The Institute of Brewing & Distilling

REPORT FROM THE EXAMINERS

2006

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 for the 2006 series of Dipl.Brew, Dipl.Distil and M.Brew Examinations consisted of the following members:

Dr D Taylor (Chairman),
Dr A Barker,
Dr G N Bathgate,
I Bearpark,
P Brookes,
Dr J Brown,
Dr J Bryce,
P K A Buttrick,
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J Shardlow,
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The Diploma and Master Brewer Examinations were held in the following world-wide Centres:

UK & Ireland	Aberlour, Moray
	Burton - Coors Brewers
	Cork
	Dublin
	Edinburgh
	London
	Magor - InBev
	Manchester
	Sunderland
Australia	Adelaide
	Brisbane
	Hobart
	Melbourne
	Perth
	Sydney
Barbados	St Michael
Cameroon	Douala
Canada	Calgary
	Toronto
China	Coors Brewers - China
Cyprus	Nicosia
France	Strasbourg
Ghana	Accra
Grenada	St Georges
Guyana	Georgetown
India	Chennai
	Mumbai
Jamaica	Kingston
Kenya	Nairobi
Malawi	Lilongwe
Malaysia	Kuala Lumpur
Myanmar	Yangon
Namibia	Windhoek
Netherlands	Heineken
New Zealand	Auckland
	Christchurch
Papua New Guinea	Port Moresby
Romania	Cluj Napoca
Russia	Kaluga
	Moscow
South Africa	Durban, SAB
	Johannesburg
	Port Elizabeth - SAB
	Pretoria (University)
	University of Stellenbosch
St Kitts	Basseterre
Surinam	Paramaribo
Tanzania	Arusha - Tanzania Breweries
	Mwanza - Tanzania Breweries
	University of Dar es Salaam
Trinidad	Champs Fleurs
Uganda	Kampala
USA	Colorado
	Milwaukee
	UC Davis
Zambia	Lusaka
Zimbabwe	Harare

A list of GC centres is available in the Examinations Section of the IBD website: *www.ibd.org.uk*

The statistics

Diploma in Brewing, Diploma in Distilling and Master Brewer

Five hundred candidates sat part or all of the Institute's Examinations (507 in 2005), at 58 centres (52 in 2005) around the world.

Seventy four candidates sat part or all of the M.Brew. Seventeen candidates accumulated passes in all modules.

Three hundred and ninety-nine candidates sat part or all of the Dipl.Brew. Seventy-two candidates accumulated passes in all modules.

Twenty-seven candidates sat part or all of the Dipl.Distil. Thirteen candidates accumulated passes in all modules.

The number of candidates who sat each module of the M.Brew, Dipl.Brew and Dipl.Distil is shown in the table above right and the split between candidates in the British Isles and the rest of the world is shown in the table right.

Number of candidates who sat each module

		2006	2005
Diploma in Brewing	Module 1	233	211
	Module 2	175	163
	Module 3	153	200
Diploma in Distilling	Module1	9	11
	Module 2	14	10
	Module 3	14	14
Master Brewer	Module1	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 – 399	120	279
	30%	***70%***
Total number of Dipl.Distil candidates – 27	25	2
	93%	***7%***
Total number of M.Brew candidates – 74	32	42
	43%	***57%***

Report from the Chairman of the Board of Examiners

During 2006, we have implemented a number of the changes to various examination structures and introduced new qualifications, as outlined in my report last year.

The last General Certificate in Brewing and Packaging examination was held in November 2005 and, as planned, the GCBP has now been replaced by two new qualifications, namely the General Certificate in Brewing (GCB) and General Certificate in Beer Packaging (GCP), both accredited by City and Guilds to the same NQF level 2 as the GCBP.

The examinations for both GCB and GCP have been structured in Multiple Choice Question (MCQ) format. The plan was to set these exams this year as on-line exams using the City and Guilds GOLA system, but, unfortunately, due to unforeseen problems relating to downloading procedures, it proved impossible to set this year's exams on-line. Consequently, we set paper MCQ exams for May 2006 and plan to hold one further paper format MCQ exam in November 2006 for both GCB and GCP. From January 2007, the on-line system will be operational, so allowing the GCB and GCP exams to be taken all year round, rather than twice a year (May and November) as current. Full details will be posted in due course and it is planned to install trial exams on the IBD wed site in January 2007, so that candidates can familiarise themselves fully with this new exam format and practise answering exam papers. The syllabi for both exams remain the same as currently published and are available from the IBD examinations department.

Also as announced last year, we have expanded the General Certificate in Distilling to include (as elective options) rum production and brandy production. The first examination for this new qualification (GCDi) was held in May 2006, at the same time (and in the same format) as the current GCD exam (which is targeted specifically to Grain distilling), essentially as a pilot exam in South Africa. The GCDi has also been accredited by City & Guilds to NQF level 2 like the GCD, which, it is proposed, will be replaced by the Grain distilling elective of the new exam in the future. For the time being, both exams will be available to candidates, whilst the GCDi becomes established and it is planned that in the near future, the GCDi will also adopt the on-line, MCQ format.

The final examination change introduced this year concerns the format of the Diploma in Brewing Module 3 (Packaging and Process Technology) which has been modified with the exam paper set out in 2 sections: – 3A Packaging Technology and 3B Process Technology, with candidates asked to answer 3 questions (from a choice of 5) from EACH section.

City & Guilds accreditation

The examination department has been working all through the year with City & Guilds to attain full accreditation of the Quality Assurance procedures for the IBD's qualifications and examinations systems. I am pleased to announce that, with effect from this year, our Diploma qualifications (both Brewing and Distilling) are fully accredited by C & G and all certificates issued this year, will be endorsed by City & Guilds. This endorsement has also been back dated for the past three years, so that any Diploma (and former AME) candidates who qualified since 2003 are entitled to apply for a new City & Guilds - endorsed certificate (cost £30). Contact the IBD Examinations Department at Clarges Street for full details.

Summary of 2006 performance

If we consider the results for this year's examinations, we see an overall improvement in average performance across all of the IBD exams, reversing the trend seen in recent years, especially at the higher levels of qualification. In total this year, there were 17 new Master Brewers qualifying, with 72 candidates achieving the Diploma in Brewing and 13 the Diploma in Distilling, plus 37 obtaining the GCB, 9 the GCP, 44 GCD and 6 the new GCDi.

I should like to pass on my personal congratulations to all who attained qualification, especially those achieving distinctions and awards. In particular, I should like to congratulate Richard Anthony Crowe, (Lion Breweries in Auckland) for obtaining the JS Ford prize (Dipl. Brew.), Brian Nation (Irish Distillers Pernod Ricard) for the Diploma in Distilling Award and Robert McClelland (Diageo, Scotland) for the GCD Scotch Whisky Association award.

I would like to draw attention to the individual examiners' reports, which contain descriptions of ideal answers, sound advice on examination technique and detailed analysis of the year's papers. For the first time this year, all the reports are included in a supplement to the The Brewer and Distiller but are also available via the IBD web site or by application to the IBD Examinations Administrator at Clarges Street.

However, I would like to summarise examination performances here. For the Master Brewer examinations, the highest number of entrants for several years was recorded, being some 20% higher than last year. Overall pass rates and pass performances were much improved compared with recent years, with 83% pass (of 35 candidates) for Module 1, 50% pass (of 26) for 2, 59% pass (of 22) for 3, 73% (of 15) for 4 and 64% pass (of 22 candidates) for module 5.

The results for the Diplomas this year were also improved in the main. Of the individual Brewing modules, there was a welcome increase in the pass rate for module 1, (73% of the 234 candidates). and for module 2 (63% of 175 candidates), but module 3 was slightly down on last year (55% of 153 candidates).

The numbers for candidates sitting the Diploma in Distilling examinations were similarly up on last year, with 78% pass for module 1, 93% for module 2 and a perfect 100% for module 3.

The first results for the new GCB and GCP in May 2005 produced slightly disappointingly low pass rates (46% for GCB and 24% for GCP), with a comment from the examiners that the MCQ format is quite demanding, since not only is the whole syllabus examined, but in greater depth.

The May 2005 GCD had 58 entrants with a pass rate of 76%, and the new GCDi achieved a 75% pass rate for the 8 candidates who sat this first examination.

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. The following advice is offered to all candidates sitting examinations:

- Practice drawing labelled diagrams of relevant vessels, processes etc. in advance
- Know the critical parameters, together with typical values, unit and range e.g. wort dissolved oxygen, 8ppm (7-9ppm)
- Consider the best structure for your answer before starting writing
- Allocate the same amount of time for each answer as far as possible
- Always answer the required number of questions

With regard to future developments in the coming year or so for new qualifications and examinations, we have already stated that the Distilling group is working on an expanded syllabus for a new Diploma in Distilling (like the new GCDi) to include elective options for Rum and Brandy production (in addition to Grain distilling) and international members have been invited to join this group of examiners.

Secondly, we are in the advanced stages of producing a new NQF level 1 qualification on the Fundamentals of Brewing and Packaging Beer, aimed at non-technical personnel or new entrants to the brewing industry. This again will be in MCQ format using City & Guilds GOLA system.

Finally, we are also formulating a Diploma in Beverage Packaging and are currently assessing the potential interest in this new opportunity.

It is with regret that I have to report that, for the first recorded time, a consignment of completed examination papers went missing and have had to be presumed lost.

The missing consignment contained all the completed scripts from

Nigeria, comprising some 70 papers from Guinness, Nigeria and Nigerian Breweries (Heineken) and included papers from all three Diploma in Brewing modules and modules 1 – 4 for Master Brewer.

Although both the courier and airline involved were vigorously pursued to locate this missing consignment as a matter of urgency, the likelihood of these papers being retrieved is now very small. Consequently, as a contingency, the Board of Examiners has prepared a new set of exam papers for all the relevant modules, exclusively for all those Nigerian candidates who so wish to re-sit the exams as soon as possible. This unprecedented action has been fully supported by City & Guilds.

I know it will be of little consolation to the candidates involved, but I pass on my sincere apologies for this incident and I am sure all members of the IBD, especially those who have personal experience of recent examinations, will sympathise with all affected.

Future action includes a full re-appraisal of our courier operations, requiring full assurance from courier companies that the risk of incidents of this nature re-occurring, are eliminated.

As I hope will be apparent from this report, this has been a very busy year for the Examinations Department and for the Board of Examiners. As ever, I should like to express my thanks to all the examiners, moderators and the Clarges Street examinations team for their hard work and support this year. In particular, I thank Rekha Sandal (Examinations Administrator) for her significant contribution to the IBD in this, her first year in the role.

To end, I look forward to the coming year with its associated new developments and I wish all prospective examination candidates all success in their pursuit of IBD qualifications

Dr David G Taylor

The Institute of Brewing & Distilling
Examinations 2006

Question Papers and Examiners' Reports

DIPLOMA IN BREWING EXAMINATION 2006
Module 1 – Materials and Wort

The examination was sat by 234 candidates compared with 211 candidates in 2005, 206 candidates in 2004 and 216 candidates in 2003. This is therefore the fourth occasion on which more than 200 candidates have sat the Diploma I (formerly AME) examination. The pass-rate for the examination this year was 73%. This compares with a pass-rate in 2005 of 67%, 2004 of 78% and 2003 of 72%. It is pleasing that there was a slight increase in the number of candidates achieving the highest grades.

The grade distribution was as follows (2005 in parentheses):
A:4% (1%); B: 9% (6%); C: 24% (23%); D: 36% (37%); E 16% (14%); F: 6% (14%) ; G 5% (5%).

It is important that candidates entering the examination have a thorough grasp of the whole syllabus. Candidates have 3 hours to answer 6 questions. While most candidates answered 6 questions, it was apparent that weaker candidates were struggling to answer questions on the whole syllabus, while others wasted time by answering 7 or even 8 questions. As I have said before, clearly labelled diagrams can save many words of explanation and thus save time. Some candidates wasted valuable time by making excessive 'rough' notes and then essentially rewriting them. Candidates should practice writing answers in 25 minutes.

It is important to write legibly, marks cannot be awarded by the examiners for writing that cannot be read. Candidates should in particular make every effort to answer the question set and get across the main points clearly.

The comments below are designed to help candidates see what the examiners were looking for. High marks could have been achieved without mentioning every point, and marks could also have been given for discussing relevant information beyond that given below.

Question 1
Describe the physiological and biochemical changes occurring during barley germination and early growth in a maltings. [20]

This question was attempted by 210 candidates (85%) with 70% achieving the pass mark.

The first thing to occur once grains are placed under suitable conditions permitting germination is the uptake of water through the micropyle, from some 12% to 40% moisture; hydration of the grain is critical to the physiology and biochemistry of germination. In order to ensure even germination, it is important that grain is turned and sprayed with water so that moisture uptake is uniform. Too much water can however result in loss of germination (water sensitivity). The optimum temperature for germination in a maltings is between 14 and 20ºC, and some cooling might be needed, as the germinating grain (and associated microflora) will give off heat. Germinating grain consumes oxygen and gives off carbon dioxide, thus adequate ventilation is required. Turning the grain will also help with temperature control and gas exchange to prevent asphyxiation of the grain.

Biochemically, in brief, the hydrated grain starts to metabolise stored sugars in the embryo which permit the embryo to synthesise gibberellic acids, which initiate the biosynthesis and release of hydrolytic enzymes from the scutellum and aleurone or activation of enzymes sequestered in the endosperm. The most important enzymes are beta-glucanase which degrades the glucan cell walls of the endosperm; proteases that break down the protein matrix surrounding the starch grains, α-amylase, an α 1,4 endoglucanase, β-amylase, an α 1,4 exoglucanase and limit dextrinase, which cleaves α 1,6 linkages of amylopectin.

Most students did well at this question, showing considerable understanding of grain physiology, and most provided suitable diagrams to illustrate the processes involved. However a number of students overreached their remit by explaining the kilning process in some detail, which was not asked for.

Question 2
What tests are done on barley at intake to a maltings? Explain why these tests are important to malt quality. [12]
Describe the consequences of poor barley storage at the maltings. [8]

This question was attempted by 194 candidates (83%) with 73% achieving the pass mark.

Tests carried out on barley at intake to a maltings are critical to assess the suitability of a consignment for malting. Some tests can be carried out by fairly quick inspections but a more rigorous analysis, including some biochemical parameters, takes much longer to do. Irrespective, a number of random samples of each consignment are needed. Ideally the "passport", detailing the variety and pesticide regimes applied will be available for inspection. A superficial visual assessment for absence of contaminants and disease can be made, also included in this initial assessment is aroma. Screenings are a measure of grain size, undersize grains are not required. Two very important criteria are moisture content (ideally 12- 20%) and nitrogen (protein) content (ideally 10.5-11.5%(w/w) protein, 1.7-1.85%(w/w) nitrogen for brewing). These analyses have been much speeded up by the introduction of NIR techniques, but this will not be available to all maltings. Germination capac-

ity can be assessed by a simple tetrazolium staining technique, however dormancy and water sensitivity are best assessed by germination assays. If time permits, the most informative analysis is in the form of a micro-malting and wort analysis, which will give a real indication of how the grain will perform.

Barley grain should be stored clean, dry (ideally 10-13% moisture) and cool (10-15ºC), and the ingress of pests such as rodents should be avoided. The consequences of poor storage can be premature germination, and infestation by microorganisms, particularly those such as Fusarium that cause gushing and mycotoxin contamination. Insect contamination can also increase under poor storage conditions. Too low a storage temperature may prevent the breaking of dormancy (if present).

This question was well answered by the majority of candidates who attempted the question. However some candidates simply presented a list of parameters for testing with no further explanation of why these tests are important or how they might be done.

Question 3

What are the requirements and specifications for either a good quality pale ale malt or a good quality lager malt. [20]

This question was attempted by 166 candidates (71%) with 75% achieving the pass mark.

The requirements and specifications of a brewing malt determine the quality of the brew that is produced from such a malt and thus a critical to the brewing process. The specifications reflect the starch and nitrogen content of the barley, the degree of modification and the hydrolytic enzymes produced during malting. Critical specifications (and significance) for lager malt include hot water extract (81%, indicative of potential extract available for brewing); cold water extract, (18-20%, indicates degree of modification); fine/coarse difference (<5%, indication of modification); diastatic power (70º DP ºIOB, alpha and beta-amylase activity); dextrinising units (40 DU, α amylase activity); glucanase activity (800 IRV, breakdown of cell walls); colour (2.5ºEBC); soluble nitrogen (0.6%, essential for yeast metabolism, head retention); soluble nitrogen ratio (38-42, the Kolbach index, an indication of modification). Other measures (friability, total amino nitrogen, fermentability, nitrosamines) are also of importance. The units in which the specifications are expressed may vary from land to land, but it is of course critical to state the units. In general, the specifications for lager malt should show that this is often less modified than the ale malt and might include specification for dimethylsulphide (DMS).

The answer to this question was generally supplied in the form of an annotated table, with extensive notes indicating the importance and relevance of each measurement, and an indication of how this might be done. Again, the poorer candidates provided a raw table (sometimes with no units) and no supporting detail.

Question 4

Give an account of the characteristics of potable water. [10]
Explain the role of calcium in brewing liquor. [10]

This question was attempted by 167 candidates (71%) with 73% achieving the pass mark.

Water accounts for approximately 94% of the total beer volume and is also used for steam raising, cleaning, and packaging. To be suitable for brewing, water must be microbiologically pure, clear and colourless, tasteless and odourless, of neutral or slightly acidic pH, of correct mineral composition, and free from heavy metal ions. Water composition can influence beer quality in three main areas: mineral composition, organic compounds and microbiological composition. A good answer included all of the above attributes and gave explanation of their importance including a description of water sources.

The mineral content of brewing liquor has long been recognised as making an important contribution to the flavour of the beer. 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. Good answers included description of the importance of water hardness/ calcium content and of the effect of calcium on fermentation performance.

The majority of candidates listed the attributes of potable water and a good number included equations in their description of the importance of calcium. Both parts of the question tended to be answered equally well.

Question 5

Describe the principles of manufacture and typical uses in beer production of hop extracts (including aroma extracts) and hop pellets. [20]

This question was attempted by 154 candidates (66%) with 60% achieving the pass mark.

This essay question involved dealing with two topics, principles of manufacture and typical uses in beer production of both hop extracts and hop pellets. Hops are the source of both bittering and aroma compounds, with production of bitterness being dependant for the most part on isomerisation of a-acids to iso-a-acids. With regard to bittering, there is thus a clear distinction between isomerised and unisomerised products. The best answers provided background on the chemical composition of hops, particularly soft resins and hop oils, and then discussed the manufacture of hop extracts and hop pellets. Answers should have described the manufacture of 'Type 90' and 'Type 45' hop pellets. In 'Type 45' pellets, more of the unwanted leaf material is removed. Their production involves freezing to -40ºC prior to crushing and milling. Kettle extracts of hops are now extracted with either ethanol or carbon dioxide (liquid or supercritical) and details of these extraction processes were generally well described. Isomerised pellets are produced by the addition of MgO and conditioning of the vacuum packed pellets at 45-55ºC over 8-14 days. With regard to isomerised extracts, two forms are available to the brewer. These are magnesium-salt isomerised kettle extract (IKE) and potassium-form isomerised kettle extract (PIKE) where IKE is neutralised with potassium hydroxide. There is also a range of reduced isomerised extracts that provide light stability and foam enhancement. Candidates with a broad knowledge also discussed purified iso-extracts used for post-fermentation bittering and 'Beta Extracts' obtained during purification of iso-a-acids. Hop oil products are produced by steam distillation, low-temperature vacuum distillation or molecular distillation.

The introduction and first part of the answer should have highlighted the importance of hops for bitterness and aroma in beer. The second part of the answer should then have focused on the use of these products either as kettle products or as post-fermentation additions and discussed the benefits of these products compared to the use of whole hops. For example, isomerised products have a greatly enhanced efficiency of a-acid utilisation and aroma can be enhanced by direct addition of hop essences to bright beer. The use of Type 45 pellets reduces the volume and weight of material used while reducing the addition of nitrates, heavy metals and pesticides. Since utilisation of a-acids often requires extended boiling times, pre-isomerised hops added late in the boil can greatly enhance aroma of the final beer (extended boiling volatilises aroma compounds).

A number of candidates with a good knowledge of hop chemistry provided a detailed, but largely irrelevant account. Candidates should make good use of their time during an examination and answer the question given rather than the question they wanted.

Examinations are excellent preparation for many aspects of the job that candidates are employed to do. A large amount of material needs to be memorised, assimilated and understood so that the relevant information can be used to answer a question or tackle a particular problem. Candidates demonstrate their understanding by presenting relevant information in a concise and clear way.

Question 6

Outline the key biological processes underlying the conversion of malt and adjuncts to a fermentable wort. [20]

This question was attempted by 182 candidates (78%) with 81% achieving the pass mark.

Conversion of malt and adjuncts to fermentable wort includes: milling, mashing, separation, boiling and cooling. The central process is mashing where ground malt and solid adjuncts (grist) are mixed with water at a set temperature and with a set volume of liquor (water) to produce a fully hydrated "mash". The main objective of mashing is to allow the conversion of starch from the malt and solid adjuncts into fermentable and un-fermentable sugars to produce a wort of the desired composition (liquid adjuncts are added later in the process). Good answers included a description of the main changes occurring during mashing and described the enzymatic processes that occur along with the optimum temperatures for each enzyme and the mashing regimes that are most conducive for sugar conversion. Other aspects to the answer included the satisfactory extraction of nitrogenous compounds and vitamins. Excellent answers included a flow diagram of the complete process with details of each part.

The majority of candidates recognised that the central process is mashing and described the enzymatic processes. Good answers combined biochemistry with technology (vessel design and use) and discussed each part of the malt-to-wort process. A small number of candidates discussed adjuncts in too much detail, failing to answer the question satisfactorily.

Question 7

Outline the theory and practical features of different wort separation techniques. [10]

Discuss their respective merits in relation of run-off rates, extract recovery and wort quality. [10]

This question was attempted by 189 candidates (81%) with 49% achieving the pass mark.

This question had a low percentage pass mark. Most candidates answered the two parts of the question separately, and this allowed effective comparison of the merits of the different wort separation techniques. Candidates were expected to outline the theory and practical features of a mash tun, lauter tun and a mash filter. Key to the theory is Darcy's Law which relates the rate of flow to the cross-sectional area, thickness of the filter bed and pressure across the filter bed. Also important are the viscosity of fluid and size of particles making up the bed. Only the cross-sectional area remains constant during mash filtration. Too many answers failed to mention Darcy's Law and a failure to understand the theory of wort separation may account for the low pass rate on this question.

The practical features of mash tuns, lauter tuns and mash filters were generally well described. However, there were diagrams of the Meura 2001 Mash Filter where the inflatable rubber membrane was clearly not in a position where its inflation would have any effect on filtration. It is important that diagrams are clearly drawn and labelled, a ruler would help many candidates to produce clearer diagrams.

Mash filters have a thin filter bed depth (based on Darcy's equation this will lead to increased flow). Modern membrane mash filters provide a high brewhouse yield (often higher than laboratory yields) low sparge liquor consumption, low spent grains moisture content and rapid throughput. The grist does not provide filtration in mash filters so they can be used with finely ground grist (hammer milled). High gravity brewing with membrane mash filters can lead to lower dextrins (higher enzyme extraction from finely ground grist), lower fatty acids (higher esters in the cleaner wort), but more extraction of polyphenols. Mash tuns produce high quality worts but extract recovery is generally lowest and cycle times are slow by modern standards only allowing 2-6 brews per day.

Poor quality malts requiring a protein or glucanase stand cannot be handled by a mash tun. Lauter tuns allow 6-12 brews per day, can filter worts with up to 50% adjunct and have excellent extract recovery (but less than mash filters). Recent developments minimise oxygen pick-up and speed the removal of spent grains.

Question 8

Write short notes on two of the following:

The principles of Quality Management systems; [10]

The principles of cleaning in place (CIP); [10]

Aerobic and anaerobic digestion of waste water. [10]

This question was attempted by 125 candidates (53%) with 79% achieving the pass mark.

Quality is frequently described as "meeting customer requirements". Quality management systems refer to the activities that are carried out within an organisation to satisfy the quality-related expectations of its customers. The pertinent systems for the brewing/distilling industries are ISO9000, Hazard Analysis Critical Control Point, and BRC Accreditation. Good answers discussed quality control and quality assurance and the importance of documentation in establishing and maintaining good quality management systems.

Pipes and mains in modern breweries are designed to be cleaned in place, they have smooth bends and no "dead legs" and the flow of cleaning fluids is fast through all the pipework. A pipe circuit for CIP should consist of pipes of the same diameter, otherwise the flow in the larger diameter pipe will be too slow. Valves in modern breweries are also designed so that they can be cleaned in place as part of the pipework cleaning cycle. The detailed features of a CIP system to be considered in this answer are: the CIP could be a "recovery", "partial recovery" or "total loss" system, the CIP programme or sequence of cleaning elements, tank CIP, choice of spray head, flow rates, delivery and return, choice of cleaning/sterilising materials, automation and monitoring, and running costs. The standard CIP cleaning and sterilising programme involves a rinse, detergent recirculation to clean the plant, a rinse to remove traces of detergent, sterilisation to destroy any remaining micro-organisms and a final rinse if it is decided that no sterilant should remain in the plant.

A good answer included diagrams to demonstrate areas of main concern in CIP and described the importance of correct positioning of sprayballs and of the use of sensors to detect detergent/sterilant strength on the return line. As general rule of thumb - plants used for hot processes e.g. mashing and pasteurisation, are cleaned hot. Those for cold processes may be cleaned cold. Many candidates also included the methods used to assess the success of CIP (quality control).

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 characterised by a 2 stage process. Aerobic treatments are either of the activated sludge or the attached growth type of process. Like aerobic digestion, anaerobic digestion of effluent BOD is fundamentally a 2 stage process. 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. Good answers gave equations for each of the two-stage processes in aerobic and anaerobic digestion and described the types of anaerobic reactor.

There was a good spread of choice between the three sections chosen by candidates. In general those attempting the management section, did very well, demonstrating a good knowledge of the quality management systems available. Most candidates used diagrams to highlight the various points of importance in cleaning in place. ■

Dr James Bryce

DIPLOMA IN BREWING EXAMINATION 2006

Module 2 – Yeast and Beer

There were 175 submitted scripts for this paper with 110 candidates achieving a pass grade to give a pass rate of 63 %. This is significantly higher than last year (53%). In fact the overall performance was much improved on last year; of the candidates who did not pass, 36 (over 55%) achieved grade E.

Unfortunately as in 2005 there were no A grade passes, but the 7 B grade passes and 35 C reflect a significant increase. 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 examination was moderated and all candidates achieving a low D pass or an E grade fail were re-marked by the moderator as were all papers at grade boundaries.

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.

As in previous years, examination technique was a clear cause of most failures, with some candidates clearly not concentrating sufficiently on answering all questions in sufficient depth. In other cases, it was clear that some candidates had not managed time adequately to provide quality responses to 6 questions. Other evidence of poor examination technique was evident where candidates failed to interpret the exact question asked.

Question 1

Outline the methods by which brewing yeast strains may be preserved in the laboratory as pure cultures and prepared for yeast supply. [10]
Describe the techniques that may be employed to assure yeast identity and purity. [10]

This question was answered by 147 candidates.

The first part of the question required the candidates to demonstrate their knowledge of laboratory storage methods (cryopreservation, lypholisation, slopes and plates stored in cold temperatures and in some cases under oil) and yeast supply (cake, slurry, procedures leading to the inoculation of propagation vessels and dried yeast). The first component was answered better than the latter although it was noted that some candidates referred to the use of long term storage (in some cases 6 months) on agar at 21°C as a means of maintaining a pure laboratory culture. Candidates should note that this should be avoided since the genetic stability of such cultures cannot be assured using such procedures and this is certainly not a generally accepted means of storing cultures. The second part of the question was less well answered with a few candidates omitting to provide an answer altogether. Model answers considered karyotyping, restriction fragment length polymorphism, PCR, phenotypic differences and petite tests for yeast identity and microbiological contamination tests for yeast purity. This latter tests was only mentioned by a few candidates. Some candidates presented extensive overviews of the measurement of viability and/or vitality and unfortunately this was not relevant and received no credit accordingly.

Question 2

Define the term Total Vicinal DiKetones (VDK) [4]
Describe the flavour attributes and thresholds and generally used flavour descriptors associated with these carbonyls in beer [4]
How is diacetyl formed and reduced during fermentation? [12]

This question was answered by 166 candidates.

The candidates were asked to define Total VDK and most successfully identified 2,3 butanedione and 2,3 pentanedione but their respective precursors were only mentioned by a few and would have earned the candidates the full marks available for this question. The capacity of the candidates to correctly identify the flavour descriptors for diacetyl was universally answered correctly, however many were less sure of the descriptors associated with 2,3 pentanedione (honey). Flavour threshold values ranged wildly. The basic principles of the metabolic pathways leading to the formation of diacetyl were reasonably well answered however very few considered its reduction despite the clear requirement for this to be addressed.

Question 3

a) The relative uses of difference and descriptive taste testing methods. [5]
b) Methods used for measuring beer foam stability. [5]
c) Techniques that can be used to measure beer colour [5]
d) The measurement of haze [5]

This question was answered by 166 candidates.

This question was reasonably well answered by most candidates. The question relied on the capacity of the candidates to list and briefly describe appropriate tests in each part of the question. The first part was answered by most who attempted this question. However, answers were generally well balanced between difference tests and descriptive tests. The measurement of beer foam stability was also well answered, those candidates who scored highly, considered more than just the Rudin and NIBEM means of measuring foam stability. Most candidates who chose to answer part C of the question demonstrated a sound knowledge of methods for measuring colour, however many chose not to attempt to answer the final part at all and those that did provided only a limited understanding of the techniques involved.

Question 4

Using appropriate metabolic pathway schematics describe the formation of the following flavour metabolites during fermentation by yeast:
a) organic and fatty acids [7]
b) ester formation; [7]
c) higher alcohols. [6]

This question was answered by 98 candidates.

The formation of organic and fatty acids was poorly reported by the candidates and many left this part of the question out altogether. For the second part, ester formation was considered. Most candidates could adequately describe the metabolic pathways involved in the synthesis of esters but only around half of these answered highlighted factor that affected the formation of these flavours from a metabolic point of view. Finally whilst the pathways involved in higher alcohol formation were accurately presented by most again the description of the formation would have been better expressed by indicating the underling principles governing the regulation of this pathway.

Question 5

What are the causes of non-biological haze in beer ? [4]
Describe the theory of formation of colloidal haze formation in beer [8]
Describe the theory and practical methods that can be used to remove proteins and polyphenols from beer. [8]

This question was answered by 166 candidates.

The range of marks awarded for responses to this question ranged from 0 to 18 out of 20. Few candidates could list causes of non-biological haze other than protein-polyphenol complexes, yet they could have mentioned b and a glucans, pentosans, and oxalate crystals. The theory of formation of colloidal haze in beer was attempted by most candidates who answered this question, and the answers were generally sufficient, however those that attempted the final part of this question did so in a rather focussed way – concentrating on one or two methods only. Candidates could have considered protein hydrolysis (papain), precipitation (tannic acid) and adsorption (hydrogel, xerogel and silica gel) and the removal of polyphenols by omission (huskless / naked barley) or adsorption (nylon 66 or PVPP).

Question 6

Write notes on the special beer treatment methods used to produce TWO of the following:
a) Low alcohol and alcohol free beers [10]

b) Ice Beers [10]
c) Beers that undergo secondary conditioning in bottle [10]

This question was attempted by 36 candidates.

Most of those that attempted this question answered part A and C and few attempted part B. On the whole part B was well answered where attempted and candidates understood the principles and practices involved. Those that answered part A (the vast majority) gave highly variable answers from the text book (vacuum distillation, vacuum evaporation, dialysis, reverse osmosis, control of mashing and fermentation and even the use of spent grains) to answers that focussed on one technique. Most credit was applied to the former approach. For part C there was considerable variation in response and the general view of the examiner is that this component was poorly answered.

Question 7
Describe the methods that can be used to identify and quantify spoilage microorganisms of wort and beer [10]
At what point in the process of beer production do the following microorganisms typically occur and what is the subsequent impact on beer quality:
a) Acetic acid bacteria [5]
b) Lactic acid bacteria [5]

This question was answered by 114 candidates.

On the whole this question was poorly answered. Most candidates failed to adequately describe methods for the identification (selective agars, biochemical tests such as API, catalase, gram staining, molecular techniques such as PCR, RAPD-PCR and others) and quantification (ATP Bioluminescence, plate counts, fluorescent techniques) of microrganisms. Most candidates failed to correctly present the occurrence and impact of acetic acid bacteria and some seemed unable to do this for lactic acid bacteria.

Question 8
Why is it necessary to maintain good hygiene standards in fermentation vessels and yeast storage tanks? [5]
How can good hygiene standards be achieved using "cleaning in place" in fermentation vessels and yeast storage tanks? Include examples of systems and chemicals that may be employed. [10]
Outline the procedures available for monitoring the effectiveness of such cleaning systems. [5]

This question was answered by 150 candidates.

This question was answered very well by most candidates who attempted it. Most understood the need for good hygiene standards in fermentation vessels and storage tanks. The response to the second part of the question was more variable with model answers providing a description of plant from schematics to spray ball descriptions, recoverable and non-recoverable systems, flow rates, chemicals and their actions and antagonisms. Some answers provided examples of CIP regimes and this was deemed appropriate providing that it referred to the underlying principles involved. The final part of the question was generally well answered, many concentrated on the microbiological stability measurements but unlike previous years the systems and chemical checks were almost universally included. ■

Professor Katherine Smart

DIPLOMA IN BREWING EXAMINATION 2006
Module 3 – Packaging and Process Technology

There were 153 candidates and 84 (55%) passed. The pass rates and details of candidates' performance on individual questions are shown in the tables below.

Pass/Fail Rates and Grades

	Grade	Number	% in grade
Passed	A	8	5
	B	17	11
	C	25	16
	D	34	22
Failed	E	29	19
	F	17	11
	G	23	15

Performance by question

Question	Answered by	Passed by	% pass rate
1	137	98	72
2	86	54	63
3	117	90	77
4	67	29	43
5	44	16	36
6	72	45	63
7	117	51	44
8	40	20	50
9	110	44	40
10	93	57	61

General Comments:

The overall pass rate of 55% is lower than last year and is most likely a result of the requirement this year to answer three questions from each of the two Sections, A and B – Packaging and Process Technology respectively.

There were two factors evident in many of the failed papers. Firstly a failure to answer six questions (always a disadvantage) and secondly an imbalance between the quality of answers given for the two Sections, with the Process Technology questions in Section B answered worse by failed candidates. Amongst the candidates who passed the paper, Sections A and B were equally well answered. Future candidates should take note that passing this module requires candidates to demonstrate competence in their knowledge of both Packaging and Process Technology.

Trainers and people preparing candidates for the Process Technology Section should try to ensure that the underlying engineering principles are explained and understood since it is often evident on the calculation questions that some candidates had little understanding of the formulae and equations being used.

Comments on candidates' performance on individual questions follow.

Question 1.
The function of packaging can be defined by the key words: contain, protect, present and inform. For one small pack product (bottle or can) and for one large pack product (keg or cask) explain how these key words apply. [20]

This was the most popular question and well answered by most candidates with the second highest pass rate. Occasionally non-relevant information was included; a case of candidates writing what they knew rather than what the question was asking. This is always a waste of valuable exam time, since marks are not awarded for information that is not relevant to the question. With the choice of one small pack and one large pack container, candidates were free to select the packages they knew best and this showed in the quality and completeness of the answers.

Question 2.

Explain the difference between Quality Control and Quality Assurance. [10]

Outline the checks that need to be made in a microbiological audit of a packaging plant (small pack or large pack). List the types of micro-organisms that are likely to be found and typical points of contamination. [10]

This was quite a popular question and was answered quite well. The first part of this question required a clear distinction to be drawn between QC and QA. This can be done in several ways, but historically, QC was concerned with end-product inspection and reject/accept decisions. Improvement was not the main focus for those carrying out the checks and only came as a result of reporting back by the QC Manger or Department to the Production Management. QC is now applied throughout the process and is often part of a QA system, but its focus is still inspection.

QA is concerned with the setting up and operation of a framework involving all employees (and suppliers and customers) to deliver quality. QA works throughout the process.

On the micro audit part of this question, some candidates gave very detailed lists of all their routine microbiological checks in packaging. A microbiological audit, either conducted by internal or external parties, is not this, but it is a detailed review and examination of how the plant micro is being controlled. So one of its aims is to assess that these routine tests and methods are adequate. Its other aims may be to improve the micro condition of the packaging plant, to identify contamination sources and to determine CIP effectiveness. In achieving these aims, information over time is needed so a review of previous records, trend charts etc. and talking with the packaging staff is a good starting point .Key processes that can affect product integrity (such as flash pasteurisation) may need to be closely investigated and if HACCP is in use, is it being used effectively? It is often helpful to break down the process into separate steps and to check the product integrity at each boundary.

The main infection groups – lactics, acetics, coliforms, *Zymomonas* and wild yeasts were only mentioned fleetingly in many answers and with no explanation of why they might be found where they are found, for example acetics are aerobic and tend to be found where beer is spilt or decanted from damaged packages.

The risk of *Legionella* in tunnel pasteurisers was well explained by most candidates and the need to control with biocides.

Question 3.

Describe the manufacturing process for one of the following primary packages:
a) two–piece can
b) non-returnable glass bottle.
c) PET bottle
d) stainless steel keg

[10]

For the same primary package and with the use of sketches, outline the key features, dimensions and properties that makes the container suitable for beer packaging. [10]

With the choice of one of four primary packages, most candidates did a good job of describing the manufacturing process for their chosen package, and this was the most popular question with the highest pass rate. Better answers carried more detail, for example the ingredients, say, for glass manufacture and, although not requested, very often with detailed sketches to enhance the description.

For the key features and dimensions of the same package, most candidates presented large annotated sketches with the key features and dimensions highlighted. For "properties", the question was less well answered and it was looking for those particular features that make the package suitable – inertness, compressive strength, vacuum capability, low weight, finish, colour, gas impermeability and so on.

Question 4.

Describe the advantages and disadvantages of "straight line" and "U-shaped" packaging lines [10]

Explain how packaging line performance can be measured. What are the key indices that contribute to these measures and what steps that can be taken to improve efficiency on packaging lines. [10]

On the first part of this question, several candidates took a wrong approach – comparing a line with "V-graph" machine speeds with a line with all machines running at the same nominal speed. The question is not considered ambiguous for the following reasons. "Straight line" and "U-shape" are common industry terminology for line layouts; it is clearly a "U" not a "V", and there can be few lines where all machines have the same design running speed.

These answers apart, candidates answered the first part well, picking out most of the advantages and disadvantages of each.

On the second part of the question, few candidates explained how the basic information on line outputs might be gathered, without which line performance cannot be measured. Simple things like recording the good full stock produced, recording rejects and rework, run times, downtime, changeover times and so on were not mentioned. Answers dived straight into the key indices, without mentioning how the data might be acquired – be it automatic or manual. Often the simplest key index, such as target units per shift, can be the most compelling and effective.

Answers were good at defining the key indices, and since there are almost as many definitions as indices, marking was generous provided an understanding was evident in their derivation from shift time, planned time, standard time etc. etc.

For improving performance, better answers described some of the techniques for achieving "buy-in" from the workforce, for example CIP – culture, information and problem solving, and the tools that go with them – 6 Sigma, 5 'S's, JIT, TQM, Quality Circles and so on.
Answers that attacked the basic causes of downtime by attention to improving maintenance, planning etc. were also well rewarded.

Question 5.

Explain how the double seam is formed during the packaging of a beverage can and outline, with diagrams, the typical faults that can occur. [10]

Explain, with diagrams, how fill level is controlled in the filling of glass bottles with beer. [10]

It was disappointing that this question was attempted by so few candidates, and then poorly answered by many who attempted, since the formation of a good hermetic can seal and the control of bottle contents are key for successful beverage packaging.

Diagrams of the 1st and 2nd operations were required showing the seaming chuck and the seaming rolls performing the 1st operation by tucking the end flange under the body hook, and then rolling the seam tight with the 2nd operation roll. Sealing compound, in the end curl, helps to make a sound seam and if drawn correctly there should be 5 thicknesses of metal in the seam – 3 can end thicknesses and 2 body thicknesses.

The faults expected to be drawn and outlined were short end and short body hooks which reduce overlap, long end and long body hooks that can cause splitting, a false seam where the end hook has not engaged with the body hook, a cut over seam and the sealing compound missing.

For the control of bottle contents, explanation of how fill level is controlled for short and long tube fillers and how volume is controlled on volumetric fillers was essential.

Filling to a "height", with the long and short tube fillers should have prompted discussion of bottles as "measuring containers" and the concept of a fill dimension from the top of the bottle finish to the liquid level. Subsequent operations to remove air from the bottle neck (by tapping or water injection) must not be excessive and cause loss of bottle contents. The close-coupling of filler and crowner is also important in this respect.

Checks on bottle contents by level check (visual or gamma ray)

either post filler and/or post pasteuriser are essential to assure correct filler operation and a reject/accept decision made. Rejects are usually weighed before return to the line, if contents are correct, or decanted if short-filled.

Diagrams, where used in this question, were often so small that the detail could not be seen; they were difficult to interpret and failed therefore to attract the marks that bigger, clearer drawings would have gained.

Question 6.

By reference to a diagram, describe the basic components of a single closed loop control system, and explain the function on each component. [4]

Describe, with the use of diagrams, how a controller will respond to a step disturbance entering the system for each of the following controller actions: Proportional (P), Proportional plus Integral (PI) and Proportional plus Integral plus Derivative (PID). [10]

Give one example each of feedback and feedforward control in a brewery and describe the suitability of each control for the particular application. [6]

This should have been a straightforward question for most candidates as a textbook answer, but few candidates attempted this question. It was however answered well by those who tried it.

The basic components of a single closed loop control system comprise the elements of measurement, comparison with setpoint, generation of an error, computation of a control action and correction via a control element. There are some variations on how this might be presented, and most candidates did a good job with this part of the question.

Good clear diagrams of P, PI and PID control were well rewarded, provided they showed the key elements of each control action i.e. offset, removal of offset and faster response/reduced overshoot respectively. Better answers gave the equations for each and discussed the effects of increasing/decreasing gain, integral time and derivate time on controller response.

Feedback loops were fairly easy to find and to describe, but not so for feedforward loops. The control of a beer chiller by measurement of the incoming disturbances on the refrigerant and beer flow, in order to prevent beer freeze-up, was the most common choice.

Question 7.

Outline the insulation materials and methods for vessels and structures that are operating below ambient temperature, highlighting the problems that can occur if the insulation is not applied correctly or if it is damaged. [6]

A cold room is constructed with walls and roof of 240 mm thick concrete and is cooled by a refrigeration system of 40 kW cooling capacity. Heat is picked up only through the walls and the roof, which have a total mean area of 2000 m^2. All other sources of heat pick-up can be ignored. Calculate the internal temperature if the outside ambient temperature is 30°C. [7]

Calculate the thickness of insulation that would have to be added to all interior surfaces if a cold room temperature of -2°C is to be achieved at the same ambient temperature of 30°C. [7]

Data

Thermal conductivity of concrete = 1.5 W m^{-1} K^{-1}

Thermal conductivity of insulation material = 0.06 W m^{-1} K^{-1}

Inside Air Film Heat Transfer Coefficient = 8 W m^{-2} K^{-1}

Outside Air Film Heat Transfer Coefficient = 17 W m^{-2} K^{-1}

Insulation of surfaces, both above and below ambient temperature, are common in breweries and candidates should be aware of the requirements for each.

Insulation works by trapping small pockets of air (which is a very poor conductor) and the small pockets also eliminate convective heat transfer. Below ambient, insulation must be impervious to water (a better heat conductor) and a closed cell structure is chosen. To prevent moist air penetrating to the cold surface and causing subsequent water condensation, a material resistant to water vapour penetration, called a vapour barrier, is applied over the insulation. Metal or plastic cladding is applied to protect this barrier and the insulation from accidental damage. Insulation containing chloride ions should be avoided on stainless steel vessels due to the risk of corrosion, or the metal protected with chloride barrier paint.

The calculation required the addition, as reciprocals, of the inside and outside film resistances and the concrete conductive resistance in order to find the overall heat transfer coefficient. An answer of 23.1°C was expected for the first part, without insulation, and an insulation thickness of 75.3mm was required to maintain the store at -2°C. Answers with some very thick insulation were given – the thickest being 150km! – without any comment, and probably therefore understanding, that the answer was nonsensical. In setting the questions, care is taken to ensure that the answers are realistic and therefore a ridiculous answer could indicate that an error has been made, perhaps!

Question 8.

Outline the key features of a properly specified steam distribution system in a brewery. [8]

Draw a clearly labelled diagram of a pressure reducing station for steam and describe the function and operation of each component part. [6]

Describe, using sketches, a flow-metering device for steam. [6]

This question was generally well answered, although attempted by the fewest candidates.

The key features of a steam distribution system start with the boiler for steam raising, and usually a standby to cover breakdown and statutory inspections, and, if fired on natural gas, with an economiser to maximise heat recovery. To smooth the steam load on the boilers, a steam accumulator is often installed between the boilers and the brewery plant.

Pipework should be designed for the pressure, (6 – 10 bar), for a steam flow rate of less than 25 m s^{-1}, insulated to reduce heat loss and laid to falls of 1 in a 100 or greater. On longer runs, expansion capability is required using bends or bellows and facilities for the removal of condensate and its recovery are needed at low points on mains and plant. Pressure relief valves are required to protect equipment, which is usually fed via a pressure reducing set.

The diagrams of pressure reducing stations were well drawn and annotated by most candidates.

Less well answered was the part about steam metering. The three main meters for steam metering are orifice plate, variable area meter and vortex meter; and they are in the same order for ease of drawing and explanation! The orifice plate is by far the easiest to draw, but there were one or two good attempts at the variable area meter. The vortex meter was avoided.

Question 9.

Describe the nature of the problem of pumping hot wort to empty a kettle and outline the possible solutions to the problem and the practicalities of implementing them. [6]

Wort from a kettle is being heated by pumped circulation at 2000 hl h^{-1} through an external calandria. The wort flows through 15 tubes of 3m length and 100mm internal diameter. Wort density is 980 kg m^{-3} and wort viscosity is 0.0003 Pas.

If the flow is even across all tubes, calculate the Reynolds Number and determine whether the flow will be laminar or turbulent. [6]

The kettle operates at atmospheric pressure. The depth of wort in the kettle is 6m and the pump is 3m below the kettle. The pump has a required NPSH (net positive suction head) of 6m and the pressure drop through the pipework and fittings from the kettle to the pump for this specific installation is given by the equation: -

$$h_{fs} = \frac{0.123\ L\ v^2}{d\ g}$$

where: h_{fs} is the head loss due to friction (m)
L is the length of the pipework = 12 m
d is the pipe internal diameter = 0.2m

g is the acceleration due to gravity = 9.81 m s^{-2}.
v is the wort velocity in the pipe (m s^{-1})

Calculate the fastest flowrate in hl h^{-1} at which the wort can be circulated at its boiling point without cavitation. [8]

This was a popular question, but it was not well answered.
For the first part, it was not sufficient just to say that the problem of pumping hot wort from a kettle was "cavitation"; this does not explain the nature of the problem and a clue to cavitation was, after all, given in the last part of the question.

It was necessary to explain that if the absolute pressure on the suction side of the pump falls below the wort vapour pressure, vapour flashing will occur. Pump performance will fall and the vapour bubbles will collapse at the pump impeller, as the pressure rises. These bubble collapses cause severe pressure shocks that can pit and damage the pump impeller.

A pump requires a minimum head – the net positive suction head (NPSH) to avoid cavitation.

There are several ways to increase the NPSH available, and hence avoid cavitation. Some are easy to implement whilst others are more difficult. Dropping the pump (often easy) or raising the kettle (difficult!) will increase the head at the pump suction. Reducing head loss due to friction in the pipe from kettle to pump will also help – a wide diameter smooth pipe with no/few valves, bends or fittings and long radius bends all help to reduce friction loss. Lowering the wort temperature would help, by lowering the wort vapour pressure, but this is not a practical or economic option. Reducing the pump speed, or throttling the pump outlet are easy practical solutions, provided cycle time is not jeopardised. It is impractical to increase the kettle pressure throughout wort offtake, even if the kettle is a pressure kettle. Finally, selecting a pump with a low NPSH is a wise choice.

Calculation of the Reynolds Number for the flow across all 15 tubes should have given an answer of about 155,000 and hence turbulent flow.

In answering the final part of the question, the energy balance equation should have been applied. Since the wort will be at, or about, its boiling point, the wort vapour pressure will be equal to atmospheric pressure by definition. This leaves the head available at the pump suction to be 6+3 = 9m, less the head loss due to friction h_{fs}, so available head is (9 -h_{fs})m. But the pump requires an NPSH of at least 6 m, so (9 -h_{fs}) must be greater than 6 m and hence h_{fs} must be less than 9 – 6 = 3 m.

But h_{fs} is also given by the equation above, from which v can be calculated as not greater than 2 ms^{-1}. Multiplying by the flow area and converting from m^3 gives a maximum flowrate of 2260.8 hl h^{-1}.

Question 10.
Outline how passivation provides corrosion resistance to stainless steel. [4]
Describe mechanisms involved in the corrosive attack of stainless steels and explain what steps can be taken in the formulation of stainless steels to minimise corrosion. [10]
Explain why the selection of material of construction for hot water tanks in breweries is such a challenge. [6]

This question was quite popular and quite well answered.
The question was looking for explanation that stainless steels are a range of alloys containing more than 10% chromium, and other metals, that exhibit good resistance to atmospheric and chemical corrosion. Under oxidising conditions, a very thin film of chromium oxide forms on the steel surface, preventing further oxidation (which would be corrosion). This is called passivation. Strong oxidising agents such as nitric acid are often used as a means of passivating steels quickly and evenly. This part of the question was generally well answered, as was the next part on corrosion of stainless steels.

The final part of this question was less well answered. Hot Water tanks constructed in stainless steel can be susceptible to stress corrosion cracking (SCC) due to the following factors:-

- Low oxygen content of the hot water due to its reduced solubility at elevated temperature.
- Chloride ions will nearly always be present and often at high levels – e.g. 150 ppm.
- Scale deposition from hard waters is likely, causing ideal conditions for shielding and pit corrosion.
- Elevated temperature speeds up reactions.
- Expansion and contraction can put stresses into the materials.

Higher quality stainless materials, such as the Duplex and ferritic steels, may have to be used.

Mild steel may corrode and cause high iron levels in the wort and beer with possible effects on the yeast and beer stability.

Cast iron tanks were common for this duty, but in recent years have come under scrutiny, following a tank failure, due to the risk of cracking and thinning, but may well still be in use.

Copper is aesthetically very pleasing and shows good corrosion resistance, but it is costly.

Wood vessels may still be in use and can continue to give good service. They are comparatively cheap, insulating, flexible enough for expansion and contraction and clean, if not "sterile", if kept sufficiently hot.

Plastics have been used but are not favoured due to worries about taints, and their strength at elevated temperatures. ■

Brian Eaton

DIPLOMA IN DISTILLING EXAMINATION 2006

Module 1 – Materials and Wort

Only 26 candidates sat the Diploma examinations of 2006, but since eight candidates sat two modules and one sat three, the total number of examinations was 37. Assessed over the three modules, the pass rate was 92%, and 13 of this year's successful candidates have now accumulated the three module passes to qualify for the IBD Diploma in Distilling.

I am pleased to acknowledge an improvement in the quality of illustrations over recent years, although there are still a few candidates who provide mis-shapen freehand drawings of equipment, and lose marks as a result. Also on the subject of drawing, it is important to show something that would work. Of course the standards of a professional artist are impossible in the time allowed per questions, but I will explain my complaint with reference to two common faults of drawings in Module 1. Some of the malt mills drawn for question 3 showed the rolls so far apart that not only grains but perhaps even melons would pass through intact. And in a cereal cooker (question 5), the steam must be injected into the grain slurry, not the head space. These are not trivial details, such mistakes suggest that the candidate does not really understand how the equipment operates.

Also in previous years I have complained about an obvious unwillingness to answer questions involving biochemistry or microbiology: these subjects are fundamental to the pre-distillation stages of the process and should be well understood by all candidates for a Diploma in Distilling. As with drawing, the situation had certainly improved this year, but not as much as I would like. There still seemed to be a reluctance to choose questions on microbiology, and some of the candidates who did, showed an unfortunate lack of microbiological knowledge.

Of the 9 candidates who sat this examination, 7 passed: 1 at grade A, 3 at grade B, 2 at grade C and 1 at grade D. With the relatively small number of candidates, any further statistical analysis is pointless.

Question 1
Discuss, with respect to biochemistry and physiology, the progress of modification of barley endosperm during malting. [20]

This question concerned the biochemistry and physiology of modification of barley endosperm during malting. The best answers provided accurate accounts of the textbook explanation of the process with the useful assistance of neat diagrams of the structure of the corn. Even the poorer answers indicated a reasonable knowledge of the malting process, but a few candidates lost marks by their reluctance to deal with the biochemical aspects. Six of the 8 answers scored a pass in this question, some with very good marks.

Question 2
With the aid of a diagram, describe the process of kilning malt for malt whisky distilling, including an explanation of achieving sufficiently low levels of nitrosamines. [20]

All nine candidates answered question 2, again with varying ability, and two failed. The diagram I had expected to illustrate the explanation of kilning was a graph of temperature and moisture content over the kilning process, preferably mentioning the "break point" and its significance. However, several good answers provided a neat sketch of the equipment, which was perfectly acceptable. Although the allocation of marks for the section on nitrosamines was not shown, those candidates who did not mention methods to prevent or reduce their formation should have realised that some penalty was inevitable.

Question 3
With the aid of a drawing, explain the process of milling malt in a malt whisky distillery, and [14]
Discuss the effect of milling on subsequent mashing and wort run-off. [6]

Question 3 was another popular question answered by all candidates, of whom six passed. Most realised that the requested drawing had to show the layout of hopper, rolls and screens in the mill; showing also the magnets and weighing and de-stoning equipment added to the good impression created by the best answers. How to obtain the correct ratios of grist fractions was probably more conveniently explained in part (a), since part (b) was allotted only 6 marks and required explanation of the extraction of yeast nutrients and the contribution of husk material to filtration in the mash tun.

Question 4
Name four of the malt enzymes associated with distillery mashing and explain briefly the role of each enzyme in the conversion process. 4 x [5]

Candidates had to choose four enzymes of the mashing process for discussion in this question, but since malt enzymes were specified, obviously the choice was limited to those involved in grain and malt whisky production. All of the 7 answers described alpha and beta amylases and limit dextrinase; alpha glucosidase/maltase was the fourth choice in most scripts. Beta glucanase was also acceptable provided its low optimum temperature and limited activity in conventional mashing regimes was mentioned, and although no-one mentioned protease, that too would have been acceptable on similar conditions. It was possible to answer the question without drawing the starch molecule, but a sketch certainly helped in the better-quality answers to explain the action of the chosen amylolytic enzymes. Answers varied widely in quality, some showing an unfortunate lack of the biochemistry which should have been an important part of the discussion, and as a result there were 3 fail marks for this question.

Question 5
a) Prepare a labelled sketch of a cereal cooker for a grain whisky or grain neutral spirit distillery showing the essential features for its operation. Include the equipment immediately upstream and downstream for heating and discharging the cooker. [10]
and
b) Describe briefly the operation of the three vessels you have illustrated. [10]

Inevitably, practical experience of grain distilling was an advantage in question 5 on the design and operation of cereal cookers. I may be doing widely-read students an injustice, but the best answers, with excellent drawings of the equipment and a detailed description of the procedure, seemed to indicate regular involvement with cereal cooking. The syllabus requires a reasonable knowledge of the process, and the information is easily available, so it was disappointing that some candidates gave very little information on how the cereal is cooked in a grain whisky or neutral spirit distillery. So, the 7 answers to question 5 varied from two of excellent quality to one failure. It was expected that answers would describe the cooker itself, preceded by the steam generator, also known as accumulator, and followed by the flash vessel for cooling and steam recovery.

However, other upstream and downstream units were acceptable with a logical explanation. Although I had hoped that the wording of the question implied batch cooking, a description of a continuous system was also accepted, giving the benefit of the doubt. Incidentally, this situation shows why the suggestion from time to time for "model answers" to appear in this report is impracticable; there was no one correct answer.

Question 6
a) Briefly explain the differences between temporary and permanent hardness of water [4]
b) Discuss the importance of temporary and permanent hardness of water to the various processes of whisky distilling. [10]
c) Give an account of the methods for removal of temporary and permanent hardness, including for maturation and bottling. [6]

It should have been obvious that the first and final sections of question 6, on the nature of water hardness and removal of temporary and permanent hardness, required mention of the salts which are responsible,

and an account of the chemistry involved in their removal. Preferably with chemical formulae, since only simple compounds and reactions are involved. So without such essential information these parts received poor marks.

Fortunately for the pass statistics, all answers included a competent discussion of the effects of hard water on the various processes of whisky distilling. The question as printed on the examination paper had suffered from the attention of computer gremlins (the examination paper in this report is the correct version), but so far as we know no candidate was adversely affected. It had always been intended that the choice of processes was up to the candidates, and they all covered a wide selection from mashing to reduction and bottling, and equipment such as boilers, condensers and CIP plant. Since that was the main part of the question, all 6 answers scored reasonable pass marks.

Question 7

a) Describe the laboratory method for measurement of the hot water extract of malt. [8]
b) How is the procedure continued to determine the fermentability of wort from that malt? [7]
c) Discuss briefly the importance of these analyses for a malt whisky distillery [5]

This question on hot water extract and its implications, was not particularly popular, and a late choice of the three candidates who answered it. However, two of the answers gave competent accounts of the laboratory procedures for HWE and fermentability, and the importance of these analyses for malt quality and prediction of spirit yield.

Question 8

a) Give an account of the obligations of a distillery with respect to release or disposal of process effluents [10]
b) With the aid of a diagram, describe a typical aerobic "bio-plant" for on-site treatment of waste waters from a malt whisky distillery. [10]

Question 8, on treatment of process effluent, was also left until late on in the examination, but was rather more popular. The six answers were of widely varying quality, including two fail marks. The best answer was a very competent discussion of the obligations to the regulatory authorities, and was accompanied by a comprehensive drawing and explanation of an effluent treatment plant. The less successful candidates lost marks from lack of detail, and also from not noticing that part (b) required both a drawing and a written explanation of the bio-plant. ■

DIPLOMA IN DISTILLING EXAMINATION 2006

Module 2 – Fermentation, Distillation and Maturation

Unfortunately one candidate failed, but 93% of the 14 candidates passed. Another impressive statistic is that 5 (36%) passed at A grade. Other pass results were 3 at grade B, 1 at C and 4 at D.

Question 1

Give an account of the effects of each of the following factors on subsequent processing and on the properties (or quality) of the resulting malt whisky new-make spirit:
a) Water supply [5]
b) Barley variety [5]
c) Kilning of malt [5]
d) Microbial contamination of malt [5]

Many of the 10 answers to question 1 discussed the four specified factors (water, barley variety, kilning and microbiological contamination) in a vague and lengthy way, and the poorer answers did not mention their effects on the new spirit. In fact, as the allocation of only 5 marks per topic implied, a relatively short statement on each was sufficient. In the context of the subject area of module 2 it was unnecessary to consider the influence of pH or hardness on mashing, and while they may affect boilers, heating coils and condensers, there is no direct effect on the spirit. Off-flavour could be introduced at any stage of the process but colour, clarity, microbiology and metal-ion content cause problems only at the reduction stage.

Selection of a barley variety with low EC potential was certainly important, but nitrogen content and predicted spirit yield could also be mentioned. The specified level of peating is obviously an important factor in kilning, as is inactivation of enzymes and therefore of secondary saccharification in the fermentation vessel. However, colour is irrelevant in a distillery malt, except in the sense that it indicates over-kilning and the resulting adverse effects. Although seldom mentioned, NDMA must be prevented as a by-product of kilning. The most important results of microbial contamination of the malt are competition between culture yeasts and contaminants for fermentable sugar, reducing the spirit yield, and the production of off-flavours. All but one answer scored at least a pass mark.

Question 2

a) Describe the formation of the following flavour congeners by yeast metabolism:
butanol [5]
diacetyl and [5]
ethyl acetate [5]
b) Briefly discuss the effect of fermentation conditions on the amounts of these compounds in the wash. [5]

Yeast metabolism was obviously an unpopular subject with this question being answered by only eight candidates. However, some of those who did choose the question provided answers of an excellent standard and all 8 gave a satisfactory recollection of the textbook explanations of the formation of the specified flavour congeners, including relevant metabolic pathways.

Question 3

a) Give an account of the methods for detection and enumeration of *Lactobacillus spp* and wild yeasts in wort and culture yeast. [12]
b) Describe, with reasons for their use, tests for the viability and vitality of yeast intended for inoculating a distillery fermentation. [8]

This question on *Lactobacillus* and wild yeast contaminants, was answered by eleven candidates, of whom eight passed. Explaining why lactic bacteria and wild yeasts are troublesome was unnecessary; all that was required was an account of their detection and counting in the laboratory. An important part of the answer to part (a) was the requirement for selective media (actidione and lysine respectively) to recover these contaminants from culture yeast, whereas non-selective

nutrient medium was preferable for culturing from uninoculated wort, since in that situation culture yeast itself is regarded as a contaminant. As expected, most answers described methylene blue and rapidly falling pH in glucose solution as tests for viability and vitality respectively of culture yeast, but alternative methods were acceptable. However, their significance had to be explained ("reasons for their use") and some lost marks by omitting that part.

Question 4

a) Discuss the requirements for hygiene of mashing and fermentation vessels of grain and malt whisky distilleries, and cooking vessels of grain distilleries. [12]

b) With the aid of a diagram, explain the operation of an automated cleaning in place (CIP) system for a stainless steel washback (fermentation vessel). [8]

Essentially the first part of question 4 concerned the necessity to clean and then sterilise fermentation vessels (washbacks) and their pipework, whereas a mash tun or cooker requires only cleaning, since the temperature of normal operation has a sterilising effect. However, a more substantial discussion than the previous sentence was required for 12 marks. The expected division of the answer was to explain the reasons for the cleaning procedure and the likely effects of omission in part (a), and concentrate on the actual cleaning, and sterilisation since the subject is a washback, in part (b). Some of the 10 answers were of an excellent standard, and all passed, although it was surprising how many otherwise excellent drawings did not show the actual washback and the means of applying the CIP liquids.

Question 5

a) Draw a diagram of the typical distribution of flavour congeners over the height of the rectifier column of a grain whisky or grain neutral spirit distillery. [8]

b) Explain how the amount collected at the spirit plate can be increased or decreased for:

a named congener more volatile than ethanol [6]

and

a named congener less volatile than ethanol. [6]

All candidates answered question 5, reproducing the expected graph of congener profile in a continuous still to varying degrees of accuracy and neatness, although a few answers showed instead the information superimposed on a sketch of a rectifier. Since the graph was worth 8 marks, it was worth drawing well, but, as one example of penalised carelessness, several candidates did not bother to calibrate the X-axis (concentration of ethanol and congeners). A few candidates suggested altering the congener concentration by manipulating fermentation conditions and therefore wash composition, but in the context of a distillation question the point of part (b) was how to alter the distribution of congeners by adjustment of the still.

So to increase the amount of the less volatile congeners at the spirit plate the expected answer was to remove less of the fusel oil fraction lower down the still (to simplify the explanation here, the adjustments are described in reverse order to the examination question). Some candidates correctly stated that it is theoretically possible to increase the amount of more volatile congeners by removing more of the fusel oil fraction, but the expected answer was to increase reflux by increased cooling of the top condenser. There were some excellent marks for this question, but unfortunately also two failures.

Question 6

Explain with respect to the chemistry and physical structure of the wood the process of "rejuvenation" by charring of oak casks for whisky maturation. [20]

This question concerned the rejuvenation of casks by scraping and recharring, and mainly required an explanation of the effect of heat on the structural components of the wood surface exposed by abrasion. Some introductory comment on the exhaustion of wood "virtue" during the previous maturation was necessary, and then reasonable detail was expected of the chemical changes to cellulose, lignin, hemicellulose and tannins (and other compounds as well, if possible) resulting from the heat treatment of re-charring. The Diploma syllabus does not involve advanced chemistry, but maturation is a topic where some chemical knowledge and familiarity with simple formulae are essential for a clear explanation (as also is metabolism, question 1). Although it was legitimate to discuss briefly the importance to the maturation process of the various products of heat-degradation, detailed information on subsequent chemical reactions during maturation was not required; that was last year's question on maturation. Almost all of the 11 answers gave good accounts of the maturation process, but not necessarily of the specific aspects required, so four failed.

Question 7

Discuss the origins of haze and floc in whisky and the methods for the control of these faults in the bottled product. [20]

For question 7, a full answer on the origin of haze in malt whisky was expected to begin with the spirit distillation: how much of the residual long-chain fatty acids and their esters should be removed in the foreshots fraction? In grain whisky, the origin could be traced back to mineral content of water for reduction before maturation. Although haze-forming compounds can be extracted from the cask during maturation, the bulk of the explanation of both haze and floc would deal with the organisation of reduction and chill-filtration at the packaging plant. The effects of rate of chilling and post-filtration warming, and rate of reduction and quality of reduction water on the development of visual faults, were important topics for discussion. Most of the 13 answers were of excellent quality, but two scored fail marks.

Question 8

Discuss Repeatability (r) and Reproducibility (R) of analytical data with reference to Difference Tests and Descriptive Tests, as applied to sensory assessment of new spirit and whisky. [20]

A good explanation of descriptive and difference tests for sensory assessment of new-make spirit and mature whisky would certainly score a pass mark, but question 8 was also concerned with the statistical reliability of these methods.

Of course it was necessary to define repeatability and reproducibility in the context of analyses in general, but reproducibility of sensory data between different sites would probably be important only occasionally (and then only for descriptive tests?) But in the context of the question some comment on standards of both repeatability and reproducibility, and both descriptive and difference tests, was expected. Although candidates may not have considered this aspect of sensory assessment before, some of the six answers dealt with it very well, but two failed. ■

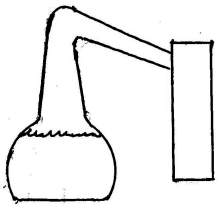
DIPLOMA IN DISTILLING EXAMINATION 2006

Module 3 – Process Technology

It is a pleasure to report 100% pass rate of the 14 candidates, and that 7 passed at grade A and 6 at grade B. Questions with calculations were more popular than I remember in the module 3 examinations of previous years, and even if part is wrong a calculation is a very effective way of gaining marks. However, it will be obvious from my comments on failure rates in individual questions that many candidates showed a wide variation in their marks.

Question 1

Although reflux is more easily changed by altering distillation rate, it is possible to increase reflux in the still shown below by structural changes. Sketch four changes which would, independently, increase reflux, and explain their effect. 4 x [5]



All but one candidate answered question 1, on increasing the reflux in a pot still. The four expected changes from the drawing on the examination paper were an upward-sloping lyne arm, installation of a purifier off the lyne arm, and as two separate changes, increased surface area of the swan neck and the shoulder of the pot. These were the choices in the majority of answers. Structural changes were requested: I did not regard reducing the volume of charge as a change to the structure of the still, but if exposing a larger area of still shoulder had not already been mentioned the appropriate marks were allowed.

Also, when candidates suggested two different changes of shape of the swan neck only one was accepted, but installation of a neck condenser and increase of neck surface area were regarded as different alterations. Sieve plates would have been an acceptable alternative to a neck condenser, but nobody thought of that one. All candidates provided a high standard of answer: Eleven were marked in the grade A range, and the other two were only slightly lower.

Question 2

Discuss the principles of operation, and the factors that influence the choice of one type of sensor for remote measurement of each of the following:

a) volume of spirit in a receiver vessel [10]

b) alcohol concentration in spirit distillate [10]

Considering the level of interest in electronic instrumentation in the distilling industry over recent years, it was surprising that question 2 was answered by only four candidates. However (quality, not quantity?), all provided good accounts of both types of instrument, explanations with drawings of how they work, and factors influencing their selection. Any appropriate equipment of candidates' experience would have been valid, but all chose to describe ultrasonic measurement of liquid depth and therefore volume, and a vibrating tube density meter recording alcohol concentration.

Question 3

With the aid of simple diagrams, describe two types of solid-liquid separation equipment which are suitable for separation of the grains from spent wash of continuous distillation. [20]

The more popular question 3 (10 answers) required a similar approach to explain equipment for clarification of spent wash. The bowl and decanter types of centrifuge are sufficiently different to be acceptable, and were competently described in most answers.

Since these units are difficult to draw, a basic sketch was all that could be expected, but the essential features of their operation had to be obvious. Some types of filter press also offer a possible separation system but for a good mark it was necessary to explain how the selected design was capable of handling the solids of spent wash and being easily cleaned afterwards.

Question 4

With the aid of a diagram, describe the circulation of liquid and vapour in a 2-column continuous still for grain whisky spirit. [12]

Describe also the procedures required for starting and closing down the still system. [8]

Since the first part of question 4 was marked on the basis of 6 marks each for the drawing and description of a continuous still, however carefully prepared the drawing might be, much more than arrows on the pipework was required to explain the liquid and vapour flows. Likewise, a poor quality drawing would detract from an otherwise perfect description. To simpify the layout of the question the actual breakdown of marks was not explained, but the phrase "with the aid of a diagram" should have been sufficient to indicate its importance.

Thus several candidates could have scored better marks than they actually did. Although details may vary between distilleries, the common principle of starting the still is to stabilise temperature and flow rate while running on water before changing to wash, and for closing down, to collect as much spirit (or, later, cold feints) as possible after the wash flow is replaced by water. Most candidates gave a satisfactory explanation of these procedures. A few were obviously unfamiliar with the practical details of start-up and close-down, but most of these individuals gave good descriptions and illustrations of the still system in continuous operation so, although one of the 13 candidates failed this question, there were some excellent marks.

Question 5

Explain the principles of heat transfer by radiation and indicate how it differs from both convection and conduction. [6]

Describe briefly two examples, taken from different stages of the process, of the importance of radiation in the distillery. Do not use heat loss from pipework, in the calculation below, as one of your examples. [6]

A 2m length of lagging has fallen off a 100 mm outside diameter steam pipe. Calculate the heat energy loss per hour from the unlagged section of the pipe. [8]

Temperature of pipe	**120°C**
Ambient temperature	**15°C**
Outside film heat transfer coefficient	**10 W $m^{-2}K^{-1}$**
Emissivity of pipe surface	**0.3**
Stefan-Boltzmann constant	**5.67 x 10^{-8} W $m^{-2}K^{-4}$**

Most answers to question 5 began well with their explanations of radiation, conduction and convection, but inevitably some were better than others; some of the best were in tabular form. The important distinction is that the electromagnetic radiation emitted from a hot object does not require a fluid or solid to transfer the energy. Obviously the high temperature of combustion in a boiler furnace creates radiation, and most candidates named the loss of energy from stills as another example of radiation in the distillery, which is true, even though at approximately 100°C the heat loss by convection is greater.

That should have been obvious from the calculation of heat loss from an unlagged steam pipe: 2381 kJh^{-1} by convection, but only 655 kJh^{-1} by radiation. Several calculations were wrong from the start: the surface area of a pipe is length $\times \pi \times$ diameter, not $\times$ $radius^2$. However, correct calculation from the wrong value of surface area received the normal marks for each subsequent stage if the working was clear. I mention this as an additional incentive for future candidates to show a clear and logical layout of their calculations. Sometimes it was not obvious what a string of figures was supposed to calculate, so I strongly suggest beginning each section of calculation by identifying its purpose, e.g. "Heat loss by convection = . . ." However, most of the 12 answers scored good marks and only one candidate failed.

Question 6

Calculate the energy theoretically available from cooling 5500 litres of low wines of 15.9% alcohol by weight (abw) collected throughout the distillation, based on an average spirit vapour temperature of 96°C, and cooled to 20°C. [10]

Specific heat of alcohol	**2.4 kJ $kg^{-1}K^{-1}$**
Specific heat of water	**4.2 kJ $kg^{-1}K^{-1}$**
Latent heat of condensation of alcohol	**837 kJ kg^{-1}**
Latent heat of condensation of water	**2260 kJ kg^{-1}**
Density of 15.9% abw	**0.9729 kg m^{-3}**

Discuss the general advantages and disadvantages of shell-and-tube and worm heat exchangers for condensing and cooling of distillate, including comments with respect to the above calculation. [10]

The calculation part of question 6 was not actually on the operation of a condenser, it was simply to calculate the total energy theoretically available from condensing the average alcoholic strength over a wash distillation and then cooling the distillate from 96° to 20°C. So when the mass of the low wines had been calculated and divided into the separate weights of pure alcohol and water, the energy yield from condensation and cooling of each could easily be determined. Unfortunately in many calculations these simple steps developed into a complicated, disorganised and (perhaps inevitably in the circumstances) incorrect mass of figures. Of course the theoretical value of 12474 MJ could never be recovered in practice, but an important aspect of the second part of the question was to compare shell-and-tube heat exchangers with worms with regard to how much of that theoretical energy they could extract for recycling. However, other factors also deserved brief mention, e.g. a comparison of sulphury flavours in the spirit, and maintenance requirements. All but one of the candidates attempted question 6 (attempted being quite an appropriate word for some scripts), but since no-one got both of the calculation and discussion seriously wrong, all 13 scored at least a pass mark.

Question 7

Discuss the advantages and disadvantages of wood, mild steel and stainless steel as materials of construction of distillery fermentation vessels. [20]

All 10 answers to question 7 provided competent essays on a comparison of wood, mild steel and stainless steel as materials of construction of distillery fermentation vessels, and discussing the practical advantages (of which wood has very few!) and disadvantages.

Question 8

With the aid of a drawing, describe the design and operation of a centrifugal pump, and discuss its value for two process liquids in a distillery. [12]

Calculate the power required to pump fuel oil, density 800 kg m^{-3}, at 2.5 kg s^{-1} from a vessel at atmospheric pressure to a pressurised tank at 3 bar g (3 x 10^5 N m^{-2}), 5 m above ground level.

The first vessel and pump are both at ground level. The frictional pressure drop is 0.05 bar g (0.05 $\times$ 10^5 N m^{-2}), gravitational acceleration = 9.81 m s^{-2}. Ignore kinetic energy of the oil flow. [8]

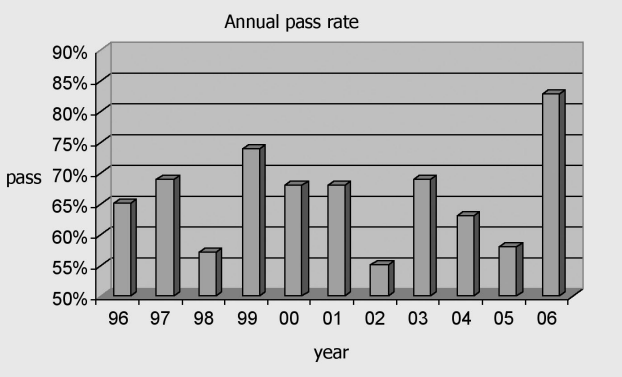
In this final question, it was an unfortunate decision not to provide an equation for calculating the power requirement of the pump. The reasoning was, what is the point in a calculation that simply involves entering the correct figures in the equation and then in the calculator? So, future candidates will benefit from memorising the basic chemical engineering equations. No-one obtained the correct value (763 Js^{-1}, or 0.76 kW), but several came close and the others scored the appropriate marks for the correct parts of their attempt. Incidentally, although some candidates realised their answer was ridiculously excessive for the relatively light duty described in the question, it was disappointing that many did not seem to notice. However, all nine candidates wrote, and drew in most cases, very good accounts of the operation of a centrifugal pump so all comfortably exceeded the pass mark. ■

Dr Iain Campbell

MASTER BREWER EXAMINATION 2006

Module 1 – Materials and Wort Production

There were 35 papers were returned; this is an increase on the previous two years. 29 (83%) candidates achieved a pass mark. This success rate should be compared with previous years' results, as shown in the chart below.



The general standard of papers this year was excellent and the pass rate is the highest recorded since the examination was introduced in modular format. This compares favourably with last year's dismal results.

There were a couple of good papers but as usual there was a cluster of candidates just on or above the pass mark. One of the candidates was re-sitting the exam having failed several times over in the last few years; his/her mentor must in future take a real interest in his/her progress and not recommend him/her to re-sit the exam until a genuine improvement is observed in his/her knowledge. 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.

In every annual report I have written for the Master Brewer module I exam and previously the Diploma Master Brewer module I exam, I have exhorted candidates to read each question carefully; the answers in this years scripts still displayed glaring errors, such as devoting the answer to question 4 entirely to protein-polyphenol hazes, when it asked about starch hazes. On a similar note one candidate passed the exam by a wide margin by just answering four questions instead of five; what would have been his/her final tally of marks if he/she had answered a fifth question to the same standard as the other four?

Question 1

Set out the principles involved in kilning malt, particularly describing how kilning conditions may be varied to produce different malt styles. Describe the production process of two speciality malt types and how they would be used in the brewery.

This question was attempted by 20 (57%) of candidates with only 9 (45%) achieving a pass. Despite being a relatively straightforward question it was not particularly well answered. Candidates should be aware that in an examination of this type they are required to do more than list the bald facts about a topic. They must be prepared to discuss the subject and elucidate their answers with information that can persuade the examiner that they really do understand the topic. In an essay answer this means introducing ideas and analyses that may be outside the strict interpretation of the question but are nonetheless relevant in the context. On the other hand it is important for candidates to read the question carefully: no marks are gained from describing the production process of roasted barley when the question specifically mentioned speciality malt types.

I know that very few brewing companies now have their own maltings. 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

List parameters that are in a specification for a lager malt. Describe typical values, with tolerances, and explain how they can be used to assess malt quality, indicating why they are important.

This question was attempted by 31 (89%) of candidates, with 25 (81%) achieving a pass mark. This was the most popular question of the paper and in general it was answered well. Candidates tended to limit themselves a very small list of specifications and thus did not give themselves the opportunity to gain extra marks by covering more parameters and to explain why they might not be used in a commercial contract with a maltster. Some aspects of a malt specification were poorly covered, such as barley variety and hand evaluation, other topics such as maltings' operational protocols such as gibberellic acid, bromate, sulphuring and abrasion were not mentioned in any of the answers.

Question 3

Hops and hop products used in the brewhouse may bring various flavour and aroma characteristics to different styles of beer. Describe the different ways hops and hop products are utilised to achieve this diversity and explain the significance of the different of hop varietals at your disposal.

This question was attempted by 26 (74%) of candidates with 19 (73%) achieving a pass mark. Though some were not very clued up on the production process for pelletisation and pre-isomerisation, this question was tackled well by many candidates. Few candidates had a good grasp of the significance of the different hop varieties and the typical flavours and aromas that may be introduced by late hopping or dry hopping. On the other hand the use of reduced hops for light strike protection and foam enhancement were well described.

Question 4

Explain the impact on quality of starch hazes in cold wort. Describe the likely causes, the investigations necessary and the corrective actions required to prevent the formation of such hazes.

This question was attempted by 17 (49%) of candidates with 11 (65%) achieving a pass mark. Many candidates seized the opportunity to describe best practice from malt purchase and milling to mash conversion and how faults at each stage might produce starch hazes in cold wort. Others gained fewer marks by restricting their answers to specific issues without addressing the broader picture.

Question 5

What are the key aspects of milling, conditioning, mashing-in and conversion of barley malt? Describe how to ensure process consistency for each of these operations.

This question was attempted by 25 (71%) of candidates with 17 (68%) achieving a pass mark. The general standard of answers was good with an admirable grasp of key aspects of these processes being demonstrated. Here the use of sketch diagrams helped to illustrate the better answers. Less well covered was the discussion of how to achieve process consistency for these operations.

Question 6

Describe a food safety and product quality audit of a brewhouse from malt intake to wort cooling. Which aspects of procedures and operations must be examined? Explain the significance of the factors you have chosen to highlight.

This question was attempted by 20 (57%) of candidates and 11 (55%) gaining a pass mark. Many candidates failed to understand the nature of this question, which was to describe a structured procedure for identifying how managers and operators are handling hazard and risk in the brewhouse. In addition to this candidates should have examined in a

logical order the operations in the brewhouse that require to be audited along with a discussion of pertinent hazards that might be reasonably expected to be uncovered. Extra marks could be picked up by describing systems, such as HACCP, quality policy, standard operating procedures and much else which are required to underpin the safe operations in a well managed brewhouse. In a poor answer, in place of the structured procedures and the pertinent examples, there was an unconnected catalogue of safety and product quality issues which candidates thought should be taken care of.

Question 7

Specify the cleaning regimes and procedures to be used in the brewhouse, from mill to trub separation device, including the plant and chemicals required. How should the effectiveness of these regimes be ensured, as well as the personal safety of operators?

This question was attempted by 22 (63%) of candidates with 13 (59%) obtaining a pass mark. Some candidates restricted themselves to simply describing a typical CIP system with caustic tank, rinse water tank and post-rinse recovery tank. This approach can only be the start of a good answer as each piece of equipment in the brewhouse has particular unique requirements, for example the heating surfaces in the kettle, and these should be discussed in some detail. Candidates had a better grasp for the need for operators to use personal protective equipment but few saw the need for standard operating procedures or equivalent, suitable training and training records.

Question 8

Describe how good brewing practice, for example brewing materials' costs, extract efficiencies, utilisation and other factors, can influence wort quality and financial performance.

This question was attempted by 13 (37%) of candidates with five (38%) gaining a pass mark. This was an unpopular question, which was not well answered. However it was an excellent opportunity for candidates to go through the brewhouse with one eye on quality and the other eye on cost and financial performance. Though many candidates recognised the inherent conflicts that this question raised few were able to explain how these conflicts may be resolved satisfactorily. Topics for discussion might have included malt specification and malt price underpinned by audits of the maltings, the quality implications of energy saving by reduction in kettle boil time, the use of pre-isomerised pellets or extract, etc. None of the answers really began to address these types of issues in a consistent and systematic fashion. ■

Dr Robert Illingworth

MASTER BREWER EXAMINATION 2006

Module 2 – Fermentation and Beer Processing

Scripts for marking were received from 26 candidates and 13 gained pass grades, a pass rate of 50%, which is a significantly poorer performance than last year. However it is pleasing to report that one candidate gained a pass at Grade A. There was also one pass at grade B. Other grades were six papers at grade C, five papers at grade D, six papers at grade E and seven papers at grade F.

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 bullet points. This approach allows a large amount of data to be presented within the time available. The highest scoring candidates consistently applied this approach. As per the usual examination structure candidates were asked to attempt five out of the eight questions set. Three candidates only attempted four questions, which generally makes it difficult to pass.

Question 1

Stating relevant assumptions, describe the design and layout of a fermentation tank farm suitable for the production of 2 million hl of lager beer per year. Briefly describe the associated plant and equipment required to service this facility.

Nine candidates attempted this question with eight passing (89%). There was one very good answer.

The purpose of the first part of the question worth 14 (70%) of the marks was to allow candidates to describe a typical fermentation tank farm in terms of design and layout of vessels, together with associated services such as product, CIP and pitching mains etc. By stating relevant assumptions, they could then demonstrate their knowledge of the factors that determine the overall productivity of a fermentation tank farm, and use typical values to make a proposal on sensible numbers of vessels and sizes required to meet the stated production capacity. Factors that should have been considered included shift patterns, downtime per vessel turn (e.g. maintenance, CIP), seasonality, vessel filling rate %, use of high gravity brewing and fermentation process time etc.

The second part of the question worth 6 (30%) of the marks invited candidates to provide brief details of other required equipment such as CIP, and yeast propagation, storage and pitching and beer recovery equipment.

The best answers made appropriate assumptions and then used these to derive a realistic proposal in terms of size and number of tanks etc., together with notes on the ancillary equipment. Less effective attempts just made a statement of the number of vessels and sizes with no justification attempted.

Question 2

Review the range of additives and processing aids available for use in the fermentation and beer processing areas of a brewery producing a range of lagers and ales. Discuss the purpose of each and comment on appropriate storage conditions.

19 candidates attempted this question with 12 passing (63%). There was one quite good answer.

This was a single part question. The use of a table or bullet points was the most economical means of providing the range of information required within the time available.

Using either technique, the candidate could then have named each additive or processing aid and gone on to describe the nature and purpose of the product, the preparation required and how it is used in the process (e.g. how and where added, typical rates etc).

Preparations that could have been discussed amongst others included antifoams, enzymes, foam stabilizers, priming sugars, colours, clarifying agents, hop preparations, anti-oxidants and stabilizers. Relevant storage conditions depended on the nature of the product but were generally in terms of segregation, temperature, dryness, ease of cleaning etc.

The best answers used a table to list each ingredient, state the purpose, point of application and usage rate. They also included recom-

mendations on appropriate storage conditions or aspects of design E.g. to achieve easy cleaning in a powder handling area, or appropriate storage temperature for liquid isinglass finings. The weakest answers just mentioned a few materials with little of the required supporting information.

Question 3

Starting at the laboratory stage, describe a yeast propagation process appropriate to achieve sufficient yeast to pitch 1000 hl of lager or ale wort. Describe routine procedures used to ensure a consistent supply of high quality pitching yeast for all fermentations.

19 candidates attempted this question with 14 passing (74%). There were two excellent answers and several other good attempts.

This was a two part question. The first part attracting 12 (60%) of the marks invited candidates to describe a yeast propagation process usually starting with a laboratory slope and finishing with sufficient volume/cell count to pitch 1000 hl of wort. Conditions to discuss included type of media or wort specifications, the need for sterility, types of vessel and sizes, volumes and top up volumes and ratios, temperatures, times, use of stirring or aeration, yeast cell count, wort gravity etc.

The second part of the question worth 8 (40%) of the marks was more general. Areas to discuss were about conditions of yeast storage and handling, such as temperature and time, sterilisation of storage tanks, mains and air mains, together with typical microbiological analyses used to determine the routine quality of pitching yeast.

The best answer used a full page flow diagram and supporting text to demonstrate the process through laboratory and industrial propagation to first generation brew. The diagram included sketches of the vessel type at each stage and all of the critical process conditions. The second part of the question was also comprehensively covered by this candidate who described conditions of yeast storage, yeast generations, cleaning and sterilizing, acid washing and microbiological analyses. Weaker answers were usually characterized by a lack of detail and unrealistic dilutions during scaling up.

Question 4

Using a format suitable for inclusion in a quality management system, describe process instructions for the fermentation and beer processing stages of the production of a 5% ABV lager beer. Include in your answer a statement of the in-process specifications for product in:
Fermenter, at the end of fermentation
AND Bright beer tank.

Thirteen candidates attempted this question with eight passing (62%). There were two very good answers.

This question was ideally suited for layout as a table in the format that many breweries use for quality management documentation. E.g. process step, unit, target value and range. The first part of the answer worth 14 (70%) of the marks, should have covered the process from wort collection through to bright beer tank with a description of the critical parameters at each stage. e.g. Fermentation temperature, cold ageing time, dissolved oxygen etc. The second part of the answer worth 3 marks (15%) should have listed the typical green beer in-process specifications at the end of fermentation (e.g. Original gravity, present gravity, pH, colour, diacetyl etc.) along with a typical target value and appropriate range. The third part for 3 (15%) of the marks required a similar list of in-process specifications for product in bright beer tank which should have included some of the above parameters along with others such as dissolved oxygen, carbon dioxide and haze.

Good answers used the process step, unit, target value and range approach to make a process description from cold wort to bright beer tank, and then went on to list typical values for process specifications for product in fermentation vessel and bright beer tank. Poor answers just mentioned a few parameters such as temperature without stating actual values, and then went on to list a few beer specifications, but again without any values.

Question 5

Prepare a comprehensive proposal of fast track and longer term practical measures that can 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 may be assessed.

Ten candidates attempted this question with six passing (60%). There were two very good answers.

The first part of the question was worth 16 (80%) 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 that hose 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.

The second part of the question was worth 4 (20%) of the marks. There are various measures that can be used to assess the improvement made. These could include beer losses, water usage ratio, utilities usage/hl, carbon dioxide recovery rate, COD or BOD of effluents.

The best answers used a table to present detailed proposals in a format which could well have been the output of group tasked with making a genuine proposal to their brewery manager. For the second part they suggested relevant KPIs such as water ratio or electricity usage per hectolitre.

Question 6

A brewery is currently producing a premium 5% ABV lager brand using a high gravity brewing process based on a brewed original gravity of 1060° (14.7Pl). Due to significant volume growth there is a requirement to extend the fermentation and processing capacity by raising the brewed original gravity to 1072° (17.5Pl) and shortening the total process time from fermentation vessel to bright beer from 17 days to 14 days. Describe in full the protocol that would be carried out to ensure an effective implementation of the new process, including ensuring that the change is not discernible by the consumer.

15 candidates attempted this question with six passing (40%). There were no good answers.

This was a single part question. The purpose of the question was to test candidates knowledge of the factors that determine overall process time, and to suggest how a combination of these factors could be manipulated to achieve the required intensified process conditions. At the same time transparency to the consumer in terms of product quality and consistency had to be assured.

The answer could usefully have consisted of a written description or chart to illustrate a process achieving the required 14 day time line. The main processes to consider were fermentation, cooling and cold ageing time. The discussion should then have gone on to propose the factors that might be adjusted to speed up the process such as pitching rate, wort aeration, fermentation temperature, use of yeast foods, diacetyl reduction time, the use of chillers and centrifuges and cold ageing time. At the same time comments were required on the effect of varying various parameters on flavour development.

Having discussed the factors involved and proposed a process, the candidate should then have gone on to describe a suitable trial pro-

gramme. Factors to consider were the number of trials, the parameters to be monitored and the analyses required at each stage. For example rate of attenuation, peak yeast cell count and diacetyl reduction profile, together with other effects such as % losses and beer filterability. Product analyses might have additionally focused on ester and higher alcohol analysis and haze stability.

In terms of ensuring transparency to the consumer, this required comments on suitable sensory tests perhaps including a market hall test. A blending programme of old to new process might have been proposed as an additional precaution.

No candidate got close to addressing the full scope of the question. In particular there was a disappointing lack of knowledge on the trial design required to evaluate the effect of such process changes.

Question 7

Describe in detail the design and operation of one type of filter suitable for the clarification of green beer.

22 candidates attempted this question with 13 passing (59%). There was one excellent answer and several other good attempts

This was a single part question. Candidates were invited to nominate a single type of filter and describe its design and how it is routinely operated. Answers based on one of plate and frame, candle, leaf or cross flow filters were expected. No credit was given to candidates who described separation devices which can be used as an alternative to filtration.

The design of the filter was most easily presented in the form of a labelled diagram with accompanying notes. Whichever filter was selected this layout could then be used to describe its configuration of inlets and outlets, the filtration mechanism whether sheets, screens, candles or cross flow modules, the position of filter aid beds (where used) and the flow of filtered and unfiltered beer, and the mechanism for discharge of spent yeast and filter aid at the end of the filtration cycle.

The operation of the filter should have described processes of sterilization, deaeration, precoating and body feed dosing including typical rates, product temperatures, flow rates and dissolved oxygen levels, handling of interfaces and process of filter regeneration.

The best answer opened with a labelled diagram of a candle filter showing the components and the flow of unfiltered and bright product, including a separate sketch of an individual candle element. This was followed by a full page flowsheet showing the associated equipment, buffer tanks, kieselguhr dosing, dilution etc. Finally the candidate used bullet points to describe sterilization of the filter, deaeration, precoating, filtration and bodyfeed doing and discharge of filter aid at the end of the filtration cycle.

Poor quality answers simply failed to cover the design and operation adequately, particularly in terms of the critical parameters such as temperature, time, dosing rate, flow rate etc.

Question 8

Describe in detail the housekeeping, cleaning and sterilisation procedures that should be used to ensure product quality and personal safety of operators in the fermentation and beer processing areas of a brewery. Discuss how the effectiveness of these procedures can be evaluated.

20 candidates attempted this question with ten passing (50%). There were no very good answers.

This was a two part question. The first part was worth 14 (70%) of the marks.

The purpose of this question was to allow candidates to display their practical knowledge of the hygiene procedures used in fermentation and beer processing. Discussion of housekeeping should have described the tasks that are routinely carried out and the equipment required for activities such as environmental cleaning of fermentation halls and powder handling areas, storage of chemicals and additives etc. On cleaning and sterilizing, the vessels, mains and ancillary equipment to be cleaned or sterilized in each area should have been discussed (e.g. beer transfer mains, yeast pitching mains and bright beer tanks), together with appropriate cleaning or sterilizing conditions such as type of chemical, concentration, time, temperature, frequency. In terms of management control the use of formal systems such as ISO9001, HACCP and COSSH was also relevant.

The second part of the question was worth 6 (30%) of the marks. The effectiveness of these procedures can be assessed through various techniques such as periodic visual

inspection of vessels after CIP, microbiological tests of plant and product at various stages, and reviews such as quality callovers, housekeeping and environmental audits, hazard and accident reporting.

Generally candidates only covered part of the scope of the question. ■

John Shardlow

MASTER BREWER EXAMINATION 2006

Module 3 – Packaging and Beer Dispense

In 2006, 22 papers were received of which 13 (59%) achieved the pass standard. This represents a slight improvement on last year's percentage. Pass marks were seen at grades A, B, C and D.

It is pleasing to note that the overall standard improved further this year and that a pass a grade A was seen for the first time in recent years. As with last year there were some excellent answers submitted for some of the questions.

The best candidates were able to clearly demonstrate their knowledge and experience across a range of topics. As in previous years, the ability to add enhancements by quoting process and quantitative detail added extra marks to a basic answer.

Examination technique continued to improve with very little evidence of candidates running out of time through poor planning.

Those failing to meet the required standard failed to demonstrate familiarity with the plant or the process. Depth of knowledge and experience could only be demonstrated, at most in one or two areas.

Question 1

Design and state the expected staffing levels for a bottling line to produce the following volume in non-returnable glass:

250 000 hl of 250 ml bottles,
500 000 hl of 330 ml bottles and
100 000 hl of 500 ml bottles.

The line should have the capability for both wet glue and self-adhesive label application and the option to pack into both tray and shrinkfilm and corrugated cases.

Draw a diagram showing the design and justify the choice of equipment, machine throughput and manning levels.

This was the third least popular question with 11 (50%) of candidates answering. It was worst answered with only two (18%) reaching the pass standard.

Line design and sizing remains a part of the syllabus which is not well covered by candidates. Good answers could clearly identify the required plant and size it suitably for the required output with sensible assumptions of operating time and machine efficiencies. Poorer answers included wrong calculations or started with a shift pattern to drive the sizing which became unrealistic. Non-feasible plant capabilities were not recognised in poor answers. The plant layout and its implications for manning are understood at a superficial level but many answers just marked manning positions on the diagram with no explanation of the tasks to be carried out.

Question 2

Describe the impact of an increase in energy costs of 25% on the budget of a packaging plant producing bottled or canned beer. Assume that the increase applies to the entire supply chain.

Detail changes that could be made to moderate the impact of this increase.

State any assumptions made regarding capital and revenue expenditure.

This was the least popular question with only seven (32%) candidates answering. It was poorly answered by those attempting and only two (29%) achieved the pass mark with no high scoring answers being submitted.

The part of the question which asked about the whole supply chain was ignored in most of the poorer answers. Most candidates wrote about the direct impact on utilities but few noted the impact on incoming packaging materials (where a feel for the energy and transport contribution to price would score very well). Similarly the changes to be made part of the question was often ignored or answered superficially. Better answers would have included the sorts of capital expenditure which might now be justified against the new cost scenario.

Question 3

Detail and justify a minimum sample plan suitable to assure product integrity in bottle or canned products.

Explain what changes would be needed to the sampling plan in response to an increase in flavour complaints.

How would this new data be used to aid appropriate corrective action and allow a return to the original sampling plan?

This was a moderately popular question with 14 (64%) candidates answering. It was the question which had the second best rate of candidates achieving the pass standard with 10 (71%) passes including two at 'A' grade.

A good answer to this question included a range of analyses with frequencies and special circumstances when samples should be taken. Sampling frequencies from hourly to monthly could be justified by the risk to product integrity. Poorer answers merely gave a basic list of analyses. Good answers then detailed the sorts of flavour complaints which might be experienced, explained which analyses would be relevant to the complaint and discussed how the issue could be brought under control allowing (where appropriate) a return to a minimum schedule. Poorer answers did not link complaints to the process or to a suitable analysis.

Question 4

For a keg or cask packaging plant, describe the process of carrying out a HACCP assessment to cover risks to both product safety and quality.

Make a list of critical control points in the plant, starting with beer in racking tank or bright beer tank and finishing with transfer to warehouse.

For each critical control point, describe how risk is minimized

This was the most popular question with 19 (86%) of the candidates answering of whom eight (42%) achieved a pass.

Good answers dealt with the whole question asked. Most candidates were able to describe a HACCP style approach to risk management but poorer submissions did not then go on to relate this to the packaging plant or gave inappropriate examples. Similarly risk minimisation was either not discussed or wrongly attributed in these answers. Better candidates were able to give good examples of CCP's and practical steps to minimise risk.

Question 5

For a new beer to be packaged in either can or bottle, describe the factors that need to be considered when setting a tunnel pasteuriser PU specification.

How do line and pasteuriser design, control philosophy and operating performance impact on the attainment of pasteurisation specifications and environmental impact?

This was another moderately popular question which was attempted by 15 (68%) candidates. The question was generally poorly answered question with six (40%) candidates achieving a pass, though two very good passes were submitted.

Good answers to this question included a range of factors to consider which included plant and process capability as well as beer characteristics. A poorer answer then did not describe adequately the impact of design, performance or control philosophy on PU or environmental impact. Good answers, however not only described how different pasteuriser design impacted on PU attainment, but could also describe the interplay of water consumption and PU as performance deteriorates.

Question 6

Describe, with the aid of a diagram, a typical installation for the dispense of draught beer from a keg or from a cask.

For each of the following trade complaints, describe how the cause of the fault could be determined and suggest possible corrective actions:

Poor head formation
Hazy beer
Fobbing beer
Off-flavours.

This was the equal second most popular question with 17 (77%) of candidates attempting the question of whom 14 (82%) achieved the pass standard, including two excellent submissions, making it the best answered question.

To achieve the best marks in this question a clear diagram showing a full system from gas to tap with provision for cleaning was required. The purpose of the various pieces of equipment on the line and in the tap and a feel for temperatures and pressures was also required. For each of the trade complaints it was possible to give at least three possible causes and describe how they might be remedied in the short and longer term. Poorer answers did not give full descriptions of the dispense system and gave few examples for the complaints.

Question 7

Detail and justify a product specification for a keg or cask beer.

Describe how the operation of the packaging plant ensures that this specification is achieved.

List practices that can be used to minimise beer loss in this type of plant.

Describe the impact these practices can have on the achievement of in-specification product.

This was the second least popular question with 10 (45%) candidates answering of whom 5 (50%) achieved the pass standard.

To score well a specification for parameters measured and controlled in packaging with suitable ranges was required. The impact of plant operating philosophy (to maintain or change) on the control of these parameters would then be described. The potential conflict between procedures to minimise beer loss and the maintenance of product quality then needed to be discussed in detail. A poorer answer either did not gives examples of beer loss minimisation or did not explain the impact of such procedures as fob recovery and reinjection on product quality.

Question 8

For either can filling and seaming or bottle filling and closing, describe how filler and closer design can impact on product quality.

What are the process controls that assure the plant is operating correctly and product quality is maintained?

This was the equal second most popular question with 17 (77%) of candidates attempting the question of whom seven (41%) achieved the pass standard, including two excellent submissions, making it the second best answered question.

The difference between a better or poorer answer to this question is very much in the level of detail and breadth of response. There are several aspects of product quality affected by these plant items. Poorer answers focussed solely on oxygen control and this was described to various degrees. It followed then that the relevant process controls to ensure the plant is delivering its design capability were limited in answers which scored badly. Conversely full answers described sensible checks and frequencies to assure quality is being maintained. ■

Dr Jon Brown

MASTER BREWER EXAMINATION 2006

Module 4 – Central Functions

Overall, 15 papers were marked and 11 were passed (73.33%), a slightly higher result than in 2005 although numbers sitting the exam were lower. Most subjects were answered satisfactorily but again the maintenance question showed candidates lack of real involvement or interest. The questions on air compressors and electrical distribution were straight forward but largely avoided by most candidates which if studied for, could have provided some good marks. Project Management and Finance were answered well but the challenge remains for candidates at this level to achieve a greater exposure and understanding of Engineering topics.

Question 1

With the aid of a diagram, describe the main components of a brewery's refrigeration system from generation to point of use.

How could energy consumption for generation and distribution be minimised and how could the efficiency of the system be assessed?

Consider a primary and a secondary refrigerant. Describe the safety risks for each and how those risks can be minimised for plant, product and people.

Attempted by 12 candidates, 8 passed (67%)

Overall the main elements of Refrigeration systems were understood but lacked detail.

Most candidates produced a diagram showing the major components and several understood the pressures and temperatures involved.

Safety systems were well understood in terms of refrigerant properties but less so in terms of action following a potential leakage or site plans and isolations.

Most candidates identified Coefficient of Performance (COP) and several identified the importance of good insulation. The better candidates discussed the use of Variable Speed Drives and the importance of good sequence control.

Question 2

Describe the use of Carbon Dioxide in three brewery or packaging processes.

What factors would determine whether it is economically viable to collect CO_2 from Fermentation Vessels, subsequent process and packaging operations?

Which gases could be used for pressurising cold storage, bright and sterile beer tanks? What are the implications for cleaning systems and tank management?

Attempted by ten candidates, all ten passed (100%)

This question was the best answered as might be expected in a brewing exam. Most candidates fully understood the effect of choice of gas on cleaning systems and the need to exclude oxygen from the product.

The better candidates were able to discuss the economics of CO_2 collection but not in great detail.

Question 3

Describe two types of air compressor and discuss their relative merits.

How could compressor start up/shut downs be minimised to meet demand?

Describe four uses of compressed air in a brewing and packaging plant, indicating the pressure and quality necessary for each.

Attempted by six candidates, four passed (67%)

It was disappointing to see a straightforward question on an important subject attempted by so few candidates. The types of compressor were well understood and some good diagrams produced but the application in the brewery showed a lack of experience. Pressures and air cleanliness were correctly emphasised but the control of start ups and demand management were not clearly demonstrated.

Question 4

Describe four ways of calculating a justification for a profit earning or cost saving Capital Project.

Describe four other justifiable reasons for capital expenditure, giving a detailed example of one.

For a non-profit earning project what are the potential effects on the brewery's revenue expenditure?

Attempted by 11 candidates, ten passed (91%)

As last year, many candidates had clearly been involved in project management and various methods of justification were well understood. There was wide knowledge of justifications other than profit earning, mostly identifying legal or environmental considerations. Less clearly understood were the effects of spending non profit earning CAPEX on the brewery's revenue budgets. Training costs were identified but effects on maintenance, updating related plant and documentation were not discussed.

Question 5

With the aid of a simple block diagram, describe the electricity distribution network of a typical large brewery. Show the voltages at the various stages of the network.

Assuming plant items are energy efficient, how could the site's consumption and electrical capacity requirement be minimised.

Produce a two-column table describing the main areas of electricity use and express each one as a percentage of the total.

Attempted by four candidates, passed by three (75%)

For such an important aspect of brewery management it was disappointing to see so many candidates avoid this question. Those who did answer produced reasonable diagrams although there were some mistakes on the voltages in use. Most candidates identified that refrigeration was the largest consumer of electricity but there were some poor answers to this section. Power Factor correction was not identified as a way of minimising overall site capacity requirement and candidates mostly presented a number of energy efficiency measures which were not asked for.

Question 6

Describe appropriate maintenance strategies for brewing, process and packaging plant.

Specify appropriate performance measures to assess the efficiency of the maintenance strategy in each area, giving examples of typical values.

Attempted by ten candidates, passed by three (30%).

This was the least well answered question by a large margin. There were some theoretical answers on RCM and TPM but no real discussion on the appropriate strategy best used for different parts of the brewery. 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.

Some candidates mentioned OEE as a measurement of performance but none looked at the financial or job related data available from a computerised system.

Question 7

A brewery is capable of three brews per day but often finds there would be no fermenting vessel available and brews are cancelled. What are the likely causes and what steps could be taken to ensure the brewery can achieve its brewing capacity if required.

If several final product types are derived from mother brews, how could traceability be ensured through each stage of the process?

Attempted by 13 candidates, passed by 8 (62%)

This was the most frequently attempted question with a wide spread of answers. Most answers identified slow fermentations and some identified poor downstream efficiencies as the most likely cause of a shortage of fermentation capacity.

Answers included capital expenditure and investigations into slow fermentations and the better candidates discussed a systematic approach to the wider implications.

There were some good practical answers to verifying traceability and Quality Systems featured several times.

Question 8

For a brewery producing 500,000 hl per year (50% in keg and 50% in bottle), what departmental budgets would be necessary to provide adequate cost control, stating what items should be included in each. For each cost item, specify which costs could be considered fixed and which would be variable, giving reasons.

What type and frequency of reporting would be essential to give Departmental Managers enough information to evaluate variances that might occur?

Attempted by nine candidates, passed by six (67%)

Compared to 2005, this finance question proved more popular and more comprehensively answered. The better candidates produced a table that identified fixed and variable costs within an acceptable range of understanding. There were variable answers on what should be included in the budget headings but materials, labour and utilities were well covered.

Reporting for management control mostly followed the usual monthly pattern. Candidates did not refer to broader definitions of cost per hectolitre or broken down by department to identify where major costs were attributed. ■

Ian Bearpark

MASTER BREWER EXAMINATION 2006

Module 5 – Case Study

This year 22 candidates sat the paper and 14 passed (64%),which is a pleasing improvement over last year (53%). 19 candidates chose question 1 and 11 of those achieved a pass, three candidates chose question 2 and all of them achieved a pass.

This year again showed a wide range grades including some very high quality and a few who found the questions too challenging but overall the standard has improved significantly over last year and that is excellent to see.

Questi**on 1**

Stating assumptions and clearly illustrating any calculations, detail the type and size of equipment required in a 1million hl. brewery for brewing, fermentation, maturation, filtration, bright beer, packaging and warehouse.
It is expected that 50% of the output is in bottle, 50% in keg and 20 Stock Keeping Units (SKUs) will be produced from four different branded liquids.

This is a question with a large subject area and a lot to get through in the time available so it was advantageous for candidates to do a clear answer plan first then focus on time management to maximize the opportunity to gain marks. The question clearly identified certain areas of the brewery and to be able to access all of the marks, each of these areas needed to be considered in even depth.

In the assumptions, the question looked for an analysis of the product types and for completion a summary of the expected shift and working week structures considered.

The first detail expected was a definition of the liquids (beers) to be produced and to work back from the volumes to be packaged to the volume brewed, it was not considered as a reasonable assumption that the four different branded beers could be sourced from one high gravity brew. From this the materials recipes were calculated and the assumptions for high gravity brewing to form a foundation for plant size and performance calculation and definition.

Most candidates who passed were very thorough in the volume and recipe calculations showing an excellent understanding of losses, pinch points and the proportion of materials in grists. Some who failed in this area had over simplified or used a recipe with which they were unfamiliar making mathematical errors more likely.

Provision of services such as steam, water and refrigeration were often forgotten and whilst they only represented 10% of the marks they are key to operating a brewery and were recognized as such by the better candidates.

Use of tables and flow diagrams were helpful in answering this question as they added structure and time management tools for the candidates. Added to these, illustrations of practical experience and knowledge, such as allowing extra vessels or silos for flexible utilization, emptying and refilling, gained marks. Working back from packaging in the script also seemed to help candidates better manage their time allocation. Those who spent the time on packaging covered principles such as the "V" graph well and found keeping units of volume and measure consistent also helped avoid simple errors. Few candidates were however able to cover what is required in warehousing with the question requiring information on size for storage time and production frequency, mix of SKUs and palletisation.

Question 2

Name and describe the principles of two accredited management systems which can be used to assure safe and consistent production of branded beers from raw materials to the consumer.
Using those systems describe and quantify the cost of implementation and supporting them in a commercial brewery producing branded beers in both small pack (bottle or can) and large pack (keg or cask).

This was only attempted by three candidates but each of them illustrated good knowledge of the ISO and HACCP systems anticipated by the question, they all appeared to have read the question carefully and passed.

Marks were awarded for illustration of both a practical and academic knowledge of the systems, how they could be used and applied, as well as the likely cost of implementation. ■

James Robertson

GENERAL CERTIFICATE IN BREWING AND GENERAL CERTIFICATE IN PACKAGING

There were 118 candidates for the General Certificate in Brewing and General Certificate in Packaging from 23 centres in 7 countries. These new examinations, which have replaced the General Certificate in Brewing and Packaging (GCBP), have also newly adopted a multiple choice question format.

General comments

Before discussing the examination results it is appropriate to respond to the helpful comments received from examination centres. Firstly, and prominently, the examiners wish to apologise for the three typographical errors which must have disconcerted candidates in the already stressful circumstance of an examination. The most serious error was on the GCP paper in the data for a packaging loss calculation. A digit was missing from the yield figure given as 687 boxes; the figure should have been shown as 6187. The question was thus unanswerably flawed and disregarded for marking. Another calculation question, in the GCB paper, had misleading character and spacing errors. In the data for a pitching volume calculation the pitching rate was given as 0.61/l instead of 0.6 l/hl.

Following a complaint from an Australian centre that the question was unanswerable the decision was taken to discount the question (though 43% of the candidates answered the question correctly, some even correcting the error on their paper); thus both the GCB and the GCP were marked out of 59 rather than 60 questions. A decision has also been taken by the Examinations Board to use the word litre in full in future examinations at this level to avoid any misreading of even the correct character. The third error occurred on the packaging paper in a question requiring the identification of a process stage in a flow diagram of a plate heat exchanger pasteuriser.

The words heat exchanger were missing. However the diagram itself was unmistakably identifiable as a pasteuriser (to those with sufficient knowledge to attempt the question), and a correct answer was given by 60% of the candidates. Interestingly, the most successful group of candidates with this question were those taking the kegging option – their success rate was 80%.

These regrettable errors occurred as a result of a last-minute change from the intended electronically delivered examination to a paper version. In delaying the decision to abandon the on-line system for this year, to give time for the GOLA downloading issues to be resolved, an assumption was made that the question files prepared for GOLA, which had been subject to very thorough editorial scrutiny, could be directly transferred into MS Word for printing. This proved impracticable so the questions were retyped completely, but the postal despatch deadlines left no time to convene the usual 'round-table' proof reading by the GCB&P team. The examiners apologise unreservedly to the candidates for the difficulties created for them.

A number of people have pointed out that there were differences between terminology used in the examination questions and the Workbooks. Editing of the Workbooks and/or the questions is now in hand to remove these inconsistencies and others such as for some value ranges. On the topic of value ranges it should be noted that the values used in IBD examinations literature must, somehow, reflect those of a world-wide industry. Such values will always be described as typical. If individual breweries operate outside the ranges, e.g. for an accelerated fermentation, candidates should be made aware of the fact. However, value ranges in the Workbooks are kept under review to ensure that current practices are represented.

Some response is necessary to those who have commented that a number of the questions presented four 'right' answers as the choices. Whilst questions should have one indisputable key (right answer) and three credible distractors (wrong answers), it is also essential that the paper as a whole has questions with a range of difficulties. One technique to achieve a more difficult question is to test the candidates' knowledge of the relative importance of a series of facts in a given context. A question may begin 'What is the main reason why…?' Or, 'What is the most important effect of…?' The answer choices will present four valid reasons or effects, but one of these will be an overriding consideration. It is not sufficient for a candidate to learn by rote a list of reasons or consequences – there must also be an understanding of their relative significance in the process in question.

Statistical data

The General Certificate in Brewing

There are two options for this qualification, Brewing for Chilled and Filtered Beer (C&F) and Brewing for Cask (Cask). As only six questions are different on the papers (at this stage in the development of the examination) the following remarks apply to the whole candidate field. A total of 81 candidates (61 C&F, 20 Cask) were examined. The pass rate was 46%. This result is disappointing and is discussed further in the conclusion to this report. The performance of candidates in the various subjects is shown in Figure 1. The chart shows the success rate for answering the questions relating to each of the syllabus sections common to both the C&F and Cask options. The value shown is an average of the percentages of correct answers for all of the questions relating to a section. No weighting adjustment is made (some sections contain more questions than others) but the result is a useful indicator of the level of knowledge within the candidate group for each topic. It can be seen that, whilst such topics as general knowledge, cleaning materials and flavour assessment were well answered, there were subjects for which the performance rating was too low for there to be a satisfactory pass rate.

Figure 1 GC Brewing performance ratings

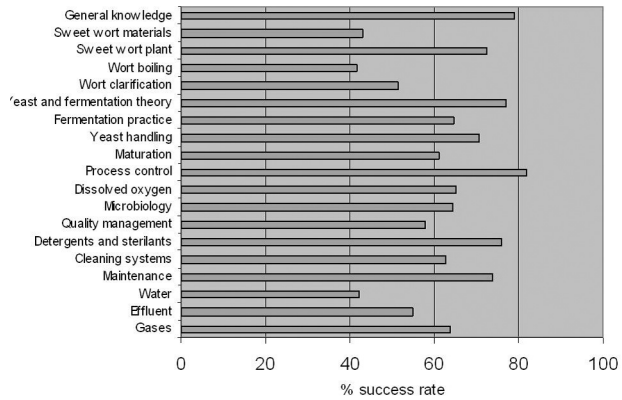
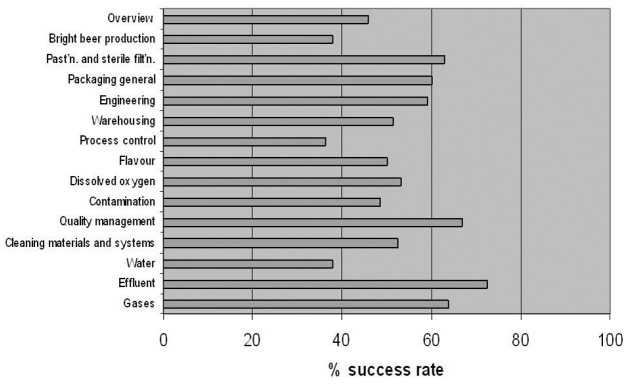


Figure 2 GC Packaging performance ratings



For their specialist subjects of stabilisation and filtration the C&F candidates scored a pleasing 79% and 73% respectively. The Cask group, however, performed badly, scoring only 46% and 43% respectively for beer maturation, and cask beer preparation, clarification and cask conditioning.

The General Certificate in Beer Packaging

There are four options for the GCP: Kegging, Canning, Returnable and Non-returnable bottling. Similarly to the GCB commentary, these remarks refer firstly to the common topics. A total of 37 candidates sat

Table 1

Candidate group	Specialisms performance rating %	Packaging general performance rating %
Kegging	81.7	58.1
Canning	61.9	60.7
Bottling	55.0	68.3

the four options, the biggest single group being those who chose Kegging (20 candidates). The pass rate was 24%, an extremely low figure discussed in the conclusion to this report. The performance indicators for the individual syllabus areas are shown in Figure 2.

Comparison of the profile in Figures 1 and 2 illustrates the reason for the lower pass rate for the GCP. In the GCP, only 6 of the 15 common syllabus areas showed a performance rating of significantly more than 60%. In particular, the lack of knowledge about bright beer production and process control should be a matter of concern. For the specialist packaging section (6 questions) the performance rating for the Kegging group far exceeded that of the Canning and Bottling (RB+NRB) candidates as shown in Table 1, which also compares the specialist section performance with that of the general packaging section.

The relative complexity of small-packaging installations may explain the apparently more rounded knowledge amongst candidates from these areas. But the significantly better performance of the Kegging candidates suggests that the examination will be made fairer and more relevant to the workplace if the specialist sections are enlarged to replace some of the general topics. It is the intention of the examiners to do this at an appropriate time.

Conclusion

The combined entry (118 candidates) for these new examinations, also advertised as to be delivered electronically via the Internet for the first time, was understandably low. However, the poor overall pass rate (34%) was lower than anticipated. The advice from City and Guilds is that, in their experience, the switch from short answer or essay type questions to multiple choice format by an institution usually results in an initially depressed pass rate. The reason often cited is the breadth of coverage of the syllabus that the change brings about. A possible explanation for the IBD's experience is that candidates who might not have been willing to sit the GCBP short answer examination may have perceived the multiple choice format as an easier option, but failed to adequately prepare for what are thorough tests of brewing and packaging knowledge. The division of the GCBP into discrete brewing and packaging qualifications has allowed a more detailed treatment of the two disciplines. This is important; in order to maintain the standard for the new awards, it is necessary to replace the wider GCBP syllabus with ones that compensate loss of subject breadth with subject depth. Therein lay the problem for the majority of candidates.

Chris Hughes

Footnote

The performance rating data shown in this report is available by centre for centres presenting five or more candidates for a given paper. There is a small administration charge for this service. Note that information for statistically small groups or individual candidates cannot be released. Details are obtainable from the Examinations Administrator of the IBD. ■

GENERAL CERTIFICATE IN DISTILLING

Only 58 candidates attempted the GCD examination of 2006, a substantial decrease from previous years. Although 14 failed, that is fewer than in 2004 and 2005, even when expressed as a percentage (24%) of the smaller number of candidates.

Only one candidate achieved Distinction, but 29% (17 candidates) qualified for City & Guilds Credit grade, a similar percentage to these two previous years, and in fact slightly better than in 2005. The average of the final marks was 63.8%: exactly the same as in 2004, and a commendable improvement on the 59.2% of 2005. As usual, the averages of the marks scored in the two papers were similar: 62.5% in paper 1 and 64.2% in paper 2.

Simultaneously with this year's GCD, 8 candidates in South Africa sat the inaugural examination of the new International GCD syllabus. Two passed at grade C and 4 at grade D, but 2 failed. Questions included options on brandy and rum, as well as the established gin/neutral spirit/vodka/whisky options of the standard GCD examination. Otherwise, most questions were the same in both the standard and international examination papers, although not in the same order. The average marks in the International examination (54% in paper 1, 58% in paper 2, over-all average 56%) were significantly lower than in the established GCD, but since it was a new type of examination, that gives little cause for concern on this occasion. With two exceptions, the following comments apply to both examinations.

It is impracticable to provide here all the possible correct answers to the questions, so as usual this report is limited to discussion of common mistakes or misunderstandings. Once again I have to point out that a common cause of poor marks was providing an irrelevant answer. As a typical example, the first part of question 3 of GCD paper 1 required candidates to "describe briefly . . . the operation of a 4-roll mill for a malt whisky distillery". Note the word "operation": answers had to describe what happens inside the mill. Those who explained why it is necessary to mill malt did not answer the question. I know that specimen questions are available for candidates to practise examination technique, and with more experience, such mistakes can be avoided. I strongly advise prospective candidates, and especially those who have not sat examinations for many years, to make full use of the tuition facilities available to them for examination practice.

Question 5 of GCD paper 1, which included a graph of yeast growth during a typical fermentation, showed that many candidates were unable to handle graphical data. In particular, these candidates were unable to superimpose the graph of alcohol production on the graph of yeast growth. The original gravity of the wort was quoted as 1060°, to allow one to estimate (or remember from practical experience) a final alcohol concentration of about 8%ABV. The %ABV increases from 0 to 8% with time, but many candidates showed a fall, i.e. they showed the graph of falling gravity, even though the axis of the graph was calibrated in %ABV. In a few scripts it was actually labelled as SG and falling from 1060, so one mark was allowed, but only a rising graph scored the allocated two marks. So, practice with preparation and interpretation of graphs is another important aspect of examination technique which would benefit future candidates. Similar mistakes appeared in answers to the equivalent GCDI questions on fermentations for brandy and rum production (paper 2, question 2), although of course the original strength, quoted in °Brix, and final alcohol concentration were different in each case.

Also concerning graphs, many candidates confused the situation in the alcohol/water vapour equilibrium graph (GCD paper 1, question 7; GCDI paper 1, question 5) and the graph of the progress of a malt whisky distillation (paper 2, question 2A; also GCDI paper 1, question 6 on pot distillation). The second graph showed the fall in alcohol concentration in the distillate over a batch distillation run. It is customary to stop when the distillate strength falls to 1%ABV (corresponding to 0.1% residual ABV in the pot ale or spent lees), since the cost of energy required to continue exceeds the value of the recovered alcohol. There are flavour implications as well, as some candidates mentioned. The vapour equilibrium graph showed the calculated alcohol concentrations in the vapour, and therefore in the distillate, from increasing strengths of alcohol from 0%ABV (pure water), and also the boiling point of the liquid (falling from 100oC for pure water). Ultimately, about 97%ABV at atmospheric pressure, it becomes impossible to separate the azeotropic alcohol/water mixture, which, incidentally, is the situation at the top of a neutral spirit rectifier column. It is possible to predict from the graph the boiling point of a particular alcohol/water mixture (bottom line), and the alcoholic strength which will be distilled, i.e. vapourised and then condensed, from that strength (top line). That was the point of some parts of GCD question 7 (and GCDI question.5).

While on the subject of distillation, all versions of question 3 of paper 2 (GCD only) had a 1-mark question on the principal problem caused by a high level of dissolved CO_2 in the wash. In the context of a distillation question, excessive frothing in the column or pot still was the correct answer, but more than half of the candidates referred to asphyxiation of workers, which is most unlikely to be a hazard at the distillation stage. Another common mistake occured in question 8 of both versions of paper 2, which was largely concerned with water supplies, but for the final part candidates had to identify the three most useful sources of energy for re-cycling on a drawing of a pot still (although the word energy was not emphasised as it is here). Four possibilities were illustrated: pot ale (i.e. the spent residue in the still), hot condensate from the heating coil, and the water streams leaving the hot condenser and after-cooler. While warm water from the after-cooler can be re-used, it is certainly does not match the other three in heat energy value. So the moral is, consider the context of the question in deciding the most appropriate answer.

I have noticed, ever since the Certificate examinations began several years ago, that the answers often have a curiously deferential attitude to laboratory and sensory assessment work. This year in several questions related to analytical work, a surprising number of candidates apparently considered that "send it to the lab" (or nosing panel) was an adequate explanation. The point of these questions was, what does the lab or nosing panel do for that analysis? Candidates for the Certificate do not require detailed knowledge of the procedures; these are assessed at Diploma level. But they are expected to have a basic understanding of what happens, of the importance of these analyses for the quality of the product, and to be able to express that knowledge in simple terms in an examination answer.

Question 7 of paper 2 of both examinations required sketches of automatic CIP systems for fermentation vessels. Accurate reproduction of workbook drawings was not required, or even expected; any system that would work was acceptable. Since fermenters have to be both cleaned and sterilised, it was necessary to sketch the layout of the supply (and recycle or disposal, as appropriate) of all three of detergent, sterilant and rinse water. The position of the jet or spray ball also had to be shown. Some drawings indicated CIP fluids entering through the bottom of the vessel. Although that is fine for filling with wort it is certainly not a practicable cleaning procedure! I have mentioned in previous years' reports that neat drawings are required for full marks; I was pleased that a majority of candidates obviously used a ruler, but there were still too many freehand drawings of undulating pipework and distorted vessels which lost marks.

It is always a difficult situation to be in the first group of candidates of a new examination, with its unfamiliar format, so I congratulate the 6 successful GCDI pioneers who performed so well. It is also a pleasure to report the excellent 76% pass rate in the GCD. Of course it is disappointing that some candidates were unable to achieve a pass mark, but as in previous years I can report that most of those who failed nevertheless produced some, unfortunately not enough, very good answers. That is reassuring for their next attempt at the examination, when hopefully with more study (and more practice in examination techniques, see above), their number of good answers will substantially increase. It was disappointing that only one GCD candidate managed to reach Distinction standard, but several others only just missed that grade and joined the commendably large number in the City & Guilds Credit category. ■

Dr Iain Campbell

The successful candidates from the 2006 Diploma and Master Brewer Examinations, who meet all IBD criteria, are listed as follows:

MASTER BREWER EXAMINATION
M.Brew Module One – Passes

Baxter, David James Connel	Great Northern
Bihl-Kirkwood, Georgia Gladys	Africa
Brown, Tracy	Great Northern
Bryan, Hazel Jayne	Great Northern
Denny, Richard Charles	Midland
Du Toit, Malcolm A	Africa
Fitzgerald, Fergus Richard	Southern
Flanagan, Brendan Gerard	Irish
Francis, Devon Milton	International
Hamilton, Graeme William	Midland
Harrington, Fiona ++	Southern
Herholdt, Tanith	Africa
Horn, John D	Africa
Huey, James Stanley	Irish
Kabila, John Ilunga	Africa
Libazi, Pilasande Bulelwa	Africa
McCoard, Brenda Helen	Southern
Meneses, Florante J	Asia Pacific
Mkhwanazi, Penelope	Africa
Putter, Gerhard Johannes	Africa
Sheils, Rory	Irish
Siaw, Yon Miaw	Asia Pacific
Stewart, Ross Gardiner	Southern
Steyn, Gary James	Africa
Tanner, Brigid Catherine	Irish
Thompson, Matthew John	Irish
Thurgeson, Christopher James	Southern
Wright, Brad	International

M.Brew Module Two – Passes

Davies, Robert Edward	Irish
Denny, Richard Charles	Midland
Flanagan, Brendan Gerard	Irish
Hamilton, Graeme William	Midland
Hollingworth, Richard Andrew	Midland
Kiyingi, Stephen	Africa
Meneses, Florante J	Asia Pacific
Morley, Shane Kelvin	Asia Pacific
Putter, Gerhard Johannes	Africa
Smith, Simon Andrew	Midland
Smyth-Ferrandez, Audrey	Southern
Steytler, Lauren Carol	Africa
Stradiotto, Steven	International

M.Brew Module Three – Passes

Andrew, Rory Durran Edward ++	Southern
Harrington, Fiona ++	Southern
Helme, Matthew Dickson	Southern
Herholdt, Tanith	Africa
Hollingworth, Richard Andrew	Midland
Mpholo, Victor Bosilo ++	Africa
Mwova, Nicholas M ++	Africa
Odendaal, Johan Danie ++	Africa
Slade, Gregory Keith ++	Africa
Smith, Simon Andrew	Midland
Stradiotto, Steven	International
Van Der Watt, James Andrew Thomas ++	Africa
Viljoen, Clint Robert	Africa

M.Brew Module Four – Passes

Andrew, Rory Durran Edward ++	Southern
Burn, Ian ++	Great Northern
Francis, Devon Milton	International
Hardie, Alan James ++	Great Northern
Kobia, Athanasius ++	Africa
McEwan, Roderick Nairn ++	Great Northern
Moloto, Lebogang ++	Africa
Ramshaw, James Edward Michael	Midland
Reid, Christopher	Irish
Van Der Watt, James Andrew Thomas ++	Africa

M.Brew Module Five – Passes

Andrew, Rory Durran Edward ++	Southern
Burn, Ian ++	Great Northern
Eppard, Tobin Lee ++	International
Hardie, Alan James ++	Great Northern
Harrington, Fiona ++	Southern
Kobia, Athanasius ++	Africa
Lees-Jones, Michael Christopher ++	Great Northern
Mbogo, George ++	Africa
McEwan, Roderick Nairn ++	Great Northern
Moloto, Lebogang ++	Africa
Mpholo, Victor Bosilo ++	Africa
Mwova, Nicholas M ++	Africa
Slade, Gregory Keith ++	Africa
Subramanya, P G ++	Asia Pacific
Tamilarasan, Arumugam ++	Asia Pacific

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

DIPLOMA IN BREWING EXAMINATION
Dipl.Brew Modules One, Two and Three – Passes

Alexander, Timothy Rohan	International
Burger, Letitia	Africa
Crowe, Richard Anthony*	Asia Pacific
Dickinson, Rebecca Jean	International
Garcia, Marco Antonio	International
Guilford, Michael	International
Henkle, Jennifer M	International
Jonland, Helen Daniel	International
Jugdeo, Kameel Sewnarain	Africa
Kabakoff, Abraham	International
Lamont, Andrew Stuart	International
Leslie, Michael Patrick	International
Madlala, Ndumiso Marius	Africa
Milazi, Dominic Ben Khothatso	Africa
Odit, Hermendra	Africa
Simpson, Gary Kenneth	Irish
Stevenson, Jan	International
Zika, Angeliki	International

Dipl.Brew Module One – Passes

Afesi, Richard Adasom	Africa
Altmann, Rebecca Anne	Asia Pacific
Andrews, Clinton Brett	Asia Pacific
Aspeling, Lindsey-Ann +	Africa
Aung, Aung	Asia Pacific
Ball, Adam	International
Barnes, Wayne Arthur	Africa
Barraclough, Miles	Asia Pacific
Bekkers, August	International
Bennett, Mark	Great Northern
Bidian, Raluca-Roxana	International
Boland, Aine	Irish
Botha, Marianka Lynette	Africa
Botwright, Benjamin James	Midland
Boudler, Sabrina	Africa
Bowman, Robert +	International

Broom, Natalie Kate	Asia Pacific
Brown, Kisha-Ann	International
Brown, Ross Alexander	Asia Pacific
Brown, William Stuart	Southern
Buthelezi, Thuthuka	Africa
Cantwell, Ron William	International
Cawley, Mark	Irish
Chamberlin, Richard Andrew	Midland
Chan, Tyrone	Africa
Chiara, Luciano Victor	Asia Pacific
Cirlescu, Nicoleta	International
Clews, Peter Keith	Great Northern
Coetzee, John Claude	Africa
Cojocaru, Livia	International
Collins, Jeffrey Edward	Great Northern
Cook, Benjamin Phillip	International
Cullen, Emma	Irish
Curran, William David	Irish
Damboiu, Corina	International
Davidescu, Costel	International
Davis, Steven John	Asia Pacific
Dempsey, Alan +	Irish
Downing, Robert Anthony	Irish
Dragancea, Mihaela	International
Drummond, Alison Caroline	Irish
Durand, Stephen Andrew	International
Dutta, Debasis	Asia Pacific
Egi, Aleksandar	International
Esteban, Martinez - Kumpel	Southern
Faulknor, Steve	Asia Pacific
Ferguson, Jaeanne Anthea Oline	International
Fidler, Greg	International
Field, Christopher Joseph	Midland
Foerstner, Dieter KJ	International
Fox, Sarah Louise	Irish
Gallagher, Andrea	Irish
Gladisch, Tanja	International
Glencross, Emma Catherine	Asia Pacific
Gosling, Andrew John	Midland
Gow, Andrew Robert	Asia Pacific
Greenidge, Colin Arlington	International
Hadley, Tully Ceman Patrick	Asia Pacific
Hallinan, Christopher Percival	Asia Pacific
Hanley, John	Irish
Heffernan, Robert Joseph	Irish
Herd, Katherine Amy	Asia Pacific
Ho, Jonathan	Asia Pacific
Hopulele, Corina-Elena	International
Hopulele, Dragos	International
Howard, Malcolm John	Asia Pacific
Howley, Sinead	Irish
Jasper, Joseph Andrew	International
Jones, Tyler Ray	International
Kavanagh, Johanna	Irish
Kelly, Richard +	International
Keyser, Amelia	Africa
Khin, Aung	Asia Pacific
Klopfer, Scott	International
Kwarciak, Dominika	Great Northern
Lash, Duncan Thomas	Asia Pacific
Laurentiu, Polschi Eduard	International
Lefoneh, Samuel Yao	Africa
Lewis, Jayne	Asia Pacific
Lloyd, Michael Jonathan	Midland
Luca, Sabina	International
Mabena, Phindi	Africa
Mack, Marvin Dexter	International
Makume, Lele Sarah	Africa
Marokane, Beverly	Africa
Matthews, Carol +	Africa
Mbugua, Hinga	Africa
McLean, Jacob Alexander	International
Mgallah, Martin Lackson	Africa
Mihailescu, Mihail Gavril	International
Moodley, Clinton	Africa
Mooney, Matthew Ray	International
Muiruri, Michael Mwaura	Africa
Musonda, Wellington	Africa
Nabeta, Francis	Africa
Nartey, Dorinda Linda	Scottish
Naylor, Toni-Marie	Midland
Nic Phiarais, Blaise Patricia	Irish
Njeru, Anthony Nyaga	Africa
Nong, Khutso Betweenia +	Africa
Nxusani, Apine Philela	Africa
O'Rourke, Alan Michael	Irish
Paisi, Patronilla Palangia	Asia Pacific
Pakhova, Natalya	International
Parkinson, Philip James +	Midland
Prabhudesai, Vithal Prasad	Asia Pacific
Pradeep, Sinha Kumar	Asia Pacific
Pretorius, Barend Johannes Voster	Africa
Rabbidge, Michele Ann	Asia Pacific
Richards, Anthony	Midland
Robinson, Ciara	Irish
Robinson, Louise	Asia Pacific
Rogers, Paul Anthony	Asia Pacific
Roza, Jeremy Ryan	International
Russell, Stephen Todd	International
Scheepers, Eugene	Africa
Seros, Carrie Alexandra	International
Shamsundar, Mathighatta Gopalakrishna	Asia Pacific
Sindle, Astrid Elizabeth	Africa
Smith, Anthony Michael	Southern
Smith, Brian	Southern
Smith, Donovan Elcoate	Irish
Sodha, Fateh Singh	International
Solan, Sarah Marie	Southern
Sproats, Christopher	Asia Pacific
Stewart, Neil Sedaka	International
Stokes, Scott	International
Strauss, Brenton Rydwin	Africa
Swift, James William	Midland
Tembo, Asher Jacob	Africa
Tettey, Charles	Africa
Thompson, Kerryn	Asia Pacific
Togbe, Daniel Kodzo	Africa
Tomblin, Steven Andrew	Southern
Ursu, Anatolie	International
Van Rijn, Kees	International
Velmurugan, Subramanian	International
Vermeulen, Marcele	Africa
Versfeld, Frederick Bryan +	Africa
Walton, Emma Louise	Great Northern
Ward, Christopher John	Asia Pacific
Ward, Gregory Andrew	Asia Pacific
Werro, Graham	Southern
Whelan, Robert	Irish
Wiese, Warren Anthony	Africa
Wilkinson, Kevin	International
Williams, Lenoy	International
Yeoh, Bun Hooi	Asia Pacific

Dipl.Brew Module Two – Passes

Abeyie, Charlotte	Africa
Adhikary, Krishanu	International
Anderson, Dominique Elizabeth	Africa
Asante, Prince Kwame	Africa
Aspeling, Lindsey-Ann +	Africa

Atwine, Alison +	Africa
Baluhya, Damian Masanja	Africa
Barnes, Wayne Arthur	Africa
Barraclough, Jayde +	Asia Pacific
Barraclough, Miles	Asia Pacific
Boland, Aine	Irish
Bond, Eve	Midland
Bowman, Robert +	International
Bradley, Kelly Wayne	Midland
Brown, Scott David	International
Buthelezi, Thuthuka	Africa
Cook, Benjamin Phillip	International
Cremer, Haiko Adriaan	International
Davidescu, Costel	International
Dawson, Leon John +	Asia Pacific
Day, Darren Warren	Asia Pacific
Dolbel, David	Southern
Dragancea, Mihaela	International
Du Plessis, Marina +	Africa
Elks, Jonathan William	Midland
Goodwin, David	Great Northern
Hanley, John	Irish
Herd, Katherine Amy	Asia Pacific
Hoohlo, Mbangose Pinki	Africa
Hopulele, Corina-Elena	International
Ingle, David Neil	Great Northern
Jansson, Petra Maria Nella +	International
Jordan, Michael J	International
Kelly, Richard +	International
Kelly, Robert Patrick +	Irish
Kilcullen, Stephen +	Irish
Killerlane, Colm +	Irish
Kirkton, William James +	Midland
Laing, Sarah Elizabeth +	Asia Pacific
Lawrence, Mickellia Guvannie	International
Lefoneh, Samuel Yao	Africa
Luca, Sabina	International
Marshall, Lisa J	Midland
Mauger, Peter Rodney +	Asia Pacific
Mbugua, Hinga	Africa
Mihailescu, Mihail Gavril	International
Monosi, Busisiwe Beryl +	Africa
Moodley, Clinton	Africa
Mooney, Matthew Ray	International
Moore, Jane Claire	Midland
Moore, Stephen Raymond	Great Northern
Morgan, John +	Midland
Nong, Khutso Betweenia +	Africa
Nxusani, Apine Philela	Africa
Oxenham, Sharon Anne +	Southern
Pakhova, Natalya	International
Parkinson, Philip James +	Midland
Pather, Pragasan	Africa
Quelhas, Michael +	International
Quinn, John Gerard +	Irish
Ratnayake, Amalka Sudeera Kumari	Midland
Reynolds, Phillip	International
Richards, Anthony	Midland
Robinson, Louise	Asia Pacific
Roza, Jeremy Ryan	International
Small, Stephanie Ann	International
Smith, Allison	Irish
Sodha, Fateh Singh	International
Sorokina, Elizaveta +	International
Spratt, Ciaran Francis	Irish
Ssozi, Isaac	Africa
Swanepoel, Pieter	Africa
Taylor, Joshua Fraser	Southern
Tetai, Reremoana	Asia Pacific
Tettey, Charles	Africa
Togbe, Daniel Kodzo	Africa
Travis, Brooke	Asia Pacific
Troncoso, Alex David	Asia Pacific
Vermeulen, Marcele	Africa
Versfeld, Frederick Bryan +	Africa
Walters, Roger Stuart	Midland
Weaver, Andrew +	Southern
Wiese, Warren Anthony	Africa
Wright, Wayne Anthony	Southern

Dipl.Brew Module Three – Passes

Afesi, Richard Adasom	Africa
Barraclough, Jayde +	Asia Pacific
Barron, Jonathan Alexander David	Midland
Bateman, Christopher Edward	Midland
Bateman, Gareth Simon Austin +	Southern
Batten, Darren Morgan +	Southern
Bekker, Annette +	Africa
Bellham, David John	Midland
Bennett, Chelsea Kate	Asia Pacific
Broadbent, Jonathan Paul +	Midland
Butler, Maria Patricia +	Scottish
Chan, Ching Fook +	Asia Pacific
Charleston, Nicola	Scottish
Claffey, Joseph	Irish
Clem, Anthony Robert +	Asia Pacific
Coup, Thomas Matthew	Asia Pacific
Dawson, Leon John +	Asia Pacific
Dempsey, Alan +	Irish
Drummond, Alison Caroline	Irish
Du Plessis, Marina +	Africa
Gorringe, Elizabeth Louise +	Southern
Harilal, Deepa	Africa
Hawkins, David	Great Northern
Horan, Thomas	Irish
Jasper, Joseph Andrew	International
Jones, Tyler Ray	International
Kavanagh, Johanna	Irish
Kilcullen, Stephen +	Irish
Laumann, Jacqueline	International
Lloyd, Michael Jonathan	Midland
Ludwig, Karl	Africa
Marokane, Beverly	Africa
Mauger, Peter Rodney +	Asia Pacific
McCalla, Steve Norman	International
McLean, Kevin Ian Maurice +	International
Mercer, Catherine	Great Northern
Mkandawire, Kondwani Ronald Jaranthowa +	Africa
Monosi, Busisiwe Beryl +	Africa
Morar, Jayshree +	Africa
Oosthuizen, Michael +	Africa
Parrell, Joseph Michael +	International
Ramsay, Robert Anthony	Scottish
Roberts, Mark Richard +	Asia Pacific
Rodina, Natalia +	International
Russell, Stephen Todd	International
Saha, Surajit +	Asia Pacific
Sanders, Graham Michael	Midland
Schofield, Matthew John	Great Northern
Seabela, Setebe Willy +	Africa
Still, Hayden Edward	Asia Pacific
Strawbridge, Martin +	Southern
Sweetman, Edward Brian	Irish
Tapsi, Prasad +	Asia Pacific
Timmons, Jean +	Southern
Transmantiner, Eva	International
Van Schalkwyk, Marna +	Africa
Vaughan, Anne +	International
Wallis, Geoffrey Damon +	Irish

Ward, Beverly Lorraine +	Asia Pacific
Weaver, Andrew +	Southern
Whelan, Robert	Irish
Whitaker, Christopher Dwayne +	Asia Pacific
Wijngaard, Hilde Henny +	Irish
Yang, Peihua	International

Dipl.Distil Module One – Passes

Campbell, Kirsteen Anne	Scottish
Egan, Colum Eamonn	Irish
Ferguson, Jane	Scottish
Lochhead, Mark Charles	Scottish
Onguru, Yonah Akungu Otieno	Africa
Stewart, Duncan McNab	Scottish
Sutherland, Kevin Donald	Scottish

Dipl.Distil Module Two – Passes

Beaumont, Vincent H. +	Irish
Clarke, Robert +	Scottish
Dean, Ian Stuart	Scottish
Donegan, William +	Irish
Livingston, Andrew	Scottish
McCallum, Kirstie +	Scottish
Muwandi, David Takura	Africa
Nation, Brian Gerard +	Irish
O'Gorman, Kevin +	Irish
Quinn, David M G	Irish
Renwick, Kirsteen Isla	Scottish
Wood, Timothy John +	Scottish

Dipl.Distil Module Three – Passes

Anderson, Alasdair John +	Scottish
Beaumont, Vincent H. +	Irish
Cameron, Victor Alexander +	Scottish
Darlington, Eliot John William +	Scottish
Donegan, William +	Irish
MacDonald, Andrew +	Scottish
Muwandi, David Takura	Africa
Nation, Brian Gerard +	Irish
O'Gorman, Kevin +	Irish
Ogilvie, Ewan Robert +	Scottish
Onguru, Yonah Akungu Otieno	Africa
Quinn, David M G	Irish
Wallace, Craig +	Scottish
Wood, Timothy John +	Scottish

+ Has passed all modules of Dipl.Brew / Dipl.Distil by accumulation
** Pass with Distinction and J S Ford Award*

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or visit the IBD website at

www.ibd.org.uk

INTERNATIONAL BREWING CONVENTION 2007

FROM HERE TO REALITY

The 2007 International Brewing Convention will be the first dedicated brewing conference and exhibition to take place in the UK for ten years.

The Institute of Brewing & Distilling and The Brewing, Food & Beverage Industry Suppliers Association, have combined resources to present this globally recognised, high quality event.

BFBi IBD

CONFERENCE

Manchester International Convention Centre
1st - 3rd October 2007

EXHIBITION

G-Mex Centre, Manchester
2nd & 3rd October 2007

for conference and exhibition reservations and further information log onto

www.ibcmanchester.org