainless steels are alloy steels containing chromium and nickel with high resistance to corrosion, non-magnetic, good weldability, ductility and good strength at both high and low temperatures – features that explain their prevalence for brewing equipment.

The two main grades in use in brewing are AISI 304 and AISI 316 and their low carbon alternatives 304L and 316L. The Examiner was not looking for exact figures for composition, since there are ranges, (although several students excelled in providing this detail), but candidates should be aware of the ball park figures.

- AISI 304 – 18 –20% Cr, 9 – 11% Ni, < 0.08% C or < 0.03% for the L version
- AISI 316 – 16–18% Cr, 10 – 14% Ni, < 0.08% C or < 0.03% for the L version and 2 –3% Mo.

Although AISI 321 was mentioned, it is not now in common use, being intermediate in properties, and cost, between 304 and 316.

Whilst a few of austenitic steel properties are given above, there are a number of other important factors in their selection for brewery use.

They are non-toxic, non-tainting and insoluble in most brewery applications. They have good corrosion resistance across the pH range of brewery fluids – 2 – 14. They can be polished for good appearance and give a smooth surface not conducive to micro growth. Maintenance of plant, both internally and externally is low since stainless steel does not require coating or painting and can be cleaned effectively with CIP. On the negative side, they have low conductivity relative to other steels, but using thin section material due to its high strength often compensates for this. Also, they are poorly wetted, which has implications when used in heating and boiling situations.

Austenitic steels are not suitable in situations where high temperature, low oxygen and chloride are all present, as might be encountered for example in a hot liquor tank. For this use, ferritic or Duplex steels are preferred.

Weld decay occurs adjacent to the weld, not at the weld itself, when two pieces of s/s are joined. In an area where the temperature reaches 650 - 800°C, chromium will migrate and react with the carbon in the steel to form chromium carbide. This depletes the chromium available at the surface to oxidise and form the chromium oxide passive layer, leaving the steel vulnerable to corrosion. The problem can be tackled in two ways – by reducing the carbon content to less than 0.03% (the L versions) so that there is less carbon to react with chromium, or to add titanium (as in 316Ti) or niobium to the steel, since they have a greater affinity than chromium for carbon, leaving the chromium still available to form the passive film.

Stress corrosion cracking is the most serious of all forms of stainless steel corrosion, occurring across the granular structure of the steel, without material loss, and causing very rapid failure for which no repair is possible. It initiates from a small area of localised attack where the passive film has been disrupted. The conditions that are particularly conducive to stress corrosion are residual stress in the material, temperature in excess of 60°C, free chlorine ions, time and continuous operation of equipment.

Question 8

Beer, at 5°C, is pumped from a bright beer tank (BBT) to the filler bowl of bottle filler through a pipe of 100 mm internal diameter at a flowrate to match the maximum filling speed of 1,000 bottles per minute of 500ml capacity. The BBT and filler bowl have a CO_2 top pressure of 1 bar gauge and 1.5 bar gauge respectively. Calculate the following:

a. Reynolds number for flow in the pipe if the viscosity of beer at 5°C is 0.0015 Pa s. State whether the flow is laminar or turbulent and comment on the flow conditions in the context of filling operations. [4]

b. the maximum power input (kW) required by the pump set, of 60% overall efficiency, when the differential hydrostatic lift between the BBT and the filler bowl is 10m and the flow pressure losses due to the pipe run and fitments is 25% of that hydrostatic head difference. [8]

c. the final CO_2 content, in g litre^{-1}, of the beer in BBT if the CO_2 top pressure is left applied for a long period of time so that equilibrium is established given that Henry's constant for beer at 5°C is 0.968 x 105 kPa mole fraction^{-1}. [8]

Data

Density of beer = 1005 kg m^{-3}

Acceleration due of gravity = 9.81 m s^{-2}

1 bar = 100 kPa

Atmospheric pressure = 101.35 k Pa

Relative molecular weight of CO_2 = 44

Relative molecular weight of beer assumed as 18.

In tackling any calculation question it is important for candidates to realise that getting the right arithmetic answer to part of the question probably only accounts for one mark. The Examiner is looking for methodology and explanation in arriving at an answer. All workings should be shown so that, in the event of the answer being wrong, marks can be given for correct method.

A lot of the answers to Question 8 demonstrated the folly of not starting the calculation with the full Bernoulli energy balance equation, Many candidates overlooked the pressure difference between the BBT and filler bowl and jumped straight in to calculate the pump power requirement on static head alone, or at best static head plus friction. This is a common mistake since candidates remember from textbooks that pump power po = Q D^h r g and take D^h to be the static head difference. But the D^h in this equation is total head and is a combination of the pressure difference, expressed as head, the static head and the friction head – kinetic heads being neglected as not significant on this occasion. A lot of candidates show reluctance to use the Bernoulli equation in "pressure" units. That is OK provided all terms from the Bernoulli equation are converted to head. By staying in "pressure units" (Pa), the pump power, in watts, is the multiple of pressure (Pa) and volume flow rate (m3 s-1) since also po = Q DP. It is a note for trainers that candidates should be able to manipulate the equation between "pressure" units (N m^{-2} or Pa), "energy" units (N m kg^{-1} or J kg^{-1}) and "head" units (m).

The Reynolds number calculated should have indicated that turbulent flow existed. Laminar flow would be preferable for transferring beer from BBT to filler but it is not achievable in practice at the flow rates required and realistic pipe diameters. Given that flow will be turbulent, additional agitation should be minimised by the use of long radius bends, few intrusions or devices, such as valves, and adequate top pressure on the filler bowl and low beer temperature to prevent gas breakout.

The final part using Henry's Law was quite well answered with a result for CO_2 content of 5.07 g l^{-1}, remembering that the pressure in the Henry's equation is absolute pressure, and not gauge pressure.

Question 9

Describe, with the use of diagrams, THREE instruments used for measuring flow, each of which is based on a different principle of operation. Discuss the advantages and limitations of each type of instrument and give an example where the instrument would be used for flow measurement in the brewery. [12]

Explain the operation of each of the following control systems, with their respective advantages and disadvantages, and give one typical brewery application of each control system: [8]

- **feedback control**
- **feedforward control**
- **cascade control**
- **ratio control**

The most unpopular question of the whole paper – which was surprising given that the first part of the answer was textbook material. However the question did ask for instruments based on three separate principles and these could be taken from the following:-

- electromagnetic
- ultrasonic
- vortex shedding
- differential pressure (e.g. venturi, nozzle, orifice plate, pitot tube)
- positive displacement (e.g. diaphragm, piston, turbine)
- variable area (e.g. rotameter, notch weir)

Diagrams were often poor with items missing – for example an orifice meter without any pressure tappings – and quite often the underlying principle was not known or explained. Quite a few candidates erroneously described a venturi, not as a meter, but as an injector device as used for CO_2 injection or with steam for thermal vapour recompression.

Information on accuracy, reliability, cost and applications was missing in all but the best answers, although a pass rate for this question of 69% was achieved.

The final part was on control. Feedback and feedforward control were generally well explained with good examples of each. Feedback control is retrospective whilst feedforward control is anticipatory. Cascade control is where a secondary controller, which is maintaining a parameter for example steam flow, has its setpoint adjusted by a primary controller which might be looking at the outlet water temperature from the calandria.

Ratio control measures and adjusts one fluid, say, at a fixed ratio (adjusted by the setpoint) to the parameters of a second fluid. Examples in brewing are high gravity beer dilution with deaerated liquor and hot and cold liquor mixing at mashing-in.

Question 10

What factors are important in the selection of suitable primary and secondary refrigerants for use in breweries? Name two examples of each. [4]

Explain, with the use of diagrams, the basic principles of operation of a closed circuit vapour compression refrigeration system. [8]

Explain why and where in the refrigeration cycle superheating and sub-cooling of the refrigerant are important. [2]

A refrigeration plant is used to extract 56,000 kJ h^{-1} from a maturation

cold room. If the condenser and evaporator pressures of its primary refrigerant are 1 and 10 bar absolute respectively and there is 20°C of superheat prior to isentropic compression, calculate the mass flowrate of the refrigerant and the coefficient of performance of the refrigeration plant. [6]

A Mollier (pressure-enthalpy) phase diagram for the primary refrigerant is attached at the back of this paper.

A good primary refrigerant is a fluid with a high latent heat that will evaporate at the required "cold" temperature and condense using ambient air or water, all at pressures that are reasonably easy to engineer. The evaporation pressure should be above atmospheric to prevent air ingress. Ideally, they should be non-toxic, non-inflammable/explosive, not ozone-deleting or give rise to greenhouse gases, non-corrosive, cheap and readily available. Examples such as ammonia, CFCs, HCFCs, hydrocarbons show that it is not easy to find all these properties in one fluid! CO_2 is perhaps one of the safest primary refrigerants, but pressures are high and hence costly to engineer.

Quite a few candidates did not differentiate between primary and secondary refrigerants, but the requirements are quite different.

Secondary refrigerants do not change phase and need a high specific heat to give good heat capacity. Usually they are based on water (good specific heat, cheap and abundant!), with chemicals added to depress the freezing point below the evaporator's temperature. Such chemicals are propylene glycol, calcium chloride, industrial methylated spirits, but not ethylene glycol which is too toxic for food use. Their other properties required are similar to primary refrigerants - non-toxic, non-inflammable/explosive, non-corrosive, cheap and readily available.

The closed circuit vapour compression diagrams were presented either as P-h/T-h diagrams or plant flowsheets, or in better answers, both. The biggest omission was not showing the refrigerant flow direction with a flow arrow. The sequence was well described in most answers with just some confusion as to which parts were isobaric, isenthalpic or isentropic. On subcooling and superheating, answers were imaginative but often not correct. Superheating after evaporation is an essential safety margin to prevent damage to the compressor if liquid was to enter. Superheating at the end of compression is a consequence of the isentropic compression and was not accepted as a valid reason alone for superheating – just because it happens. Subcooling of the liquid refrigerant after condensing creates a higher liquid fraction prior to evaporation and hence a higher refrigeration effect for the same refrigerant flow rate and energy input – hence higher COP.

The calculation required reading of the enthalpies from the Mollier diagram and the most common error made was to take the superheat temperature as 20°C (293K) and not as "20° of superheat", which is 20°C above the saturated vapour temperature leaving the evaporator. The question was not ambiguous, but this mistake was not heavily penalised and marks were awarded if candidates proceeded then to use the enthalpies correctly in calculating the refrigerant flow rate and the COP.

Brian Eaton – July 2008

DIPLOMA IN DISTILLING EXAMINATION 2008

The examination attracted 32 candidates, mostly for only one module. Two candidates sat and passed two modules, and one sat all three, achieving Distinction grade and the Worshipful Company of Distillers award Another 5 gained the Diploma in Distilling by passing the 3 modules over 2 or 3 years. This year there was a 100% pass rate over the three module examinations, although a few candidates scored only marginally above the pass mark. As usual, the average marks were similar for all three modules: 64.4%, 62.4% and 61.0% respectively for modules 1, 2 and 3.

I have only a few comments which apply to the examination as a whole. This year there were several instances of candidates being unable to complete the final question. While ignorance of the topic was a possible reason, I suspect that running out of time was more likely. Each module has a 3-hour examinatiion, with a choice of 6 questions from 8, i.e. 30 minutes each.

Even if that is not enough to answer a question as completely as you would like, a reasonable attempt at all 6 questions will almost certainly score better than spending more time on 5 and having little or no time to answer a sixth. Although most of the examination scripts had neat handwriting and drawings, sadly there were some where presentation left much room for improvement. In both this report and on numerous previous occasions

I have advised that drawings are marked according to quality. While there is no deliberate deduction of marks for poor handwriting, that could happen by default if I am unable to decipher scribbles that may or may not be the correct information. Otherwise, comments and advice appear in the section dealing with the particular question which caused my approval or annoyance.

Module 1 – Materials and Wort

Question 1

Summarise the desirable characteristics of barley for malting. [5]
Explain why three of these characteristics are so important in assessing the suitability of barley for production of a malt for a malt whisky distillery. 3 x [5]

Sixteen candidates sat Module 1; all chose question 1, mostly as their first answer, and all but 2 passed. Quality varied from an excellently presented summary of an extensive list of barley characteristics (more than I had expected) to only moderately successful attempts to remember what is important to a maltster. To be strictly accurate, many of the desirable properties (e.g. screenings, and nitrogen and moisture content) are factors influenced by cultivation and harvest and not really characteristics of the actual barley, whereas attributes such as 1000-corn weight and endosperm structure are. However, all candidates rightly regarded the former as relevant to the answer. However, both parts of the answer had to refer to barley, not the final malt. As one example of the distinction, ethyl carbamate potential is a property of the barley variety, but NDMA is produced during kilning and therefore irrelevant to question 1. I was disappointed to see so many candidates not quoting actual values when writing about such important properties as moisture and N content and minimum corn size, implying that they did not know.

Question 2

Discuss the basic principles of the design and operation of one type of malt kiln. [10]
Give an account of the changes which take place in the malt.during kilning, **and explain why these changes are so important for the mashing process. [10]**

Question 2 was answered by 15 candidates. Whichever design of kiln was chosen, all answers showed a satisfactory understanding of its operation. I was surprised by the absence of an explanatory drawing from some scripts, and it was sometimes unclear where the first half ended and the second part began. A properly labelled temperature v moisture graph demonstrating drying rates would also have been helpful, but was absent from the poorer answers. However, all candidates scored at least a pass mark.

For the second part of the question, many changes take place in malt during kilning, but not all are relevant to the mashing process (although not stated in the question, both grain and malt distilleries were assumed to be understood). Limiting the inevitable reduction in enzyme activity during kilning, by drying at relatively low temperature in a rapid air flow, is particularly important for grain distilling. Since development of melanoidins is associated with high temperatures, colour is a useful indicator of excessive heating. This is equally applicable to both grain and malt distilling malts, whose laboratory extracts should be essentially colourless. Explanations of peating and nitrosamine formation were included in some answers and also accepted as relevant because of their effect on the wort, even though they do not influence the actual mashing process.

Question 3

With the aid of a flow-sheet diagram (sketches of the actual plant are not required), explain briefly the function of each item of equipment between the malt storage bin and entry of milled malt to the mash tun of either a grain or a malt whisky distillery. [20]

Various answers were possible for question 3 according to the type of distillery and whether green or kilned malt was used. Essentially a good mark required descriptions of not only the mill and Steel's masher (if used) but also the equipment for removal of dust, stones and metal, and weighing, in the correct sequence. All 14 answers competently described the plant. Perhaps inevitably, some were more detailed than others but all comfortably exceeded the pass mark.

Question 4

Sketch the molecular structure of the component parts of the starch granule and how they are arranged in the granule's structure. Using these diagrams, explain the enzymic activities involved in the hydrolysis of starch and how their action is influenced by swelling and gelatinisation of the granule during mashing. [20]

In previous years most candidates have avoided biochemistry questions, so it was a pleasant surprise to find 14 answers to question 4 on hydrolysis of starch. Marks varied widely according to the clarity and accuracy of sketches of molecular structure, and evidence of understanding of the enzymic reactions. Two candidates failed; a contributory factor was that they were among the four who made no comment on the importance of swelling and gelatinisation to amylolysis, despite specific mention of these events in the question.

Question 5

Draw the essential features of typical equipment for pressure-cooking of maize or wheat for grain whisky distilling and describe the operation of the cooking cycle (an explanation of subsequent cooling is not required) [12]

Describe briefly, including comment on advantages and disadvantages, one alternative method for preparing the cereal for mashing.[8]

The first, main, part of question 5 concerned the standard batch pressure-cooking process. Therefore I expected both a description of the procedures of one cooking cycle and a drawing showing at least the essential stirring gear, safety valve (surprisingly, omitted from many drawings), pressure gauge and valve for venting off air, as well as indicating how the grain, water and steam are added and the cooked slurry is discharged. The 11 answers ranged from a bare pass in this section, to excellent. Subsequently, candidates could discuss the advantages and disadvantages of either lower-temperature processing of milled grain or continuous pressure cooking as the shorter second section. Unfortunately one did not answer that second part, and failed in question 5 as a result.

Question 6

The following processes could be required for water used in grain and malt whisky distilleries: demineralisation, selective ion removal, activated carbon treatment, boiler feed water treatment.

For each, explain briefly

(a) one reason why the treatment could be necessary,

(b) how the procedure is carried out, and

(c) its relevance to whisky quality. 4 x [5]

Only eight candidates attempted question 6, perhaps deterred by such a long question. However, only a brief account of the three specified factors was expected for each of the four treatments. I had intended "demineralisation" to imply removal of hardness salts by ion exchange and "selective ion removal" the precipitation and subsequent removal by filtration of soluble iron and manganese. It became obvious that some candidates were accustomed to different nomenclature, but appropriate treatments for the situations they described were accepted as correct. The two fail marks were for more serious reasons of confusing the effects of organic and inorganic impurities, and the required treatments; otherwise the section on activated carbon for removal of colour or flavour taints caused no problems. Since treatment for both grain and malt distilleries was specified, it was necessary to mention that boiler additives to prevent sludge must not cause a flavour taint of the steam for injection into cookers and stills.

Question 7

With the aid of a diagram, explain the operation of a "biofilter" for treatment of distillery effluent and discuss the effectiveness of the unit for reducing BOD for discharge to a river. [8]

A distillery with access to a municipal "activated sludge" plant may choose to discharge process effluent to the sewer. Sketch and explain the operation of that type of effluent treatment, and discuss briefly the advantages and disadvantages to the distillery. [12]

It was obvious that only two of the four candidates who attempted question 7 understood the activated sludge process. The other two answered only the 8-mark biofilter section, insufficient to attain a pass mark for the whole question. Although few Scottish distilleries have access to a local authority activated sludge treatment plant, the process appears in the syllabus. One of the important advantages is its ability to process a high BOD load of distillery waste water diluted by the much greater volume of relatively low-BOD domestic effluent.

Question 8

Describe the design and operation of the Friabilimeter and discuss its value, or otherwise, in the analysis of malt. [14]

What are the implications of an unacceptably low result of the Friabilimeter test? [6]

Question 8, on the friabilimeter, was chosen by 15 candidates. Answers varied in quality from a bare pass (partly due to the absence of a drawing of the machine) to almost full marks. Everyone was obviously aware of the operation of the equipment and the value of the results, provided other data are considered as well. However, I was surprised that only one person mentioned the value of the friabilimeter as one of the few (necessarily rapid) quality checks possible before unloading a delivery of malt.

Iain Campbell July 2008

Module 2 – Fermentation, Distillation and Maturation

Question 1

Describe, both in words and by a series of sketches showing the principal organelles, the growth of a yeast cell over one generation cycle. [20]

Question 1 was answered by 11 of the 14 candidates sitting this examination; 8 answers scored good to excellent marks. The other 3 failed for not explaining cell reproduction. Since the question concerned the growth cycle, the most important parts of the answer were the development of the bud, division of the mother cell's nucleus and transfer of one of these nuclei into the bud. Of course a single accurate sketch of the organelles of a fully grown cell deserved some marks, but did not fulfil the requirement for a series of sketches illustrating the principal stages of the growth cycle from bud initiation to the separation of the fully grown bud. Even a good drawing of a yeast cell and competent explanation of the function of the organelles scored badly when the growth cycle was not mentioned.

Question 2

Explain the formation of esters and higher alcohols during fermentation by yeast. [14]

In the context of the limited possibilities for variation within the Scotch whisky regulations and similar restrictions elsewhere, explain how changes in fermentation conditions affect the amounts of these compounds in fermented wash. [6]

Question 2 was another biochemistry question chosen by most of the candidates. Of the 10 answers, all but one competently explained the involvement of keto acids and acetyl CoA in higher alcohol and ester formation. Some answers included a more thorough account of the Embden-Meyerhof pathway than was really necessary. Of course that detail was appreciated, but I was happy to accept a basic outline as far as pyruvate, the starting point of the various metabolic activities related to the answer. Those candidates who supplemented their descriptions with formulae of the compounds concerned were generously rewarded. Although variation in fermentation conditions should be avoided in distillery practice, for the purposes of the short second part of the question, discussion of effects of altered pitching rate or temperature was certainly expected. Most answers provided that information, often in an informative tabular form. Wort aeration, variation in wort composition by mashing problems, and even use of different yeast strains, were also suggested by some candidates and accepted as fair comment.

Question 3

Explain the difference between "viability" and "vitality" as applied to pitching yeast, and describe one method each for measurement of these parameters. [12]

Comment on the value of viability and vitality tests in general, and also of the two specific methods you have described, for assessment of the quality of pitching [8]

Everyone answered question 3, showing a good understanding of the principles of viability and vitality tests on yeast, although one candidate left insufficient time to achieve a pass mark. In question 2 there was no specific advice on the amount of detail required, hence my favourable comment above on more than expected about Embden-Meyerhof. However, in answering question 3, some candidates tried to impress by providing a full list of possible viability and vitality tests rather than the requested one of each. There were no marks for that irrelevant information, even though it was always factually correct. That unnecessary effort would have been better expended on writing useful information elsewhere.

For only 8 marks, it would be unreasonable to expect "comment on the value of viability and vitality tests in general" to include details of all possible methods. I wanted only a brief discussion of both types of test being required to predict an efficient fermentation. One of the better answers claimed that a vitality test should not be needed for fresh commercial distilling yeast. I agree, but would argue that it is a useful test to decide between using or throwing out yeast after longer storage. Most answers mentioned methylene blue or alternative redox dyes which are widely used to measure viability (i.e. ability to reproduce) but they actually indicate metabolic activity. Not all answers discussed the implications of that discrepancy.

Question 4

Bioluminescence and the polymerase chain reaction (PCR) are two possible methods for rapid detection of bacterial and wild yeast contaminants of pitching yeast and supposedly sterilised equipment. Explain briefly the principle and application of each of these techniques for these purposes. [20]

Since the principles of both bioluminescence and PCR required extensive explanation, most of the marks for question 4 were allocated to these explanations, and one example each of detecting the two types of contaminant was sufficient. It was obvious that only those with a good understanding of these topics had chosen to answer the question. The three answers competently explained the principles of the methods, and the possibilities, and the limitations, of their application.

Question 5

Describe in detail the cleaning requirements for mashing and fermentation vessels of malt and grain whisky distilleries, and the cooking vessels of grain distilleries. Include an account of suitable materiials for these purposes. [20]

Question 5 was much more popular, answered by 12 candidates. Although all were good answers, I was really impressed by the detailed descriptions in some scripts, e.g. on the different procedures for wooden and stainless steel washbacks. An important part of a good answer was the distinction between cleaning and sterilisation, the latter being necessary only for fermentation vessels in the equipment specified in the question. Being operated at high temperature, mash tuns and cookers require only routine cleaning, to prevent accumulation of soil which could support growth of micro-organisms which produce off-flavours. Therefore the account of suitable cleaning materials had to distinguish between just the removal of soil, and the additional requirement to sterilise the cleaned surfaces where appropriate. Assessment of effectiveness was not included in the question, so although a brief mention of that aspect of cleaning and sterilisation was an acceptable final part of the answer, a more substantial assessment did not receive any more marks.

Question 6

Explain how "cold feints" and "hot feints" are produced in continuous distillation of whisky. Describe how they are recycled, and treated if necessary, to minimise loss of ethanol from the still system but maintain the quality of the spirit. [20]

All answers to question 6 were also of a high standard, and since it is unlikely that all 11 candidates work in grain distilleries, I deduce that staff of malt distilleries are now taking seriously the requirement have a good knowledge of continuous distillation practice. Although not specifically requested, I hoped that explanations of sources of cold and hot feints would be clarified by sketches of the relevant parts of the still system. I was pleased to note that all answers included some kind of sketch, but a few in the style of Picasso were not really an asset. However, most were carefully drawn, as I have requested in many previous reports. The words ". . . maintain the quality of the spirit" at the end of the question particularly applied to hot feints, and specifically the possibility of aeration to eliminate ethyl carbamate and volatile sulphur compounds. For cold feints, i.e. either condensate from various top condensers or out-of-specification spirit, re-distillation is necessary, and because of the high alcohol content (a fact which some candidates omitted to mention) the feed rate must be carefully controlled to avoid de-stabilising the still. In any case, controlling the recycling rates of both hot and cold feints to maintain steady state conditions in the stills is important for spirit quality.

Question 7

Explain the concepts of additive, reductive (or subtractive) and productive processes during maturation and describe two examples of each type. [20]

All candidates answered question 7, and all but one passed. Some were confused about the distinction between additive and productive processes, both of which add new congeners to the spirit. According to well-established terminology, "additive" means extraction into the spirit of existing compounds in the structure of the cask, and "productive", generation of congeners by chemical reaction (e.g. esterification, hydrolysis, oxidation) within the maturing spirit. Only two examples of "additive" were required from the lignin degradation compounds, tannins, sugars, lactones, etc present in charred wood.

Even if a lignin aldehyde was mentioned in the context of additive reactions, subsequent changes of that compound to acid and ester were acceptable for "productive", but of course there were numerous other possibilities. Although specialists in maturation chemistry would rightly disagree, I simplified the question by requiring only two examples of removal of congeners from the maturing spirit, whether by absorption or evaporation (subtractive) or by chemical reaction (reductive). Incidentally, evaporation of ethanol and water, used as an example by several candidates, was not accepted as a genuine subtractive process. There were many other compounds to choose from, acetaldehyde and dimethyl sulphides probably being the most important. Since lignin derivatives and tannins have complex structures, I was prepared to be lenient over minor inaccuracies, but was impressed by the number of scripts showing the chemical formulae correctly.

Question 8

Define 'balanced' and 'unbalanced' operation of wash and spirit stills and discuss briefly the advantages and disadvantages of each system. [8]

Draw graphs of the approximate values of the volume (expressed as a percentage of the actual charge volume as 100%) and alcohol content in the spirit still charger vessel (a combined low wines/feints receiver) over an 8-hour period when:

(a) both stills operate once on an 8-hour cycle. [6]

(b) the wash still has two 4-hour runs and the spirit still has one 8-hour run. [6]

Eight candidates answered question 8, and defined correctly the concepts of balanced and unbalanced distillation. Unfortunately three candidates did not achieve a pass mark, by misunderstanding what was required for the graphical part of the question; indeed some of those who passed were also confused in that section. Although the 2-for-1 distillation programme (b) did not actually have the random effect of truly unbalanced operation, it gave the opportunity to compare volume and alcohol strength in the combined receiver vessel with the 1-for-1 programme (a). Obviously precise values could not be expected, but I was disappointed that so few graphs showed the general picture. Basically, for both programmes, the volume graph would show three stages:a rapid increase while both stills were feeding the low wines/feints receiver vessel, slower while the spirit still was filling the spirit receiver, and finally more rapid again during collection of feints. To be absolutely accurate, there would be a short period during run (b) while the second wash still charge was heating up and only the spirit still was feeding the receiver, but I did not expect anyone to allow for that (I was right!) The alcohol graph (a) would be, essentially, the well-known graphs of wash and spirit still distillations combined, but again showing no feed from the spirit still during spirit collection, and run (b) of course would have two wash still graphs in succession.

Iain Campbell July 2008

Module 3 – Process Technology

Question 1

Explain the significance of the design of body, neck and lyne arm of a spirit still, and the rate of distillation, on the composition and quality of the spirit produced by that still. [20]

Six of the 7 candidates who sat the Module 3 examination answered question 1. All answers gave competent assessments of the effects of distillation rate and still shape, in particular of the neck and lyne arm, on reflux and therefore on (a) the nature and amount of congeners in the spirit and (b) the opportunity for reaction between the spirit vapour and the copper surface of the still. The best answers also mentioned supplementary fittings to increase reflux, e.g. a 'purifier' in the lyne arm, although no one answer provided a complete list of all possibilities.

Question 2

With the aid of appropriate illustration, explain how the spirit vapour is fractionated in the rectifier column of a continuous still to produce spirit of acceptable quality for grain whisky. [20]

Question 2 was answered by five candidates; three passed. "Appropriate illustration" could include a general drawing of the rectifier, but I expected that the graph of the distribution of the principal congeners over the height of the column would be an important part of a good answer. That was largely true, although one candidate did manage to provide a satisfactory explanation of the separation of congeners without the assistance of the expected graph. However it was a general shortage of relevant information rather than any specific omission which caused two of the answers to score a marginal fail mark.

Question 3

Explain in words and by sketches of velocity profiles in pipes the differences between laminar and turbulent flow. Discuss the relevance of these two flow regimes in different situations which occur in the distilling industry. [7]

Cold wort of density 1060 kg m^{-3} and viscosity 0.003 kg m^{-1}s^{-1} flows through a 50 mm internal diameter circular pipe at a rate of 3.5 kg s^{-1}. Determine the mean velocity (u) of the wort in the pipe and determine the centre-line velocity (u_{CL}) given that: u= 0.5 u_{CL} for laminar flow; u = 0.82 u_{CL} for turbulent flow. [6]

Explain the concepts of measuring the effect of pipe geometry on fluid flow as multiples of pipe diameter and number of velocity heads. As an example, state whether a gate or globe valve in the fully open position has the higher value, and explain why the difference exists. [7]

The two candidates who attempted Question 3 both scored acceptable marks. Normally I would consider it would be unfair to comment on only two answers, but in the final part there was clearly a suspicion that my simple question implied more than I had intended. All I wanted was an explanation of the concept of treating the frictional losses associated with bends, valves, etc as equivalent to the frictional effect of pipe diameter, and of course to show an understanding of fluid flow through the two different designs of valve.

Question 4

Draw, and briefly explain the function of, the principal features of the equipment for pressure-cooking unmalted cereal for grain whisky production, and for energy recovery from the cooked cereal. [10]

Using the data below, calculate (a) the initial temperature of the water/grain slurry and (b) the weight of steam required to heat a batch of 15 tonnes of wheat to 140°C, assuming a perfectly insulated cooker vessel. [10]

Initial water charge to cooker = 37.5 tonnes

Temperature of initial water charge = 80°C

Specific heat of water = 4.2 kJ kg^{-1}K^{-1}

Initial temperature of wheat = 12°C

Specific heat of wheat = 1.5 kJ kg^{-1}K^{-1}

Latent heat of condensation of steam at average temperature of slurry over heating programme = 2256 kJ kg^{-1}

Question 4 was answered by all candidates. As usual, the quality of drawings varied from neat and accurate to abstract, but even distorted shapes received reasonable marks if all necessary equipment was shown. Most candidates were able to calculate the temperature of the grain/water mixture as 71.5°C, but some then used the original 80o of the water rather than 71.5° in the calculation of steam requirement, obviously losing marks for the inevitable wrong answer. Others, perhaps not trusting their answer to the first part if it was lower than their own experience, calculated the steam requirements for heating the water and grain separately, also getting the correct answer 5465 kg. Unfortunately, two avoided the 10-mark calculation completely and, inevitably, failed.

Question 5

Explain the basic principles of a plate heat exchanger and describe the heat-transfer implications of operation with co-current and counter-current flow. [5]

Hot condensate is collected from four points in a distillery and combined for use in a heat exchanger. Calculate the temperature and flow rate of the combined stream if the flow rates of the individual water streams are as follows:

(a) 0.5 kg s^{-1} at 72°C, (b) 1.2 kg s^{-1} at 82°C, (c) 1.4 kg s^{-1} at 90°C, (d) 0.8 kg s^{-1} at 68°C [5]

The combined hot stream feeds a counter-current heat exchanger to heat fresh water from 8°C to 70°C. What is the flow rate of cold water if the heat exchanger is operated to cool the hot stream to 20°C? [5]

What is the total plate area of the heat exchanger? [5]

Specific heat of water = 4.2 kJ kg^{-1}K^{-1}

Overall heat transfer coefficient of the heat exchanger = 850 W m^{-2}K^{-1}

All five answers to question 5 gave competent accounts of co- and counter-current heat-exchange systems. Unusually, the calculation part of the question provided most of the marks, which was unfortunate for the one candidate who failed. It was especially unfortunate that his/her arithmetic was presented in such a disorganised way that it was impossible to follow my normal practice of awarding marks for correct parts of the answer. I emphasise again that a logically presented calculation, even if ultimately leading to a numerically wrong final answer, will be awarded marks for correct intermediate stages, or for parts that are organised in the correct way. For example, although one candidate calculated the temperature and flow rate wrongly, subsequent correct calculations from the already-penalised wrong figures scored full marks for the relevant sections.

Question 6

Describe, with sketches, two types of centrifuge which could be used for separation of grains-in spent wash of a grain distillery into spent grains and a supernatant stream for subsequent evaporation. [14]

Comment briefly on the advantages and disadvantages of each type. [6]

Question 6 was also answered by all candidates The decanter type of centrifuge was the first choice in most of the scripts, but, surprisingly, in two answers good drawiings of decanters were scored out in favour of two different designs of bowl centrifuge. I was unwilling to accept two similar bowl centrifuges as different designs. However, they were well drawn, and I did, very exceptionally, make an allowance for the good quality of the scored-out material, which was clearly to candidates' advantage in showing their knowledge of different types of relevant equipment.

Question 7
Describe the basic principles of design and operation of instrumentation for the following measurements:
(a) fermentation temperature.
(b) volume in a low wines receiver vessel,
(c) flow rate of spirit from continuous still to receiver vessel and
(d) alcohol content of reservoir vessel for cask filling.
Choose a different type of instrument for each measurement. 4 x [5]

I had assumed it was obvious that question 7 referred to the design and operation of electronic instruments for temperature and volume. But I have to agree that a mercury thermometer and a dipstick are instruments, and thanks to a detailed explanation of their use were accepted, as was a similarly detailed explanation of the use of a hydrometer for alcohol measurement. Otherwise the expected vibrating tube system was explained, and all 5 candidates described modern flow meters. This was the best-answered question of the paper, all with clear passes.

Question 8
Explain with the aid of a drawing how a wash still and its shell-and-tube condenser are protected from damage by accidental internal pressure changes. Give a brief description of these safety devices and their operation, and the likely causes of such pressure variations. [8]
Describe, also with appropriate drawings, the equivalent problems and protection for the plates of the two columns of a continuous grain whisky still with grains-in wash. [12]

Only four candidates attempted question 8. Three passed, although in their answers the safety features of only one of the pot or column still were answered well, presumably reflecting practical experience of only one system. However, possible causes of pressure variation were not as fully discussed as I had hoped. The three safety devices expected for a pot still were the air and anti-collapse valves of the still itself and the tail pipe of the condenser. For individual column plates the seal pots and safety valves performed somewhat similar functions, but the complete still also requires a safety valve. Drawings were an important part of the answer, hence the uneven distribution of marks between batch and continuous distillation.

Iain Campbell – July 2008

DIPLOMA IN PACKAGING EXAMINATION 2008

Examiners Summary

2008 was the pilot year for this examination, and only Modules One and Three were launched this year, with Module Two available to candidates from October 2008 for the 2009 exams.
The results from both Modules have given an overall Diploma in Packaging pass rate of 79%, with particularly pleasing results in Modules Three which had a 100% pass rate. Going forward this qualification will hopefully ensure that the industry is able to recognise those candidates who can demonstrate their knowledge and understanding of the packaging formats which are seen or used by both customer and consumer. Each Unit of the Diploma in Packaging was assessed in three components, viz. assignment (35%), short answer questions (30%) and one long answer question (35%). The Unit scores were then combined to give an overall mark and grade for the Module. As with the Diploma in Brewing, an overall pass in the Diploma is only awarded when all three Modules have been successfully completed.

Whilst detailed commentary for each unit section is given in the report below there were some common themes which need to be brought to the attention of candidates.

In the Assignment, the key areas looked for were relevance to brief, quality of discussion, range of references accessed and appropriate use of them, extent of analysis and evaluation, comment and originality. It is important to ensure that the submission answers the assignment questions, with a good answer being to the point with sufficient depth of discussion. The assignment should include references in order to show that the candidate has read round the subject. Once used these should then be cited and listed using the Harvard referencing system. A guide on this is provided to all candidates, and should be used – something which was not clearly demonstrated throughout the assignments by a number of candidates.

The short answer question is based on 15 multiple-choice questions which are designed to test the candidate's breadth of knowledge of the overall syllabus. It was pleasing to see that this was generally well attempted in most Units, and calculation questions demonstrated a candidate's ability to apply their knowledge into a practical workplace situation.

The long answer question section requires the candidate to choose to answer one question from two. These questions are set at a similar level to those used in the Diploma in Brewing and are designed to test a candidate's in depth knowledge of a particular area of the syllabus. These questions tended to show which candidates had only a superficial knowledge of their chosen subject, whilst good candidates were able to provide excellent answers.

Module One
14 candidates sat this unit, with two candidates having Recognised Prior Learning exemptions on Unit 2 based on demonstrated evidence of their previous qualifications. Overall a good pass rate of 71.4% was achieved, with two candidates gaining Grade B (14%), four candidates gaining Grade C, and four candidates gaining Grade D (28%).

Module 1 : Unit 1 – Packaging Theory and Materials

(a) Assignment

a. Select a non primary packaging material with which you are familiar. Obtain the current specification used to purchase this material.
b. Investigate whether this material is delivered within this specification and how it is maintained within specification from delivery to point of use on the packaging line.
c. Discuss the appropriateness of this specification and give proposals as to what can be done on the packaging site to ensure consistency and minimise failures on the packaging line.
d. Discuss how the required specification can be achieved by the manufacturer of the material and what issues that manufacturer may have.

This was the first assignment. 2,500 words were given as a guide to the length of assignment – with the one which only had 1150 words not surprisingly lacking information.

Good assignments followed the brief and gave a good description of the selected non-primary material, and how it was used on the packaging line. Most people selected a corrugated carton. Poor answers either selected a primary package, a carton not used for beer or a mixture of secondary packaging. Candidates should also be careful in not going outside the brief by, for example, giving a detailed description of carton manufacture and then not having enough space to complete the main brief.

The assignment needed a challenging review of issues which arose when using the selected material from purchase to storage to use on the machine. Good answers highlighted damage issues in the delivery chain and the importance of the correct storage conditions and time in storage in order to achieve a good quality material (mostly board) on the machine. However, most assignments would have benefited from more investigative work, analysis and a clear presentation of those findings.

Jeremy Browne, July 2008

(b) Short answer questions

The results in this section ranged from a highest score of 11 correct answers to a low of 6 correct. Calculation questions were generally answered well by most candidates, although it was clear from some of the factually based questions that candidates had not studied the learning material in detail. This paper also showed up a general weakness in candidates' knowledge of how packaging materials are manufactured, and their individual properties and uses.

(c) Long answer questions

All 14 candidates chose to answer question 2, with no answers submitted for question 1. The majority of candidates provided a reasonable level of answer to the question, although there were two very poor answers, and one outstanding one.

Question 1

a. Describe the manufacturing processes required for the manufacture of a batch of kegs, from order placement through to delivery to the production site. [12]
b. Write brief notes on the quality assurance steps which should be observed throughout the manufacturing process. [4]
c. List any additional precautionary steps required when a new batch of kegs is first used on a production line. [4]

It was disappointing that no candidates felt confident enough to attempt this question. The manufacturing processes used to produce key primary packaging materials are an underpinning element of this unit, and this should have been a section which was clearly understood. A good answer would have covered the order specification for the kegs before going on to describe the keg manufacture process in detail. Delivery and quality assessment areas should ten have been covered, including any trials / segregation that should be done on and off line before the kegs are placed into routine production.

Question 2

a. Provide a table of information to explain the functions and basic properties of primary, secondary and tertiary packaging materials, along with examples of each material. [12]
b. Selecting one material explain briefly how it provides the required consumer information. [4]
c. List the relevant checks undertaken on the production line which are required to validate the consumer information. [4]

Most candidates displayed a reasonable knowledge of the split between primary, secondary and tertiary materials, although there was a wide variation in the standard of information provided about the function and basic properties of each. The best answers given were in a clearly detailed table and listed a number of examples of each type of packaging material along with their functions and basic properties. The functions of each packaging material should provide a clear description of what the material contributes to the pack, with the properties of the material describing how the material does this. It is important for candidates to have an understanding of a wide range of materials – with poorer answers only providing one example of packaging and one or two word descriptions. Two candidates obviously mis-read the question and wrote answers about marketing and technical aspects of packaging – without covering the areas requested in the question.

The section on consumer information was generally well covered with candidates listing the mandatory information such as best before date, and legal information. Those candidates who also included the advisory information – such as number of units, health advice – gained a higher mark overall.

The final section of the question required a candidate to list the checks to validate the consumer information. In general this was not as well answered, and required a candidate to look at the line based quality checks e.g. ABV, volume and correct use of materials. The better answers also explained how the checks could be undertaken and the frequency they would expect to do them. Too many candidates failed to link the checks to the consumer, and there was no recognition of how the checks can link to supplier vendor assurance schemes.

Ruth Bromley – July 2008

Module 1 : Unit 2 – Beer Appreciation

(a) Assignment

a. Identify the key parameters within a product specification, which should be analysed at each stage of the brewing process to enable a product type of your choice to be produced consistently.
b. For each stage of the brewing process up to bright beer tank, identify which of these parameters can be influenced by that stage. Also explain how each stage can influence the consistency of the final product.
c. Identify how the key specification parameters may be influenced by the brewing process, including dilution, and how this relates to the beer in final package.
d. Compare your findings with the current specification and analysis schedule.
Recommend and justify any changes which could be made.

It is important to ensure that the submission answers the assignment questions. Good answers need to be to the point with sufficient depth of discussion.

The references should show that the candidate has read round the subject. A good understanding of the Brewing Process is required. This was not demonstrated by several candidates who demonstrated only a superficial understanding. Poorer answers concentrated on describing the process and some of the plant and did not discuss how key specification parameters were influenced by the different stages of the brewing process through to final package. Similarly findings were not compared with the current specification and analysis schedule.

Appendices quoted in the text need to be enclosed with the submission.

Eric Candy – July 2008

(b) Short answer questions

The results ranged from a highest score of 13 correct answers to a low of 7 correct.

A few questions, somewhat surprisingly, caused several candidates some problems to answer. For example, it would be expected that packaging candidates would know that the main objective for filling the headspace of a bright beer tank is to minimise the rate of dissolved oxygen pickup, rather than prevent loss of carbon dioxide; also that the best conditions for encouraging carbonation are low temperature and high pressure. Finally, it was somewhat disappointing that so few candidates knew that brewing yeast reproduces by budding.

(c) Long answer questions

Five candidates elected to answer question 1, with 7 choosing question 2. In the main, the answers to question 1 were of a higher standard, although 2 candidates provided good answers to question 2.

Question 1

a) List the types of substances which can cause the production of non-biological haze in beer. [5]
b) Describe the production procedures which may be employed to stabilize beer against the formation of such hazes. [15]

Most candidates were able to identify the most likely sources of haze material in beer, with the correct emphasis on the role of oxygen in oxidising polyphenols and interactions between polymerised polyphenols and polypeptides leading to chill haze and permanent haze formation. Also noted was the potential for haze particles resulting from collapsed foam from denatured polypeptides or hop acids (especially reduced products, like tetra-iso-α-acids). Some candidates also listed calcium oxalate, filter powder let-by or even unfiltered PGA (for foam enhancement). Most candidates, however, remembered to include carbohydrate hazes, such as β-glucans and pentosans or even α-glucans (residual starch or yeast autolysis products such as mannan).

There were some good answers for the second section, with candidates describing all the control points throughout the brewing process to minimise the risk of carry over of potential haze forming material into finished beer. This started with selection of raw materials, optimising brewhouse conditions (with adequate calcium ions present to ensure pH control and precipitation of calcium oxalate), especially boiling and trub compaction and removal and use of kettle finings. Ensuring good yeast separation and temperature control post fermentation, followed by very low temperature conditioning (brewing at high gravity helps here) are also key. Filtration at as low a temperature as possible, with all process additions pre-filter (except PGA, which therefore should be micro-filtered separately) is also important. Surprisingly, a few candidates omitted to describe the use of silica gels or tannic acid or papain to remove sensitive proteins/polypeptides or PVPP to remove polyphenols, which are, of course, major factors to be involved in stabilising beer against haze formation! All candidates stressed the importance of good control over dissolved oxygen pick up during all stages of beer processing and packaging.

Question 2

Describe the factors that can affect beer flavour stability during prolonged storage of packaged beer. [20]

All candidates were well aware of the importance of dissolved oxygen control during beer processing and packaging in relation to resistance to development of stale flavour characteristics during storage of packaged beer. Also, the need to ensure package integrity (crown seals, can seams, keg spear seals) was discussed, some candidates noting the value of oxygen scavenging crowns for bottles. The risk of microbiological contamination as a consequence of poor package integrity was also commented on. However, too much emphasis was given to ensuring that pasteurization or sterile filling had been carried out correctly. Clearly, this is important for good practice, but of little relevance to a discussion on prolonged storage of packaged beer, since any significant microbiological contamination present at zero time will develop very quickly in relation to shelf life.

Very few candidates commented on the necessity for oxygen barriers for PET bottles and again there was little commentary on the actual flavours associated with staling (such as papery, bready, cardboard characters and increased sweetness) and no information on the potential reactions involved.

Most answers discussed the benefit of low temperature storage of packages and identified some of the practical difficulties associated with widely varying ambient temperatures, especially the risk of freezing. Some commented on humidity and the risk of crown rusting, which could affect flavour for customers who drink directly from the bottle!
Others also commented on other potential risks to flavour from package defects, such as poorly applied or poorly cured lacquers in cans and aluminium kegs.

Several candidates noted the potential for light striking reactions in unprotected clear or even green bottles, and the use of reduced hop products to avoid this flavour development.

No candidates mentioned flavour developments associated with bottle-conditioned products and really good answers would have noted that bitterness tends to be reduced on prolonged storage, mainly due to the loss of the trans-iso-_-acids.

David Taylor – July 2008

Module 1 : Unit 3 – Beer Preparation, Micro Stabilisation for Packaging including Small Pack Filling Operation

(a) Assignment

a. Draw and describe a microbiological stabilisation installation (plate pasteurisation, tunnel pasteurisation, sterile filtration) on a packaging line of your choice including associated utilities.
b. Obtain the design specification and manufacturer's recommended operating conditions for this system.
c. Research this method of microbiological stabilisation and produce a document describing how, when using this type of microbiological stabilisation, infected product could still be found in the final package.
d. What control measures are required to prevent this happening with minimal flavour change?
e. What other control measures are required to prevent any subsequent damage to the packaged product? Your answer should include a description of the appropriate methods required to ensure that the chosen microbiological stabilisation method is consistently achieving the desired microbiological and flavour stability.
f. Using the information gathered investigate how your installation is designed and operated, and identify whether the design and control measures are adequate and, if not, recommend any changes.

Nearly 80% of the candidates selected tunnel pasteurisation. For this assignment it was extremely important to follow the brief. Some candidates just gave a generic description on how the pasteuriser worked and this was not enough to earn high marks.

Good assignments gave a description of the process with clear diagrams and process parameters for operation. This was followed up with an analysis of the operation and comments on the process as a result of the findings. It is important that the process is understood. Poorer assignments showed a lack of understanding of the process, and did not include any investigative work into its operation.

One part of the assignment asks about other control measures that are required to prevent any subsequent damage to the packaged product. Many candidates missed the need for oxygen control which is what this part of the assignment was looking with regard to flavour stability.

The appendices varied considerably. Appendices should only be used to illustrate or re-enforce a point. Copying pages out of manufacturers' manuals or internal documents are not required and are not encouraged. Good appendices will include diagrams and/or data collected which support the assignment.

Jeremy Browne, July 2008

(b) Short answer questions

The results ranged from a highest score of 10 correct answers to a low of 5 correct.

Whilst the majority of the papers showed a general based grounding in small pack filling operations, there were some areas which were well known, and others which were much weaker. In general pasteurisation and principles of small pack line design seemed to have been well learnt, and basic calculations were again well answered. However this paper showed a number of weakness areas with candidates not able to apply their calculation in practical situations.

(c) Long answer questions

Question 1 was answered by 9 of the candidates, with the remaining 5 chosing to answer question 2. Both questions generally had average results, with answers to question 2 being slightly better structured and hence scoring slightly higher marks.

Question 1

a. Describe the processes required to fill an empty glass bottle from the point at which it enters the filler to the point at which it is discharged from the crowner. [8]
b. List the checks required, from bottle infeed to pasteurizer discharge, to ensure the finished product will meet relevant food safety legislation. [4]
c. Produce a table of the key analytical checks undertaken at the bottle filler. Include the reason for the check, the frequency and the expected range of results (including any relevant units). [8]

The descriptions provided for bottle filling ranged from poor to excellent. The most complete answer detailed the whole filling process including cam movements, gas pressurisation sequences, vent tube information and bottle movements. However a number of candidates ignored both the jetting and crowning processes and so lost marks as a result, with only a limited number of answers covering missing crown detection systems.

The checks to meet food safety legislation should have been covered by following the process through the front end of the bottling line. Most candidates covered checks for contents and ABV, with some limited descriptions of foreign body checks at the rinser and EBI. Risk from CIP residue was also mentioned, however microbiological contamination of the pasteuriser and legionella checks were generally missing from most descriptions and only one candidate discussed bottle burst protection sequences.

The table of key analytical checks was generally disappointing with candidates identifying the parameters they would test for, but then only providing limited details of the reason for, and the frequency of, the test.

The expected range of results was also limited, and should be an area understood by candidates at this level.

Question 2
a. Describe, with the aid of a diagram, the operation of a tunnel pasteurizer, clearly detailing all relevant times and temperatures at each stage of the process. [10]
b. List the routine checks required on a tunnel pasteurizer to ensure relevant personnel safety aspects have been addressed. [4]
c. List all of the key actions and checks required on the pasteurizer, if a batch of product is placed on hold as a result of under pasteurization. [6]

The standard of drawings provided by candidates for this question was good, with most showing a clear representation of the operation of the tunnel pasteuriser with good references to times and temperatures. The descriptions were also generally of a reasonable standard, with good answers explaining the rationale for regeneration zones, and the links between zones. The best answers covered off exit temperatures of the containers, along with the reasons behind this, as well as use of PU monitoring devices along with an explanation of how cold spots can occur in containers.

The second stage of the question was looking for candidates to identify personnel safety aspects, and was not generally well answered. A good answer should have included use of PPE, housekeeping, chemical identification and bunding requirements along with safe operation and entry systems to allow for maintenance where required. Perhaps the most worrying was the lack of reference to legionella monitoring and treatment by the majority of candidates.

For the final section of the question the majority of the candidates correctly focussed their answer on the pasteuriser checks – although some candidates did waste time and marks providing long and detailed checks that they would carry out on the beer in order to determine whether or not it could be released safely.

Ruth Bromley – July 2008

Module 1 : Unit 4 – Quality and Hygiene

(a) Assignment
a. Describe the quality system in place for a primary packaging material used on a packaging line of your choice to ensure that this primary packaging material does not affect the quality of the finished product.
b. Provide details of the checks that are currently in place.
c.How could this system be improved towards achieving zero defects?

It is important to ensure that the submission answers the assignment questions. Good answers need to be to the point with sufficient depth of discussion. The quality of some submissions was most encouraging. Good submissions clearly identified the primary packaging material chosen with a discussion which included supplier QC and supplier partnerships.

The better submissions entered into the spirit of the assignment by critically investigating the chosen quality system and identifying where improvements could be made and suggesting possible solutions.

Eric Candy, July 2008

(b) Short answer questions
The results ranged from a highest score of 12 correct answers to a low of 8 correct. Generally there was a consistent spread of correct answers across the majority of the questions with only two questions appearing to cause candidates an issue. The steam requirements for sterilisation appeared not to be well known amongst candidates, and no candidate correctly identified the best graphical method of displaying and monitoring analytical results.

(c) Long answer questions
Question 1 was answered by 8 of the candidates, with the remaining 6 choosing to answer question 2. Neither question was particularly well answered, with nearly all candidates failing to score even half marks.

Question 1
a. Describe the principles and operation of a CIP system for a non-sterile fill canning line. [10]
b. List the key design criteria and materials of construction which should be considered for a canning line in order to minimize microbial contamination. [10]

Neither section of this question was particularly well answered by any of the candidates. The first section of the question was looking for a candidate to be able to explain the relationships in the CIP process between time, temperature, mechanical and chemical cleaning properties and their effect on soil. This was generally not done, and it was surprising how many candidates failed to detail what the chemical used for cleaning was. Most candidates then continued by only referring to the CIP regime for the filler, and generally ignored the cleaning requirements for the buffer tanks, pipework and utilities with a few exceptions.

The section on design criteria and materials of construction was answered with more details, although there seemed to be very little application of the theory to the actual reality of microbiological results achieved on a canning line. A good answer would have included aspects of the design including things like sensor positions, pump types and specifications, access hatches, pipework design and installation to name but a few. Some of the better candidates could identify the difference between 304 and 316 stainless steel, but very few recognised the need to use different materials on manually connecting pipework joints.

Question 2
a. Describe the analytical sampling processes required for a packaging line of your choice. [10]
b. Explain the different error factors which must be taken into account when interpreting the data produced. [10]

Most candidates produced a reasonable answer for the first part of this question. A good answer covered off each of the sampling areas in turn – from bright beer beer through to final package – and detailed the sampling and analysis that was required at each stage. A couple of candidates also explained why some analyses only happened by exception e.g. bitterness sampling in bright beer, and this helped demonstrate their understanding and application of the process in the real world. The best answers detailed the timings and frequencies of the sample schedule, as well as the risks and reasons behind the samples. Disappointingly only two candidates linked the samples to their previous reference point – i.e. from bright beer to holding tank. Very few candidates also mentioned the need to calibrate and check laboratory equipment, and there was no mention of sampling and analysis validation processes e.g. inter laboratory collaboration checks and blind sampling.

The second half of the question was much less well answered – with one candidate choosing to ignore it completely. Of the remaining five candidates most listed the issues around operator capability, and the repeatability and reproducibility of results with in analytical environment. However most then ignored the use of statistical analysis and trending of results, sample preparation conditions and threshold factors to name but a few of the errors that can creep in to the results.

Ruth Bromley – July 2008

Module Three
5 candidates sat this unit, with no candidates having any Recognised Prior Learning exemptions based on demonstrated evidence of their previous qualifications. Overall an excellent 100% pass rate was achieved on the exam, with one candidate gaining Grade B (20%), two candidates gaining Grade C (40%), and the final two candidates gaining Grade D (40%).

Module 3 Unit 9 – Process Gases for Packaging

(a) Assignment
a. Draw and describe a carbon dioxide collection system with which you are familiar.
Obtain the manufacturers performance specification for the quality of the collected carbon dioxide.
Investigate and describe the potential differences between the quality of the collected carbon dioxide collected against purchased carbon dioxide.

Describe the principal components of a carbon dioxide collection system and discuss the function of each.
b. For a beer supply system of your choice state the gas/ gases used along with the pressure and temperature conditions used for bright beer storage. Using solubility data supplied separately, calculate the equilibrium carbon dioxide concentration in the liquid in the tank, and compare this concentration with the specifications for the product stored in this tank.
Comment on the appropriateness of this pressure and temperature regime.

It is important to ensure that the submission answers the assignment questions. Good answers need to be concise but with sufficient depth of discussion.

Good answers should compare the quality of the carbon dioxide collected against the agreed specification. This should include looking at non oxygen impurities.

Part B answers identified some problems with mathematical errors plus use of the wrong conversion factors. It is vital that work is shown as the majority of marks are awarded for the approach used rather than obtaining a mathematically correct answer. The later is however important to your company as mathematical errors can lead to wrong decisions being made which could impact on product quality!

Good submissions explored the effects of various temperatures and pressures.

Eric Candy, July 2008

(b) Short answer questions

The strongest candidate achieved 11 correct answers out of 15 with the weakest achieving just 4.

The multiple choice questions spanned the entire syllabus including in some instance short computations. Candidates had most difficulty gas quality specifications and mixed results with the computational questions. All candidates displayed good know of CO2 liquification processes.

(c) Long answer questions

Question 1
a. Explain by using the appropriate physical relationships how the rate of carbonation of beer is affected by the beer temperature, carbon dioxide pressure, and method of introduction of CO_2. [7]
b. Identify and compare three different modes of carbonation. [7]
c. Beer at 1°C containing 2.5 vol/vol of CO_2 (at STP) is fed to a filler bowl and in transit it warms to 8°C. Determine the pressure the filler bowl must be held at in order to keep the CO_2 in solution. [6]

Henry's constants for CO_2:

Temperature (°C)	*Henry's constant for CO_2 (kPa/mole fraction)*
0	*78916*
5	*96799*
10	*115943*

1 mole of ideal gas at STP occupies 22.4 l
Molecular weights: CO_2 = 44, H_2O = 18

Two candidates chose this question and both passed. The first part should have principally been a discussion of the first order rate equation for carbonation identifying surface area, mass transfer coefficient and concentration driving force. It could also include Henry's law relating dissolved gas concentration to gas pressure, but it was not essential for this part.
The second part of the question asked candidates to indentify three types of carbonating systems (top gas, sparging, and inline venturi, for instance) along with some measure of comparison.
The final part was a relatively straightforward Henry's law calculation where determining the mole fraction of CO_2 (0.002) was required. In order to complete the calculation the candidate need to perform a linear interpolation on the Henry's constant data in the table provide to identify it as 108284 kPa/mole fraction at 8°C

As is always the case, the candidates are encouraged to read the question carefully and direct their answers specifically to what is being asked.

Question 2
a. From production to the point of use, describe with the aid of a diagram how compressed air for a packaging department is produced and distributed. Include in your answer typical key components and operating parameters, describing their relevant merits. Highlight appropriate safety requirements. [15]
b. List typical uses of compressed air in the packaging department, their differing quality requirements, and how those quality requirements are achieved. [5]

Three candidates chose this question and all passed. The examiner was looking for a detailed description of the components and layout of a compressed air system along with operating parameters and relative merits - that is, answering the question of "why is this component necessary?" An example could have been the relative merits of reciprocating versus screw compressors – a single compressor for a packaging department most likely will be a reciprocating compressor, while a distributed system for an entire brewery might be multiple screw compressors. Only one candidate chose to discuss safety requirements. The latter part of the question asked candidates to list uses along with differing requirements, for instance air quality for conveyor guides versus instrument air.

Tom Shellhammer, July 2008

Module 3 Unit 10 – Fluid Dynamics for Packaging and Materials of Construction

(a) Assignment

a. Describe and draw the beer supply system from bright beer tank to filler with which you are familiar. Include dimensions of pipe diameters from bright beer tank to the point of container fill. Record the pressures across the system and estimate the maximum and average flowrates. Include details from the manufacturer's plates of any equipment in this system.
b. Assess the filling performance of the filler against the manufacturer's guarantee with special reference to the stability of fill, fill height variations and filling rate.
c. Obtain the pump curves for the pumps in the system. Stating your assumptions calculate the Reynolds numbers for maximum and average flowrates for each pipe diameter.
d. Critically discuss the findings as to their relevance to the filler performance and beer supply system design. Suggest and justify if required any changes which would improve filling performance.

All the candidates achieved better than half marks with two submissions being very good and one being close to excellent.

In summary therefore, there were some encouraging good submissions. Good answers need to be to the point with sufficient depth of discussion. Some submissions lacked enough critical discussion.

However it important to ensure that the correct units are used. The unit of velocity is not m3/s! The critical angle of this assignment was to demonstrate an understanding of the effect of velocity on turbulence and subsequent stability of fill.

Eric Candy, July 2008

(b) Short answer questions

The strongest candidate achieved 12 correct answers out of 15 with the weakest achieving just 4. The majority answered more than half the answers correctly.
There was a good level of knowledge and understanding in the areas of turbulent flow, the parameters for calculating Reynolds Number, pumps and valves.

Pipe friction and the expression of equivalent head loss were not well understood. The unit for viscosity was not known by all but one candidate.

(c) Long answer questions

Question 1
a. Explain the terms austenitic, martensitic, ferritic and duplex when used to describe stainless steels. [8]
b. Why are austenitic stainless steels used most extensively for the

construction of beer processing and packaging plant? [4]
c. Describe various circumstances in which the corrosion of stainless steel can take place and the precautions that can be taken to minimise the rate of corrosion. [8]

Two candidates attempted this question with the better of two poor answers achieving just seven marks out of twenty.

In explaining the terms austenitic, martensitic, ferritic and duplex when used to describe stainless steels, a good answer would have included practical applications of each type to support specific, detailed information on the essential characteristics. The better of the two answers still failed to quote chemical analyses accurately. The weakest answer included neither analyses nor typical applications.

Both candidates provided a very superficial list of attributes for why austenitic stainless steels are used most extensively for beer processing and packaging plant. A reasonable answer would have listed, as a minimum, high resistance to corrosion, good weld-ability, toughness at sub-zero temperatures and excellent ductility.

Corrosion of stainless steel was covered fairly well by one candidate with a reasonable understanding of precautions that can be taken to minimise the rate of corrosion. Neither answer was able to adequately quote recognised limits for time, temperature and chloride ion concentration and preventative measures within the design and construction of plant.

Question 2
a. Describe, with the aid of a diagram, an appropriate type of automatic hygienic valve for product routing from a complex bright beer operation. [8]
b. Starting from an energy balance equation, derive an expression for the flowrate of a liquid through a horizontal pipe fitted with an orifice plate, the pressure difference across the plate being measured by a differential manometer. [6]
c. Explain why in practice a discharge coefficient has to be applied to the expression. [2]
d. Water flows at a rate of 1.2 x 10^{-3} m^3s^{-1} in a horizontal pipe of 150 mm internal diameter fitted with an orifice plate containing a concentric hole of 50 mm diameter. If the discharge coefficient is 0.61, the density of water is 1,000 kgm^{-3} and the gravitational constant is 9.81 ms^{-2}, what will be the difference in level on a water manometer connected across the orifice plate? State any assumptions. [4]

This question was answered by three candidates with the best answer achieving half marks.

Surprisingly, only one candidate chose a double seat mixproof valve for their description of an appropriate type of automatic hygienic valve for product routing from a complex bright beer operation. A butterfly valve was the choice of the remaining candidates.

Clearly the requirement to derive an expression for the flowrate of a liquid through a horizontal pipe fitted with an orifice plate and subsequently carry out a calculation proved to be a daunting prospect.

The derivation of the flowrate expression relied on the candidates' ability to combine Bernoulli's energy equation (applied to an upstream point and the orifice plate), with an equation representing the same pressure difference shown on the differential manometer. An expression for velocity can then be multiplied by the orifice area to give the flowrate.

No candidate satisfactorily explained that the discharge coefficient accounts principally for energy losses, losses due to turbulence and eddies and the fact that the minimum area for flow is not exactly at the orifice.

The calculation was solved by substituting the given information into the derived expression.

Robin Cooper, July 2008

Module 3 Unit 11 – Thermal Energy Transfer for Packaging

(a) Assignment

a. Using a packaging line of your choice list and describe the thermal energy transfer processes from Bright Beer Tank to Warehouse.
b. For three of these thermal processes estimate the theoretical thermal energy transfer requirement per hour by utility used. Please show your calculation methods in detail.
c. Compare this theoretical figure with your actual thermal energy transfer per hour (you might have to submit an estimate for this).
d. Comment as to whether and how the thermal energy efficiency could be improved.

The candidates' submissions produced marks ranging from poor, through moderate to good with one excellent result.

It is important to ensure that the submission answers the assignment question – this was a particular problem for one candidate. Some answers lacked sufficient depth of analysis and discussion.

Good answers compared theoretical performance with actual performance along with an attempt at rationalising the difference. Again it is vital that all working is shown as it is the approach which attracts the majority of the marks.

Eric Candy, July 2008

(b) Short answer questions

The range of correct answers was between 4 and 10 which represented a disappointing level of knowledge and understanding of this area of the syllabus.

Questions about the SI unit of heat, latent heat and an example of sensible heat were generally answered correctly by the candidates.

The majority of the remaining questions showed general weakness with no real pattern to the answers.

Of particular concern was the apparent problem in answering the two questions on units – firstly, deriving the unit for specific heat from a given equation and, secondly, knowing (or being able to derive) the unit of thermal resistance.

(c) Long answer questions

Question 1
a. Describe the equipment used and the process of both
i) flash (bulk) pasteurization of beer and ii) tunnel pasteurization. Answers should include flow diagrams of typical equipment and the temperature profiles through the process. [14]
b. What problems could occur with these plants and their operation that would compromise the integrity of the processes? [6]

Five candidates attempted this question with all candidates achieving half marks or better with two answers being awarded the highest mark of 13.

The flow diagrams of the flash pasteuriser and tunnel pasteuriser varied in quality. Worryingly there was a distinct absence of control equipment. The better answers included temperature and pressure instrumentation and the (requested) temperature profiles through the process.

Problems which could occur with these plants and their operation that would compromise the integrity of the processes include, for a flash pasteuriser: plate leakage; low pressure in the holding tube; low temperature in the holding tube; long periods of beer recirculation; plant cleaning. For a tunnel pasteuriser: line stoppages; speed control of the bed leading to under or over pasteuriser; loss of water temperature control; plant cleaning.

A number of candidates concentrated on the safety aspects of the tunnel pasteuriser, particularly the potential for legionella bacteria, which, whilst very important, was not being sought as an answer on the integrity of the pasteurisation process itself.

Question 2
a. Describe insulation materials and methods for insulating vessels and pipework that are operating both above and below ambient temperature, highlighting the problems that can occur if the insulation is not applied correctly or is damaged. [12]
b. A steam pipe is to be covered with two layers of insulation. Given the data below, calculate, as a percentage, by how much the effective conductivity is reduced when the better insulator is on the inside. State any assumptions made. [8]

Outside diameter of steam pipe: 200 mm
Thickness of each layer of insulation: 50 mm
Thermal conductivity of one type of insulation material: 0.16 $Wm^{-1}K^{-1}$
Thermal conductivity of the other type of insulation material:

0.04 $Wm^{-1}K^{-1}$

Disappointingly, none of the candidates attempted this question.

Candidates should understand the requirements for insulating surfaces both above and below ambient temperature.

Insulation is an example where poor heat transfer is a virtue. The vast majority of insulation systems rely on the poor thermal conductivity of air. However to prevent convection currents causing a pathway for the heat the air is immobilised by using a fibrous or porous structure. Above ambient temperature an open pore insulating material is chosen which will allow any water vapour in the insulation to permeate out. For applications below ambient insulation must be impervious to water, a better heat conductor, and a closed pore structure is selected. To prevent moist air penetrating to the cold surface and causing water condensation a material resistant to water vapour penetration, called a vapour barrier, is applied over the insulation. Metal or plastic cladding is added to protect this barrier and the insulation from damage. Insulation containing chloride ions should be avoided on stainless steel vessels due to the risk of corrosion, or the metal surface protected with chloride barrier paint.

The examiner would have expected examples of typical insulating materials for varying duties to have been included in a candidate's answer.

The solution to the calculation would have relied on a knowledge of how to apply Fourier's equation in steady state conditions and an understanding of thermal resistance calculation for multilayer systems. A candidate would, of course, have had to calculate logarithmic mean radii to produce a correct answer.

Robin Cooper, July 2008

Module 3 : Unit 12 – Process / Line Control and Instrumentation

(a) Assignment

a. Using a packaging line of your choice, list all the different sensors on the line, identifying their purpose, process accuracy required and calibration check interval.
b. Obtain the manufacturer's specification accuracy and calibration check interval.
c. Compare the manufacturers' specification with the process requirements and current calibration checks.
d. Comment on any changes that should be considered.

It is encouraging that there were some good submissions which identified all the sensors on the chosen packaging line. It is important to rationalise the process requirement with the specified acceptable maximum tolerance for the parameter measured. For example, is +/- 1°C acceptable for a temperature sensor controlling a pasteuriser? The effect of this variation on the process it is monitoring or controlling.

More detailed analysis of performance and calibration records would have been preferable with some submissions.

The better submissions entered into the spirit of the assignment by critically investigating the chosen quality system and identifying where improvements could be made along with suggesting possible solutions.

Eric Candy, July 2008

(b) Short answer questions

The strongest candidate achieved 13 correct answers out of 15 with the weakest achieving 9, thus this cohort had moderate to satisfactory understanding of this material.

The candidates clearly had a firm understanding of basic control theory and the basis upon which typical sensors operate. The weakest area involved understanding open versus closed loop systems.

(b) Long answer questions

Question 1

a. Describe with the use of diagrams an operation involving a control loop with which you are familiar. Your answer should include appropriate labelling and identification of the various signals, inputs and outputs. Include an example of a particular controlling algorithm for this system. [12]
b. Discuss how the system above might be monitored from a distance and how this information might be viewed or used elsewhere in the brewery. [8]

Three candidates chose this question and two passed. The first part should have included specific components of a control loop (i.e. the process, a sensor, the controller, and the controlling mechanism) with a specific example of each, preferably placed in the context of a familiar control loop in the candidate's working area. The candidates should have indicated the nature of the signal that is being passed throughout the loop, for instance an analogue signal leaving the controller that needs to be converted to a pneumatic signal to be used by a controlling actuator on a control valve. None of the candidates included a controlling algorithm describing how an error term is generated and what type of controlling action should be taken. The second part was weaker than the first in that the candidates did not elaborate sufficiently on the difference between a PLC controller and the SCADA system. Furthermore, the candidates spoke only in general terms that different parts of the plant could view the runtime/downtime data so that "plans could be made…".

Question 2

a. Discuss the range of control systems, from the simple to the complex, that may be found in a packaging plant. Present the advantages and disadvantages of each. [20]

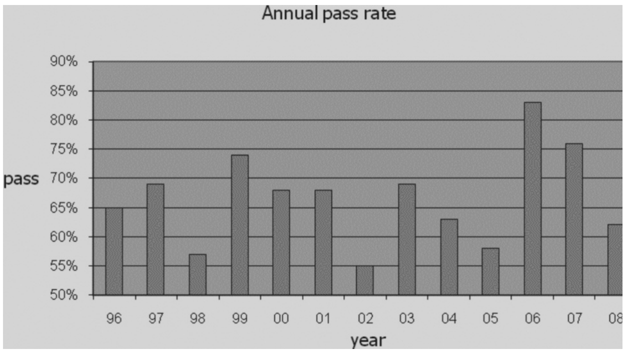
Two candidates attempted this question and one passed. This question asked candidates to examine the range of control systems from simple to complex. The examiner did not intend the candidate to describe all the various items that must be controlled, nor a detailed explanation of a single control system. The focus should have been discussing the range of controlling systems from the simple (for example, time stamp printing in response to a proximity detector switch) to the complex (for example, beer pasteurizer control relying on multiloop control using P, I, and D controlling algorithms). Stronger answers should have included specific details in how and why a control system was executed and why it was simple or complex. None of the candidates described the advantages and disadvantages of the systems they chose to describe.

Tom Shellhammer, July 2008

MASTER BREWER EXAMINATION 2008

Module 1 – Raw Materials and Wort Productuion

There were 34 papers were returned; this is twice last year's number. 21 (62%) candidates achieved a pass mark. This success rate should be compared with previous years' results, as shown in the chart below.



This year the general standard of papers was not particularly good but there were several papers with marks above 60%, which is unusual. The pass rate at 62% compares unfavourably with most other years.

I make no apologies for reminding candidates and mentors again to take note of the following points:

- Candidates often fail to answer five questions or answer their fifth question very badly. Good time management is as important in the examination room as it is at work.
- Too many candidates fail to read the questions carefully enough and either miss out some parts or misinterpret the question. For example one candidate answered the question about mash conversion systems by describing mash separation systems.
- Mentors should be encouraging their pupils to get as wide a range of practical brewing experience as is feasible in their individual situations and to read as widely as possible from textbooks, journals as well as electronic media. Mentors also have a responsibility to ensure that candidates under their tutelage are properly prepared for the examinations.

Question 1 – Maltings Audit
Describe an audit to assess the suitability of a maltings to provide malt for brewing. Discuss how such an audit process can ensure that the malt conforms to the brewer's specification as well as providing assurances for food safety.

This question was attempted by 12 (35%) candidates with only 5 (42%) achieving a pass. Few brewing companies now own their own maltings so it becoming increasingly difficult for brewers to get experience in the malting industry, though mentors must try and get their pupils placements in maltings, whenever possible. Audits are the best way for a brewer to ensure that the malt purchased will conform to specification. A good answer to this question would have briefly outlined the malting process, but not made this aspect the core part of the answer. Other issues which could have been discussed would include:

- quality management systems, e.g. quality policy, organisational structure, management commitment and review, internal audit, record keeping, traceability etc
- maltings environmental standards, e.g. buildings, equipment, maintenance housekeeping and hygiene, etc
- product control, e.g. malt inspection and analysis, stock rotation control on non-conforming product
- personnel, e.g. training and protective clothing.

Question 2 – Global Warming and Barley Growing
What might be the effect of rising global temperatures on farmers' ability to produce barley suitable for malting? Is it possible that climate change is influencing the current state of the global market for malting-quality barley?

When the quality of barley is poor, what techniques does the maltster have at his disposal to ensure that modification proceeds satisfactorily to produce a malt to the required specification?

This question was attempted by only 6 (18%) candidates, with 4 (67%) achieving a pass mark. There were several good answers to this question from candidates who had given some thought to this topical issue. The question invited speculation but in general brewers seem unwilling to move outside their comfort zone and think through the possible consequences of climate change. For instance, many stated that global warming will produce drier weather, this may be true of some parts of the world but for other parts wetter climates may well be the future. Only one candidate pointed out that if the world warms up then the latitudinal zone for growing barley may shift northwards in the northern hemisphere or southwards in the southern hemisphere. The second part of the question elicited some sound advice to maltsters for ensuring indifferent quality barley produces satisfactory quality malt.

Question 3 – Hop Markets
Discuss and explain the recent turbulence in world hop markets. Describe some techniques that may be used to lessen the effects that these events have brought about.

This question was attempted by 21 (62%) candidates with 17 (81%) achieving a pass mark. Clearly, candidates have been studying previous years' exam papers and have seen this question, or one similar, comes up quite often. I was pleasantly surprised to see haw many candidates had studied the current industry press (and possibly the internet) and identified the 'turbulence' as being (amongst other reasons) crop failures due to adverse weather conditions, loss of growing acreage, the use of hops for purposes other than brewing and a devastating warehouse fire in the USA. Techniques for lessening the effects of a hop shortage were described reasonable well by most who attempted this question.

Question 4 – Removing Unwanted Ions in Brewing Water
Outline two different methods of removing unwanted ions from a raw water supply and describe, with advantages and disadvantages, typical commercial installations which utilise these methods. List which ions are important to the brewing process and explain the contribution each one makes to final beer quality; rank them in order of their importance to the process and indicate how you have determined the ranking order.

This question was attempted by 24 (71%) candidates but only 9 (38%) achieved a pass mark. The general standard of answer to this question was very poor with a surprising number of candidates unable to describe correctly either a de-ionisation plant or a reverse osmosis plant. Those candidates who made a reasonable attempt were unable to supply anything like the amount of detail which a good answer requires. Many candidates could not define the terms temporary hardness and permanent hardness properly. This aspect of water composition is key to brewhouse performance and control of pH.

Question 5 – Physical and Chemical Changes during Mashing
Discuss how the brewer can influence the chemical and physical changes which occur during the mash conversion process. Describe two systems for carrying out this process indicating how these methods evolved and the parameters which must be controlled in order to guarantee the quality of the wort produced.

This question was attempted by 29 (85%) candidates with 12 (41%) achieving a pass mark. Despite this being the most popular question, the general standard of answers was poor. Many candidates failed to explain how and why different mashing systems evolved and these historical aspects are important in illuminating and explaining the different ways of brewing beer. Surprisingly, the parameters which must be controlled in order to guarantee the quality of wort produced were only adequately described in the best answers.

Question 6 – Wort Boiling Systems
There have been several innovations in the technology of wort boiling systems over recent years. Describe the operation of three commercially available systems, indicating how each one achieves the physical

and chemical changes which wort should undergo during the boiling process. Explain the market forces that are driving these developments.

This question was attempted by 23 (68%) candidates and 11 (48%) gained a pass mark. Candidates were much better prepared for this question than several years ago when a similar question was asked. With one surprising exception, all the systems on offer from the major manufacturers were described. Many candidates failed to highlight the two crucial purposes of boiling which are the chemical processes that take place at high temperature and the physical process of removing volatiles by evaporation. A good answer described how each of the systems chosen satisfied these two requirements.

There were several candidates who failed to note that the question asked: 'innovations ... over recent years' and 'commercially available systems', and then went on to describe direct fired coppers. Few candidates failed to observe that the rapidly rising cost of energy is one of the drivers behind these new technologies.

Question 7 – The Importance of pH
Discuss the importance of pH during the wort production process and its influence on subsequent processing and beer quality. Provide typical values at each stage. Review the different methods that have been used to adjust pH levels in the brewhouse and which conform to national or international regulations.

This question was attempted by 22 (65%) candidates with 15 (68%) obtaining a pass mark. Although the pass rate was high there were very few good answers. Calcium was identified by most as having a significant effect on pH in both the mash conversion stage as well as the boiling stage though there were quite a few who failed to explain the mechanisms. Few candidates described adequately the various methods, which include adding naturally produced lactic acid as well as mineral acids such as phosphoric and sulphuric, depending on local legislation, for reducing pH either in the mash conversion vessel or copper.

Question 8 – Brewhouse Health and Safety Audit
Design an audit to check on health and safety provisions for operators in a brewhouse and illustrate your answer with pertinent examples. Discuss how such an audit would ensure that risk and hazard are correctly identified and how these factors must be evaluated in order to recommend changes which would improve safety.

This question was attempted by 27 (79%) candidates with 19 (70%) gaining a pass mark. Similar questions have been posed in previous years' examinations and I have advised candidates, in previous exam reports, to outline a structured procedure for checking all the activities that ensure health and safety of operators. These can typically include evaluating risk and hazard, standard operating procedures, training initiatives and much else, all backed up by suitable records. Where appropriate, pertinent examples help illuminate a good answer. Candidates should be aware that the term 'health and safety' relates to the health and safety of brewery personnel, whereas the term 'food safety' relates to the health of the final consumer.

Bob Illingworth July 2008

Module 2 - Fermentation and Beer Processing

Scripts for marking were received from 24 candidates and 15 gained pass grades, a pass rate of 62.5%, which is a deterioration compared to last year and there were no passes at Grades A or B. There were 5 passes at grade C and 10 papers at grade D. Of the candidates who did not pass there were 7 papers at grade E and 2 at grade F.

As in previous years, the range of questions set were best answered using a combination of tables of data, labelled drawings or flow diagrams, and/or text laid out in the form of bullet points. This approach is usually a more effective way of presenting the information required than many paragraphs of long hand.

As a generalisation the poorer scoring this year appeared to be due quite simply to a lack of a comprehensive technical knowledge of the syllabus by many candidates. In particular it was surprising that there were only 13 attempts at the filtration question whilst the more general health and safety question was the most popular with 23 answers returned.

Examination technique can still be improved. In some instances candidates answered a different question to the one set (Question 2 was explicitly about health and safety not food safety). Others wasted time repeating information already presented earlier in the answer (again Question 2 where in some instances candidates described slips, trips and falls three times in the same answer and with the same information, under separate headings fermentation, processing and bright beer).

Candidates need only write the question number at the start of their answers. There is no benefit or score attracted by copying out the question from the examination paper.

Question 1
What measures should be taken in fermentation and beer processing to ensure colloidal haze stability in bottled or canned beer with a declared shelf life of twelve months? What tests are available to determine the level of stability achieved?

15 candidates attempted this question with only 4 passing (27%).
The first part of the question worth 15 (75%) of the marks required a description of colloidal haze stability and a proposed scheme to achieve a twelve month shelf life in bottle or can. Conditions to consider included:
- General factors to ensure good fermentation. For example yeast viability, wort dissolved oxygen, temperatures, yeast cropping, yeast storage etc.
- Maturation. Time and temperature. Oxygen control.
- Filtration. Use of precoats & body feeds. Temperatures.
- Stabilisation treatments. Proposed treatments (for example silica hydrogel, polyvinylpolypyrrolidone), methods of application and suggested rates of use.

The second part of the question worth 5 (25%) of the marks invited a brief description of the various tests that can be used to measure haze stability. For example an as is test would be to measure the haze of a sample stored at room temperature after twelve months. More useful are the various predictive tests such as the heat forcing or Chapon tests.

Most answers scored poorly because they failed to make a practical proposal of a stabilization procedure to achieve the required shelf-life and merely suggested a few of the treatments that are available for beer stabilization.

Question 2
Describe the main health and safety hazards that may be present in the fermentation, processing and bright beer areas of a typical brewery. What steps can be taken to minimise the risks to personnel working in these areas?

23 candidates attempted this question with19 passing (83%). Most were comfortable passes and there was one very good one.

This was a single part question worth 20 (100%) of the marks.

A table would have been an effective way of approaching this question using headings for the hazard itself, the nature of the hazard, and steps that can be taken to minimize the risk. It was expected that a discussion of the main hazards would have included:
- Carbon dioxide
- Hot water & steam
- Detergents and sterilents
- Electricity
- Confined spaces
- Manual handling
- Kieselguhr
- Slips, trips and falls
- Moving equipment

Actions to minimise the risk should have included a description of activities such as safe chemical storage, ventilation of fermentation cellars, storage and handling methods to minimize exposure to kieselguhr dust, manual handling, housekeeping, use of personal protective equipment etc. It was also expected that answers would include mention of management controls such as COSHH, risk assessments, work permits, hazard reporting etc.

The best answers systematically covered all of the areas mentioned above. Less complete accounts often identified the hazards correctly, but then only made vague statements regarding the steps that should be taken. For example when handling detergents, "Wear PPE", needed also to mention the actual equipment such as goggles, visors, gloves, aprons etc. Some answers included discussion of food safety which was not within the scope of the question.

Question 3

Starting at the laboratory stage, describe a yeast propagation process appropriate to achieve sufficient yeast to pitch 1000 hl of lager or ale wort.

Outline routine procedures used to ensure a consistent supply of high quality pitching yeast for all fermentations.

19 candidates attempted this question with 16 passing (83%). Most were comfortable passes and there were three very good answers.

This was a two part question. The first part attracting 14 (70%) of the marks invited candidates to describe a yeast propagation process usually starting with a laboratory slope and finishing with sufficient volume/cell count to pitch 1000 hl of wort. Conditions to discuss included

- Type of media or wort specifications
- The need for sterility, types of vessel and sizes
- Volumes and top up volumes and ratios,
- Temperatures, times, use of stirring or aeration, yeast cell count, wort gravity etc.

The second part of the question worth 6 (30%) of the marks was more general. Areas to discuss were about conditions of yeast storage and handling, such as temperature and time, sterilization of storage tanks, mains and air mains, together with typical tests used to determine the routine quality of pitching yeast.

The best answers used full page flow diagrams or tables to demonstrate the process through laboratory and industrial propagation to first generation brew. The second part of the question was also comprehensively covered by describing conditions of yeast storage, yeast generations, cleaning and sterilizing, acid washing and microbiological analyses. Weaker answers were usually characterized by a lack of detail and unrealistic dilutions during scaling up.

Question 4

Describe the range of equipment available for the filtration of green beer. Discuss the advantages and disadvantages of each.

13 candidates attempted this question with only 5 passing (38%). There were no good answers.

This was a single part question worth 20 (100%) of the marks.

This should have been a very straight forward question. It was expected that candidates would base their answer on a description of plate and frame, candle, leaf and crossflow filters. A well labelled diagram of each would have been a good starting point to achieve this. Supporting text should have gone on to discuss the relative advantages and disadvantages of each. Parameters to consider were those such as flow rate, turnaround time, ease of automation, maintenance requirements, cleaning, flexibility etc.

The main reason candidates scored poorly was due to a lack of detailed knowledge of the equipment. In particular candidates tended to make only vague statements regarding the advantages and disadvantages.

Question 5

Due to malt shortages and increasing prices a brewer is considering reducing a proportion of the malt in a premium lager, ale or stout brand with a liquid or cereal adjunct. Describe a suitable trial process for evaluating the effects of the change in fermentation, beer processing and finished product and for achieving a flavour match with the original liquid. Discuss the likely composition of the project team.

Nine candidates attempted this question with seven passing (78%). There was one good answer.

This was a two part question.

The first part was worth 16 (80%) of the marks. A good answer would have started with an assumption regarding the current recipe (for example 100% malt) and then proposed a certain adjunct rate for the modified recipe (for example 15% of a nominated liquid or cereal adjunct).

A suitable trial programme would then have been described in terms of the number of trials and perhaps proposing a start up at pilot scale before progressing to industrial size brews. Factors to evaluate should have included:

- Wort composition (with regard to factors effect yeast performance)
- Fermentation performance over successive yeast generations
- Beer filterability
- End product analyses including haze stability
- Sensory including expert panel, the nature of the test used, the number of trial samples, and perhaps the use of external consumer tests.

The second part was worth 4 (20% of the marks). All that was required were some brief notes on the likely composition of the project team including not only brewers but also engineers, planners, packagers, quality and brand owners.

To answer this type of question well candidates need to have a clearer idea of what constitutes a trial programme. For a brand of strategic importance it is not usually adequate to undertake an immediate changeover to the new recipe, even if a blending programme is included.

Question 6

Discuss the possible causes and effects of microbiological contamination of beer in the fermentation and beer processing areas of a brewery.

Outline the steps for taking an aseptic sample from a tank of beer.

Briefly describe the microbiological techniques used for detection of beer contamination.

12 candidates attempted this question with 7 passing (58%). There was one good answer.

This was a three part question.

The first part was worth 12 (60%) of the marks.

The causes of microbiological contamination may include:

- Plant design leading to inadequate cleaning e.g. Pipework deadlegs, shadows under cooling pipework, poor surface finishes (crevices)
- Inadequate cleaning & sterilizing of tanks, hoses, fittings, gas mains
- Perished valve or door rubbers
- Poor environmental housekeeping
- Use of contaminated yeast for pitching
- Poor fermentation performance
- Overfoaming
- Beer recovery
- Inadequate procedures of lack of training on hygiene related procedures

Effects of microbiological contamination in beer are often observed as:

- Haze
- Ropiness
- Deposits
- Super-attenuation
- Off-flavours

The second and third parts of the question were each worth 4 (20%) of the marks.

The second part required a back to basics description for taking an asceptic sample. This section was generally competently covered.

The third part required a description of typical media together with innoculation techniques, such as spread plates, pour plates, forcings etc. Incubation times and temperatures should also have been included. For most candidates this was the weakest part of their answer.

Question 7

Describe Key Performance Indicators (KPIs) that could be used to monitor the performance of the fermentation and beer processing areas of a brewery. For each KPI indicate the factors that influence performance and the areas to focus upon in order to achieve further improvement.

18 candidates attempted this question with 7 passing (39%).

This was a single part question worth 20 (100%) of the marks. There were two good answers.

This question was intended to assess candidates' knowledge of the factors that determine the operational and business effectiveness of the fermentation and beer processing areas of a brewery, and how these can be measured and improved upon.

An ideal answer would have presented the information in the form of a table with separate columns naming and describing each key performance indicator (KPI), indicating typical performance and suggesting relevant areas to focus on to achieved improved performance. Typical KPIs that might have been mentioned ranged from conformance to process time, losses, quality indices, utilities usage, productivity and financial measures.

Few candidates got near the full scope of the question. Many mentioned various in process targets such as original gravity, attenuation limit or yeast viability. Although important, such factors are not normally considered to be KPIs. Please note, where local abbreviations are used it is essential that these are adequately defined.

Question 8
Review the techniques available for the recovery of beer from yeast and describe the advantages and disadvantages of each. What are the options available for the further utilization or disposal of the recovered beer?

11 candidates attempted this question with seven passing (64%). There were no particularly good answers.

This was a two part question.

The first part was worth 15 (75%) of the marks. This section should have described the design and operation of equipment most commonly in use for recovery of beer from yeast, typically yeast presses, centrifuges and cross flow filters. Advantages and disadvantages are generally around yield, rate of processing, cleaning and maintenance, automation potential and space requirements.

The second part of the question was worth 5 (25%) of the marks. When recovered beer is added back to the process the possibilities include:

- Whirlpool or before wort cooler
- Fermentation vessel during active phase of fermentation
- Beer transfer main between fermentation and cold ageing
- Beer transfer main before filtration (from cross flow filter)

Typical addition rates of recovered beer range between 0-15%.

John Shardlow - July 2008

Module 3 – Packaging and Beer Dispense

In 2008, 26 papers were received of which 15 (58%) achieved the pass standard. This represents a slight increase on last year's percentage.

Pass marks were seen at grades B, C and D.

The increase in pass rate back to the level of 2006 was encouraging and the overall standard was also improved on last year. There were three particularly good scripts and several candidates produced excellent answers to some of the questions.

It is worth noting that again five of the questions were more popular than the other three, though not as markedly so as last year This suggests a clear focus by candidates in a restricted part of the syllabus. The paper is taken from the full scope of the syllabus and candidates who are conversant with the full breadth will have an increased chance of scoring highly.

The best candidates were able to clearly demonstrate their knowledge and direct experience of a topic area. To score a good pass this standard is needed across a range of answers.

Generally, examination technique was good with only a couple of candidates appearing to run out of time through poor planning this year. It is almost always the case that five evenly spread answers will achieve a better overall result than all the effort being focused in two or three answers.

Lack of detail in scripts, typified by answers containing only sweeping generalities, lead to very few marks being scored.

Question 1 – Plant Design
Design a canning line to produce the following annual volumes based on 24 hr production availability and a 7 day week
50, 000 hectolitres of 250 ml cans
350, 000 hectolitres of 330 ml cans
600, 000 hectolitres of 500 ml cans.
The line should have the capability of packing into both solid board multi-pack and tray and shrink formats.
Draw a diagram showing the layout of the line.
State any assumptions made, including the expected staffing levels, and justify the choice of equipment and machine throughputs.

This was the second most popular question with 22 (85%) of candidates answering. However, it was generally poorly answered with only10 (45%) reaching the pass standard, though there was one extremely good answer.

Line design was dealt with disappointingly by candidates this year. Many candidates could not deal with the three different sized cans, nor could they identify clearly unfeasible options when calculations went wrong. Good answers could clearly identify the required plant and justify selections. The calculation based on sensible assumptions of operating time and machine efficiencies formed a good core of the marks.

Question 2 – Management Information System
Describe the key features of a computer-based management information system used to facilitate the control of all aspects of packaging production from order planning to dispatch.
Your answer should include reference to supply chain, production and quality data handling.

This was the least popular question with only six (23%) candidates answering. It was generally poorly answered by those attempting and only two (33%) achieved the pass mark, though one of these did answer particularly well.

There was the potential in this question to display a broad knowledge of the information needed to run a packaging line and the benefits of organising that information. Good answers mentioned a wide range of data and explained the benefits of a variety of reports for control of the operation. Poorer answers only contained a very restricted range of information with little thought as to the uses of the data.

Question 3 – Environmental Impact
What is the environmental impact of a returnable bottling line operation?
How can this impact be measured and minimised?

This was a moderately popular question with 20 (77%) of candidates answering. It was well answered with 13 (65%) achieving the pass standard, including one excellent answer.

A good answer to this question included a broad view of the various direct and indirect impacts on the environment which are caused by the operation of a packaging plant. Energy usage, material usage and emissions (including noise) of both the plant and indirectly the supply chain could be included. Poorer answers had limited scope (e.g. focussing solely on the bottle washer) and did not deal convincingly with the control of the discussed impacts.

Question 4 – Budgets
Describe the components which make up a revenue budget for a keg OR cask filling line.
What would be the impact of a significant energy cost increase on the various components described?
What steps could be taken to reduce the effect of the increase? Both revenue and capital expenditure options should be considered

This was the third least popular question with only ten (38%) of the candidates answering of whom six (60%) achieved a pass.

Good answers to this question gave a clear outline of a revenue budget and the relative importance of the main contributors to spend. The energy part of the question requires a knowledge of the importance of the energy contribution to all components not just the energy used directly in the plant and good answers were able to identify this and this lead to sensible cost saving measures. Poorer answers had an unstructured approach with little feel for the relative magnitudes of the various budget components and therefore cost saving measures were general and untargeted.

Question 5 – Retail Outlet
What are the important features in a retail outlet cellar, or equivalent beer storage area, selling both draught and small pack beer?
Explain how the features described help to assure the best quality taste, presentation and hygiene of the retailed product.

This was the most popular question with 24 (92%) of candidates answering. It was also well answered with 16 (67%) reaching the pass standard.

The key to a good answer in this question was to relate the well known features of a cellar to the quality assurance part of the question. Poorer answers were restricted to describing the features of a cellar with no explanation of why the features are important. Good answers were able to relate the features to specific quality parameters and detail the consequences of poor cellar design.

Question 6 – Keg/Cask Control of Cleaning and Filling
Describe in detail, the processes of internal cleaning and filling of kegs OR casks.
Explain how the processes ensure that product quality is not compromised.
What process and quality control checks are made to ensure correct operation of the plant involved?

This was a moderately popular question with 19 (73%) of candidates answering. It was generally well answered with 13 (68%) achieving the pass standard, including two excellent answers.

To achieve the best marks in this question the technical detail of cleaning and filling was first required. Some detail of why the processes are in place and the consequences of process failure would then lead logically to checks to put in place to confirm correct operation. Again practical detail is needed to produce a substantial answer. Poorer answers to this question tended to restrict the discussion exclusively to the process of cleaning and filling only and ignored the other parts of the question.

Question 7 – Packaging Materials
For a bottling line handling non-returnable bottles, packed into both tray and shrink and solid board multipacks, describe how poor packing material quality can adversely affect each stage of the process from material intake to finished goods warehouse.
Discuss suitable specifications for packaging materials.
Describe the systems required to ensure that these specifications are met.

This was the second least popular question with only eight (31%) candidates answering. It was only moderately answered with four (50%) achieving the standard needed for a pass.

To score well on this question evidence of understanding of the impact of material quality at a practical level needed to be demonstrated. By discussing the specifications a comprehension of the important parameters could be demonstrated and finally some detail of methods of quality assurance was needed. Poor answers tended to focus only on one part of the operation or only deal with one or two materials (e.g. only the bottle itself).

Question 8 – Bottling/Canning Process Control
For either a bottling or a canning operation, list the process control measurements which should be taken to assure product quality.
Explain the rationale for each measurement, and detail the expected targets and tolerances.
What actions should be taken if an out-of-tolerance result is recorded?

This was the third most popular question with 21 (81%) of candidates answering. It was well answered with 16 (76%) achieving the pass standard and there were two excellent responses.

The marks in this question were evenly distributed between the three parts. Poorer answers either lacked breadth (only focusing on the filler) or depth (not being able to supply necessary detail). Good answers focused on product quality, identified critical areas where quality could be compromised and gave sensible specifications and corrective actions.

Jon Brown – July 2008

Module 4 – Materials and Wort Production

Summary

Of the 14 candidates this year 12 passed (85.7%), a higher proportion than last year but with lower overall marks. Only one candidate achieved a B grade, five a C grade and six a D grade. Knowledge and experience of brewing central services was good and the results for Health and Safety were excellent. The Finance question was again avoided and where attempted was failed. That was disappointing as finance is so important for brewers to understand and the questions are generally not difficult. It was encouraging to see very few examples of questions being interpreted to fit the candidate's knowledge.

Question 1 – Refrigeration
Attempted by 10, passed by 7 - (70%)
For a brewery with a centralised refrigeration system show on a diagram the main components with typical refrigerants, temperatures and pressures.
How can efficiency be assessed for the overall system and describe how the critical items of plant affect efficient running.
If performance was declining what could be the possible causes and how could the problems be rectified.

Answers showed the many types of systems in use in the candidates' experience. There were some good detailed diagrams but several were sketchy with few details. All candidates understood the principle of performance measurement and most had a good understanding of investigating and rectifying a drop off in performance.

Question 2 – Process Gases
Attempted by 13, Passed by 12 – (92%)
Describe, with a labelled diagram, the principal uses of process gases within a brewery including a small pack and a large pack operation.
How can gas quality be ensured and what procedures can be put in place to eliminate process gasses as a product quality complaint.
What factors determine whether it is economical to recover CO_2 from brewing and packaging.

Generally well described with a wide interpretation including sterile air alongside the more obvious CO_2 and Nitrogen. Ensuring gases were not a feature of potential customer complaints was less well answered but the better candidates emphasised the importance of routine checks. There was a good understanding of factors that would make CO_2 recovery viable.

Question 3 – Quality Systems
Attempted by 12, Passed by 8 – (67%)
There have been a number of complaints about an off flavour in a brewery's packaged beer. Describe in detail:
a) A short-term action plan to contain the problem;
b) A systematic investigation to identify source of the problem.
Note that the problem does not appear at the time of packaging but is recognisable within one week of packaging.

A straightforward question that was well answered although several candidates did not emphasise the importance of the urgency to contain a problem in the short term. The better answers included a very detailed description of procedures to investigate, drawing in all the relevant personnel as a team. Some described methodical problem solving techniques and the importance of records and traceability.

Question 4 – Project Management
Attempted by 9, passed by 6 – (67%)
What factors would be considered in the justification for the following projects?
a) High efficiency motors for a packaging line.
b) A new boiler.
c) Additional fermenting vessels.
To integrate a new multi-packing box erector into a bottling line, describe methods and procedures to ensure transfer of ownership from the project team to the packaging department.

Candidates were good at identifying justification for project expenditure and some had clearly experienced an implementation. The better answers stressed the importance of early involvement of user department personnel to build in transfer of ownership. The less good candidates relied on procedures to control contractor performance.

Question 5 Air Compressors
Attempted by 8, Passed by 6 – (75%)
Describe, using diagrams, two types of air compressor and the advantages and disadvantages of each for brewery operation.
How can costs for compressed air generation and distribution be minimised?

Less well understood than refrigeration but again demonstrating the diversity of equipment in use. Some good diagrams but others had no real experience. Most candidates demonstrated knowledge of potential losses from leaks but few considered efficiency at generation or management of multiple compressors.

Question 6 – Plant Capacity
Attempted by 5, Passed by 2 – (40%)
For a brewery producing two types of beer, 50,000 hl annually at 9% ABV and 350,000 hl annually at 5% ABV, estimate the size and number of fermenting, conditioning and bright beer tanks required to run the plant on a two shift pattern for five days/week (80) hours. State any assumptions made and specify any raw materials used. Assume:
a) the brew length at 5% is 500 hectolitres and all output is bottled at 150 hl/hr;
b) time from mashing to filtered bright beer is 3 weeks for the 5% and 4 weeks for the 9% beer;
c) peak weeks are met without overtime but all brewing time is used.
If demand for the 9% beer increases to 60,000 hl annually and 390,000 hl annually for the 5% beer, what plant or operational modifications would be necessary. Identify where costs would change.

This question was not attempted by many and poorly answered. Some candidates derived the number of vessels logically but assumptions and descriptions lacked detail. The effect of changes in capacity on costs also lacked detail but did include some good ideas on maximising outputs without additional plant.

Question 7 – Health & Safety
Attempted by 10, Passed by 10 – (100%)
For a packaging line describe the potential hazards for each item of equipment, service or area.
Describe the safety procedures that should be in place for the following individuals to carry out work on the line:
a) Production operator;
b) Maintenance technician;
c) Contract staff from the equipment supplier.

This question was very well answered and should re-assure us all that candidates have a firm grip on the importance of Health and Safety. There was a clear understanding of the hazards associated with a packaging line and how different personnel are affected. One candidate achieved full marks for this question.

Question 8 – Finance
Attempted by 3, Passed by none – (0%)
If electricity, gas (or oil or coal), water and effluent are considered as semi-variable costs, provide a chart identifying for a brewery with both bottling and kegging, the areas of consumption and the proportion of typical costs. For each area specify what proportion could be considered as variable and why.
Describe the equipment and control processes that need to be in place to monitor and control the departmental financial performance for electricity, gas (or oil or coal), water and effluent in a manner that permits end user accountability.

Once again candidates avoided this question on finance and although straightforward, all scored less than the pass mark. For some it was the last question at the end of the paper and for others there was no understanding of the difference between fixed and variable costs.

Ian Bearpark - July 2008

Module Five - Case study

This year 20 candidates sat the paper and 13 passed (65%),which is a slight improvement on last year (58%). 9 candidates chose question 1 and six of those achieved a pass, 11 candidates chose question 2 and seven of them achieved a pass.

It was again apparent that some of the marginal and failed candidates did not read the questions carefully, particularly question two which was about management systems not just quality systems however it was good to note more scripts being planned for layout and structure with some better use of tables and diagrams.

Question 1
Stating your assumptions, describe in detail:
a) The recipe and
b) The product costing
For a 5% ABV canned lager to be sold in a take home market of your choice.
What key areas of planning, procurement, production, warehousing and transport will significantly influence the quality and profitability of this product?

The question was looking for an understanding of standard product costing and a good way to start the answer was with a component cost table or matrix for the unit of sale chosen such as a case of 4x6x500ml. Each part of the costing should then be derived from recipe calculations and material bills also making reference to the overhead costs, their level and split. Good candidates then commented on the merits of marginal costing to show understanding of the relationship between fixed and variable costs as well as describing manufacturing techniques which could reduce unit costs if pursued.

Candidates covered raw materials in brewing quite well but packaging materials and processes were not so well covered with few candidates highlighting the proportion of final pack costs associated with packaging cans and very little mention was made of basic packaging performance measures such as fill control. Good answers referred to extending and use of high gravity brewing, the importance of loss monitoring and control at every stage of operations and the impact of efficiency on items such as utilities. Also the good candidates linked this with the planning process to ensure stocks were at the right level and process flow was optimized.

Overall there was still far too much emphasis upstream of the bright beer tank with significantly less understanding illustrated for processes and controls down stream.

Some candidates then spent too much of their time going in to the detail of product quality system and analytical specifications without making the link between quality, cost and profitability this meant they spent little or no time considering planning, procurement, transport and warehousing restricting their opportunity to gain marks. The better candidates managed their time to ensure they described some key points in these areas.

Question 2
In a new brewery operation based in an emerging market, what management systems would need to be put in place to ensure beer quality and legal compliance?
Describe how these systems would be prioritized, implemented and maintained.

This question is looking for the candidate to exhibit knowledge of how management systems are structured and tie together, too many candidates launched in to it without reading what it asked and went on to focus totally on quality systems only thus severely restricting the amount of marks available to them.

In the introduction candidates should describe the scope of the brewery, its size, site and local environment; from this a management structure is defined along with the relevant workforce structure and skills requirement.

Good candidates then outlined quality systems such as ISO, and HACCP describing how they can be used as a management tool rather than their definition. Linked to quality systems good answers covered health and safety systems such as COSHH and Human Resource schemes including grading and training.

Legal compliance called for the candidate to introduce local expectation in the assumption and cover both business requirements such as environmental and taxation such as excise duty.

Only a few of the better candidates referred to the requirements of packaging particularly primary package material checking and content control including provision of insurance for third party injury or product contamination.

The second part of the question required the candidate to integrate the systems described and comment on priorities, people requirements, outline costs and the order in which they could be set up. Good candidates illustrated how these systems would be built from the ground up by sound management rather than the easier option of imposing a large company system from afar.

Most candidates mentioned auditing as a key part of system maintenance and this along with specification management, taste evaluation and record keeping was well covered by many.

Jim Robertson - July 2008

THE GENERAL CERTIFICATE IN BREWING AND PACKAGING EXAMINATIONS

November 2007

The Autumn series of examinations for the General Certificates in Brewing and Packaging (GCB, GCP) was held on 12 November 2007 at 35 centres in 15 countries.

This was the fifth of the new multiple-choice examinations with specialist options for brewing and packaging variations, i.e. Cask, Keg, RB (Returnable Bottles), NRB (Non Returnable Bottles) and Can.

There were 286 entries, with an overall pass rate of 57%, slightly lower than of late.

The break-down between GCB and GCP results is shown below in table 1.

Table 1

Subject	Distinction	Credit	Pass	Fail	Pass rate %
Brewing	0	18	57	73	51
Packaging	0	20	68	50	64

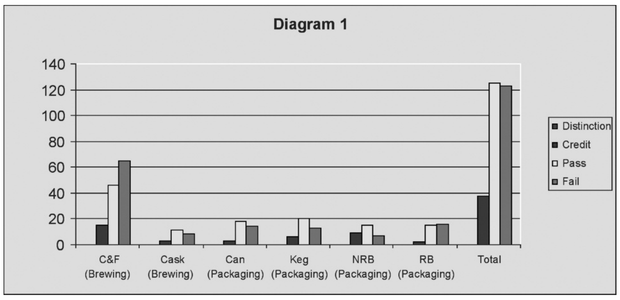


Diagram 1: a graphical distribution of pass grade by option.

Comments

Overall the pass rate for GCB was, unfortunately, one of the lowest on record, with 'C&F' significantly worse than 'Cask'.
For GCP, however, the figure was to expectation (around 67%).
No distinctions (90%) were awarded.

The difference in performance between GCB and GCP candidates is difficult to explain, especially given that 30 of the 60 questions set for all six papers come from a common question bank, being based on the same sections of the syllabi, i.e. beer quality, plant cleaning, engineering maintenance and utilities.

One question from the GCB paper was deleted from the marking schedule as it contained a significant spelling error.

It appears from the results that, unfortunately, many of the GCB candidates have been ill-prepared for this examination.

Companies are encouraged to ensure that the support and commitment they give to their examination candidates i.e. the quality of course material, tutoring and mentoring, is always to the required standard.

It should be noted that

a) the BOE is examining candidates on the entire GCB/P syllabus, and not just the revision notes;

b) the pass mark for a multiple-choice examination, given the chance of random selection of the correct answer, has by its very nature to be much higher than for a traditional 'narrative' examination: whereas the latter was set at 55%, the former requires 40 correct answers out of 60 for a 'pass' to be awarded: 'credit' is set at 48 correct answers, and 'distinction' is set at 54

Colin McCrorie

May 2008

The Spring series of examinations for the General Certificates in Brewing and Packaging (GCB, GCP) was held on 12 May 2008 at 42 centres in 16 countries.

This was the sixth of the new multiple-choice examinations with specialist options for brewing and packaging variations, i.e. C&F, Cask, Keg, RB (Returnable Bottles), NRB (Non Returnable Bottles) and Can.

There were 227 entries, with an overall pass rate of 63%, better than the 57% achieved at the previous November examination.

The break-down between GCB and GCP results is shown below.

Table 1

May 2008

Exam	Option	Distinction	Credit	Pass	Fail	Total
GCP	Can (Packaging)	1		2	1	4
	Keg (Packaging)			8	7	15
	NRB (Packaging)			5	4	9
	RB (Packaging)			9	18	27
GCB	C&F (Brewing)	5	36	69	52	162
	Cask (Brewing)		1	8	1	10

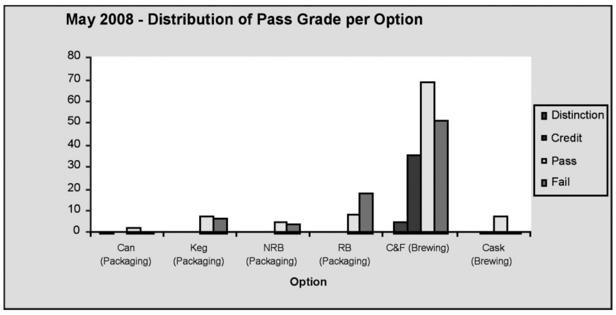


Diagram 1: a graphical distribution of pass grade by option

Comments

Overall the pass rate for GCB was 69%, with 5 distinctions (90%) and 37 credits (80%): this was a significant improvement in standard, especially in the number of 'good' passes.

For GCP, however, the figure was, at 45%, disappointingly low, with one distinction and no credits being awarded.

It appears from the results that many of the candidates who achieved marks around the pass/fail interface have been ill-prepared for this examination: there was evidence within these scripts of candidates with extensive knowledge of one syllabus section and little if any knowledge of other sections, suggesting they went in to the examination armed only with experience of their own job, with no additional preparation or study.

Given the nature of this multiple-choice examination, candidates need to study the entire syllabus to maximise their chances of passing.

Companies are encouraged to ensure that the support and commitment they give to their examination candidates i.e. the quality of course material, tutoring and mentoring, is always to the required standard.

Colin McCrorie

General Certificate in Distilling Examination

November 2007

The November 2007 examination was offered in three versions, one being the standard GCD. For the first time the GCDI was offered both in English and Afrikaans, for the convenience of eight South African candidates. Four candidates sat the standard GCD, two passing at Credit grade, but unfortunately one failed. Results in the International version were much less successful; only two of the 10 candidates passed, one at Credit grade. As usual, most of the candidates who failed nevertheless provided some very good answers, but not enough of them.

Previous reports have provided an opportunity for me to comment on the more serious mistakes in the scripts, or perhaps just more commonly-occurring. This was mainly intended as advice to future candidates, so on this occasion such a discussion would be pointless. As has been well IBD magazine *The Brewer & Distiller International*, future GCD examinations will be entirely in the form of multiple-choice questions.

Candidates for the May 2008 examination will be advised individually of the new syllabus and examination arrangements, but it may be of general interest to summarise the changes here. There will be only one examination (equivalent to the previous GCDI) in which 40 multiple-choice questions are based on those aspects of the syllabus which are common to distilled spirits produced from grapes, sugar-cane molasses of cereal starch, and the other 20 examine the candidate's knowledge of only one of these specialisations. However, there will continue to be a choice of answering either on maturation of "brown spirits" or on the production of gin and vodka. Also, candidates from the whisky industry can choose questions on the technology of either grain or malt distilling.

For some years now the number of multiple-choice questions in the examination papers has gradually increased, without causing any obvious problem. So I am confident that the introduction of a completely multiple-choice examination will be welcomed by candidates.

Iain Campbell

May 2008

Of the 108 candidates who sat the new multiple-choice Certificate examination, 78 passed (72.2%). This is similar to the pass rates in the past two years of the old-style examination, and much better than the 63.5% pass rate of 2005, the last time we had over 100 candidates. However, no Distinction grades and only 15 Credit grades (13.9%) are poorer statistics than previously; perhaps the changed style of examination caused problems for some candidates. It is impracticable to publish the complete list of questions with their correct answers, not least because we want to re-use as many as possible some time in the future! The intention of each 4-part question was to provide one correct answer in association with three plausible but wrong statements. Perhaps many of these "distractors" were too plausible to candidates who were not sufficiently knowledgeable of the topic of the question, but it is equally possible that candidates did not read questions carefully enough to appreciate exactly what was being asked. So I have chosen the following examples of questions which generated a high proportion of wrong answers to illustrate the strategy of answering different types of multiple-choice question.

Firstly, however, there were a number of questions where the correct answer could be identified by reasoning, even without previous experience of the situation. One such example concerned the correct order of the processes of blending, chill filtration and reduction to filling strength for packaging. Obviously blending had to be first, to create a single product for the other procedures, and only one of the four sequences provided that option.

All previous GCD papers have included questions on preparation or interpretation of graphical data. Preparation of graphs by candidates is no longer possible within the constraints of multiple-choice format, but deducing information from prepared graphs continued to perplex some candidates. In the question based on.graphs of normal and faulty fermentations, the fall in pH was carefully drawn identically on both graphs but the graphs of yeast growth showed pitching rates of approximately 8 and 2 g/litre respectively. Even if candidates did not use g/litre in routine measurements at work, the four-fold difference should have been the clue to the correct answer: insufficient pitching yeast. With the allowance of an average of 2 minutes per question, there is ample time to consider carefully all of the information provided.

That includes interpreting correctly the wording of the question. One question which many candidates answered wrongly concerned triple distillation, specifically on the principal difference between double and triple in the hypothetical situation of distilling the same wash. Many candidates chose "triple distillation produces stronger whisky". It is true that the new spirit is stronger, but after the necessary reduction, the maturation and bottling strengths of the whiskies will be the same. The correct answer was "triple distillation produces whisky with a lower content of low-volatile congeners": partly due to the greater rectification, and partly due to the proportionally greater post-distillation dilution, reducing the content of these congeners even more.

For some questions it was impossible to devise three plausible "distractor" statements so the format was reversed to provide three correct and one wrong. Alternatively, candidates had to identify the statement least rather than most likely to be correct.

Although both are legitimate types of question, that situation clearly confused some candidates, not least in the question on the least effective source for recovering energy from hot water. I was surprised by the high proportion of answers naming a shell-and-tube condenser, which can be operated to give high water temperature throughout distillation. In fact that is the best of the four named sources of recovered heat energy. I sympathise with those who chose condensate from pot still heating coils (probably re-used as top-up boiler water), but that was regarded as wrong since the question asked candidates to consider not only temperature and volume, but also availability throughout distillation, which is true of coil condensate. Since the volume of spent lees is relatively small, and available only at the end of distillation, that was accepted as the correct answer. That section also included a question on identifying the lowest BOD of the following packaging wastes: bottle rinsing water, waste detergent, filter washings and spilt whisky (e.g. from leakage or broken bottles). I assume that the frequent choice of spilt whisky was based on the reasoning that since spillage should not happen, then it should not contribute to BOD. But the question concerned the actual BOD of these four specified liquids, not the amount accumulated in a given time in a well-run packaging operation. In fact, a whisky spillage, if it occurred, would probably be the highest BOD on the list. On the reasonable assumption that only new bottles are used, the clean rinsing water must be the lowest BOD.

Although only a few questions and answers have been analysed for this report, I hope that they illustrate sufficiently the principles of answering multiple-choice questions. Essentially you have to read each question very carefully, also any associated graph, sketch or table, to understand what is required. Of course there was never any intention to mislead candidates, but for some questions the response to a less than thorough reading might not be correct.

Iain Campbell

Successful Candidates

The successful candidates from the 2008 Diploma and Master Brewer Examinations, who meet all IBD criteria, are listed as follows:

MASTER BREWER EXAMINATIONS

Master Brewer – Module One Passes

NAME	SECTION
Alobwede Metuge, Charles	Africa
Audet, Travis	International
Bajner Robert, Erno	Africa
Broadbent, Jonathan Paul	Midland
Brown, Lianne	Great Northern
Cousins, Winston Anthony	International
Donehower, Weston John	International
Gilleland, Emma-Jane	Midland
Harrington, Criona Threase	Irish
Hayward, Monika	International
Impey, Michael Martin	Irish
Kilcullen, Stephen	Irish
Leslie, Michael Patrick	International
Marchetti, Marcello	Asia Pacific
McLean, Kevin Ian Maurice	International
Ngubane-Ngwenya, Blessing	Africa
Oates, Neil Anthony	International
Parkinson, Philip James	Midland
Pitso, Gabriel	Africa
Radegonde, Andrea	Africa
Sneddon, Ewan	Southern

Master Brewer Module Two passes

Bajner, Robert Erno	Africa
Cousins, Winston Anthony	International
Dickinson, Rebecca Jean	International
Herholdt, Tanith	Africa
Impey, Michael Martin	Irish
Kenmogne, Maurice	Africa
Kwarciak, Dominika	Great Northern
Mahesh, Rajamanickam	Asia Pacific
McLean, Kevin Ian Maurice	International
Parkinson, Philip James	Midland
Radegonde, Andrea	Africa
Saha, Surajit	Asia Pacific
Taylor, Joshua Fraser	Southern
Walton, Emma Louise	Great Northern

Master Brewer Module Three passes

Baxter, David James Connel ++	Midland
Britt, Alison	Southern
Coulson, Adam Nathaniel	Asia Pacific
Hamilton, Graeme William	Midland
Hayes, Keith	Great Northern
Iyogbon, Hamilton Ehidiamhen	Africa
Jennings, Belinda	Southern
McGregor, Emily Joan	Great Northern
Morley, Shane Kelvin	Asia Pacific
Ngubane-Ngwenya, Blessing	Africa
Ramshaw, James Edward Michael ++	Midland
Sheils, Rory	Irish
Stewart, Ross Gardiner ++	Southern
Steyn, Gary James	Africa
Wright, Brad	International

Master Brewer Module Four passes

Adadevoh, Eric Sewonu	Africa
Baxter, David James Connel ++	Midland
Bell, Irene	Asia Pacific
Davies, Robert Edward ++	Irish
Du Toit, Malcolm A	Africa
Fitzgerald, Fergus Richard ++	Southern
Harrington, Criona Threase	Irish
Kilcullen, Stephen	Irish
McFarlane, Angus Black	Africa
Nagandi, Saphan	Africa
Nisbet, Robert Patrick	Southern
Tanner, Brigid Catherine ++	Irish

Master Brewer Module Five passes

Appiah-Danquah, Martin ++	Southern
Baxter, David James Connel ++	Midland
Bihl-Kirkwood, Georgia Gladys	Africa
Butler, Bogart	Africa
Davies, Robert Edward ++	Irish
Fitzgerald, Fergus Richard ++	Southern
Iyogbon, Hamilton Ehidiamhen	Africa
Patkar, Keshav Laxminarayan	Asia Pacific
Peters, Ann Margaret ++	Southern
Ramshaw, James Edward Michael ++	Midland
Sparks, Donovan Roy ++	Africa
Stewart, Ross Gardiner ++	Southern
Stradiotto, Steven ++	International
Tanner, Brigid Catherine ++	Irish

++ has passed all modules of the M.Brew by accumulation

DIPLOMA IN BREWING EXAMINATION

Dipl. Brew Modules One, Two & Three Passes

Birdwell, Scott	International
Caire, Justinian	International
Dehlinger, Eva	International
Delaney, Byron	International
Eggemeyer, Kevin	International
Foster, Jeffrey	International
Jovancic, Bjanka	Africa
Kuchle, Chase	International
Maharaj, Suraksha	Africa
Marlow, Lisa Marie	Irish
Martin, Ashley	International
Meeker, William	International
Moothi, Kapil	International
Nordman, Joel	Asia Pacific
Oddone, Gian Michele	International

Oliver, Donald	International
Passau, Andrew Hardy	Asia Pacific
Poor, Elysia Alberta	International
Schultz, Nikolaus	International
Schurman, Timothy	International
Weisel, Seth	International
Wieland, Bernhard Elliot	International
Willemse, Nathaniel	Africa

Diploma in Brewing Module One passes

Adedayo, Timothy Oludare	Africa
Adodo, Oluyomi	Africa
Akman, Michael	Africa
Alvarez Silva, Ignacio Jesus	International
Badura, Michael	Irish
Bailey, Monique Roxanne ++	International
Baldry, Dawn Marie	Southern
Baptista, Sergio Costa	Great Northern
Bellham, David John	Midland
Benson, Michael Andrew	Great Northern
Bergin, Ailish	Irish
Berner, Jacobus	Africa
Bhardwaj, Sharad	Asia Pacific
Bharne, Pankaj	Asia Pacific
Billig, Marcus Charles	Midland
Boatemaah, Barbara	Africa
Brestovansky, Jan	Irish
Bricknall, Sarah	Asia Pacific
Broadhead, Sarah Helen	Great Northern
Burch, Christopher	International
Calman, Nathan Garth	Asia Pacific
Carlot, Lucie	International
Catala, Miguel	International
Chauvin-Schera, Celine	International
Clarke, Richard ++	Irish
Coffey, Dayton Joseph	Asia Pacific
Cooney, Carl	Irish
Crawford, Lindsay Matthew	Asia Pacific
Cressey, Ian Anthony ++	International
Crutchfield, Evan	International
Curran, Greg	International
Curren, Richard James	Asia Pacific
Dallies, Nathalie ++	International
Dambergs, Kai Robert	Asia Pacific
De Jager, Louis Richard	Africa
Deenanath, Evanie Devi	International
Dolbel, David	Southern
Durgin, William Smith	International
Gross, Cathia	International
Gupta, Vishnu	Asia Pacific
Gutfreund, Laurence	International
Hayes, Matthew John	Southern
Hettinger, James W	International
Howard, Samantha Lee	Asia Pacific
Howley, Joann	Irish
Hughes, Mark	International
Kapoko Tagne, Innocent ++	Africa
Kaporina, Elena	International
Karadsheh, Yazan	International
Lanthois, Ben Kevin	Asia Pacific
Laumann, Jacqueline	International
Legnard, John	International
Luedtke, Robin	International
Malloy, Todd	International
Mann, Peter James	Southern
Mata Osoro, Paula	Southern
May, Chloe	Southern
Mcginty, Patrick Joseph	Midland
Medronho, Paula Alexandra	Africa
Merrington, Peter Anthony	Asia Pacific
Mogorosi, Mildred	Africa
Morgan, Haydon Peter	Asia Pacific
Morgan-Jones, Andrew	Asia Pacific
Mueller, John	International
Mulu, Mary Mutanga	Africa
Muriithi, Esther Wambui	Africa
Ndlovu, Khumbula	Africa
Ngoile, Eric Wilhelm	International
Ngoma Mapenda, Esther	Africa
Nine Rey, Maria Victoria	Great Northern
Numair, George	International
Nyam A Mpon, Guy Thierry	Africa
O Driscoll, Bernadette	Irish
O'Connor, Fearghal Patrick ++	Irish
Ogunwale, Gbenga Adeniyi	Africa
Omosanya, Lateef Oyetunde	Africa
Oshiegbu, Osemeke	Africa
Parker, Robert James	International
Parnis, Craig John	Southern
Parsons, Patrick Roy ++	Irish
Pelt, Rashaad	International
Perkins, Todd Philip	International
Quinn, Kevin	Scottish
Rick, Justin	International
Rogers, David	Asia Pacific
Rust, Jason Bert	International
Schrama, Inge Joanna	International
Scott Paul, Daniel	Great Northern
Seddon, Lewis	Asia Pacific
Sharma, Raj Kumar	Asia Pacific
Short, Alan ++	Great Northern
Shuell, Iain Harry	Great Northern
Simpson, Peter	Irish
Smith, Julie E ++	International
Sturman, Anna Victoria	Great Northern
Tang, Samuel Chei-kit	Asia Pacific
Thadel, Manoj Parameshwara	Asia Pacific
Thomas, Jody ++	Asia Pacific
Tripathi, Arijit	Asia Pacific
Tucker	Alexander
Charles	Asia Pacific
Uherova	Alexandra Irish
Upadhyay, Ravindra Nath	Asia Pacific
Vaitilingom, Marc Michel ++	International
Vaughan, Caolan Gerard	Asia Pacific
Welby-Solomon, Marvin	Africa
Wijsman, Theo	International
Ypenburg, Dirk Jan Nicolaas	International

Diploma in Brewing Module Two passes

Andrews, Clinton Brett ++	Asia Pacific
Benne, Patricia Lynn ++	International
Bhardwaj, Sharad	Asia Pacific
Bharne, Pankaj	Asia Pacific
Botha, Marianka Lynette ++	Africa
Breish, Russell	International
Bricknall, Sarah	Asia Pacific
Brown, Kisha-Ann	International
Casey, John Thomas	Irish
Charleston, Nicola ++	Scottish
Cherukut, Alfred Stefan	Africa
Clarke, Richard ++	Irish
Cressey, Ian Anthony ++	International
Curran, Greg	International
Currie, Margaret Lilian	Asia Pacific
De Bordenave, Channing Williams	International
Eder, Michael Josef	International
Egan, Lawrence ++	Irish
Eribankya, Nicholas ++	Africa
Grant, Matthew Paul ++	Irish
Hettinger, James W	International
Howard, Malcolm John ++	Asia Pacific
Hughes, Mark	International
Ivie, Mark ++	International
Joshi, Atul	Asia Pacific
Kapoko Tagne, Innocent ++	Africa
Lash, Duncan Thomas	Irish
Leclaire, Jessica	Southern
Legnard, John	International
Leichel, John	International
Lim, Chui Wan	Asia Pacific
Mckibbin, Samuel Alan	Irish
Medronho, Paula Alexandra	Africa
Minihane, Shane	Irish
Morrow, Ryan James Robert	International
Moxom, Richard John ++	Irish
Muriithi, Esther Wambui	Africa
Musonda, Wellington	Africa
Mwanja, Samuel ++	Africa
O'Beirne, Kieran ++	Irish
O'Brien, John	Irish
O'Connor, Fearghal Patrick ++	Irish
O'Meara, Ryan James	Asia Pacific
Oshiegbu, Osemeke	Africa
Paff, Emily Jane	Asia Pacific
Parsons, Patrick Roy ++	Irish
Pawlowsky, Karin Marie Daniele	Southern
Perez, Belen	Southern
Perkins, Todd Philip	International
Pradeep, Sinha Kumar	Asia Pacific
Pretorius, Barend Johannes Voster	Africa
Rust, Jason Bert	International
Sapkota, Jaya Bahadur	Asia Pacific
Schofield, Vanessa Helen	Southern
Searle, Bradley David	Asia Pacific
Sharma, Raj Kumar	Asia Pacific
Shashikala, Bijageri	Asia Pacific
Shijagurumayum, Gogochandralal	Asia Pacific
Smith, Julie E ++	International
Spencer, Thomas	Midland
Sproats, Christopher	Asia Pacific
Still, Hayden Edward ++	Asia Pacific
Takurukura, Gordon	Great Northern
Thadel, Manoj Parameshwara	Asia Pacific
Thomas, Louise	Southern
Thorn, Ian John	Southern
Toose, Natalie Renee	Asia Pacific
Transmantiner, Eva ++	International
Ushi, Osmund Emeka	Africa
Vel, Brian Michel	International
Vickers, Jemima Victoria	Southern
Walker, Stefan John ++	Asia Pacific
Willcock, Chris Joel	Asia Pacific

Diploma in Brewing Module Three passes

Afolabi, Olusesan Samuel	Africa
Aldred, Peter ++	Asia Pacific
Alvarez Silva, Ignacio Jesus	International
Bailey, Monique Roxanne ++	International
Balami, Daniel Gombe ++	Africa
Benne, Patricia Lynn ++	International
Bennett, Mark ++	Great Northern
Bhat, Balachandra ++	International
Bhowruth, Veekash	Southern
Botha, Marianka Lynette ++	Africa
Botwright, Benjamin James ++	Midland
Boudler, Sabrina ++	Africa
Brittle, William Ross	International
Burch, Christopher	International
Casey, Troy ++	International
Catala, Miguel	International
Cawley, Mark ++	Irish
Chesterman, Miles Robert William ++	Southern
Coetzee, John Claude ++	Africa
Cooper, Zoe	Midland
Cottam, Joseph L ++	International
Cullen, Emma ++	Irish
Dallies, Nathalie ++	International
De Jager, Maret ++	Africa
Draper, Ivan John	Midland
Du, Yuguo ++	Asia Pacific
Egan, Bryan Daniel ++	International
Felaar, Timothy Arnold ++	Africa
Ferguson, Jaeanne Anthea Oline ++	International
Fidler, Greg ++	International
Fox, Sarah Louise ++	Irish
Gautreau, Paul ++	International
Goodall, Adam Anthony	Great Northern
Goodwin, David ++	Great Northern
Gosling, Andrew John ++	Midland
Graham, Damian	International
Grootendorst, Carl Eric Oliver	International
Gupta, Vishnu	Asia Pacific
Hadley, Tully Ceman Patrick ++	Asia Pacific
Heffernan, Robert Joseph	Irish
Howard, Malcolm John ++	Asia Pacific
Joseph, Egangu	Africa
Kaporina, Elena	International
Kayange, Kelvin ++	Africa

Khin, Aung ++	Asia Pacific
Kumar, Ganesh ++	International
Laurentiu, Polschi Eduard ++	International
Lawrence, Mickellia Guvannie ++	International
Lewin, David Roger ++	Southern
Lewis, Elizabeth-Jayne ++	Asia Pacific
Madigoe, Ezekiel Makwadinkga	International
Maphutha, Kwena Selby	International
Marriott, Louise	Southern
McLean, Jacob Alexander ++	International
Mehrtens, Kathryn Charlotte Louise ++	Asia Pacific
Moon, Stuart	Southern
Ndlovu, Khumbula	Africa
Nxusani, Apiwe Philela ++	Africa
Nyam A Mpon, Guy Thierry	Africa
Oghonim, Onyelelue Everest ++	Africa
Oiko, Samuel ++	Africa
Okol, Moses ++	Africa
Omamogho, Arho Harrison ++	Africa
Onuoha, Benneth Chibueze ++	Africa
Pedder, James	Southern
Prior, Miss	Irish
Ratnayake, Amalka Sudeera Kumari ++	Midland
Robinson, Louise ++	Asia Pacific
Rosti, Johannes ++	International
Sandford, Jennifer Anne	Irish
Sheils-Ryan, Paula	Irish
Small, Stephanie Ann ++	International
Smith, Anthony Michael ++	Southern
Smith, Brian ++	Southern
Sodha, Fateh Singh ++	International
Stephens, Jeremy Matthew ++	Scottish
Stewart, Neil Sedaka ++	International
Tetai, Reremoana ++	Asia Pacific
Thomas, Jody ++	Asia Pacific
Thompson, Kerryn ++	Asia Pacific
Tomblin, Steven Andrew ++	Southern
Upadhyay, Ravindra Nath	Asia Pacific
Ushi, Osmund Emeka	Africa
Van Dieren, Teunis	International
Werro, Graham ++	Southern
Williams, Kelly Lindsay ++	International
Wilson, Alan William ++	Asia Pacific
Wilson, Nkrumah	International
Wood, Iain James	Irish
Yates, Elisabeth Anne ++	Southern
Yeoh, Bun Hooi ++	Asia Pacific

++ has passed all modules of the Dipl.Brew by accumulation

DIPLOMA IN DISTILLING EXAMINATION

Dipl.Distil Modules One, Two and Three – Passes

Whyte, Tracey	Scottish

Diploma in Distilling - Module One passes

Carr, Lisa Marie	Scottish
Carson, James	Scottish
Clark, Christopher Anthony	Scottish
Duguid, Caroline	Scottish
Flaherty, Aaron Charles Frederick	Scottish
Hall, Stephen John	Scottish
Harrison, Elaine	Irish
Macinnes, Norman MacLean	Scottish
McCulloch, Andrew James	Scottish
McIntyre, Sandy	Scottish
McNair, Ian Alexander	Scottish
McNally, Darryl Joseph	Irish
Tapsi, Prasad ++	Asia Pacific
Thomson, John Andrew	Scottish
Wright, Holly Annabell	Scottish

Diploma in Distilling - Module Two passes

Anderson, Russell Ian	Scottish
Burke, Daniel	Irish
Conway, Niall	Irish
Geddes, Caroline	Scottish
Hall, Stephen John	Scottish
Jack, Frances Ruth	Scottish
Macinnes, Norman MacLean	Scottish
Martin, Caroline Mitchell	Scottish
McCarthy, Noirin Ide	Irish
Mcguigan, Frank	Irish
Power, Michael	Irish
Savage, Fiona	Irish
Thompson, Marie Anne	Scottish

Diploma in Distilling - Module Three passes

Dean, Ian Stuart ++	Scottish
Ferguson, Jane ++	Scottish
Lindsay, Roy F ++	Scottish
Mclean, Mark Bruce ++	Scottish
More, Carol	Scottish
Tapsi, Prasad ++	Asia Pacific

++ has passed all modules of the Dipl.Distil by accumulation

DIPLOMA IN PACKAGING EXAMINATION

Diploma in Packaging passes

Appelbee, James +	Midland
Austin, Michael Collin +	International
Elson, Robert Mark +	Midland
Glenn, Ryan John +	Southern
Morris, Steve James +	Southern
Nduati, David Thiong'o +	Africa
Paul, Lachlan Kenneth +	Asia Pacific
Potter, Wayne Anthony +	Asia Pacific
Rathbone, Sean Graham +	International
Scheleyer, Samantha Kathryn +	Asia Pacific
Callison, Andrew Iain +++	Midland
Etheridge, Ashley +++	Midland
Gregory, Tupu Arthur +++	Asia Pacific
Johnstone, Adrian +++	Midland
Quinn, Christopher Michael +++	Midland

\+ Candidate passed Module 1

+++ Candidate passed Module 2

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