



IBD

The Institute of Brewing & Distilling

REPORT FROM THE EXAMINERS 2007

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

Board of Examiners and Examination Centres 2006

The Board of Examiners 2007

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

UK & Ireland	Aberlour Alton Bedford Burton on Trent Cork Dublin Dundee Edinburgh Elgin Islay Kilkenny Leeds London Magor Manchester Newcastle Northampton Orkney Reading Sunderland Tadcaster	Grenada Guyana India Jamaica Kenya Malaysia Myanmar New Zealand Papua New Guinea Romania Russia Samoa Seychelles St Kitts St Vincent South Africa Sri Lanka Trinidad Uganda USA Zambia Zimbabwe	St Georges Georgetown Chennai Mumbai Meerut Mumbai Kingston Nairobi Kuala Lumpur Yangon Auckland Christchurch Port Moresby Brasov Moscow Apia Mahe Basseterre Campden Park Cape Town Durban Johannesburg Port Elizabeth Pretoria Colombo Champs Fleurs Kampala Atlanta Colorado Davis Milwaukee Pennsylvania Lusaka Harare
Australia	Adelaide Brisbane Hobart Melbourne Perth Sydney		
Barbados	St Michael		
Botswana	Gaborone		
Cameroon	Douala		
Canada	Calgary Nova Scotia Quebec Toronto		
France	Strasbourg		
Ghana	Accra		

The statistics

Diploma in Brewing, Diploma in Distilling and Master Brewer

553 candidates sat part or all of the Institute's Diploma and Master Brewer Examinations (500 in 2006) at 57 centres around the world.

69 candidates sat all or part of the Master Brewer. 10 candidates accumulated passes in all modules.

447 candidates sat part or all of the Diploma in Brewing. 99 candidates accumulated passes in all modules.

37 candidates sat all or part of the Diploma in Distilling. 8 accumulated passes in all modules.

The number of candidates who sat each module of the Master Brewer, Diploma in Brewing or Diploma in Distilling is shown in the table above right and the split between candidates in the UK & Ireland and the rest of the world is in the table to the right.

Number of candidates who sat each module

		2007	2006
Diploma in Brewing	Module 1	233	211
	Module 2	175	163
	Module 3	153	200
Diploma in Distilling	Module 1	9	11
	Module 2	14	10
	Module 3	14	14
Master Brewer	Module 1	35	31
	Module 2	26	29
	Module 3	22	25
	Module 4	15	22
	Module 5	22	17

Split between UK and the rest of world

	UK and Ireland	Rest of world
Total number of Dipl.Brew candidates – 477	101 23%	376 77%
Total number of Dipl.Distil candidates – 37	26 70%	11 30%
Total number of M.Brew candidates – 69	30 43%	39 57%

Report from the Chairman of the Board of Examiners

IBD Examinations 2007

The results for the 2007 examinations show several positive features in that, in the main, candidate numbers registering for the examinations continue to increase and the overall improvement in average performance across all of the IBD exams seen last year, was essentially maintained this year. In total this year, there were 10 new Master Brewers qualifying, with 99 candidates achieving the Diploma in Brewing and 8 the Diploma in Distilling, plus 60 candidates obtaining the GCB and 43 the GCP in November 2006, with 85 and 35 passing GCB and GCP respectively in May 2007. In addition, 47 candidates obtained the General Certificates in Distilling.

I should like to congratulate all candidates who have attained qualifications, especially those achieving distinctions and awards. In particular, I should like to congratulate Sandra Van Nierop (SAB Miller) for obtaining the June 2007 JS Ford prize (Dipl.Brew) and Brendan McCarron (Diageo Global Supply – Scotland) for the Diploma in Distilling Award. In addition, Julia Atchison, from Molson - Canada was awarded the Crisp Malting award (for the best paper in Dipl.Brew Module 1) and Scott Stokes, from Labatt – Canada was awarded the Brewery Engineers Association award (for the highest result in the Process Technology section of Dipl.Brew Module 3). Also this year, the Board of Examiners has made an additional special award of the JS Ford prize to Ifeanyichukwu Theophilus Ezeodili (from Nigerian Breweries) for achieving a very high distinction grade in Diploma in Brewing, following the special 2006 re-sit examinations held in February 2007, as a consequence of the lost consignment of completed exam papers from Nigeria in June 2006. My special congratulations go to those M.Brew. and Dipl.Brew. candidates from Nigeria, who through no fault of theirs, ended up sitting the examinations twice!

Finally, congratulations are extended to Katherine S Jones (Greene King plc, Suffolk) and S L Howard (Mountain Goat Beer Pty Ltd, Richmond, Australia) for obtaining the Worshipful Company of Brewers award for GCB and GCP, respectively, in 2006. As announced previously, Robert McClelland (Diageo, Scotland) received the 2006 GCD Scotch Whisky Association award.

Obviously, we cannot award 2007 General Certificate prizes, until after the November round of examinations.

As in previous years, I would like to draw attention to the individual examiners' reports, which, like last year, are published as a special supplement in the Brewer and Distiller International, but are also available via the IBD web site, in the Journal (JIB) or by application to the IBD Examinations Administration team at Clarges Street.

These reports really are essential reading for future examination candidates in that they contain descriptions of the ideal content of answers, sound advice on examination technique and detailed analysis of the year's papers.

However, I would like to summarise examination performances here:

For the Master Brewer examinations, the increased number of entrants seen last year was maintained in 2007. Overall pass rates and pass performances were very much similar to last year, with 76% pass (of 17 candidates) for module 1, 77% (of 26, compared to 50% pass last year) for module 2, 54% pass (of 24) for module 3, 74% (of 23) for module 4 and 58% pass (of 24 candidates) for module 5.

The results for the Diplomas in 2007 were also improved in the main. Of the individual Brewing modules, the pass rate for module 1, (70% of the 184 candidates) was similar to last year, but much improved for module 2 (70% of 208 candidates) and for module 3 (70% of 167 candidates).

The high pass rate for candidates sitting the Diploma in Distilling examinations achieved last year was maintained this year, with 94% pass for module 1, 92% for module 2 and a perfect 100% for module 3.

As reported last year, the first results for the new GCB and GCP in May 2006 produced disappointingly low pass rates, but the results in November 2006 (GCB 55% pass; GCP 61% pass) and in May 2007 (GCB 54% pass; GCP 45% pass) show the hoped for improvement, indicating to the examiners that candidates are becoming more familiar with the MCQ format.

The May 2007 GCD had a pass rate of 74%, comparable to last year.

On the slightly negative side, yet again examiners commented on the need for candidates to concentrate their efforts in answering the exam questions by paying particular attention to preparation, organisation and precision. One is moved to ask just exactly how some candidates actually spend the allocated reading time prior to the start of the examinations. Clearly some would be best advised to plan their answers in more detail than it would currently appear.

Another cause for concern is the fact that several candidates for Master Brewer do not seem to be fully prepared in terms of the technical experience that this high level examination requires. Candidates are urged to enlist the help of their mentors to gain the necessary exposure to all facets of beer production in line with the M.Brew syllabus.

With regard to new and ongoing IBD examination developments, in January 2007, we set the first examination in the new NQF level 1 qualification on the Fundamentals of Brewing and Packaging Beer for 46 In-Bev candidates (achieving a pass rate of 80%). This new qualification is currently aimed at non-technical personnel or new entrants to the brewing industry and the examination again uses the MCQ format. It is planned that in 2008, this qualification will be made available to a wider spectrum of interested candidates, building on the new relationship that IBD now has with the Beer Academy.

Secondly, the formulation of the new Diploma in Beverage Packaging is now complete and has been offered to candidates for examination of modules 1 and 3 in June 2008 and several candidates have already registered. In a departure from previous IBD exam structures, this qualification will be examined not only by written exam papers (partly by multiple choice questions), but also incorporating some element of continuous assessment, involving a number of assignments through the year. Further, there are also opportunities for recognition of prior learning subject to acceptance by the examining board of the appropriate portfolio of evidence. In addition, a distance learning package, organised directly by the IBD is available; a similar scheme for the Diploma in Brewing was also used for the first time this year and has proved to be successful for the candidates involved.

Also, as announced last year, we have expanded the General Certificate in Distilling to include (as elective options) distilled products based on cereals, or on grapes, or on sugars. Examinations for this new qualification have been piloted since May 2006 in the same format as the current GCD exam (which is targeted specifically to Grain distilling). The syllabus has been revised and it is planned that, with effect from May 2008, this new qualification, adopting the now established MCQ format, will become the new General Certificate in Distilling, with candidates receiving certificates indicating the appropriate cereal, grape or sugar elective. It is planned to set the last GCD exam in the current format in November this year.

The new GCD has also been accredited by City & Guilds to NQF level 2 like the existing qualification.

As stated previously, the Distilling group continues to develop a similarly expanded syllabus for a new Diploma in Distilling (like the new GCD) to include elective options for rum and brandy production (in addition to grain distilling) and it is hoped to have this available for examination in 2009.

For the time being, all IBD MCQ format examinations will remain paper-based. Our attempts to adopt the City and Guilds-based GOLA system have proven to be in vain, since the software package involved is not compatible with many brewing companies' IT systems, in that it is regarded as a breach of their firewall and can only be uploaded with rather expensive intervention by the IT suppliers. We will continue to investigate the concept of on-line examinations for the future.

Finally, following the unfortunate mishap with the exam papers from Nigeria last year, a full re-appraisal of all IBD courier operations has been carried out, with total success achieved to date.

As I hope will be apparent from this report, this has again been a busy year for the IBD Board of Examiners and the Examinations Department. As ever, I should like to express my thanks to all the examiners and moderators for their important contributions and, also, to welcome a number of willing volunteers who have joined or will be joining the Board of Examiners for the coming year. Most of this "new blood" comes from outside the UK, to add further to the truly international

structure of our examination system.

My final thanks go the Clarges Street based examinations team for their hard work and support this year. As you may be aware, Rekha Sandal resigned in March from the role of Examinations Administrator and my sincere thanks go to Jessica Clark and Andrea Williams (who have adopted the examination administration between them) for their significant contributions in organising the IBD examinations this year.

To end, I am confident that everyone involved with the IBD qualifications system looks forward to the next year of examinations, especially with the proposed new developments and I would like to take this opportunity to wish all prospective candidates success in the pursuit of IBD qualifications.

Dr David G Taylor - August 2007

The Institute of Brewing & Distilling Examinations 2007

Question Papers and Examiners' Reports

DIPLOMA IN BREWING EXAMINATION 2007

Module 1 – Materials and Wort

The examination was sat by 184 candidates, compared with 234 candidates in 2006 and 211 in candidates in 2005. The pass rate for the examination this year was 70%. This compares with a pass rate in 2006 of 73% and 2005 of 67%.

The grade distribution was as follows (2006 in parenthesis):

- A: 1% (4%)
- B: 8% (9%)
- C: 30% (24%)
- D: 30% (36%)
- E: 19% (16%)
- F: 11% (6%)
- G: 1% (5%)

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. To achieve your potential in examinations you must practise in the same way that athletes train for an event. 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.

Question 1

What are the desirable characteristics of barley for malting? [10]
Explain the analyses that are done to assess the suitability of barley for malting. [10]

This question was attempted by 170 candidates (92%) with 66% achieving the pass mark. The majority of students did very well at this question, however those who presented a list of bullet points with no further explanation did not score as highly as those who wrote properly argued answers.

Poor barley will produce poor malt. Thus it is critical to assess random samples of barley at intake for desirable characteristics prior to malting. The grain should be at an optimum temperature and moisture content (12-15%) to avoid storage problems, and of favourable protein content (10.5-11.5%), which reflects on starch content, fermentation, foam production and beer stability. These functions can be assessed by NIR but other methods are also applicable. The grain should be of an approved variety, be accompanied by the "passport" which monitors agrochemicals applied to the crop, and of a minimum grain size (reflecting high starch content) with few broken grains. Fungal contamination should be minimal as this can lead to storage problems, beer gushing and mycotoxin contamination. Insect contamination is also a problem during storage. These aspects can be assessed by visual

inspection and by aroma of the sample. Physiological functions of barley that impact on malt quality include dormancy, germination capacity, germination energy, and water sensitivity. These can be measured by simple germination tests that however do take a few days to carry out. The most comprehensive test for desirable barley characteristics consists of a micromalting, which when coupled to biochemical assays for specific malt enzymes and wort components will give a strong indication of the suitability and performance of a given batch, but this set of operations does take a week or longer to carry out.

Question 2

Describe the basic principles of design and operation of a specified malting system. Explain what parameters are controlled in the operations of steeping, germination and kilning, and the significance of their control. [20]

This question was attempted by 154 candidates (84%) with 83% 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.

Malting systems consist of three sequential operations; steeping, germination and kilning. These operations may take place in one physical arrangement (eg tower maltings) or be separated into discreet units of various design (for example: conical-bottom steep tank, Saladin box, single floor kiln). The purpose of steeping is to wash and hydrate grain to ca. 42% moisture without drowning or physically harming the grain. Thus arrangements must be made for addition of grain, water, aeration, carbon dioxide removal and air rests. Hydrated grain is then germinated at carefully controlled temperatures (15-20°C), it being imperative to physically turn the grain to avoid hot-spots and root entanglement and to ensure homogeneity. During this process, a control of air temperature (air-on and air-off temperature), and moisture supply is critical to avoid over or under-modification. Following germination, kilning is required to halt the germination process, preserve enzyme activity and impart colour and flavour to the malt as well as influencing the DMS content of the malt. The key parameters that must be controlled are temperature and airflow. Free drying at about 50°C removes superficial water and there is 30°C difference between air-on and air-off temperature. Once this difference drops (break-through), the temperature can be increased to 70°C to remove water from deep in the grain. Lastly, temperatures of 80-110°C can be used to dry malt to around 5% moisture or less and impart colour (curing). The kilning process must also minimise production of nitrosamines.

Question 3

Describe the types of adjuncts used as sources of fermentable extract in brewing. [10]
List the reasons for their use and their respective advantages and disadvantages. [10]

This question was attempted by 158 candidates (86%) with 60% achieving the pass mark.

There is a wide range of adjuncts used in brewing as sources of fermentable extract. Many candidates tackled the question by covering

first the range of solid adjuncts and then the range of liquid. When tackling a question like this, it can also be helpful to subdivide these major groups of adjuncts into smaller groups. For example, wheat and barley have starch that gelatinises at mashing temperatures and can therefore be added directly to the mash. In contrast, the gelatinisation temperature of starch from rice, maize and sorghum is higher. Therefore, these adjuncts require pre-treatment before adding to the mash. This can take the form of micronisation or torrefaction to gelatinise the starch, or cooking immediately before mash addition.

Liquid adjuncts are either sourced from sucrose or starch. If the sugar is from sucrose, then invert sugar can be produced from sucrose hydrolysis. Liquid adjuncts can be produced from starch sources by acid or enzyme hydrolysis (or a combination). Barley syrups and malt extracts can be produced with a sugar spectrum (and nitrogen composition) very similar to wort.

Adjuncts are used because they are a cheap source of fermentable extract, but depending on the source, the adjunct may also lead to improved processing due to a reduction in beta-glucans and haze forming protein. The flavours from malt may be diluted to produce a 'lighter' tasting beer or sweetness may be increased by fructose. Care needs to be taken to ensure that there is adequate nitrogen available for yeast metabolism, and most importantly alterations in the ratio of carbon to nitrogen can alter diacetyl and ester production. There are many reviews and tests on adjunct use, but it is worth noting that there is a 'new-generation' of syrups that are being produced by techniques that allow virtually any carbohydrate profile. These syrups can thus be introduced at any appropriate point in the process without altering the wort carbohydrate profile (Stewart, 2006, Adjuncts, Handbook of Brewing, 2nd Edition, Taylor and Francis).

Question 4

Outline the role and significance in brewing of calcium. [10]

Discuss the advantages and disadvantages of ion exchange and reverse osmosis systems for the removal of inorganic ions from brewing water (liquor). [10]

This question was attempted by 115 candidates (63%) with 60% achieving the pass mark. The majority of candidates obtained similar marks for both parts of the question. Good answers used appropriate tables, diagrams, or equations.

The mineral content of brewing liquor has long been recognised as making an important contribution to the flavour of the beer, with calcium being one of the most significant. Calcium is responsible for the fall in pH during mashing, boiling and fermentation by reacting with buffering compounds such as phosphates to form an insoluble compound which releases H⁺, causing a drop in pH. Failure to add sufficient calcium will result in higher wort and beer pH, and poorer fermentation and quality. A minimum concentration of 40 ppm calcium ions is necessary in finished beer. Calcium also has other beneficial effects including: protection of alpha-amylase from thermal degradation, improvement of protein precipitation during the boil, limitation of colour formation during the boil, improvement of yeast flocculation, removal of oxalates, and stimulation of proteolytic and amylolytic enzyme activity. Most candidates highlighted the effect of pH reduction. Good answers included description of the importance of water hardness/ calcium content and of the effect of calcium on fermentation performance.

Reverse osmosis (RO) uses a semi-permeable membrane to achieve separation of substances dissolved in liquid. This semi-permeable membrane is permeable to water and retains micro-organisms, colloids, ions of dissolved salts and also molecules of organic substances.

Ion exchange is an exchange of ions between two electrolytes or between an electrolyte solution and a complex. Ion exchangers are either cation exchangers that exchange positively charged ions (cations) or anion exchangers that exchange negatively charged ions (anions). There are also amphoteric exchangers that are able to exchange both cations and anions simultaneously. Ion exchangers can be unselective or have binding preferences for certain ions or classes of ions. Ion exchange is a reversible process and the ion exchanger can be regenerated or loaded with desirable ions by washing with an excess of these ions.

Most candidates used tables and diagrams to compare the two processes. Advantages of using RO include the generation of high quality water with little waste, and minimal use of chemicals. It also has higher production capacity to space ratio compared with other technologies and lower operational and maintenance costs. Ion exchange processes, on the other hand, incur high resin replacement costs, substantially higher

regeneration costs and inordinate downtime costs due to the need for replacing ion exchange columns. Ion exchange does however have the advantage that the ion content of liquor may be tailor-made. While the biggest operating costs for ion exchange systems are regeneration chemicals, the major cost component in RO is energy i.e. electrical power to operate the RO feed pump.

Question 5

Describe the action of malt enzymes during mashing that lead to the production of a fermentable wort. [14]

Discuss briefly the factors that would either stabilise or degrade these enzymes. [6]

This question was attempted by 170 candidates (92%) with 74% achieving the pass mark. This question was generally well answered and good answers were accompanied with diagrams illustrating enzyme actions, and also time/temperature profiles during mashing to explain the different processes and the effect of temperature changes on these.

The malt that goes into mashing should already partially modified, as the glucanases and proteases that break down the cell wall and protein matrix components of the endosperm have been active during germination, and the starch hydrolases that break down amylose and amylopectin (alpha-amylase, beta-amylase and limit dextrinase) have been synthesised and/or activated, and have initiated limited starch breakdown. However the bulk of starch hydrolysis takes place during mashing. The extent of this depends on the quality of the malt (the degree of modification/enzyme potential), the addition of adjuncts (e.g. unmodified cereals) and the conditions during mashing, since each enzyme has optimal conditions (temperature, pH) for activity and conditions under which activity is lost (generally thermal denaturation). Undermodified malt will require a stand at a reduced temperature (ca. 50°C) since proteases and glucanases are denatured at higher temperatures. Starch is much more accessible to enzymes once the grains have been gelatinised; this occurs at temperatures above 60°C. Beta-amylase is optimally active at 60-65°C whereas alpha-amylase has a temperature optimum at 65-68°C. The enzyme beta-glucan solubilase is however thermally stable and may give problems by releasing excess glucans at temperatures where beta-glucanases are inactive. Enzyme stability is favoured by optimal pH (5-6), calcium ion concentration, higher mash concentrations to protect enzymes against inactivation and optimised temperatures.

Question 6

Describe three chemical reactions that occur during wort boiling. [15]

Discuss the requirements for clarification of boiled wort. [5]

This question was attempted by 157 candidates (85%) with 65% achieving the pass mark.

This question gave candidates the opportunity to demonstrate their knowledge of chemical reactions occurring during wort boiling. Those chosen included isomerisation of alpha-acids, oxidation of beta-acids to form hulupones, calcium phosphate precipitation, protein coagulation, formation of melanoidin compounds and production of DMS from S-methylmethionine. Weaker candidates were aware of the reactions taking place but were unable to describe the chemical changes that were occurring.

Two approaches were taken by candidates in answer to the question on the requirements for clarification of boiled wort. The key points are that vegetable matter is removed along with insoluble proteins and protein-polyphenol complexes. Some candidates focused their answer on the chemical requirements for the formation of hot trub and the need to avoid shearing forces that would disrupt the insoluble complexes. Failure to achieve adequate wort clarification can lead to poor yeast performance, unsatisfactory fermentations and poor beer stability. Other candidates describe the plant requirements. For example, if whole hops were used the a hop back or screw hop strainer would be appropriate to remove hop cones and vegetable matter.

Question 7

Outline the principal sources of liquid effluent in a brewery. [5]

Identify the key components of brewery liquid effluent and their potential impact on the environment. [5]

Describe the principal features of aerobic and anaerobic digestion systems. [10]

This question was attempted by 116 candidates (63%) with 77% achieving the pass mark. Each section tended to be tackled at the same level. Some candidates did answer the first two sections in detail spending more time on these sections than the value warranted.

Packaging typically creates the greatest volume of liquid effluent in a brewery through cleaning. Most candidates described the relative contributions of the brewhouse, fermentation and yeast handling, maturations, conditioning and filtration, and packaging. Good answers gave a more detailed breakdown.

Effluents from individual process steps are variable and most candidates recognized this. For example, bottle washing results in a large volume but it contains only a minor part of the total organics discharged from the brewery whereas effluents from fermentation and filtering are high in organics/biochemical oxygen demand (BOD) but low in volume. Most candidates correctly described the effect of organic compounds, suspended solids, oils, heavy metals, and yeast on the environment and their direct effect on aquatic life. Good answers included the effects of ions, pH and temperature. Process specific materials e.g. normal processing aids, label glues, label pulp, inks, finings were also mentioned.

Biological treatment of effluent can be carried out under either aerobic or anaerobic conditions. The basic mechanism of aerobic removal of BOD from effluent by micro organisms can be characterized by a 2 stage process that creates carbon dioxide and water – good answers contained equations to describe this and named the aerobic micro organisms involved. Aerobic treatments are either of the activated sludge or the attached growth type of process. Anaerobic digestion of effluent BOD is also fundamentally a 2 stage process, and again good answers defined each stage and named the products and micro organisms involved. In anaerobic effluent treatment systems the micro organisms grow more slowly than in aerobic reactors. This means that the solids need to be retained longer in order to maintain high levels of activity and that the sludge production is lower than in aerobic systems. An advantage is that reactor vessels are smaller than aerobic systems.

Question 8

Discuss the relevance of brewhouse plant design to hygiene control.

[5]

Outline the range and main constituents of commercially available cleaning agents and explain how their action can be validated. [15]

This question was attempted by 55 candidates (30%) with 60% achieving the pass mark. 55 candidates answered this question, and for many it seemed a 'last resort'. As a result, the overall standard was quite poor.

In order to ensure effective cleaning of brewhouse vessels and pipework a number of considerations must be made in plant design: The plant capacity needs to be large enough to allow time for cleaning, the parts of the plant where very high standards of hygiene and sterility are required should be capable of being cleaned hot. The materials of construction should be capable of withstanding strong detergents like caustic soda. The plant design should either allow access for manual cleaning or more commonly, ensure that detergent can flow over the surface at the speed required to give a vigorous clean. There should be as few encumbrances in vessels as possible. Vessels must drain well. There must be no "dead legs" in the pipework. Pipes must be designed for fast flow of detergent during cleaning and spray heads must be sited in the correct position. The choice of material that the plant is made from needs to be suitable for the detergents and sterilants that are going to be used. Most modern plants are constructed of a suitable quality of stainless steel; however, pump glands, sensing equipment, hoses and valves must also be compatible with what might be very corrosive substances. Most candidates listed a number of these considerations, with good answers containing at least five.

There are literally hundreds of detergent mixtures available that are specifically tailored to the needs of the brewer. A detergent must be capable of wetting surface(s) to allow it to penetrate the soil deposits and to thus act more quickly and efficiently. The detergent must have the capacity to break the soil into fine particles and to hold them in suspension so that they do not redeposit on the cleaned surface. Detergents also must have good sequestering power to keep calcium and magnesium salts (beerstone) in solution. There are two types of cleaning detergents: alkaline or acid which are often formulated with surfactants, chelating agents, and emulsifiers to enhance the effectiveness of the detergents. The most effective detergents in the brewery today are formulated with alkaline solutions that have chelators and surfactants.

Acid Detergents – The use of acid detergents is commonly restricted to the removal of beerstone, water scale (calcium and magnesium carbonates), and aluminum oxide. Tannins, hop oils, resins, and glucans are unaffected by acids. Acid detergents are more effective against bacteria than are alkaline detergents. The two most common types of acid detergents are phosphoric and nitric.

Alkaline Detergents – Alkaline detergents are most effective in removing organic soils, i.e., oils, fats, proteins, starches, and carbohydrates encountered in brewing. Alkaline detergents work by hydrolysing peptide bonds and breaking down large, insoluble proteins into small, more easily soluble polypeptides. In general, cleaning problems associated with organic soils can be avoided by ensuring that pre-rinsing is carried out with the minimum of delay and by using cold water pre-rinses at low pressure. Alkaline detergents will not remove calcium oxalate and other inorganic compounds that lead to a buildup of beerstone. Some of the more common alkalis are sodium hydroxide, sodium percarbonate, sodium hydrogen carbonate, sodium orthosilicate, and sodium metasilicate. Good candidates gave examples of commonly used detergents and their effectiveness. Others also discussed the additives used to improve formulations.

A number of methods may be used to monitor plant hygiene, including ATP bioluminescence and culture methods. Good answers included these, giving examples of supplier names, and gave a description of culture techniques.

Dr James Bryce – August 2007

DIPLOMA IN BREWING EXAMINATION 2007

Module 2 – Yeast and Beer

There were 208 submitted scripts for this paper with 145 candidates achieving a pass grade to give a pass rate of 70%. This is significantly higher than last year (63%). In fact the overall performance was much improved on last year; of the candidates who did not pass, the majority (nearly 80%) achieved grade E.

Also, unlike 2006, there were three A grade passes, which, with 13 B grade passes reflects a significantly improved performance. Of those that failed a small proportion achieved good individual marks for some questions but failed to answer the requisite number of questions adequately.

The examiner and moderator were generally encouraged with the quality of the answers given by the vast majority of the candidates, compared with last year.

However, as ever, examination technique was a clear cause of most failures. For instance, there were too many instances of candidates failing to appreciate exactly how to answer precisely the actual question as set, apparently choosing, instead, to provide an answer for what they hoped (erroneously) the question really could have been!! This is somewhat disappointing, because it leads one to wonder just how exactly these candidates used the 15 minutes pre-examination reading time. Two questions were particularly badly answered because of this fault; viz. questions 3 and 7b (as detailed below).

In addition, some candidates clearly did not concentrate sufficiently on answering all questions in sufficient depth, while in other cases, it was clear that there had been difficulty in managing time adequately, to provide quality responses to six questions.

Question 1

(a) With the aid of fully labelled diagrams, describe the key features of a typical, actively fermenting, brewing yeast cell and outline the functions of the sub-cellular organelles and structures, as seen in electron micrographs. [15]

(b) Outline the methods for distinguishing lager yeasts from ale yeasts. [5]

This question was answered by 181 candidates, with 72% achieving pass.

In the first section, marks were awarded for presentation of details in the drawings (NOT for artistic merit!!), with higher marks if additional drawing(s) were also included (for example, of cell wall, cell membrane, mitochondrion, etc.). Description of subcellular organelles' functions achieved good marks if candidates could ascribe functions (correctly) to all the organelles included in their diagrams.

In the second section, the examiner was really looking for the various, relatively straight forward distinctions between lager and ale yeasts, such as, flocculation characteristic, chain-forming potential, melibiose utilisation, growth at 37°C, colony morphology, Cu²⁺ tolerance, as well as more sophisticated procedures such as DNA fingerprinting.

Question 2

(a) Describe the process and plant design features required for the successful propagation of yeast for commercial fermentations. [10]

(b) Outline the methods of storing yeast for re-pitching into brewery fermentations and the basic principles involved that ensure high levels of viability and vitality. [10]

This question was answered by 175 candidates, with 66% achieving pass.

For a good answer to the first part of this question, the examiner was seeking not only a detailed description of propagation methods, including drawing(s) of an idealised propagation plant and vessel(s), but also some indication of understanding of the objectives, process conditions, etc. involved in propagation procedures.

Especially useful were comments on why propagation is necessary and how ideal yeast propagation conditions differ from fermentation conditions and how to handle the likelihood that the first production beer after propagation may be slightly aberrant.

Many candidates merely presented an outline operating manual for the propagation procedure in use in their brewery, without apparently considering either that there are other possible procedures or the outcomes of what the process is designed to achieve.

For part two, a detailed description of the ideal conditions for keeping

yeast for re-pitching was required. This would apply principally to slurry storage, but also acknowledgement of yeast pressed and storage as "cake", plus direct cone-to-cone pitching options should have been included. The examiner expected discussion of conditions required during yeast collection and storage designed to maintain viability and vitality (low temperature/ O₂ – free/ dilution with de-aerated water to reduce alcohol and/or CO₂ concentrations, etc), all geared to reducing stress and maintenance of glycogen and trehalose contents, plus some comments on the necessity for and methods of acid-washing. What was not required, but some candidates presented erroneously, was description of methods for long term storage of yeast. Additionally definitions of vitality and viability were useful, but detailed descriptions of how to assess/ measure were not needed.

Question 3

Describe briefly the mechanisms by which yeast cells take up carbohydrates from brewery wort. [5]

Outline the biochemical pathways involved in the metabolism of these carbohydrates, by yeast cells during fermentation, leading to the production of ethanol. Emphasise the key steps involved in energy generation and the importance of the reactions involving the oxidation and reduction of the co-enzymes NAD and NADP. [15]

This question was answered by 150 candidates, with only 55% achieving pass.

There were many satisfactory answers for the relatively easy introduction section for this question on sugar uptake, in terms of sequence of uptake, secretion of invertase, role of permeases for maltose and maltotriose and the control mechanisms for their synthesis and related genetics, plus discussion of Crabtree and Pasteur effects, etc. Many candidates scored the full five marks.

However, answers for the main section were very poor. Most candidates apparently decided that all the examiner required was just a re-hash of the Embden-Meyerhof-Parnas (EMP) pathway and that is all that was presented. However, the only candidates to score well realised that what was appropriate was detail around the kinase steps, (using ATP (energy) in the early phosphorylation stages and generating ATP at the phosphoglycerate and enolpyruvate reactions) and why the net increase in energy is necessary to the cell and what it is used for, plus why and how fermentation is less efficient in terms of energy production than respiration (again why the Crabtree effect occurs).

Equally important was discussion about NAD reduction and oxidation and its importance in a number of dehydrogenase reactions, not least of which being the importance of the alcohol dehydrogenase enzymes, plus the importance of glycerol synthesis. Also of great significance (and very few answers addressed this point, although it was clearly required from the wording of the question) was description of the need for the Pentose Phosphate shunt pathways (to which some 20% of the cellular glucose is committed) to generate reduced NADP (used for fatty acid and sterol synthesis). Very few candidates described the shunt pathways (only outline was needed) with little or no comment on how the cascade of reactions from pentoses can generate EMP intermediates (fructose 6 P and glyceraldehyde 3 P) and so how this pathway can still lead to ethanol synthesis. Somewhat worryingly, several candidates clearly did not know what NADP is nor its role in anabolic reactions or thought that it was the reduced form of NAD.

This was almost a classic example of candidates answering the question they wanted, not the question that was asked!

Question 4

Describe the physical and chemical processes involved in the maturation/ conditioning and cold storage phases of beer production. [20]

This question was answered by 126 candidates, with 69% achieving pass.

A bit of thought was needed to answer this question completely satisfactorily. Discussion was required about: lagering/ aging; clarification; stabilisation; conditioning (carbonation); additions/ blending, etc., and there were some very good answers. However, the ideal answers would have been structured around the concept of interactions between physical actions, such as Stokes law (sedimentation/ centrifugation), solution of CO₂/ volatiles removal (Henry's law), with descriptions of chemical and biochemical activity, such as flavour development (diacetyl removal/ risk of oxidation/ yeast autolysis, etc), plus the physical/chemical actions involved in haze

development and stabilisation with silica gels/ tannic acid/ proteolytic enzymes/ PVPP, etc.

Good answers identified how these physical and chemical activities interplay, like physical sedimentation being enhanced by yeast flocculation and finings action and clarification of protein/ polyphenol complexes being influenced by action of the various chemical agents acting as absorbents/ precipitants, etc. Carbonation, either “naturally” by krausening or priming or by injection systems is another crossover between physical and chemical processes, as is removal of volatiles, such as SO₂, H₂S, acetaldehyde. Some answers did try (as the question asked) to distinguish between physical and chemical actions, although many candidates apparently just churned out everything they could think of about maturation.

Question 5

Write notes on TWO of the following topics:

- (a) The basic principles of Quality Management Systems. [10]
(b) The mechanism of yeast flocculation and its significance in brewing. [10]
(c) The formation and methods of measurement of beer foam. [10]

This question was answered by 191 candidates, with 78% achieving pass.

Option (a) of this question was the least popular but was, in the main, adequately answered with some candidates receiving very good marks for their descriptions of structured QMS approaches, including the need for fully documented systems, Total Quality approaches, ISO-schemes, World class manufacturing systems, involving GMP, HACCP, COSSH, Supplier quality management, Statistical Process control, etc.

Option (b) produced some very good answers, where details were included of modern thoughts on how flocculation occurs, such as the Lectin theory, with descriptions of factors influencing the phenomenon, like Ca²⁺ ions, glucose / maltose levels, pH, ethanol concentration, plus details of genetic control via FLO genes. Also several answers provided distinctions between lager and ale yeasts and the consequences of early or late flocculation, powdery yeasts, etc. Some description of flocculation tests and schemes for the categorisation of brewing yeast was valuable too. This topic is well covered in the workbook but clearly many candidates had also read more widely around the subject.

Good answers for option (c) included good descriptions of the physical aspects of bubble formation, drainage, disproportionation, and surface tension effects, plus the need for glycoproteins (40–60 K Daltons), with hydrophobic and hydrophilic actions, input from foam positives, like iso- α -acids (especially reduced hop products), divalent cations, nitrogen gas, PGA etc. Description of the actions of foam negatives, like lipids was also valuable. Many answers included good description of methods of analysis and discussion of their merits and limitations. Most candidates described NIBEM and Rudin methods in detail, with some adding others like Ross & Clark, sigma, plus basic and sophisticated visual methods. Although the question did not specify the required balance between description of foam formation and methods of assessment, those answers that just concentrated on methods did not score very highly.

Question 6

Describe the influences on beer flavour of inorganic ions and compounds derived from hops. [10]

This question was attempted by only 107 candidates and only 46% attained a pass grade.

Predictably, this question was neither popular nor well answered, especially the first part. In the first section, the examiner was looking for descriptions of the classical, historical links between water supplies and their hardness contents and beer types, such as pale lagers from Pilsen, bitters from Burton-on-Trent, mild, sweeter beers from London, and dark beers from Dublin and Munich). Good answers would have provided more detail on the direct effects of ions on flavour (such as H⁺, Na⁺, K⁺, Fe³⁺, Cl⁻, SO₄²⁻, etc), but also developed discussion on how many ions can have indirect effects on beer flavour development, such as influence on pH (Ca²⁺, PO₄³⁻, CO₃²⁻, HCO₃⁻), effects on yeast requirements, both “structural” or health related (Mg²⁺, PO₄³⁻, etc) and enzymic/ chemical influences on potential flavour generation, like Zn²⁺ on alcohol and higher alcohols (and hence esters) via alcohol dehydrogenases; Fe³⁺/Cu²⁺ on oxidation reactions, etc.

Basically, the second section of this question required more than just

relating perceived bitterness to isomerised α -acids. Data describing the increase in bittering potential from hops and hop products depending on the degree of processing/ purification (ie extracts > pellets > whole hops), plus different bittering potential of the various cis- and trans- isomers of iso- α - acids. In addition, describing the differential contributions from reduced products (rho-, tetra-, and hexa-) was also rewarded, especially if it had been noted that standard iso- α -acids can lead to light-struck flavour from the generation of 3-methyl, but-2-ene, 1-thiol (MBT). Also descriptions of the contributions to aroma and flavour from hop oil fractions were needed.

Additional marks were awarded for noting: the small potential contribution to perceived bitterness from β -acids on oxidation during boiling; cheesy/ rancid characters from oxidation degradation of α -acids during storage, to generate isobutyric and isovaleric acid; possible enhanced beer reducing power (resistance to oxidation) from hop polyphenols.

Question 7

Outline the methods available to identify and quantify microorganisms that can cause spoilage of wort and beer. [10]
What is the potential impact on beer quality of:
a) lactic acid bacteria [5]
and
b) wild yeasts? [5]

This question was answered by 135 candidates, with 72% passing and, on the whole, was well answered.

Responses to the first part of the question, should have been based on good general, working knowledge of microbiological techniques applicable throughout the brewery, but especially covering aseptic sampling (including continuous sampling) and where applicable, basic techniques of spread and pour plates, membrane filtration (and where relevant), use of general and differential media, forcings, etc; many candidates adequately described these methods for the identification (selective agars, biochemical tests such as API, catalase, gram staining, molecular techniques such as PCR, RAPD-PCR and others).

Quantification methods should have included ATP Bioluminescence, plate counts, and fluorescent techniques.

What was not wanted (which some answers unnecessarily provided) was regurgitated laboratory microbiology manuals and procedures, since the key word in the question was “Outline”.

The second parts (a) and (b) should have included names of likely organisms to be included as lactics (*Lactobacillus*, *Pediococcus*) and wild yeasts, and how their presence can affect beer, like diacetyl generation, lactic acid, rope, turbidity, etc for lactics, and over-attenuation (*S. diastaticus*), 4-vinylguaiaicol production, etc for wild yeast.

Answers gaining top marks also noted that in some instances, the flavour contribution from these organisms was favourable, as in lambic beers, weissbier and the use of lactic fermentation for mash acidification (*L. delbrückii* or *amylolyticus*) in accordance with *Reinheitsgebot* requirements.

Question 8

Select TWO of the following topics to answer.
(a) Outline the advantages and disadvantages of high gravity brewing. [10]
(b) Describe briefly the key features of systems and chemicals designed for ‘cleaning-in-place’ (CIP) of fermentation vessels in a brewery and outline the methods available for monitoring hygiene status. [10]
(c) Outline the theoretical basis of beer filtration procedures using powders and discuss the potential applications and advantages of cross-flow membrane filtration systems. [10]

This question was answered by 174 candidates, with 77% passing. The three options appeared to be equally popular and were equally well answered.

Many candidates approached option (a) by the very simple technique of constructing a table of advantages and disadvantages and easily covered enough points to achieve good marks. More detailed answers noted that although the main incentive for high gravity brewing may be to avoid capital expenditure, some new equipment may well be required, such as sophisticated water de-aeration plant, blending equipment, plus perhaps increased syrup storage capacity.

DIPLOMA IN BREWING EXAMINATION 2007

Module 3 – Packaging & Proces Technology

Good answers to option (b) demonstrated good background knowledge about the key procedures needed for CIP of fermenters, especially taking note of the type of soil, presence of CO₂, required frequency, etc, with sensible discussion of single or multi-use systems. The responses were more variable, with model answers providing a description of plant with schematic diagrams, plus spray equipment descriptions, recoverable and non-recoverable systems, flow rates, chemicals and their actions. Some answers provided examples of CIP regimes and this was deemed appropriate provided that it referred to the underlying principles involved.

Also some demonstration of knowledge of detergent and sanitiser formulations was required, such as the need for surfactants, sequestrants, etc, plus discussion of the merits of caustic or acid, hot or cold, etc; if caustic is routine, then occasional acid to remove scale or, even, 2 stage cleaning with both acid and alkali.

Where several answers failed was all that was presented was a re-hash of in-house cleaning cycles or standardised diagrams of single use or partial- or full- recovery systems. Many answer that did NOT even take account of the fact that the question was specific to fermenters!

Finally, brief descriptions of post-clean, hygiene monitoring methods, such as visual checks, swabbing, assessment of final rinses, but especially ATPase methods, should have been included

In option (c), the examiner wanted notes on the relevance of Darcy's law and the impact of the various parameters, with descriptions of various powder filtration systems. It should have been noted that the process is really depth filtration and hence the need to constantly add body-feed. Answers should have included that a powder like perlite is just a depth filter, but DE also combines absorption features. Also better answers would have identified that powder addition rate should be linked to beer suspended solids content, best monitored by turbidity (pre- and post-filter), plus (and many forgot!) the system must operate ideally below 0°C.

Finally, good answers gave a brief description of how cross-flow filtration operates and candidates should have picked up on the obvious benefits of operating without DE, plus providing knowledge of the various working systems for beer filtration that are now operating in several plants world-wide, rather than just beer recovery from yeast, tank bottoms, etc, which have been available for several years.

David Taylor - July 2007

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

General Comments:

It was very encouraging that the pass rate for Module 3 Diploma in Brewing in June 2007 was 70%, and a lot higher than in 2006. Perhaps the message that both parts of the syllabus need to be studied for a good result has been heeded. It was also good to see that the number of grade F and G failures was very much reduced and fewer totally unprepared candidates sat the exam than in previous years. It is possible that the training workbooks are helping those who previously might have struggled to find adequate learning material. There was an even balance between performance on the packaging and process technology questions for most candidates except for those at the tail-end (grades F and G), where either one or the other predominated and this was usually the main reason for these candidates failing.

Table 1: Overall Pass/Fail Rates and Grades

Diploma in Brewing Module 3 – June 2007
Number of Candidates 167

Passed	117	70.06%
Grade		
A	12	7%
B	26	16%
C	35	21%
D	44	26%
Failed		
Grade		
E	27	16%
F	16	10%
G	7	4%

Table 2: Performance by Question

Diploma in Brewing Module 3 - June 2007

Question	Answered by	Passed by	Passed %
1	34	24	71%
2	105	67	64%
3	114	91	80%
4	93	45	48%
5	148	108	73%
6	111	66	59%
7	158	127	80%
8	104	64	62%
9	52	26	50%
10	59	45	76%

Question 1

Describe, with sketches and with typical values for time, temperature and pressure, the cleaning, sterilisation and filling cycles of a multi-stage keg cleaning/filling machine. [20]

This was the most unpopular question but well answered by most candidates who attempted the question with a high pass rate of 71%. Whilst kegging is not popular in all countries, candidates for the Diploma in Brewing are expected to know about this technology and are advised that if it is in the syllabus it can be asked as a question. Times, temperatures and pressures will vary from machine to machine but candidates are expected to at least know a typical sequence of the washing and filling operations and some idea of the fluids involved, their approximate strength and whether they are hot or cold. There are a large number of possible sequences, for example the detergent could be caustic, acid or caustic and acid, and, in awarding marks for this question, all logical and believable scenarios were rewarded.

Question 2

Explain how beer fill is monitored and controlled on ONE of the following packaging plants and discuss what factors make it difficult to achieve a consistent fill of a: -

A can filler/seamer

A bottle filler/crowner

A keg racker.

[20]

In last year's report, it was mentioned that the question (Q5) in last years' paper on bottle fill control had been poorly answered and it was disappointing since it is key to a successful packaging operation. It was therefore pleasing to see that a question on a similar topic this year was attempted by 63% of candidates and well answered with a pass rate of 64%.

For can filling, the wide diameter of the can necessitates very close control of the fill height on conventional fillers, and then preventing any product loss from filler to final sealed package. Volumetric fillers use either a measuring tank or meter to achieve the fill accuracy.

For bottle filling the concept of a bottle as a measuring container with a fixed fill height and comparison with volumetric filling, giving variable fill heights and potential customer comment, was well covered in most answers.

For keg filling, the greatest challenge for many brewers is the variation in tare weight of the empty keg due to a mixed and varied population. This means that the weighing of full kegs can only be a rough check and alternative means of fill control must be used. Brim filling and detecting overflow by conductivity probe is workable with a new population of accurately made kegs, but dents and "stretching" over time can alter their nominal capacity, down and up respectively. Therefore meter filling is widely used and systems need to be employed to ensure calibration of these meters, either automatically by gross and tare weighing, or manually by putting pre-tared kegs through the machine and re-weighing full.

For all package types, good answers had considered more of the variables that can influence the objective of a "black fill", including the beer temperature, CO₂ content and pressure.

Question 3

Outline the purity requirements for process gases in relation to beer quality and the adverse effects that can occur if purity specifications are not met.

[8]

Explain the difficulties of reducing the carbonation level of a beer prior to packaging and the possible adverse effects of this procedure on beer quality.

[6]

Outline THREE means by which the carbonation level of a beer can be increased.

[6]

This question was popular since 68% of candidates attempted an answer and a very high pass rate of 80% was achieved.

Most students decided that the scope of "process gases" should include CO₂, N₂, oxygen and air. For the latter two, microbiological quality was paramount since they are used for wort aeration/oxygenation. Air is produced on site and needs to be oil-free and dry. Oxygen is usually purchased and purity, particularly "food grade" is more than adequate for the duty.

For CO₂ and N₂, the main problem contaminant is oxygen. Levels of 30ppm or less are required, particularly if used for carbonation or nitrogenation. Two scares with benzene in gases has tightened specifications on hydrocarbons (typically <0.02 ppm), carbonyls (typically < 0.1ppm) and Total Volatile Hydrocarbons TVH (typically <50ppm). A purity of 99.9% or better is required.

Most candidates were familiar with the negative effects of reducing carbonation – loss of foam proteins, loss of hop, denatured fob causing haze, and the operational delays caused by this time-consuming task. If attempted in maturation tank, the stirring up of sediments can lead to difficulties in filtration and short filter runs. Since most candidates knew how to reduce carbonation, I can only assume that it does happen! Reducing tank pressure and purging with CO₂ or N₂ were popular as was blending with a lower carbonated beer, which is arguably the best option if beer is available. The raising of the beer temperature to drive off CO₂ was considered not to be an option, but some candidates were aware of the membrane technology that might be used.

Adding CO₂ is a lot more straightforward and candidates were almost all aware of in-line venturi dosing, in-tank purging via a "stone" or nozzle with applied top pressure, top pressure alone (very slow!) and in-line addition through a membrane or sintered candle.

Question 4

Outline the plant changes required to convert a glass bottle filling line, with in-package pasteurisation, to sterile filling.

[10]

Explain the basic principles of the additional precautions required to achieve a successful sterile filling operation.

[10]

This question had the lowest pass rate and was only attempted by just over half of the candidates.

Most candidates said that a clean room with controlled access, pressurised sterile filtered air etc. was an essential requirement. Beer is not a high risk product due to its pH, alcohol and hop content and therefore it is not essential to adopt aseptic filling procedures, ('clean' rooms and sterile positive pressure air systems). Kegs have been sterile filled for a long time without "clean" room technology but admittedly with the benefits that the keg is self-sealing and steam provides the sterility. Steam use has been tried on bottle sterile filling but has not been successful due to thermal shock breakages.

It was surprising how few candidates were able to outline the plant changes that might be required.

In converting the line, the tunnel pasteuriser can be removed, but might be left in place as a bottle warmer to help with label application. The beer will be presented to the filler after flash pasteurisation and/or sterile filtration.

If returnable bottles are used, the bottle washer will stay, but effective separation of the 'dirty' infeed and the 'clean' discharge will be required, ideally with a double-ended machine. In any case, a final sterile water spray will be required as well as careful attention to the spray nozzles, temperatures and caustic strengths for washing, and vapour extraction from the washer to limit cross contamination.

For NRBs, the bottle washer is removed and a rinser installed. There are quite a few options for the rinsing fluids – sterile water, CO₂, steam. The rinser itself must also be capable of being cleaned so that bottle contact parts do not introduce infection. It is helpful to ensure that the bottle supplier is maintaining a "clean" bottle from the hot end of the bottle manufacturing process through to palletisation, storage and delivery.

A 'blocked' arrangement of rinser/filler/crowner has advantages in minimising the exposure of the bottle between operations.

The long tube filler may be thought of as dated technology but it has advantages for sterile filling, since there is less contact with the non-sterile air in the bottle and the displaced gas is not returned to the filler bowl.

The bottle crown is little risk to sterility, provided they have been stored in a clean, dry environment. Attention to the sterility of all utilities – air, CO₂, jetting water etc. – is required.

A dedicated CIP system for each line is required to ensure the constant availability of cleaning and sterilising fluids. Regular and frequent external spray cleaning of all filling machinery is required in order to maintain a very high standard of cleanliness, and equipment design can facilitate ease of cleaning.

Of prime importance however is the buy-in, training and knowledge of the operators. Awareness of the risks and attention to personal hygiene, hand washing and protective clothing are key.

The QC/QA staff is also heavily involved in checking plant cleanliness and product stability - bioluminescence swabs, in-line membrane sampling and forcing tests on the bottled product.

In answering this question, many candidates did not cover the full scope of making this changeover. Candidates were given marks for specifying clean room technology even though it may not be required.

Question 5

Explain the desired properties of a primary packaging material for beer.

[10]

**Describe in detail the manufacturing process for ONE of the following beer containers: -
glass bottles**

**two-piece can
stainless steel keg
PET bottle** [10]

This was the most popular packaging question, attempted by 89% of candidates and with a pass rate of 73%.

Having defined a primary packaging material as one in contact with the product, most answers listed the keywords – contain, protect etc. – with a short sentence of explanation. Poorer answers limited the scope to just the production aspects whereas the better answers also covered the logistical, marketing, sales and legal perspectives.

For the manufacturing process, the majority of candidates opted for glass bottle manufacture, with cans a close second. PET bottle and stainless keg manufacture were least popular. This was textbook stuff and most answers were well constructed with a good use of sketches to illustrate the process. Good answers had more detail – for example the percentage of each raw material for glass manufacture rather than just “sand”. Not many answers mentioned the very important inspection and testing that takes place during and after manufacture of a primary package to ensure that the package meets specification.

Section B – Process Technology

Question 6

Outline, with the use of diagrams, the key features of internal and external heating units used for wort boiling, and discuss the relative merits of their thermal performance including fouling of the wort side heating surface. [8]

**A mash conversion vessel of wall thickness 20 mm is heated by an external steam jacket with a heating area of 40m² using saturated steam at 3 bar gauge pressure.
When the mash conversion vessel contents are at 65°C, calculate: -
the overall heat transfer coefficient [6]
the rate of heat transfer to the mash [3]
the steam flowrate assuming heat losses are negligible [3]**

*Steam side film heat transfer coefficient = 8000 Wm⁻² K⁻¹
Wort side film heat transfer coefficient = 350 Wm⁻² K⁻¹
Thermal conductivity of the wall material = 50 Wm⁻¹ K⁻¹
Steam side dirt coefficient = 10,000 Wm⁻² K⁻¹
Wort side dirt coefficient = 1000 Wm⁻² K⁻¹
Latent heat of steam at 3 bar gauge and 144°C = 2133 kJ kg⁻¹*

The Examiner was looking for ‘process technology’ reasons for differences in thermal performance of internal and external heating units, in addition to good sketches and explanation of their key features. Whilst internal and external calandrias were the expected, there were also a several answers that specified steam jackets and direct firing. (Are these internal or external heaters? The source is external to the vessel, but the heating surface is internal to the vessel).

Since $Q = U A \Delta T$, the greater surface area possible with the external calandria should enable the steam temperature, and hence ΔT , to be reduced, which will reduce fouling, hence higher U or maintained for longer. U can also be increased by forced convection using a pump (both on internal and external calandrias) during wort heat-up. The material of construction can affect U and most candidates were able to explain about surface wettability and nucleate and film boiling in relation to copper and stainless steel construction. Thermosiphoning is a benefit, enabling the circulation pump to be by-passed during the boil phase.

It always helps to draw a sketch when starting to answer a calculation question since it can highlight any information that is missing and has to be calculated. This calculation was however quite straightforward, provided it was remembered that it is the reciprocals of the heat transfer coefficients (the resistances) that are added together. A number of candidates did this correctly for the steam and mash side film coefficients and for the wall, but added the dirt coefficients directly without taking the reciprocal. Whilst I can’t explain why candidates should have done this, the units should have made it obvious, since they are the same for all the coefficients.

A value of U of 223 Wm⁻²K⁻¹ should then have given a rate of heat transfer of 704.7kW and a steam flow rate of 0.33kg s⁻¹.

Question 7

Explain, with the use of diagrams, the design and operation of a flash pasteuriser for the preparation of bulk beer for packaging. [8]

What problems could occur with the plant and with its operation that would compromise the integrity of the process? [4]

Calculate the pasteurisation units given to a beer with a residence time of 20 seconds at 72°C in the holding tube of a flash pasteuriser, given that PUs per minute = 1.3932 (T - 60) where T is the holding tube temperature, °C. Comment on the validity of the answer. [2]

Calculate the pressure that would need to be applied in the holding tube to retain a level of 4.0g l⁻¹ of CO₂ in the beer. Assume that beer has the same properties as water. [6]

Density of water = 1000 kg m⁻³

Henry’s Constant for CO₂ at 75°C = 437 × 103 kN m⁻² (mole fraction)⁻¹

Molecular weight of carbon dioxide = 44

Molecular weight of water = 18.

The outline diagram of a plate pasteuriser was usually well drawn but there was often a lack of the controls and the things that make it work. Since this was a process technology exam, temperature and pressure instrumentation at the very least was expected. Also pasteurisers without any regeneration were drawn – it is hoped, for the sake of the environment and energy costs, that they do not exist!

The integrity of the process could be compromised in a number of ways: -

Plate leakage, from non-sterile to sterile and from utilities to the beer. Most candidates were aware of the need to keep the beer pressure higher than the utilities so that leakage was not into the beer. Only a few candidates mentioned a boost pump after the holding tube to raise the sterile beer pressure above the non-sterile.

Low pressure in the holding tube, (due to main beer pump failure or cavitation, pressure sustaining valve failure) can lead to gas breakout that can reduce the residence time in the holding tube and lead to ineffective pasteurisation.

Long periods of beer recirculation can ‘cook’ the beer. Water recirculation is preferred in the event of SBT full or IBT empty, and at start-up and shutdown.

Low temperature in the holding tube - control failure is unlikely, but it is important to ensure that the temperature probe at the holding tube discharge is calibrated on a regular basis since it controls the PUs being applied.

Plant cleaning – reduced heat transfer could be the result of inadequate cleaning. The control system should compensate and maintain the PUs up to the point where no further increase is possible. The system should then alarm or alarm/shut-down. Not all systems may have this in-built security and un-pasteurised beer could result.

The calculation of the PUs was straightforward and most candidates coped well, although a few forgot to calculate the PUs for 20 seconds instead of one minute. The calculated PUs of 17.8 is typical for beer but the equation assumes a Z value (decimal reduction temperature) of 7°C for brewery organisms (actually 12.5°F = 6.944°C). Low alcohol beers and ciders may require a higher level of PUs and it should be remembered that pasteurisation does not achieve sterility.

The final part of the question was well answered by most candidates in calculating a balance pressure of 7.149 bar. Although a number of students used the mole ratio rather than the mole fraction, the error in this instance is small and marks were not deducted.

The question had the equal highest pass rate of 80%.

Question 8

Explain, with the use of diagrams and with examples of typical brewery applications, the differences between positive displacement pumps and centrifugal pumps. [10]

Calculate the theoretical pump power required to raise 1000m³ per day of water from 1 bar to 16 bar pressure. [6]

If the pump efficiency is 55%, calculate the shaft power required. [2]

If the electrical efficiency is 95%, calculate the electrical power required. [2]

Density of water = 1000 kg m⁻³
1 bar = 100kPa

This question was looking for the main differences between centrifugal and positive displacement pumps and candidates often failed to make any comparisons. Simply sketching and describing pumps was not the answer. However, uses in the brewery for the various pumps were well answered.

The calculation required candidates to know that pump power is the multiple of the pressure developed and the volume flow rate, (differences in kinetic energy and height being assumed to be zero). It was then a case of multiplying 15 × 105 Nm⁻² by 0.011574 m³ s⁻¹ to get 17.361 kW, and then dividing by 0.55 to get 31.565 kW shaft power and again by 0.95 to get 33.227 kW electrical power input. Errors made were often to multiply by the efficiencies rather than divide.

Question 9

Describe, with the use of sketches, the principles of operation of each of the following: -

- A venturi meter [3]
- A rotameter [3]
- A magnetic flow meter [3]

$$Q = C_d A_2 \sqrt{\frac{2 \Delta P}{\rho \left(1 - \left(\frac{A_2}{A_1} \right)^2 \right)}}$$

Using the continuity equation and Bernoulli equations, derive from first principles the following equation for an orifice plate meter: -

Where Q is the flowrate

A₂ is the orifice area

A₁ is the pipe cross-sectional area

Δ P is the pressure difference across the plate

ρ is the fluid density

C_d is the discharge coefficient [6]

An orifice plate meter with an orifice diameter of 350mm and a C_d of 0.62 is used to measure the flow of water in a pipe of 500mm internal diameter. Calculate the mass flowrate if DP is 0.26 bar. [5]

Density of water = 1000 kg m⁻³
1 bar = 100 kPa

This question was asking for the principles of operation of three common types of meter. Candidates often failed to explain the principles, although the sketches were mostly good.

The venturi meter operation is based on Bernoulli and the explanation sought was that the restriction caused the velocity to increase and hence the pressure to decrease and by measuring the pressure difference, a measure of flow rate could be obtained. The meter has a high C_d of 0.90 – 0.98.

The rotameter is a variable area meter working on the principle that the float weight is balanced by the pressure difference across the float. As flow increases, the increased pressure difference lifts the float until, as the flow area increases, the balance is re-established. The pressure drop is constant and the rate of flow is a function of the flow area.

The magnetic flow meter works on the Faraday principle that a conducting fluid moving through a magnetic field (from coils around the pipe) will create a potential difference across the pipe that can be measured on a voltmeter attached to electrodes in the pipe wall. The voltage generated is a direct measure of the rate of flow.

The derivation of the orifice plate equation required the application of the continuity equation, ρ u₁ A₁ = ρ u₂ A₂, and of the Bernoulli equation between points 1 and 2. Since height differences can be assumed negligible, ρ g₁ h₁ = ρ g₂ h₂ and cancel out. Substituting for u₁ (= u₂ A₂/A₁) and rearranging the Bernoulli equation gives the equation as shown, but without the factor C_d. An explanation is needed that the flow rate will be less due to friction losses and that a C_d factor is introduced to account for these losses.

It is a quite acceptable mathematical ploy to work forwards from the Bernoulli equation and backwards from the answer until the two meet and the proof is complete. It is not however OK to jump straight to the final equation without showing any workings, as quite a few attempted,

but without receiving any marks!

The calculation needed nothing more than care, having first calculated the two areas, in putting the numbers into the equation given and ensuring that the units were correct to get an answer of 490 kg s⁻¹

Question 10

Stainless steel is often the preferred material for the construction of vessels in a brewery. Name THREE other materials that are used in preference to stainless steel for vessel construction. For each of these materials, identify the applications and explain why it is preferred to stainless steel. [15]

Specify the floor construction for a beer filtration area, explaining the reasons for your choices of materials. [5]

This was not a question about stainless steel, so it was totally wasted time and effort to describe stainless steel and its corrosion resistance, which a number of candidates attempted to do. It is imperative to read the question and to answer what is asked. There are no marks for material that is not relevant to the question and depressing for the examiner not to be able to reward the effort.

The question asked for materials used in vessel construction, so answers that talked about pipes, heating elements etc. were not answering the question. Kegs and casks were accepted as valid “vessels”.

Candidates identified copper (for kettles), mild steel (for grist cases, silos etc. and, when suitably lined, as beer cold tanks), cast iron (for water tanks) and aluminium for fermenters and beer kegs/casks. Wood was often mentioned – it is hard to believe that it is a preferred material nowadays (except in lambic beer and spirits such as whisky where it plays a key role!), but there are still a few examples existing of wooden fermenters and beer storage vats. Plastics were also a popular choice but marks were deducted if the material was not defined, for example polypropylene. Surprisingly, concrete (for malt silos, effluent tanks, water tanks etc.) was seldom mentioned despite its benefits of cost, strength and insulation.

For the filter room floor construction, good answers addressed the sub-floor as load bearing, usually reinforced concrete. A screed (sand/cement or epoxy) is laid over the sub-floor, with falls of 1:100 or greater to drains or gratings to take away the wash water flows. A top finish is applied with a coating (epoxy, polyurethane, quarry tiles etc.) applied to provide a smooth, non-slip, crevice-free surface that is resistant to acid, alkali and chemical cleaner attack.

If the filter room is to be temperated, it may be required to insulate the floor with a sub-layer of closed-cell foam or aerated concrete to reduce its U value and reduce heat gain.

Some interesting alternatives to the above were suggested, probably the most unusual being a floor of stainless steel!

J B Eaton – July 2007

DIPLOMA IN DISTILLING EXAMINATION 2007

Thirty candidates sat the three examinations of 2007. Of that number, three sat and passed all three modules and a further three sat two module examinations. With only one failure in each of the three modules the pass rate over the 37 individual examinations was an impressive 91.9%, with a total of 8 grade A and 16 grade B passes over the three modules. In addition to the three candidates who passed in single sitting this year, a further five have now accumulated the three module passes to qualify for Diploma in Distilling. More detailed discussion of the statistics is included in the reports on the individual modules.

I had not noticed this as a problem before, but this year several candidates did not show the numbers of the questions they had attempted in the box on the front cover of the answer book (in the actual order answered, please, not numerical order). More seriously, some candidates showed only five numbers in the box but had answered the full choice of six questions. I probably would notice it, but I can not guarantee to find a sixth answer hidden in the paper if I am unaware that it exists, so in some circumstances this could cause a candidate to fail: the candidate's own fault, not mine. So future candidates please note that filling in that box on the cover correctly is very important. Also on the subject of answering only five questions: if you have run out of time or knowledge to complete a sixth question, you are strongly advised to start it. The first two paragraphs of a new question would probably score more marks than the final two paragraphs of the previous one, and this also could mean the difference between pass and fail.

That is my only comment which applies to the examination as a whole. Complaints or suggestions that concerned one specific module or question are included in the relevant section of the report.

Module 1 – Materials and Wort

Of the 18 candidates who sat module 1, 17 passed: 5 at grade A, 8 at grade B, 3 at grade C and 1 at grade D. The average of the 18 final marks was 67.8%.

Question 1

Give an account of the related problems of residual dormancy, water sensitivity and water uptake in barley, explaining both their relevance to the malting process and how they may be overcome. [20]

Question 1 was attempted by 15 candidates, most covering the main points requested as thoroughly as would be possible in the time available. Strangely, several of the answers did not specifically address the part of the question concerning relevance to the malting process, but in the context of otherwise excellent answers that had only a minor effect on their marks. Although there was no requirement to write in that way, I noticed that answers explaining the topics of dormancy, water sensitivity and water uptake as three separate sections generated the best marks, whereas attempting to explain all three within a single essay was obviously a more difficult task. However, these are minor complaints, perhaps not really complaints at all, and all answers scored well above the pass mark.

Question 2

Describe the operation of combined steeping, germination and kilning vessels, and discuss the advantages and disadvantages of such equipment compared with separate units for the three processes. [20]

Question 2 was less popular, chosen by only 11 candidates, but well answered by most, and only one failed. Although the question did not allocate separate marks as (a) the description of SGK operation and (b) discussion of its advantages and disadvantages, it was safe to assume they were of equal value. Assessment was not quite as inflexible as that, but a reasonable amount of part (b) above was necessary for a good mark, and few answers were as comprehensive as I expected. For example, the commitment to several hundred tonnes of grain over the prolonged period of the SGK sequence creates numerous potential disadvantages which were seldom discussed adequately. Also, it was expected that the descriptions of the processes of steeping, germination and kilning would specifically refer to the operation of SGK vessels, not traditional plant, which only needed to be mentioned if relevant to advantages and

disadvantages of SGK units. In fact, some answers lost marks by describing germination and kilning operations in a way that would happen only in traditional vessels, which I interpreted as lack of knowledge of the SGK system.

Question 3

Discuss the requirements for a good quality malt for either a grain or a malt whisky distillery. [20]

Question 3 was attempted by all candidates. Although other strategies were equally acceptable, most provided a malt specification. However, for a full answer; the reasons for the specified properties were also an essential part of the discussion. So if those who chose to specify the requirements for a grain distillery had an easier way of earning that share of the marks, the total effort required was similar for both the grain and malt versions of the answer. Some malt distillers provided specifications which were commendably detailed (and so far as I could tell, accurate) for examination conditions but it was acceptable to explain only the reasons for the main items. Future candidates please note that for a question such as this, with two different correct answers, it is important to state, at the beginning, which version you are answering. Some candidates forgot, but fortunately made it clear later in the answer so on this occasion all was well, and everyone scored above the pass mark; well above, in most cases, so this question produced one of the highest average marks of the examination.

Question 4

Explain the operation of a mill for kilned malt and discuss the importance of particle size of milled malt fragments to both grain and malt distilling. [20]

Question 4 on milling was also 100% popular, and again with 100% pass rate. This time the requirements of both grain and malt whisky distilleries had to be explained. Taken literally, the wording of the question required only one type of mill to be described (preferably with the assistance of the drawing which most candidates provided), so a roller mill would have been acceptable alone as the only type suitable for both malt and grain distilleries, but of course with different roller settings and grist analyses. However, a full discussion of the particle sizes for grain distilling would also have to mention the required finer grind, also achieved by a hammer mill, and most candidates played safe by describing and illustrating that mill as well. But since kilned malt was specified in the question, any other type of mill or grinder to handle green malt was irrelevant. Although grist analysis data did not feature in the wording of the question, it should have been obvious that some mention was necessary in a discussion on particle size, so a few scripts lost marks by that omission.

Question 5

Give an account of the properties of malt a and b amylase and discuss the importance of these characteristics to the process of mashing in a malt whisky distillery. [20]

In many previous reports I have complained about candidates avoiding biochemical questions. This year I was pleasantly surprised to discover that 14 (78%!) of the candidates had answered question 5 on the amylases of malt, and that all but 2 had scored at least a pass mark. However, I was disappointed by fact that so few answers included a simple diagram of the structure of starch to illustrate the sites of activity of the α and β enzymes. Also, many lost marks by the scarcity (or complete absence from some answers) of information on the importance of the properties of these enzymes to the process of mashing: yet another example of candidates not answering part of the question.

Question 6

Explain the principles of ion exchange and activated carbon treatment of distillery process water, and why these treatments may be necessary. [20]

The above criticism also applied to question 6 on water treatment. Although the operation of the specified filters was competently described in most answers, the reasons why the distillery had to carry out the treatments in the first place, and the benefits of the treatments, were inadequately explained, if at all, in the poorer scripts. However of the seven candidates attempting question 6, all passed.

Question 7

Name the factors involved in the Mogden formula (or other appropriate method) for calculating effluent treatment costs and describe briefly how changes of operating procedures could reduce these costs for a distillery. [20]

A different type of water treatment inspired 14 answers to question 7. The following comments apply to the British charging system based on the Mogden formula, which did not necessarily have to be reproduced in the answer, although the basic principles had to be understood, and the full formula was welcome (or an explanation of an overseas candidate's own system). The service charge and volumetric charge are based on the total flow, and the suspended solids per litre and BOD after settlement are assessed separately for inclusion in the final bill. Therefore it was expected that answers would at least discuss means of reducing BOD, SS and total volume of waste water to drain, although the nature of the liquid BOD and solids (biodegradability, in effect) also influences the cost and should also have been mentioned briefly. However, pH, temperature and copper content are restrictions rather than chargeable items, so they were irrelevant to the answer and mention of these factors scored no marks. The question was competently answered in most of the 14 scripts, but 3 failed.

Question 8

Describe a laboratory procedure for each of the following determinations:

Total nitrogen of malt. [10]

Free amino nitrogen of wort. [10]

A good answer to question 8 required only a description of the laboratory method for each of the two analyses, which clearly were familiar techniques to the candidates, judging by the detail provided. Unfortunately one person had left insufficient time even to make a significant start to the answer, but all of the other 7 candidates provided acceptable accounts of the two methods, some even providing, unnecessarily, descriptions of both the Dumas and Kjeldahl methods for total nitrogen.

Module Two – Fermentation, Distillation and Maturation

Twelve candidates sat paper 2, and 11 passed; the average of all marks was 63.7%. Grades achieved were 1 at A, 5 at B and 5 at C.

Question 1

Give an account of the importance of the cytoplasmic membrane of yeast in the uptake of nutrients from wort. [20]

Question 1 was answered, with varying levels of expertise, by eight candidates. Although all, including the two failures, mentioned the selectivity of the transport systems of the membrane for specific sugars and amino acids, the poorer answers lacked detailed information. The question did not specifically request an account of the structure of the cytoplasmic membrane, but providing that information in words and drawing very obviously assisted the best explanations of nutrient transport systems. These highly-marked answers also scored points for their full information on the sequence of uptake of the different fermentable sugars, and the equivalent effect for amino-acid transport requiring the biosynthesis of proteins from a limited range of wort amino acids. Since variation in sugar and amino-acid metabolism affects production of flavour congeners, that too had to be mentioned for a full answer.

Question 2

Describe the storage requirements and inoculating (pitching) procedure for each of the three different forms in which yeast can be purchased for distillery fermentations [20]

Although not mentioned by name in question 2, everyone correctly deduced that I meant cream, dried and pressed yeast. I would have accepted brewing yeast as an alternative to dried, but that generosity was unnecessary. Many of the 11 answers were obviously based on frequent practical experience, at least of working with cream and pressed yeast, but since dried yeast is not yet widely used in Scottish distilleries, that part was less competently explained in some of the scripts. However, the general principles of yeast storage and pitching were well enough

explained for all candidates to pass, in fact this was by far the best-answered question of the paper, and of the entire Diploma examination, with an average mark of 16.9/20, a most impressive statistic. But I was surprised by the number of times the storage temperature of cream and pressed yeast was quoted as < 4°C, which is wrong: "less than 4°C" extends down to absolute zero. The upper and lower values of the acceptable temperature range (e.g. 2–4°C) should have been stated; certainly it is important that the yeast must not freeze (as most answers mentioned, so no-one was penalised on this occasion for sloppy use of numbers).

Question 3

Discuss the lactic acid bacteria and their effects on distillery fermentations. [20]

Question 3 on lactic acid bacteria, which includes more than just the genus *Lactobacillus* which featured alone in most of the eight answers, required both a discussion of the biology of these organisms and an assessment of their effects, good and bad, on distillery fermentations. So, *Pediococcus* deserved a brief mention, as did the likely occurrence of lactic bacteria on malt as contaminants, and the different metabolism of "homolactic" and "heterolactic" types. Although lactic bacteria in large numbers compete with culture yeast for fermentable sugars and by their acid production suppress secondary amylolytic activity during fermentation, in many malt whisky distilleries a low level of lactic bacterial contamination is considered to improve spirit flavour by direct production of congeners and subsequent development of lactic esters. A really good answer had to include all of these points; few did, and unfortunately one omitted too many to reach a pass mark. Methods for detection of lactic bacteria were not necessarily required, but were included in two scripts and accepted as a reasonable contribution to the microbiological part of the answer.

Question 4

(a) Give an account of the principal types of cleaning and sterilisation agents for washbacks (fermentation vessels). Give reasons for the choice of one specific regime (description required) for treatment of the vessels by either a manual or an automatic procedure. [15]

(b) Describe one type of microbiological test to confirm the effectiveness of the sterilisation process. [5]

There were various possible answers to question 4 on cleaning and sterilisation of fermentation vessels, since candidates could choose to describe either an automatic or manual system and vessels of either steel or wood construction. Although the description of cleaning and sanitising agents had to cover the principal types, only one system of actual cleaning had to be described. That first part of the question was competently answered by all nine candidates, but some made the mistake of referring to steam and/or peracetic acid as cleaning agents. That is wrong: they are excellent sterilising agents, but can not remove soil from surfaces.

Most answers benefitted from including a sketch of the main features of the cleaning system, but that advantage is somewhat reduced by poor drawing. Freehand drawings of irregular shapes like pot stills (irrelevant to question 4) are tolerable, but surely a ruler was necessary to indicate the straight lines of pipework and vessel walls. Answers to the second, shorter, part of the question varied widely in quality, the commonest fault being vagueness about the culture medium used to test the swab or rinsings for viable micro-organisms. 'Agar medium' without identification of its nutrient composition was a meaningless answer suggesting a lack of understanding of microbiology. Similarly, some of the candidates who chose bioluminescence as the test of sterility could not explain how exactly the test worked; another unfortunate example of lack of knowledge of the principles of microbiological techniques.

Question 5

Explain why the congeners of higher and lower volatility than ethanol, which are recycled as foreshots (heads) and feints (tails) during each batch distillation, do not accumulate to unacceptable levels in the charge to the spirit still. [20]

Question 5, on the congeners of malt spirit distillation, required not only recollection of the kinetics of the process, but some thought about the implications as well. Of the eight candidates who attempted it, only four passed. Most answers, pass or fail, correctly noted that the quantity of recycled foreshots/feints over successive distillations maintained a

constant volume of charge to the spirit still, at a constant alcoholic strength, but for a pass mark the amount of congeners also had to be considered.

Basically the same situation applies to congeners as to ethanol, i.e. each charge of wash introduces new congener material, and approximately the same amount is removed with each batch of spirit. But the situation is complicated by the fractionation of high-, medium- and low-volatile congeners and the selective distillation of high- and low-volatile compounds into the recycled foreshots/feints fraction. Although most answers included the well-known graph of spirit distillation showing the partitioning of congeners between foreshots, spirit and feints, to be relevant it had to be related to the losses of congeners from the still system.

Good answers explained that the losses of low-volatile congeners in pot ale and spent lees, and uncondensed high-volatile congeners in vapour at the start of foreshots distillation, helped to remove those components which were not distilled with the spirit. The better answers also mentioned the separation of fusel oil in the receiver vessel between runs as a further loss of low-volatile congeners.

Question 6

Discuss the importance of wash alcoholic strength, temperature and flow rate in the operation of a grain whisky or neutral spirit still, and the quality of the product. [20]

Question 6 was more popular, answered by ten candidates, of whom all but one passed. Ideally, none of the three listed factors, wash %ABV, temperature and flow rate, should vary during the run, and routine operation of a continuous still is largely concerned with maintaining constant temperature and flow rate. One possible approach to discussing their importance was a description of likely effects of accidental variation on product quality.

However, with regard to alcoholic strength, another interpretation of the question could be to speculate on the differences between a run at constant 8%ABV and another at 10%, with considerable energy saving but possible adverse effects on flavour. There were several excellent answers of both types, but as in question 5, some included the textbook graph of distribution of flavour congeners during distillation without explaining why it was relevant. Using the graph to illustrate the effect of each of the stated variables was acceptable, but just to include it as proof of good memory did not impress.

For similar reasons, a drawing of the still system was relevant to the answer only if it showed how temperature and flow rate were controlled.

Question 7

Give an account of the chemical changes caused by charring of the inner surface of an oak cask and explain their importance to the process of maturation of the spirit. [20]

Nine candidates answered the maturation question 7, which I had intended to relate to the heat-degradation products of cellulose, hemicellulose, lignin, tannins and if possible other components of oak wood, and their contribution to whisky flavour and colour. However, I agree that charring is a chemical change in its own right, so the absorptive effects of the char layer, which almost everyone mentioned, were also accepted as a valid part of the answer.

Only a small part: for good marks the answers had to mention breakdown of the polysaccharides to simple sugars which would impart sweetness to the maturing whisky, and the release of simple tannins which contribute to flavour complexity.

Most importantly, it was necessary to describe the guaiacyl and syringyl heat-degradation products of lignin, and their subsequent oxidation and esterification during maturation, as an essential part of the maturation process. I was pleased to see so many of the explanations illustrated with simple chemical formulae, and of course scoring better marks as result, but unfortunately one answer did not quite reach the pass mark.

Question 8

Describe briefly four different quality management tests carried out between wort collection and bottling of the mature whisky, and explain their importance to the quality of the final product. 4 × [5]

Since there are so many quality management tests between collection of wort and packaging of mature whisky, the choice of question 8 by six candidates gave them a wide range of topics to discuss, and produce consistently high marks. However, the answer had to include both a brief description of the method and an explanation of why the test was

necessary, so a competently described experimental protocol alone scored only half marks for that section. I had hoped that candidates would choose examples from the whole range of activities of mashing, fermentation, distillation and packaging, but provided they were distinctly different types of test, even four from the same stage of the process, e.g. packaging as in some answers, had to be accepted.

Module Three – Process Technology

Of the 7 candidates who sat paper 3, 2 passed at grade A, 3 at grade B and 1 at grade C. The average mark was 66.7%.

Question 1

Discuss the advantages and disadvantages of increasing the alcohol content of wash for malt and grain whisky distilleries with the intention of saving energy in distillation. [10]

Calculate the energy required to distil 100 kg of alcohol, calculated as pure ethanol, from wash of 8.0% alcohol volume/volume (= 6.4% weight/weight). Assume that the wash feed to the analyser column has already been heated to distillation temperature in the rectifier wash coil of the Coffey still, and that 100% of the ethanol and 50% (by weight) of the water are evaporated. Ignore heat losses from the still. [5]

If the alcoholic strength of the wash is increased to 10% v/v (= 8.0% w/w), how much energy is saved in the evaporation of 100 kg of alcohol? Assume again that 100% of the ethanol and 50% of the water are evaporated. [5]

Latent heat of evaporation of water = 2260 kJ kg⁻¹

Latent heat of evaporation of ethanol = 840 kJ kg⁻¹

All seven candidates attempted question 1, with varying levels of competence, although all passed. Of course the reason for distilling stronger wash is a saving of energy, and that was covered by the calculation, which showed (with the help of simplifying assumptions) that distilling from 10% rather than 8%ABV wash saved 353.1 MJ per 100 kg of pure alcohol produced. If your answer was slightly different from that, did you forget to subtract the 100 kg of ethanol from the calculated weight of wash which would produce that amount of pure spirit? Surprisingly, another occasional mistake was calculating as alcohol by volume rather than weight. Some mention of the energy aspect was expected in the first, essay, part but the answer should have been mainly concerned with the significance to the mashing, fermentation and distillation operations, and to the final flavour of the spirit, of using a higher original gravity and higher %ABV in the still.

Question 2

'Fusel oil' from continuous distillation can be removed by either a 'decanter' or an auxiliary still. With the aid of diagrams, explain these two operations and compare their value to the overall distillation process, including efficiency of recovery of ethanol. [20]

Question 2 concerned the two possible systems for removal of fusel oil from a column still. All four answers were of an impressively high standard. The operation of both the auxiliary still and decanter system was well explained in words and neat drawings, and the efficient recycling of ethanol to the main columns from the fusel-oil still was also competently discussed. The decanter, in contrast, produces fusel oil with a higher content of ethanol, although within British excise limits, and recovery of the ethanol in the water layer is unlikely to be energy-efficient.

Question 3

Discuss the qualitative and quantitative advantages and disadvantages of direct firing of pot stills or indirect heating by steam coil. [10]

Calculate the volume of air per hour (assume 21% O₂, 79% N₂) required for complete combustion of natural gas (assume pure CH₄) consumed at 180 m³ h⁻¹. [10]

Density of air = 1.293 kg m⁻³, density of methane/natural gas = 0.717 kg m⁻³.

H = 1, C = 12, O = 16

Question 3 was also chosen by only four candidates, and again all passed.

Although all pointed out that direct firing is currently very rare, that was irrelevant to the answer. However, everyone provided competent assessments of the advantages and disadvantages of direct firing before agreeing on the superiority of steam heating. All mentioned the abrasive effect of the obligatory rummager, but I was surprised that no-one blamed the fire itself as a cause of more rapid corrosion of the base (also known as crown) of a direct-fired still. There were mixed fortunes in the calculation, in one case even getting the equation for combustion of methane wrong, a bad start. Although it is not normal practice to use volumetric measurements in chemical engineering calculations, there was one final mark for converting the 2458.3 kg per hour into the volume of air required (1901.2 m³), which some did not notice.

Question 4

Discuss the possibilities for energy recovery or re-use in a malt whisky distillery which has no on-site co-products (by-products) plant.

[8]

As one example of heat recovery, wash weighing 11000 kg, collected at 30°C at the end of fermentation, is heated to 65°C in a plate heat exchanger against a counter-current flow of the 7150 kg of pot ale remaining from the previous distillation. What is the outlet temperature of the pot ale?

[6]

How many heat exchanger plates of area 0.9 m² are required to pre-heat the 11000 kg of wash from 30° to 65°C in 45 min?

[6]

Assume for the calculations that both wash and pot ale are pure water, specific heat 4.18 kJ kg⁻¹K⁻¹, and that the pot ale is at constant temperature 98°C while it remains in the still. Overall heat transfer coefficient of plates = 800 W m²K⁻¹

Question 4 on recoverable energy specified a distillery without a pot ale treatment plant in order to limit the possibilities to wort cooling, still heating coil condensate, condenser coolant and of course the spent still contents which featured in the calculation. The quality of the essay part of the answers varied widely, some excellent but with additional ideas which could more correctly be described as energy generation (e.g. methane from anaerobic digestion), not energy recovery. Most candidates correctly calculated the outlet temperature of pot ale from the heat exchanger as 44.2°C. As usual, someone got the inlet and outlet streams mixed up in the LMTD factor of the second part of the calculation, which resulted in a larger heat exchanger than the 38 plates actually required (since 37.1 would leak badly). Five candidates attempted this question, and four passed.

Question 5

Describe, with the aid of a flow diagram (drawings of plant are not required), the stages of the basic process for concentration of spent wash from continuous distillation of 'grains-in' wash to 'dark grains' for animal feed.

[10]

Explain, with the aid of a sketch of the relevant equipment, how the energy efficiency of the process is improved by multiple-effect evaporation of the water content.

[10]

Question 5 specified a description of the concentration of spent wash from a continuous distillery "with the aid of a flow diagram", implying that the diagram should assist, not replace, the text. So, however good the diagram (they all were), without the required explanation that part of the answer was marked lower than its potential. That criticism did not apply to the explanation of multiple-effect evaporation, where the standard textbook diagrams were explained well: to good effect, one might say. Some of the six answers were excellent, and all passed.

Question 6

Discuss the design and operation of the control system for automatic cleaning-in-place of stainless-steel fermentation vessels, for both total-loss and recovery modes of operation.

Give diagrams as appropriate.

[20]

Only two candidates attempted, and passed, question 6. As usual with such a small number, I confine my report to the expected answer. Comments on microbiological aspects were welcome, but there would be little opportunity since the relationship of the control equipment to the vessels, pipework, valves and pumps had to be drawn and explained in the

time available.

Question 7

Define the terms "stainless steel" and "austenitic stainless steel".

[4]

Describe the composition of two common stainless steel alloys.

Discuss the advantages and disadvantages of these two alloys for the principal items of distillery plant, in comparison with each other and also in comparison with other possible structural materials for these items.

[16]

Question 7 was more popular; attempted by 6 candidates, all of whom competently reproduced the textbook data on their choice of stainless steels, supplemented with a variety of views on their suitability versus other materials for construction of distillery plant.

Question 8

Discuss briefly the significance of Reynolds number with respect to the flow of process liquids through pipework and heat exchangers.

[5]

Sketch an orifice flow meter and explain briefly the principle of its operation.

[5]

The relationship between flow rate and pressure drop through that instrument can be expressed as:

$$Q = C_d A_2 \sqrt{\frac{2(p_1 - p_2)}{\rho [1 - (A_2/A_1)^2]}}$$

Name, giving their SI units of measurement, the factors Q, A₁, A₂, p₁ and p₂ in the above equation; also, what is the significance of the dimensionless factor C_d?

[4]

An orifice meter with an orifice diameter 70 mm and C_d 0.62 is used to measure the flow rate in a water main of 100 mm internal diameter. Calculate the flow rate if the pressure difference across the meter is 0.25 bar (0.25 x 10⁵ N m⁻²).

[6]

Density of water, ρ = 1000 kg m⁻³.

Finally, four candidates, of whom three passed, answered question 8 on fluid flow, all including the required discussion of laminar and turbulent flow. Although all sketched the basic principle of the orifice plate flow meter adequately, none mentioned the positioning of the pressure measurement points: upstream, 1 pipe diameter from the orifice, and even more important, 0.5 of the inside diameter downstream. So they were suitably penalised. The calculation of flow rate in a water main involved little more than inserting numbers into the calculator, but it was successfully accomplished by only one of the candidates, whose answer was almost the same as mine (68.4 m³h⁻¹). The reason for two others producing wildly wrong answers was the inexcusable mistake of calculating area from the square of the diameter, not the radius of the circles.

Iain Campbell – July 2007

MASTER BREWER EXAMINATION 2007

Module 1 – Raw Materials and Wort Production

There were 17 papers were returned; this is less than half last year's number. 13 (76%) candidates achieved a pass mark. The general standard of papers this year was good and the pass rate compares favourably with last year's.

There were some really good papers but as usual there was a cluster of candidates just on or above the pass mark. The candidate I mentioned in last year's report who was re-sitting the exam having failed several times over in the last few years finally managed to pass this year, but only just!

Would candidates and mentors please take note of the following points:

- Several candidates failed to answer five questions or answered their fifth question very badly. Good time management is as important in the examination room as it is at work.
- Too many candidates failed to read the questions carefully enough and either missed out some parts or misinterpreted the question.
- 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 text-books, 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

Malting plant design

Draw up a design brief for a new malting plant capable of producing sufficient malt for an adjacent 2 million hectolitre per year brewery. Specify all of the items of plant to be used including the capacities required. State all assumptions.

This question was attempted by four (24%) of candidates with only two (50%) achieving a pass. Despite being a relatively straightforward question it was not particularly well answered. It is clear that candidates are not getting to grips with the production process for arguably the most important raw material in brewing. Here the use of sketch diagrams helped to illustrate the better answers. Candidates, with the support of their mentors, must do more to ensure that they get experience in a maltings, preferable spending a few weeks working with managers and operators. In this way they will get a real understanding of how barley becomes malt.

Question 2

Moisture content during malting

Discuss the importance of the control of moisture content during the malting process on malt quality. Describe practical ways in which the maltster can reduce water usage and effluent production.

This question was attempted by 11 (65%) of candidates, with eight (73%) achieving a pass mark. There were some good answers to this question though some candidates were unable to quote realistic moisture values at the different stage of malt production. Water is the leitmotif that runs through the entire brewing process; candidates must make themselves aware of how this important raw material interacts with the process of making beer at all stages.

Question 3

Hop products

Describe the production processes for two named hop products. Debate the reasons for using hop products rather than whole hops in the brewhouse.

This question was attempted by 11 (65%) of candidates with four (36%) achieving a pass mark. This question was not tackled well by many who attempted it. In too many answers the processes for pelletisation and pre-isomerisation were very discussed in a very sketchy manner with much of the detail missing or just incorrect. Hops like malt are a vital brewing ingredient so candidates, with support from their mentors, must get better acquainted with hop growing and processing, by spending time at a hop farm, especially during harvest, as well as at a hop processing facility.

Question 4

Brewing water

Discuss the importance in the brewing process and on beer quality of the various ions present in brewing water. Set out two water specifications, one to produce a pale Pilsen-style beer and the second a Burton-style pale ale.

This question was attempted by 9 (53%) of candidates with 5 (56%) achieving a pass mark. The general standard of answer to this question was inadequate with a surprising number of candidates unable to describe a realistic water specification for either a Pilsen-style beer or a Burton-style pale ale. The concept of temporary water hardness and permanent water hardness also seemed to be understood poorly. The role of calcium in pH alteration and other ions on flavour and yeast growth were however described with more authority.

Question 5

Calculating brewing materials requirements

Estimate the annual brewing materials requirements to produce 2 million hectolitres of 5.2% alcohol by volume lager using 85% malted barley, 5% malted wheat and 10% liquid adjunct. 60% of the volume is packaged into 500 ml cans and the rest into 30 litre kegs. This beer has a bitterness of 25 BU.

Specify the batch size and brewing frequency for the wort production stage of this lager. State all assumptions and show all calculations.

This question was attempted by 11 (65%) of candidates with eight (73%) achieving a pass mark. The general standard of answers was good with assumptions on losses and utilisation being well presented. A couple of papers picked up on the likely difference in losses between the canning line and the kegging line. Candidates often use their local knowledge for setting assumptions but should be aware that when these deviate markedly from industry norms an explanation must be forthcoming. In the calculation part most candidates came up with the correct quantities though some did end up with a tenfold or even a hundred-fold error. This sort of mistake can be easily prevented by expressing large numbers by raising them to the power of 10, for example, 20,000,000 litre degrees = 2×10^7 litre degrees.

Question 6

Wort boiling

Review the physical and chemical mechanisms involved in the boiling of wort. Identify the key parameters that need be controlled to ensure that consistent wort is produced.

This question was attempted by 14 (82%) of candidates and ten (71%) gaining a pass mark. This was the most popular question in the examination and the standard of answers was good. Surprisingly though several candidates failed to identify the key parameters, such as evaporation and energy input and there are more, which need to be controlled to ensure that wort of a consistent quality is produced.

Question 7

Outlining a quality plan

Prepare a quality plan outlining the procedures and sampling requirements needed to control the production of wort in the brewhouse from raw materials intake to the transfer of cooled wort to the fermenter.

This question was attempted by 12 (71%) of candidates with nine (75%) obtaining a pass mark. In general this question was answered with competence and those papers with a plan that had been tabulated tended to score more highly. A plan which followed the logical flow of product through the plant also lent credibility and a believable framework to the answer.

Question 8

Aspects of safety in a maltings or a brewhouse

Discuss all aspects of safety (include personnel and product) in either a maltings or a brewhouse.

This question was attempted by 10 (59%) of candidates with seven (70%) gaining a pass mark. As with similar questions from previous years'

examinations, candidates who outlined a structured procedure for identifying how managers and operators could ensure safety, that is to say handling hazard and risk, scored good marks. Extra marks could be picked up by describing systems, such as HACCP, quality policy, standard operating procedures and much else, that are required to underpin the safe operations in a well managed production facility. In a poor answer, in place of the structured procedures and the pertinent examples, there was an disconnected roll call of safety and product quality issues.

Bob Illingworth - July 2007

Master Brewer Examination 2007

Module 2 – Fermentation and Beer Processing

Scripts for marking were received from 26 candidates and 20 gained pass grades, a pass rate of 77%, which is a great improvement compared to last year. One candidate gained a pass at Grade A. There was also two passes at grade B, seven papers at grade C and 10 at grade D. Of the candidates who did not pass there were three papers at grade E, two papers at grade F and one unclassified.

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.

There was evidence of an improvement in examination technique this year, with all candidates answering the required 5 questions and most also appearing to manage their time to ensure they could make a reasonable attempt at each. There were some well drawn labelled diagrams, particularly for the centrifuge question, and it appeared that candidates had heeded the advice offered in last years report to practice their 'stock' diagrams in advance. The range of equipment in use is relatively stable and the advice to practice drawing diagrams of relevant vessels, separators, filters etc. in advance will continue to be very good preparation for future candidates.

An area that many candidates can still improve upon is the quality of detail they provide in their answer: very often information is still presented such as reduce the fermentation temperature or increase the pitching rate. Whilst these may be appropriate actions, the examiner is always looking for such statements to be suitably qualified by a statement of the original value and the proposed new value, range and unit.

Question 1

An international brewer is considering granting a licence to another company to brew and package its premium beer brand. Propose an audit schedule that could be used to assess the capability of the potential partner to meet requirements in all aspects of the fermentation, processing and bright beer operations. Include in your answer the audit content and the standards that would be expected. Describe a suitable trial programme and comment on the ongoing follow up that the licensor would be likely to undertake to ensure expected quality standards are maintained in the long term.

Eight candidates attempted this question with only one passing (12.5%).

The purpose of the first part of the question worth 10 (50%) of the marks was to allow candidates to give practical details of how they would carry out an effective audit process while focusing on the technical details, equipment, standards and systems they would wish to evaluate within the area of fermentation and beer processing. Comments on the audit process might have suggested the use of questionnaires and checklists, opening meeting and agenda, closing meeting report back, corrective action plans, proposed duration etc. The audit content should have focused on the equipment present in the fermentation and beer processing areas, along with the condition, capacities, current quality performance, analytical capability, housekeeping standards, use of quality, food safety and environmental systems etc. For each of these areas the examiner hoped to find further details of the standards that the auditing brewer might be hoping to find.

Making the assumption that the outcome of the initial audit was successful, the second part of the question also worth 10 (50%) of the marks was about the trial process that would be used in fermentation and beer processing to validate a successful start up, together with the ongoing licensor follow up required to ensure quality standards are maintained. For the trial programme, the candidate was expected to raise points such as the number of trials, parameters to be monitored, and what success would look like in terms of flavour match etc. The use of consumer tests might also have been briefly mentioned. Ongoing follow up might include annual technical audits, licensee monthly reports of physico-chemical, microbiological and sensory results, as well as dispatch of an agreed number of final pack samples to the licensor head office.

It was surprising that few candidates were able to suggest even an outline plan for the audit or the ongoing follow up. As in questions of previous years, the number of candidates able to suggest reasonable details of a practical trial schedule was also surprisingly few.

Question 2

Describe a typical fermentation and conditioning profile for either a lager or an ale. Include all of the key parameters that will influence process consistency and final beer quality. Discuss the measures that may be taken during fermentation and beer processing to maximise the opportunity for good foam performance in the finished product.

24 candidates attempted this question with 19 passing (79%). Most were comfortable passes and there were two very good ones.

The first part of the question worth 14 (70%) of the marks was most effectively answered by the use of an annotated process chart illustrating a typical lager or ale fermentation and conditioning profile. Parameters to be shown included wort original gravity, wort dissolved oxygen, attenuation Vs time, fermentation temperature, yeast cell count, pH and diacetyl, time of crops, cooling profiles as well as overall process time. In each case appropriate values and units should have been stated.

The second part of the question on foam worth 6 (30%) of the marks required a description of the measures that can be taken to avoid the loss of foam potential through overfoaming in fermentation, yeast mortality effects, gas washing in bright beer or other means. Foam enhancing opportunities included the use of foam stabilizers in the form of alginates or reduced hop products.

Good answers were based on the usual profile diagram with the various parameters plotted against time from fermentation vessel filling to end of conditioning. For each parameter there was annotation and appropriately labelled axis to indicate the value and the unit over time e.g. attenuation, yeast count, diacetyl etc. The factors influencing foam performance were then systematically reported. The few poor answers really only illustrated fermentation temperature and attenuation on the profile, and just lacked enough knowledge on the foam part.

Question 3

Discuss the options available for extending production capacity in the fermentation and beer processing areas of a brewery without resorting to major capital investment.

22 candidates attempted this question with only three passing (14%). There were no good answers.

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

The principle opportunities for extending process capacity included the use of high gravity brewing and improved vessel filling rates (vessel utilization), shorter process times or reduced complexity and wastage. Any proposal which might affect product quality or consistency would generally need to be evaluated by a suitable trial programme, especially if a flavour match is essential.

The principles of high gravity brewing are well known. For the purpose of the answer the candidate could usefully have described the benefit by stating an assumption of an appropriate 'current' brewed original gravity and then illustrating the capacity effect achieved by moving to some (realistic) higher value. Fermentation vessel filling rates can often be usefully improved by the use of antifoams.

Other process time proposals might have included faster fermentation by optimizing yeast performance or raising temperatures (including for diacetyl reduction time), or reducing cold storage time.

Filterability can be enhanced by careful control of yeast count through use of sedimentation aids and centrifuges. Control of body feed dosing to suit actual solids load is also beneficial in terms of maximizing filtration run length.

Where fermentation vessels are routinely used as part of the industrial stages of yeast propagation then fewer yeast strains can assist in reducing the number of part full vessels tied up for this process. The use of a mother beer from which a number of different brands can be derived might have been suggested as a way forward.

Most answers just lacked content and went little further than a general description of high gravity brewing.

Question 4

With the aid of diagrams, describe the design and operation of a green beer centrifuge suitable for use in the fermentation and beer processing areas of a brewery. Discuss the applications for which centrifuges may be used downstream of fermentation and the process benefits they offer.

14 candidates attempted this question with 13 passing (93%). There were three very good answers and the remainder were also mainly comfortable passes.

The first part of the question worth 14 (70%) of the marks, required a labelled diagram and text to demonstrate the design of a suitable green beer centrifuge. For a typical disc stack design the diagram should have shown the principle components such as infeed, disc stack, centrate and solid discharges, and the movement of liquid and solids within the machine.

The second part of the question was worth 6 (30%) of the marks. Operational applications should have covered yeast removal from green beer post fermentation, separation of beer from tank bottoms and centrifugation before filtration. Dependent on the particular application, the usual advantages are in terms of process time reduction, improved vessel utilization, process control (by controlling yeast count), improved quality (e.g. in terms of recovered beer handling), improved filterability, reduced losses, and cost savings due to reduced requirement for settling agents or filter aids.

Good answers presented labelled diagrams accompanied by supporting text to describe the design of a disc stack centrifuge, and then systematically described the operational applications and advantages of their use.

Question 5

Prepare a comprehensive proposal of fast track and longer term practical measures that may be taken to improve the environmental performance of the fermentation and beer processing areas of a brewery. Include comments on how the level of improvement achieved can be assessed.

Ten candidates attempted this question with four passing (40%). This was a direct repeat of a question set last year (2006). There was one good answer and two other reasonable attempts.

This was a single part question worth 20 (100%) of the marks. The opportunities for environmental performance improvement mainly ranged around effluent, water conservation and carbon dioxide. Fuel usage, noise and odours could also have been considered. In terms of effluent the main contributors are yeast, beer, spent kieselguhr and CIP fluids. In each case there are short and long term measures that can improve the situation. For example a short term measure to reduce the amount of yeast and beer to drain might be to eliminate fermentation vessel overfoaming by the use of antifoam. A longer term measure involving capital expenditure could be the installation of green beer centrifuges to improve yeast beer separation and reduce kieselguhr usage. Similarly for CIP a quick fix might be to start recovering final rinse water for pre-rinse, while a longer term measure may be to consider replacing a single use system with a recovery system. Water conservation can be further achieved by various means including adopting a 'dry' cleaning culture minimizing the use of water for washing away yeast etc. Hose pipe guns are a cheap option to avoid unattended wash down hoses running to drain. Minimizing the impact of carbon dioxide is by the use of a collection system and aiming for self sufficiency in the gas for process and packaging applications.

Measures used to assess the improvement made could have included beer losses, water usage ratio, utilities usage/hl, carbon dioxide recovery rate, COD or BOD of effluents.

The one good answer used a table with headings of fast track, long term and means of measurement to cover the ground. Poor answers lacked content.

Question 6

Describe the main desirable beer flavour compounds formed during beer fermentation and conditioning. State typical levels present in finished beers and discuss how these may be influenced by the brewer. Describe a practical routine for sensory evaluation of beer in process and comment on the off-flavours that may occur.

Five candidates attempted this question with three passing (60%). There was one good answer.

The first part of the question worth 14 (70%) of the marks required a description of the esters and higher alcohols normally present in beer including the types of flavours they impart and the typical concentrations of the different compounds e.g. ethyl acetate 18–20ppm, isoamyl alcohol

60–80ppm. Some control can be achieved via tuning of parameters such as yeast strain, wort gravity, wort dissolved oxygen, pitching rates, pressure. As usual a suitable trial process with analyses and taste panels is recommended to assess or validate the effect of any process changes used.

The second part of the question was worth 6 (30 %) of the marks.

In process tasting is normally intended to detect obvious variations from the norm, off-flavours, or contamination by coolants or CIP chemicals. This enables defective product to be isolated and later blended away or destroyed if there is some form of contamination or gross infection. In fermentation and conditioning it might be routine for production staff to taste every fermentation vessel and cold storage tank before transfer. The result is often just a pass/fail status rather than any other quantitative evaluation. Obviously any suspected variation from the usual flavour would be examined further by a larger group probably including taste panel members.

Tasting of bright beer tanks before packaging would be likely to be more qualitative and probably include brewery taste panel members who might record a numerical rating and use a wider range of flavour terms.

Off flavours that might be detected could include amongst others diacetyl, acetaldehyde, Yeast bitten, acetic, mercaptan, oxidized or soapy (caustic contamination).

Question 7

Describe the design and operation of a CIP (cleaning in place) plant suitable for use in the fermentation area of a brewery.

Outline microbiological tests and other checks that may be used to monitor the effectiveness of the CIP process.

25 candidates attempted this question with 22 passing (88%). There was one near perfect answer, three very good ones and the remainder were also all mainly very competent.

The first part of the question worth 15 (75%) of the marks was best addressed by means of a diagram illustrating the typical features of a recovery or single use CIP system. Dependent on the type of system selected, design features to show included concentrated and dilute detergent and sterilent tanks, water and rinse water tanks, spray heads, mains, valves, pumps, heat exchangers, along with temperature and conductivity probes. The operation part of the question was looking for a brief description of the plant to be cleaned and typical cleaning cycles including rinses, detergent and sterilent washes with details of appropriate times, temperatures and concentrations.

For the second part of the question worth 5 (25%) of the marks microbiological tests included plant swabs and rinses, appropriate platings etc, and product forcings. The use of rapid micro methods could also have been described. Other checks could have considered periodic inspection of vessels and sprayballs, detergent and sterilent analyses, instrument calibration and audit of cleaning cycles.

Most candidates based the first part of their answer on a brief description of the equipment to be cleaned and a detailed diagram describing all of the features of a recovery or single use CIP set. They then went onto describe a typical CIP cycle of rinses, detergent washing and sterilization, together with appropriate times, detergents, concentrations and temperatures. Appropriate checks were then described as above. The weakest part of most answers was a lack of detail of the microbiological tests: a swab is not a test, just a means of sampling!

Question 8

The filtration run length for a kieselguhr filter has reduced significantly over recent weeks. Suggest the possible causes of the problem and how they may be overcome.

Outline the quality parameters normally monitored during kieselguhr filtration.

Comment on the practical requirements for storage and handling of kieselguhr in the brewery.

22 candidates attempted this question with 14 passing (64%). There was one very good answer and several other good attempts.

The first part of the question, worth 10 (50%) of the marks, required a discussion of the factors that might have resulted in a reduction in filtration run length. Factors that could have been mentioned included cold storage time and temperature, use of settling agents, centrifuge performance, use of filter aids and filtration operational factors. Various other practical factors could have been mentioned such as yeast slugs to

the filter, need to replace filter sheets, trap filter blinded etc.

The second and third parts were each worth 5 (25%) of the marks.

Quality parameters to mention could have included beer temperature, deaerated water palate and dissolved oxygen, beer dissolved oxygen, original gravity and ABV, haze, carbonation, beer palate, gas sterility, filter sterilization time and temperature and beer microbiological status. Suggested values should have been included where appropriate.

Comments on the storage and handling of kieselguhr should have been based on the need for easy cleaning, the use of dust extraction systems, protective clothing and dust masks, handling of bags and the availability of automated handling systems to reduce dust.

Good answers showed practical knowledge of the issue in hand and were able to suggest the possible causes in a problem solving way. The part on kieselguhr handling was generally only thinly covered by comments on dust extraction and dust masks etc. Few mentioned the use of automated equipment to avoid handling of bags by personnel.

John Shardlow – July 2007

Master Brewer Examination 2007

Module 3 – Packaging and Beer Dispense

In 2007, 24 papers were received of which 13 (54%) achieved the pass standard. This represents a slight decline on last year's percentage.

In addition to the slight decline in pass rate the overall standard was down on last year's high and more in line with other recent years. However, there were some excellent answers to some of the questions.

It is worth noting that five of the questions were very much more popular than the other three. 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.

The recently noted improvement in examination technique continued with very little evidence of candidates running out of time through poor planning again this year.

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

Question 1

Plant design

With the aid of diagrams, design a keg packaging line for a facility to produce the following annual volumes based on 24 hr production availability and a 5 day week:

150,000 hectolitres of 30 litre keg

850,000 hectolitres of 50 litre keg.

State any assumptions made, including the expected staffing levels, and justify the choice of equipment and machine throughputs.

This was the equal third (with question 5) most popular question with 20 (83%) of candidates answering. It was also generally well answered with 12 (60%) reaching the pass standard.

Line design was dealt with more convincingly by candidates this year. 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. Poorer answers included wrong calculations and clearly inappropriate plant sizes were not recognised. Generally, the sizing of plant to deal with the two container sizes was not dealt with well with many plants sized on an assumption of 30 litre running all year.

Question 2

Supply chain

Describe the data required, and the processes involved, in ensuring that packaging materials for a bottling line producing multiple Stock Keeping Units (SKUs) are available to the correct specification and in the correct quantity to meet production demand.

Detail what level of communication would be required between production and supplier to ensure that performance is optimised.

This was the second least popular question with only four (17%) candidates answering. It was poorly answered by those attempting and only one (25%) achieved the pass mark with no high scoring answers being submitted.

To answer this question well the relevant elements of supply chain planning need to be discussed as well as control of quality. The issues around stock holding and just-in-time deliveries also need to be discussed. Poorer answers tended to focus on only one material or on short term communications with suppliers.

Question 3

Environmental impact

For either a bottling line or a canning line, describe the overall environmental impact of the various operations involved. How can this impact be minimised?

Jointly with question 8 this was the most popular question with 24 (100%) of candidates answering. It was also the best answered with 16 (67%) achieving the pass standard.

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

Capital investment

For either a keg or a cask packaging plant, which has had no significant capital investment for 20 years, describe how capital investment might be used to improve plant performance and reduce operating costs.

This was the third least popular question with only 6 (25%) of the candidates answering of whom 3 (50%) achieved a pass.

Good answers dealt with the question systematically, firstly identifying areas where performance and costs would be likely to have room for improvement and then logically identifying how new plant could help. Most candidates focussed on the racking equipment. Poorer answers merely described a new racker. Good answers both detailed how a new racker could bring down revenue costs and considered other plant items.

Question 5

Glass risks

What are the specific risks associated with packaging beer in glass?

From glass receipt at the filling line through to palletisation of filled product in cases, how are the risks to consumers, personnel and plant minimised?

This was the equal third (with question 1) most popular question with 20 (83%) of candidates answering. It was also generally well answered with 11 (55%) reaching the pass standard.

It is not enough in answering this question to just deal with the theory of HACCP. To achieve good marks details of specific risks to all three groups need to be identified and discussed. Details of actual actions taken to minimise the risks are also needed rather than generalised statements. Good answers were possible in tabular form or in organised paragraphs.

Question 6

Plant hygiene

Describe the plant hygiene requirements for either filling of kegs or aseptic filling of bottles.

How is plant hygiene assured?

What data should be collected to allow a timely intervention in the event of a hygiene breakdown?

Although this was only the fifth most popular question, it was still attempted by 19 (79%) candidates. However, it was not generally well answered with seven (37%) candidates achieving the pass standard.

To achieve the best marks in this question a structured view of risks to product and how they are managed from a hygiene standpoint is needed. This needs to include beer supply, packaging materials, plant and personnel. Again to achieve good marks detail of processes and procedures is required. Poorer answers to this question tended to restrict the discussion exclusively to pasteurisation.

Question 7

Case packers

Describe the operation of one type of case packing machine.

How may poor efficiency of this machine affect line performance?

What elements of design and operational procedure may be put in place to minimise the effect of poor machine efficiency?

This was the least popular question with only three (13%) candidates answering. None of those who attempted the question (0%) achieved the standard needed for a pass.

The core marks for this question could be obtained from the descriptive part. To score well, an understanding of how different failure modes (leading to different times and frequencies of stops) impact on the rest of the packaging line should be demonstrated. This leads into the steps taken to deal with these failures. Poorer answers showed only a sketchy knowledge of packer operation.

Question 8

Beer quality in glass

What factors can adversely impact on the quality of beer served in a glass in a retail outlet selling both small and large pack products?

How may the quality of the beer in glass be optimised?

Assume that beer quality is satisfactory on delivery to the outlet.

Jointly with question 3 this was the most popular question with 24 (100%) of candidates answering. It was reasonably well answered with 13 (54%) achieving the pass standard of whom three produced excellent responses.

The requirement here, for a good answer, was to be able to clearly describe the factors affecting beer quality in a retail outlet. The cellar, dispense system and bar area all need to be considered for their impact on final product quality. Good answers included targets and tolerances, where appropriate, and described the benefits of meeting targets. Poorer answers only dealt with one of these areas and tended to include brewery information excluded in the question.

Jon Brown – July 2007

Master Brewer Examination 2007

Module 4 – Central Functions

Overall, 23 papers were marked and 17 were passed (73.91%), almost identical to 2006 although numbers sitting the exam were higher. Most subjects were answered satisfactorily although Electricity and Finance again proved unpopular. Finance was not answered well but the few who tackled and passed the electricity question gave good answers. Project Management and Water Systems were answered well and it was good to see so many candidates competently answering questions on Safety Policy and Food Safety.

Question 1

Project management

Describe four reasons why a capital project would be considered necessary in a brewery giving two examples of each.

Identify the key stages to complete a successful project and what the roles and responsibilities of the participants would be.

What difference in the process would there be between a small and large project?

Attempted by 16 candidates, 13 passed (81%)

Most candidates could identify reasons for a project to take place and describe the stages for implementation. Although candidates are now far more knowledgeable on the process, few adequately considered involvement of the user department and the handover from the project team. Most candidates identified the central role of the Project Manager and other support staff dealing with finance and planning. Agreeing the scope was evident but candidates did not emphasise the importance of good site management during installation. The difference between large and small projects was generally identified as differences in resourcing and financial approval.

Question 2

Electrical voltages and consumption

Describe where four different voltages of electricity might be used in a brewery, giving an example of plant or equipment for each and what proportion of the site's consumption they represent.

For each type of use describe appropriate plant and techniques to minimise consumption.

What type of protection for plant and personnel would be appropriate in each case?

Attempted by 4 candidates, all 3 passed (75%)

This question was well answered by the 3 candidates who passed with a good understanding of voltages and consumption. There were some good answers to minimising consumption including power factor correction, variable speed drives and a wider description of ensuring refrigeration and air compressor plant was run efficiently.

Question 3

Site safety policy

What factors should be considered for a site Safety Policy?

What are the responsibilities for Directors, Managers and individuals?

Describe appropriate controls and methods to ensure safe working for contractors and access for visitors.

Attempted by 20 candidates, 15 passed (75%)

The responsibilities and contractor control parts of this question were well answered but the policy section was often a list of Health and Safety rules. Elements on training, evacuation and control measures were largely missing although the better candidates considered auditing, departmental meetings, accident reporting and the relationship with Health and Safety authorities.

Question 4

Packaging line maintenance

Describe methodologies for maintaining a packaging line to ensure optimised running conditions over the life of the plant. Consider labour organisation, time, spares and any other necessary factors.

How might a computerised maintenance management system be used to assist?

Attempted by 18 candidates, eight passed (44%)

For a high number of candidates attempting the question, this was a badly answered question. There were some theoretical answers on RCM and TPM as used in the candidate's organisation but no real discussion on methodologies best used for a packaging line. However, good consideration was given to spares holdings, proximity to use and availability at short notice.

Given that effective maintenance has such a fundamental impact on efficiency in the brewery, there is a problem understanding effective measures to improve line performance.

The better candidates considered the data available from a computerised system could be used for KPI measurement and links with spares inventory.

Question 5

Brewery budget – fixed and variable costs

For a Brewery budget, identify the principle fixed and variable costs giving reasons for each choice and identifying those costs that Production Management can control on a routine basis. Show on a table how those elements fit into a Standard Cost or equivalent system for cost per hectolitre brewed and packaged. If additional plant was installed to increase capacity, which costs would be affected and what would be the impact on cost per unit of packaged output?

Attempted by eight candidates, passed by 2 (25%)

For such an important aspect of brewery management it was disappointing to see so many candidates fail this question. Levels of understanding have increased for many parts of the syllabus but Finance remains a weak area. Detail on typical values was missing and answers looked theoretical, not based on experience.

Compared to 2006, the finance question proved much more popular but was poorly answered. The better candidates produced a table that correctly identified fixed and variable costs but few understood the effect of new plant and capacity on standard costs.

Question 6

Food safety and traceability

Describe systems and procedures which would demonstrate to customers the brewery's competence in food safety and traceability for investigating complaints.

What role does auditing have in ensuring compliance and how might that be applied to suppliers?

Attempted by 18 candidates, passed by 13 (72%).

There were some good practical answers to verifying traceability through Quality Systems and in general HACCP was considered as the main procedure for ensuring food safety and was well answered. The better candidates described the process in some detail and typical factors to be considered.

Auditing was seen as a tool to ensure compliance and was described in more detail by the better candidates

Question 7

Water systems and treatments

Describe the water supply system for the brewery and outline which treatments would be appropriate for brewing, plant cleaning, steam raising and general cleaning.

If a 1 million hectolitre brewery requires 8 hectolitres of water to brew and package 1 hectolitre of beer, what would be a realistic target figure to set at the start of a water usage reduction exercise? How might the reduction be achieved and how might effluent costs be affected?

Attempted by 18 candidates, passed by 17 (94%)

This was the most frequently attempted question with some good answers and diagrams, particularly on treatment for the different uses. Most candidates were looking for a water ratio of 4-6 and offered some good suggestions on how to reduce consumption including re-use where possible, leak minimisation and CIP optimisation.

The better candidates included measurement to identify usage and involvement of site staff to raise awareness.

Question 8

Steam plant

Describe an appropriate steam raising plant for a 1 million hectolitre brewery showing the principle components on a diagram. Give examples of temperatures, pressures and flow rates.

What factors should be considered in the design to ensure reliable, economic steam supply?

Describe the principal daily and weekly checks to ensure safe reliable operation.

Attempted by 13 candidates, passed by nine (69%)

Most candidates included an adequate diagram as requested and the better ones showed some realistic temperatures, pressures and flows for different areas of brewery usage. The more comprehensive answers included boiler availability to meet demand, alternative fuel supplies, insulation and the importance of good condensate return.

Daily and weekly checks were generally well answered with consideration given to safety systems.

Ian Bearpark – July 2007

Master Brewer Examination 2007

Module 5 – Case Study

This year 24 candidates sat the paper and 14 passed (58%), which is a disappointing result compared to last year (64%). 6 candidates chose question 1 and three of those achieved a pass, 18 candidates chose question 2 and 11 of them achieved a pass.

This year it was pleasing to note more evidence of candidates having read the question carefully, planned their answers and taken note of examiners comments in previous years. However there was still rather too much irrelevant information put in to scripts in the hope that it could attract marks.

It is also becoming evident that the use of acronyms and company shorthand is becoming increasingly popular; in general I do not have a problem with this as long as the candidate is diligent in defining their meaning when first used. The most repeated error in this area was the reference to parts per billion specifications and the acronym ppm noted, if written out in full at the first time of use I feel sure candidates would have corrected their error.

Even well known shorthand such as SPC per SKU will not get the marks, a defined Standard Product Cost per Stock Keeping Unit would.

Question 1

Describe in detail the methodology for an energy and environmental audit of a 1 million hectolitre brewery which has both bottle and keg packaging.

Develop an action plan to address likely issues arising from the audit. This should include expected utility usage targets, priorities for attention and introduction of appropriate new technology and innovation.

The question required a plan to the answer with a logical audit progression including definition of the team. When describing the audit there needed to be a brief section on how to audit but most focus should be on what to audit. This was not an opportunity to write about ISO or quality management systems theory but CCTV investigation of drains would have gained marks.

Good answers included both financial and public relations aspects and went beyond the bright beer tank to cover gate in to gate out including the site itself. Most candidates covered the different forms of environmental impact with solid and liquid waste, better candidate's added vapour and noise but ground contamination was barely mentioned.

Having identified the points of interest in the first section, good answers tended to use a comparative table to address data values and improvement plans. The question was looking for expected usage levels and unit costs for all of the major utilities particularly electricity, fuel, water and effluent.

Less well covered was local neighborhood impact, capital definition and appraisal or innovation. Some scripts made reference to renewable energy sources such as wind power but none built these in to a credible evaluation with expected costs and benefits. Similarly I would have expected good answers to consider the opportunity for combined heat and power generation in a brewery of this size.

Finally it is important to structure the answer to best use time and too many of the scripts relied on repetition to achieve marks particularly when analyzing potential improvement plans. Flow diagrams of the brewing process were only relevant if they related to the question and not recipe sizing or process operations.

Question 2

A brewing company is producing its global premium lager brand at a brewery, in a new market, which has no experience of producing such a beer.

In trials, strong paper and bready flavour notes have been described along with occasional phenolic taints.

Describe the likely causes of these flavour issues and how the whole production process would be investigated to address them. Describe a management system which could be implemented to ensure flavour stability and adherence to specifications.

Some candidates answering this question had a tendency to go too quickly to detail without first spending time to draw up an overall plan and analysis. From the analysis logical evaluation steps should be tabulated for the product and production process with sample frequency influenced by rate of change and impact rather than size or scale.

The question is in two parts, firstly flavour defects which required to be evaluated to highlight likely causes and effect before describing how they may be eradicated.

Good scripts covered such areas as product handling, packaging control and the impact of services and materials. Better candidates widened their evaluation of potential phenolic taints beyond microbiological sources to include utilities and raw materials.

Linking to the second part of the question a few more structured scripts mentioned the use of HACCP or quality gates to identify key points in the process where production is evaluated and held from going further until satisfactory quality specifications are met.

Good candidates then went on to describe a robust quality management program which could be accredited to an ISO standard and how that would be supported by a logical staff structure with the correct authority and resource. Marks were given for candidates who described the set up, resourcing and training of taste panels and how they would be used to evaluate not just product but also utilities and raw materials.

J I C Robertson - July 2007

THE GENERAL CERTIFICATE IN BREWING AND GENERAL CERTIFICATE IN PACKAGING EXAMINATIONS

GCB & GCP NOVEMBER 2006

The Autumn series of examinations for the General Certificate in Brewing (GCB) and General Certificate in Beer Packaging (GCP) was held on the 13th November 2006 at 31 centres in ten countries. This was the second of the new multiple-choice format examinations with options for special emphasis. That is, the GCB candidates may chose between papers which include a specialist sections on Chilled and Filtered beer (C&F) or Cask beer (Cask); for the GCP the specialist options are on Canning (Can), Kegging (Keg), Returnable (Ret), or Non-returnable (NRB) packaging lines. There were 180 entries (some candidates submitted entries for both a Brewing and a Packaging option); the overall pass rate achieved was 57%. The breakdown between grades and options is shown in Table 1 below. The distribution of pass grades (Distinction, Credit and Pass) is shown in Diagram 1. (Note that the two bottling options have been combined in both of these analyses.)

Table 1. Numerical breakdown of GCB and GCP results.

Subject	Paper	Distinction	Credit	Pass	Fail	Pass rate %
Brewing	C&F	1	14	35	39	56
Brewing	Cask	2	1	7	11	48
Packaging	Can	0	0	10	8	56
Packaging	Keg	0	12	3	7	68
Packaging	Bottle	0	2	16	12	60
TOTALS		3	29	71	77	57

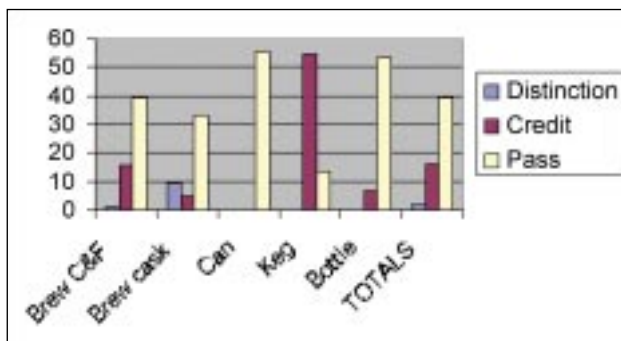


Diagram 1 Graphical distribution of pass grades by option.

The pass rate was greatly improved from the 46% recorded in first series of the new format examination in May 2006, and much closer to the Examination Board's target for a 60% pass rate for the qualification. The Board was also delighted to see a return to a more normal distribution of pass grades and offer their special congratulations to the three candidates who achieved distinctions. One of the main reasons for splitting Brewing and Packaging into separate qualifications was the difficulty for candidates, who tend to specialise in their work, to score highly enough in both Brewing and Packaging knowledge to achieve a good grade. Some interesting comparisons between options have emerged from the distribution analysis, for example, between Canning and Kegging. The successful Canning option candidates scored only Pass grades whereas almost 85% of the Kegging option passes were credits. On this occasion the samples were too small and heavily influenced by a single centre to make any generalisations about skill levels. But as data accumulates, some useful guidance for packaging training may emerge from such analyses.

There were no particular syllabus areas that necessitate comment, though the data from this examination will be combined with that from the May 2007 papers to provide the usual detailed commentary. However, one misunderstanding about the nature of the specialist option scheme, does need to be brought to the attention of future candidates.

The various option papers still feature questions about general principles which may draw on data from any type of process or equipment. For example, in the Kegging paper there may well be a question requiring an efficiency calculation which uses data from a canning line. What is being tested is not canning knowledge, but the principle of how line efficiency is calculated – the formula is exactly the same though the data range may be quite different. Similarly, candidates for Cask may be asked about the typical fermentation characteristics for lager. The respective syllabi make the requirements for general and specialist knowledge very clear. Candidates and their mentors should therefore ensure that their studies are guided by the syllabi.

GCB & GCP MAY 2007

The Spring series of examinations for the General Certificates in Brewing and Packaging (GCB, GCP) was held on 14 May 2007 at 39 centres in 17 countries.

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

There were 235 entries, with an overall pass rate of 51%.

The break-down between General Certificate in Brewing and the General Certificate in Packaging results is shown in the table below.

	Distinction	Credit	Pass	Fail	Pass Rate %
GCB	0	17	68	72	54
GCP	0	5	30	43	45

The next table shows the distribution of pass grade by option.

	CF	Cask	Can	Keg	NRB	RB	Total
Distinction	0	0	0	0	0	0	0
Credit	15	2	1	1	1	2	22
Pass	65	3	0	9	15	6	98
Fail	63	9	8	4	13	18	115

Comments

Overall the pass rate for GCB was higher than for GCP. Unfortunately no distinctions (90% plus) were awarded.

In the GCP examination, candidates who opted to sit the 'kegging' paper fared significantly better than their small-pack colleagues, with the result profile for the canning paper being especially poor.

Although on average around 50% of candidates who sat the GCB/P May examinations passed, there was some polarisation of results achieved by some of the major companies, with some companies achieving a good success rate and others a poor rate.

Companies are encouraged to ensure that the support and commitment they give to their examination candidates is always to the required standard.

Colin McCrorie- August 2007

THE GENERAL CERTIFICATE IN DISTILLING (& INTERNATIONAL)

November 2006 & May 2007

Only two candidates say the GCD (International) examination, in South Africa, in November 2006 and both passed at grade D. With such a small number the customary statistical analysis of scripts is pointless; also with only 2 scripts to comment on, it would be unfair to discuss candidates' answers. Fifty-eight candidates sat the GCD examination of May 2007, the same number as last year, but again only two candidates in South Africa sat the examination on the International GCD syllabus. So the following report refers mainly to the GCD examination, in which four candidates achieved Distinction and 12 City & Guilds Credit grade. The average of the final marks was 61.2%, a 2.6% fall from last year but better than in 2005. Although the averages of the marks scored in the two papers were reasonably close, 62.9% in paper 1 and 59.5% in paper 2, that 3.4% difference was slightly larger than in previous years. However; no question of paper 2 seemed to be unusually difficult since all had a reasonable number of 10-mark answers. The table (foot of page) of GCD examination statistics covers the past 5 years, a period of sufficiently large numbers of candidates to give the data validity.

Although the recent drop in enrolment is disappointing, a good standard of marks and pass rate has been maintained. Unfortunately 15 candidates failed (a similar percentage to the years 2004 and 2006), partly due to a lack of knowledge of the topics of some of the questions. However, a frequent cause of wrong answers was that candidates misunderstood the questions. It is only fair to point out that this applied also to some candidates who eventually passed, thanks to a sufficient number of good answers elsewhere in the examination. As in previous reports, I make no attempt to comment on answers to all questions or provide a list of correct answers, but the following discussion of common mistakes or misunderstandings is intended to improve the answers, and examination technique, of future candidates.

First, a general observation on the multiple-choice questions, which form an increasing proportion of the examination, with the intention of becoming 100% in the near future. The scoring system for GCD is 1 mark for a correct answer, 0 for wrong. Unlike some other multiple-choice examinations, there is no deduction for a wrong answer. Therefore even if unsure of the correct answer, candidates should mark one of the boxes; there is a reasonable chance of gaining one more mark.

In questions 1 and 3 of paper 1, both of which required definitions or explanations of technical terms such as maturation or germination, it is possible that many candidates scored fewer marks than their level of knowledge deserved because they did not provide sufficiently full information. And of course a definition can not include the actual word it is intended to define, a fault which was particularly common in attempts to explain maturation. Some answers to question 3 provided descriptions of the processes of steeping, germination and kilning, which scored no marks since the question required an explanation of the purpose; i.e. why they were done, not how.

A similar problem affected the part of question 4 concerning reasons why consistent milling is important to the mashing process. One possible way of answering would be to explain what would happen if grists of different sieve analysis were used for successive mashes. This is given as an example; other forms of answer also scored full marks, but certainly it was unacceptable simply to describe the process of mashing. Yet another such situation affected the first part of question 10, requiring explanations of the terms pH, final gravity and % abv as applied to specified liquids, and reasons for their importance. Many candidates did not define the terms, but only gave typical values. This was a particularly strange misunderstanding since these numbers were requested in a later part of the same question. So please read each question carefully to determine exactly what information is required. Questions 1 and 10 also appeared in the GCDI paper, but since that examination was concerned only with brandy and rum, questions 3 and 4 were different. Incidentally, also in GCD question 4, I estimate that about 40% of the candidates confused the words "grist" (the milled malt) and "grits" (which, as coarse or fine, form two of the sieved fractions of the grist).

All GCD (and GCDI) examinations so far have included a question on interpretation of the graph of distillation of an alcohol:water mixture. Although I

cannot promise such a question for every future examination, its consistent appearance until now should have stimulated a better understanding of the concept of azeotrope, and better ability to interpret graphical information, than was shown in many of the answers to question 6 of paper 1 (question 3 of GCDI). Also, I was surprised by the number of candidates who were unable to express the progress of a fermentation (question 5 of GCD paper 1; question 2 of GCDI paper 2) in graphical terms. So it is important that candidates are able to (a) prepare graphs and (b) read graphical data. It is unlikely that the examination would appear without some form of graphical question, so practice with graphs is an important part of candidates' preparation for future examinations.

In GCD paper 2 there were two questions in which the correct answer was different for whisky or other distilled spirits. Therefore candidates were requested, in very obvious bold type, to state which product they were describing. So another way of losing marks was by not providing that necessary information, e.g. in question 3 of GCD paper 2, stating an alcohol concentration at the spirit plate without identifying the product being distilled meant that the answer could not be marked, e.g. 94% abv was acceptable for grain whisky spirit but wrong for neutral spirit. Also on the subject of continuous distillation, part of question 7 (GCD only) required candidates to identify two sources of recovered heat energy from the type of still in the illustration. The expected answers were the spent wash (surprisingly, ignored in most answers, even though in large quantity at approximately 100°C it is the best source of energy) and the heated water from the spirit cooler. Many answers mentioned the top condenser of the rectifier, which in the drawing was used to heat the incoming wash. This did not fulfil my intention of providing heat energy for use elsewhere in the distillery, but was accepted as technically correct.

As a final example of not answering the question, it was unfortunate that the requirements of number 10 of paper 2 were misunderstood by (another estimate) at least 30% of the candidates. This question on packaging concerned the operational factors which contributed to, or detracted from, meeting packaging specifications, and should have been answered by recollection of the table on quality parameters and their relevant determining factors in the packaging section of the workbook. Although there were other wrong ideas as well, the commonest mistake was to describe the effects on the product or to the customer of failure to meet these specifications, rather than provide the expected explanation of how to control them in the first place.

I congratulate the successful candidates, but as in previous years, I can say that many of the failed candidates provided some excellent answers. Unfortunately they did not have wide enough knowledge to score such marks over a sufficient number of questions. However, poor examination technique was also a factor, preventing some candidates from obtaining full value from such knowledge as they did have, so more practice is obviously required.

Iain Campbell – July 2007

GCD 5 Year Examination Statistics

Year	Number/percentage of candidates					Average mark %		
	Sat	Passed	Failed	Distn	Credit	Final	Paper 1	Paper 2
2003	87	83.9	16.1	12.6	33.3	69.5	-	-
2004	76	72.4	27.5	13.1	22.4	63.8	-	-
2005	104	63.5	36.5	5.8	18.3	59.2	58.0	60.4
2006	58	75.9	24.1	1.7	29.3	63.8	62.5	64.2
2007	58	74.1	25.9	6.9	20.7	61.2	62.9	59.5

Successful Candidates

The successful candidates from the 2007 Diploma and Master Brewer Examinations, who meet all IBD criteria, are listed as follows:

Master Brewer Examinations

M.Brew Module One - Passes

Britt, Alison	Southern
Dickinson, Rebecca Jean	International
Engelbrecht, Vanitha	Africa
Gittens, Steven Patrick Clifford	International
Iyogbon, Hamilton Ehidihamhen	Africa
Jennings, Belinda	Southern
Jonland, Helen Daniel	International
Kenmogne, Maurice	Africa
Morley, Shane Kelvin	Asia Pacific
Okello, Tobias	Africa
Patkar, Keshav Laxminarayan	Asia Pacific
Saha, Surajit	Asia Pacific
Weston, Philip N	Africa

Master Brewer Module Two - Passes

Baxter, David James Connel	Midland
Bihl-Kirkwood, Georgia Gladys	Africa
Britt, Alison	Southern
Brown, Tracy	Great Northern
Du Plessis, Marina	Africa
Du Toit, Malcolm A	Africa
Engelbrecht, Vanitha	Africa
Fitzgerald, Fergus Richard	Southern
Francis, Devon Milton ++	International
Iyogbon, Hamilton Ehidihamhen	Africa
Jennings, Belinda	Southern
Megna, Kassimou	Africa
Nagandi, Saphan	Africa
Ngubane-Ngwenya, Blessing	Africa
Nisbet, Robert Patrick	Southern
Price, Joseph	Irish
Siaw, Yon Miaw	Asia Pacific
Stewart, Ross Gardiner	Southern
Steyn, Gary James	Africa
Wright, Brad	International

Master Brewer Module Three - Passes

Croker, Jenna Catherine ++	Southern
Davies, Robert Edward	Irish
Denny, Richard Charles ++	Midland
Fitzgerald, Fergus Richard	Southern
Flanagan, Brendan Gerard	Irish
Francis, Devon Milton ++	International
Hewitt, Jayne L ++	Great Northern
Kilcullen, Stephen	Irish
Putter, Gerhard Johannes ++	Africa
Reid, Christopher ++	Irish
Sneddon, Ewan	Southern
Tanner, Brigid Catherine	Irish
Weston, Philip N	Africa

Master Brewer Module Four - Passes

Croker, Jenna Catherine ++	Southern
Denny, Richard Charles ++	Midland
Flanagan, Brendan Gerard	Irish
Gilleland, Emma-Jane	Midland

Hamilton, Graeme William	Midland
Hollingworth, Richard Andrew ++	Midland
Jones, Catherine Lindsay ++	Africa
Kenmogne, Maurice	Africa
Kuntz, Robert James	International
Patkar, Keshav Laxminarayan	Asia Pacific
Putter, Gerhard Johannes ++	Africa
Sheils, Rory	Irish
Siaw, Yon Miaw	Asia Pacific
Stewart, Ross Gardiner	Southern
Steytler, Lauren Carol ++	Africa
Stradiotto, Steven	International
Weston, Philip N	Africa

Master Brewer Module Five - Passes

Croker, Jenna Catherine ++	Southern
Denny, Richard Charles ++	Midland
Du Toit, Malcolm A	Africa
Francis, Devon Milton ++	International
Hewitt, Jayne L ++	Great Northern
Hollingworth, Richard Andrew ++	Midland
Jones, Catherine Lindsay ++	Africa
Kiyingi, Stephen	Africa
Putter, Gerhard Johannes ++	Africa
Reid, Christopher ++	Irish
Steytler, Lauren Carol ++	Africa
Viljoen, Clint Robert ++	Africa
Wafula, Peter	Africa
Weston, Philip N	Africa

++ Has passed all modules of M.Brew by accumulation.

Diploma in Brewing Examination

Dipl.Brew Modules One, Two and Three - Passes

Alala, Felix Onyango	Africa
Atchison, Julia Brooke	International
Baugh, Christopher Eric	International
Bourke, Owen	Irish
Brunelle, Karine	International
Capcha, Ricardo F	International
Donehower, Weston John	International
Dykins, Erron S	International
Fuller, Margaret E.	International
Gathenya, Richard Mbugua	Africa
Gerteisen, Stephen	International
Gradman, Jonathan	International
Grant, Gerold C.	International
Hansen, David J	International
Jones, Andrew	International
Kennedy, Daniel Bruce	International
Lephoto, Catherine Mosebatho	Africa
Levesque, Mathieu	International
Maruyama, Robert	International
Misiko, Ruth C	Africa
Moni, Andiswa	Africa
Mungai, Hellen Njeri	Africa
Ndungu, Naftaly Theuri	Africa
Nel, Hayley Carmen	Africa
Ocharo, Irene Moraa	Africa

Olewine, Nathan Lewis	International	Mwanja, Samuel	Africa
Orlansky, Samuel	International	Nakitto, Maximilia	Africa
Ouderkirk, Michael Jeffrey	International	Nganda, Eric Ng'Ang'A	Africa
Song, John Choo	International	O'Beirne, Kieran	Irish
Stansbury, Kevin	International	O'Meara, Ryan James	Asia Pacific
Styles, Chad	International	Onuoha Chibueze, Benneth	Africa
Switzer, Jeremy James Christopher	International	Paff, Emily Jane	Asia Pacific
Van Nierop, Sandra Nadine Egbertine	Africa	Penny, Dirk	Asia Pacific
<i>Dipl.Brew Module One - Passes</i>		Pfeffer, Benjamin David	International
Alcaine, Samuel	International	Ratnayake, Amalka Sudeera Kumari	Midland
Aldred, Peter	Asia Pacific	Richter, Kenneth C	International
Anderson, Kade Beau	Asia Pacific	Rodrigues, Nicolene	Africa
Anikori, Moses +	Africa	Rosti, Johannes	International
Banh, Vinson	International	Sager, Matthew	International
Barron, Jonathan Alexander David	Midland	Satchell, Sherieka Georgia	International
Bateman, Christopher Edward +	Midland	Schehl, Beatus	Irish
Benne, Patricia Lynn	International	Shashikala, Bijageri	Asia Pacific
Berube, David	International	Shield, Cameron Bowen	Asia Pacific
Campbell, Edmond	International	Shijagurumayum, Gogochandralal	Asia Pacific
Casey, Troy	International	Slocombe, Edward	Midland
Charleston, Nicola	Scottish	Smith, Douglas Andrew	International
Cormack, Mark	Asia Pacific	Spencer, Paul	Great Northern
Cottam, Joseph L	International	Still, Hayden Edward	Asia Pacific
Coup, Thomas Matthew	Asia Pacific	Tetai, Reremoana	Asia Pacific
Crain, Brandon	International	Thomas, Louise	Southern
Currie, Margaret Lilian	Asia Pacific	Thorn, Ian John	Southern
De Jager, Maret	Africa	Transmantiner, Eva	International
Du, Yuguo	Asia Pacific	Trifan, Liliana	International
Egan, Bryan Daniel	International	Vel, Brian Michel	International
Egangu, Joseph	Africa	Vickers, Jemima Victoria	Southern
Eribankya, Nicholas	Africa	Walker, Stefan John	Asia Pacific
Eromomene, Felix	Africa	White, Alexandra Louise	Africa
Felaar, Timothy Arnold	Africa	Williams, Huw Rhys	Southern
Fletcher, Stephen Barry	International	Williams, Kelly Lindsay	International
Gautreau, Paul	International	Williams, Marshall Justin	Africa
Goldschmidt, Ulrich Charl	Africa	Yang, Peihua +	International
Goodwin, David	Great Northern	<i>Dipl.Brew Module Three - Passes</i>	
Govender, Kervindran	Africa	Aldred, Peter	Asia Pacific
Harilal, Deepa +	Africa	Anikori, Moses +	Africa
Harvey, Vayden	International	Bailey, Monique Roxanne	International
Hawkins, David	Midland	Bateman, Christopher Edward +	Midland
Hazell, Ashley Graham	Asia Pacific	Bennett, Mark	Great Northern
Hellesoe, Sean Richard	Asia Pacific	Berube, David	International
Hubner, Florian	Irish	Botwright, Benjamin James	Midland
Hum, Chung Ghee	Asia Pacific	Boudler, Sabrina	Africa
Ivie, Mark	International	Bredenkamp, Astrid Elizabeth +	Africa
Johnson, Phillip	International	Casey, Troy	International
Kayange, Kelvin	Africa	Cawley, Mark	Irish
Kiyingi, Patrick Banadda	Africa	Chamberlin, Richard Andrew	Midland
Kumar, Ganesh	International	Cirlescu, Nicoleta	International
LeBlanc, Simone Marcella	International	Coetzee, John Claude	Africa
Levien, Steven Craig	Asia Pacific	Cottam, Joseph L	International
Lewin, David Roger	Southern	Crankshaw, Alan Gavin	Great Northern
Lim, Chui Wan	Asia Pacific	Cullen, Emma	Irish
Malik, Evgeny	International	Dallies, Nathalie	International
Manickum, Collin Krishna	Africa	Destree, Brian J +	International
Mckibbin, Samuel Alan	Irish	Drummond, Alison Caroline +	Scottish
Mills, Gregory Earl	International	Du, Yuguo	Asia Pacific
Mohoto, Kgadi Alex	Africa	Durand, Stephen Andrew	International
Moraday, Daniel Francis	Asia Pacific	Dutta, Debasis	Asia Pacific
Morris, Daniel	International	Egan, Bryan Daniel	International
Morrow, Ryan James Robert	International	Egi, Aleksandar	International
Moxom, Richard John	Irish	Eromomene, Felix	Africa
Munoz, Raul J.	International	Fahey, Simon J +	Asia Pacific

Felaar, Timothy Arnold	Africa	Wadyka, Daniel H +	International
Ferguson, Jaeanne Anthea Oline	International	Ward, Christopher John	Asia Pacific
Fidler, Greg	International	Werro, Graham	Southern
Fox, Sarah Louise	Irish	Whelan, Robert +	Irish
Frieslaar, David +	Africa	White, Alexandra Louise	Africa
Gallagher, Andrea +	Irish	Wilkinson, Kevin Anthony +	International
Gautreau, Paul	International	Williams, Huw Rhys	Southern
Gosling, Andrew John	Midland	Williams, Kelly Lindsay	International
Gross, Cathia	International	Williams, Lenoy	International
Hadley, Tully Ceman Patrick	Asia Pacific	Wilson, Alan William	Asia Pacific
Hallinan, Christopher Percival +	Asia Pacific	Witty, Rachel Margaret	Great Northern
Harilal, Deepa +	Africa	Yang, Peihua +	International
Heary, Aaron Joel	Asia Pacific	Yates, Elisabeth Anne	Southern
Heary, Daniel Israel	Asia Pacific	Yeoh, Bun Hooi	Asia Pacific
Hopulele, Dragos	International		
Johnson, Phillip	International	Dipl.Brew Module Three - Passes	
Kavanagh, Johanna +	Irish	Alobwede, Metuge Charles +	Africa
Kayange, Kelvin	Africa	Amagna, Jean Martin	Africa
Khin, Aung	Asia Pacific	Andrews, Clinton Brett	Asia Pacific
Klopper, Scott	International	Assur, David +	Scottish
Kumar, Ganesh	International	Austin, Micheal Collin	International
Laurentiu, Polschi Eduard	International	Barraclough, Miles +	Asia Pacific
Lewin, David Roger	Southern	Bennett, Natasha Coleen	Africa
Lewis, Jayne	Asia Pacific	Boland, Aine +	Irish
Lloyd, Michael Jonathan +	Midland	Bond, Eve +	Midland
Lloyd, Stephen Sheldon	International	Bredenkamp, Astrid Elizabeth +	Africa
Mabena, Phindi +	Africa	Brown, Scott David +	International
Mahesh, Rajamanickam +	Asia Pacific	Buthelezi, Thuthuka +	Africa
Malik, Evgeny	International	Carter, Bradley Vernon	International
Martin, Carmen Estelle	Africa	Chisha, Mwamba +	Africa
McLean, Jacob Alexander	International	Clarke, Richard	Irish
Mehrtens, Kathryn Charlotte Louise	Asia Pacific	Cooney, Carl	Irish
Mercer, Catherine	Great Northern	Cousins, Winston Anthony +	International
Mhlabane, Beverly +	Africa	Cressey, Ian Anthony	International
Morisey, Matthew Lloyd	Asia Pacific	Davidson, Rodney Scott	Asia Pacific
Muiruri, Michael Mwaura	Africa	Day, Darren Warren +	Asia Pacific
Murphy, John Gerard	Irish	Dragancea, Mihaela +	International
Nabeta, Francis +	Africa	Elks, Jonathan William +	Midland
Njeru, Anthony Nyaga	Africa	Eribankya, Nicholas	Africa
O Driscoll, Bernadette	Irish	Gallagher, Andrea +	Irish
Okebe, Oko Agwu +	Africa	Guerrero, Ana Silvia +	Asia Pacific
O'Mahony, Liam	Irish	Hallinan, Christopher Percival +	Asia Pacific
Onuoha Chibueze, Benneth	Africa	Hanley, John +	Irish
Rabbidge, Michele Ann	Asia Pacific	Harty, Christopher George	International
Ramsay, Robert Anthony +	Scottish	Ho, Jonathan +	Asia Pacific
Rice, Susan	Great Northern	Hooхло, Mbangose Pinki +	Africa
Robinson, Ciara +	Irish	Hopulele, Corina-Elena +	International
Rogers, David	Asia Pacific	Jordan, Michael J +	International
Rosti, Johannes	International	Kannan, Kumarasamy +	Southern
Russell, Stephen Todd +	International	Kapoko Tagne, Innocent	Africa
Ryan, Christian	International	Kwarciak, Dominika +	Great Northern
Sager, Matthew	International	Luca, Sabina +	International
Satchell, Sherieka Georgia	International	Luedtke, Robin	International
Shamsundar, Mathighatta Gopalakrishna	Asia Pacific	Mabena, Phindi +	Africa
Sheehan, Christopher Alan John	Asia Pacific	Marshall, Lisa J +	Midland
Short, Alan	Great Northern	Mbugua, Hinga +	Africa
Smith, Anthony Michael	Southern	McCartney, Errol Peter +	International
Smith, Brian	Southern	Mihailescu, Mihail Gavril +	International
Smith, Donovan Elcoate +	Irish	Mills, Gregory Earl	International
Stewart, Neil Sedaka	International	Moore, Jane Claire +	Midland
Stokes, Scott +	International	Morris, Daniel	International
Tembo, Asher Jacob	Africa	Moxom, Richard John	Irish
Thomas, Jody	Asia Pacific	Munoz, Raul J.	International
Tomblin, Steven Andrew	Southern	Musselman, Jeffrey D.	International
Ursu, Anatolie	International	Mutale, Chisanga Justin	Africa
Vaitilingom, Marc Michel	Scottish	Mwanja, Samuel	Africa

Nabeta, Francis +	Africa
Nganda, Eric Ng'Ang'A	Africa
Ngoma Mapenda, Esther	Africa
Ngoumela Fokou, Georgine	Africa
Oates, Neil Anthony +	International
O'Beirne, Kieran	Irish
O'Connor, Fearghal Patrick	Irish
Osbourne, Clayton Jay Dwight	International
Parsons, Patrick Roy	Irish
Pather, Pragasan +	Africa
Pfeffer, Benjamin David	International
Reeves, Felicity +	Great Northern
Reynolds, Phillip +	International
Riley, Kevin	International
Ryan, Christian	International
Sharpe, Sheldon Kamania	International
Smith, Donovan Elcoate +	Irish
Smith, Julie E	International
Sobolewski, Maureen	International
Stokes, Scott +	International
Tang, Samuel Chei-kit	Asia Pacific
Taylor, Joshua Fraser +	Southern
Travis, Brooke +	Asia Pacific
Troncoso, Alex David +	Asia Pacific
Vaitilingom, Marc Michel	Scottish
Walker, Stefan John	Asia Pacific
Walton, Emma Louise +	Great Northern
Wiese, Warren Anthony +	Africa
Wright, Wayne Anthony +	Southern
Yetman, Gerri +	International
Zimmermann, Janie +	Asia Pacific

Diploma in Distilling Examination

Dipl.Distil Modules One, Two and Three - Passes

Barnett, Ann Marie	International
Darroch, Robert Lindsay	Scottish
McCarron, Brendan Anthony	Scottish

Dipl.Distil Module One - Passes

Anderson, Russell Ian	Scottish
Conway, Niall	Irish
Cunningham, Alastair	Scottish
Geddes, Caroline	Scottish
Lindsay, Roy F	Scottish
McCarthy, Noirin Ide	Irish
Mcguigan, Frank	Irish
Mclean, Mark Bruce	Scottish
Muwandi, David Takura +	Africa
Power, Michael	Irish
Quinn, David M G +	Irish
Savage, Fiona	Irish
Simpson, Claire Louise	Scottish
Thompson, Marie Anne	Scottish

Dipl.Distil Module Two - Passes

Egan, Colum Eamonn	Irish
Ferguson, Jane	Scottish
Lindsay, Roy F	Scottish
Lochhead, Mark Charles	Scottish
McGrandle, Euan William +	Scottish
Morehead, Peter	Irish
Sutherland, Kevin Donald +	Scottish
Tapsi, Prasad	Asia Pacific

Dipl.Distil Module Three - Passes

Campbell, Kirsteen Anne +	Scottish
Flaherty, Aaron Charles Frederick	Irish
McGrandle, Euan William +	Scottish

+ Has passed all modules of the Dipl.Brew/Dipl.Distil by accumulation.



The Institute of Brewing & Distilling
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**For full information about the IBD examinations,
contact the Examinations Administrator.**

Tel: +44 (0) 20 7499 8144
Fax: +44 (0) 20 7499 1156
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