Institute & Guild of Brewing Examinations 2002

CHAIRMAN'S REPORT

The pass list and summary statistical details of the 2002 AME and DMB examinations are now published along with the reports of the individual Examiners for each of the papers. Prospective candidates who failed the examinations in 2002 are urged to study these reports.

First may I congratulate all candidates for this years Institute and Guild of Brewing examinations, scripts have again this year illustrated the hard work many individuals put in to gain one or more of our three brewing and two distilling qualifications. I took over the chair of the Board of Examiners in November last year and I would like to take this opportunity to say a sincere thank you to Dr. George Philliskirk who has handed on such a well managed and respected committee, it is yet another illustration of the enormous time and effort George commits to support of the IGB.

Candidates this year showed a good standard with many excellent results coming from as wider a geography as can be imagined, we were however disappointed that no DMB candidate scored well enough to achieve an award this year. My advice to future candidates will be much the same as that given by many of my predecessors and that is to remember examination technique as well as learning technical facts and processes. Many a marginal or average script could be improved if the candidate carefully read the paper, answered the question asked and planned their time appropriately. Charts and diagrams, tables and bullet points are all valid mechanisms to enhance scripts and illustrate knowledge, they are however under used and often of poor clarity and completeness.

In closing I would like to emphasise two points to candidates, firstly to understand that all of our examinations are based on a published syllabus and that any workbooks, courses, booklets or training are there to help as part of the learning process and do not constitute the whole scope of the examination. Secondly can I recommend the individual examiners reports to you, they are designed to give help and instruction to any candidate sitting the examinations and to allow them to learn from others who have gone before.

Finally, thank you to the members of the Board of Examiners for their time, effort and professionalism and thank you to the Administration and Section members who ensure the process runs as smoothly as possible.

JIC Robertson
July 2002

INSTITUTE & GUILD OF BREWING EXAMINATIONS 2002

AME and DMB

The Board of Examiners for the 2002 series of AME and DMB Examinations consisted of the following members:

J I C Robertson (Chairman), Dr G Philliskirk (Vice-Chairman), Dr J Bryce, Dr D Taylor, Prof C Webb, Dr I Campbell, I B Smith, R F Illingworth, J R Stead, P K A Buttrick, Dr J Brown, M R Partridge, W T Morris, R Cooper, J B Eaton.

The Examinations were held in the following worldwide Examination Centres:

UK & Ireland

- The Guild Hall, Station Street, Burton
- Guinness Learning Centre, Dublin
- New College, Durham
- Heriot Watt University, Riccarton, Edinburgh
- Guinness Social Club, Park Royal, London
- Interbrew UK Ltd, Magor Brewery, Magor
- Manchester Business School, Manchester

Australia

- NT University, Darwin
- Queensland University of Technology, Brisbane
- Murdoch University, Perth
- University of Melbourne, Melbourne
- University of South Australia, Adelaide
- University of Tasmania, Hobart, Tasmania
- University of Technology, Sydney

Barbados

- Ministry of Education, Bridgetown, Barbados

Cameroon

- The British Council, Yaounde

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Canada

- University of Calgary, Calgary
- York University, Toronto

China

- Shenyang Normal Institute, Shenyang, China

France

- Heineken, Rueil-Malmaison

Ghana

- The British Council, Accra

India

- The British Council, Chennai (formerly Madras)
- The British Council, Mumbai (formerly Bombay)

Jamaica

- University of West Indies, Kingston

Kenya

- University of Nairobi, Nairobi

Lusaka

- The British Council, Lusaka

Malaysia

- The British Council, Kuala Lumpur

New Zealand

- University of Otago, Auckland
- Christchurch Polytechnic Institute of Technology, Christchurch

Nigeria

- The British Council, Lagos

Papua New Guinea

- University of Papua New Guinea, Papua New Guinea

Romania

- Dreher Breweries, Budapest

South Africa

- SAB Prospecton Brewery, Durban
- SAB Technical Training Institute, Rivonia, Johannesburg
- The Yardstick, Ibhayi Brewery, Port Elizabeth
- University of Cape Town, Cape Town

Sri Lanka

- The British Council, Colombo

Tanzania

- The Co-operative College, Moshi
- University of Dar es Salaam

The Netherlands

- Heineken, Zoeterwoude

Trinidad

- Carib Brewery, Champs Fleurs, Trinidad

Uganda

- The British Council, Kampala

USA

- Siebel Institute of Technology, Chicago
- Sudwerk Brewpub (UC Davis), Davis
- University of Wisconsin, Mellencamp Hall, Milwaukee

Zimbabwe

- The British Council, Bulawayo
- University of Zimbabwe, Mount Pleasant, Harare

AME (including Distilling) and DMB

Four hundred and fifty-two candidates sat part or all of the Institute's Examinations (475 in 2001), at 47 centres (41 in 2001) around the world.

Ninety-four candidates sat part or all of the DMB. Sixteen candidates accumulated passes in all modules and thus qualified as Diploma Members.

Three hundred and thirty-seven candidates sat part or all of the AME. Eighty candidates accumulated passes in all modules, and thus qualified as Associate Members.

Twenty-one candidates sat part or all of the AME in Distilling. Seven candidates accumulated passes in all modules and thus qualified as Associate Members.

The number of candidates who sat each module of the AME and DMB is as follows:

- AME Module 1 – 181 (199 in 2001)
- AME Module 2 – 137 (167 in 2001)
- AME Module 3 – 117 (139 in 2001)
- AME Distilling Module 1 – 9 (7 in 2001)
- AME Distilling Module 2 – 2 (5 in 2001)
- AME Distilling Module 3 – 7 (3 in 2001)
- DMB Module 1 – 22 (37 in 2001)
- DMB Module 2 – 31 (36 in 2001)
- DMB Module 3 – 34 (47 in 2001)
- DMB Module 4 – 28 (34 in 2001)
- DMB Case Study – 21 (38 in 2001)

The statistics for the number of candidates who sat the IGB Examinations are as given below.

	UK and Ireland	Overseas
Total number of AME candidates – 337	99 **29%**	238 **71%**
Total number of AME Distilling candidates – 21	20 **95%**	1 **5%**
Total number of DMB candidates – 94	36 **38%**	58 **62%**

The successful candidates from the 2002 Examinations, who meet all IGB criteria, are listed as follows:

DIPLOMA MASTER BREWER EXAMINATION

DMB Module One – Passes

Anders, John Stephen	Irish
Bell, Irene	Africa
Bromley, Ruth Helen	Great Northern
Chatterjee, Jaydeep	Asia Pacific
Else, Nicola-Ann	Africa
Groeneveld, Steven Craig	Africa
Hewitt, Jayne L	Great Northern
John, David W G	Great Northern
Jones, Catherine Lindsay	Africa

Mudzoki, Nebson	Africa
Sparks, Donovan Roy	Africa
Subramanya P G	Asia Pacific

DMB Module Two – Passes

Bell, Irene	Africa
Bradford, M Ian	Midland
Burn, Ian	Great Northern
Chettiar, Sothipragasan	Africa
Dickson, Alistair H	Great Northern
Ganesh Ramu, Adesanatti Venkataramanan	Asia Pacific
Grobbelaar, Albert Stefanus	Africa
Gulliver, Marie Kathryn	Great Northern
Hardie, Alan James	Great Northern
Healy, Shane Martin	Irish
John, David W G	Great Northern
Kuzela, Robert	International
MacDonald, Hector F	Midland
Mpholo, Victor Bosilo	Africa
Mudzoki, Nebson	Africa
Odendaal, Johan Danie	Africa
Peters, Ann Margaret	Southern
Salisbury, Helen Claire	Great Northern
Sparks, Donovan Roy	Africa
Young, Georgina Margaret	Southern

DMB Module Three – Passes

Appiah-Danquah, Martin	Southern
Dickson, Alistair H	Great Northern
Dowd, Paul	Africa
Feasey, Paul Robert	Irish
Gulliver, Marie Kathryn	Great Northern
John, David W G	Great Northern
Kalule, Joseph ++	Africa
Kamdem, Alain Rousseau	Africa
Katorobo, Edward M	Africa
Kobia, Athanasius	Africa
Kuzela, Robert	International
MacDonald, Hector F	Midland
Ogwal, William Wilson	Africa
Osborn, Kevin John	Africa
Runcie, Andrew Lawrence ++	Midland
Shieldon, Robert A ++	Midland

DMB Module Four – Passes

Brimble, Timothy John	Midland
Chilton, David James ++	Midland
Deakin, Christopher Ronald ++	Midland
Dobner, Mark A ++	Southern
Ejiofor, Sylvester N ++	Africa
Fleming, Shona ++	Africa
Haywood, Richard John ++	Midland
Heasman, Toby Andrew ++	Midland
Kalule, Joseph ++	Africa
Liddell, Robin	Southern
Markham, Frank Anthony ++	Great Northern
Ogbedeh, Anselm O C	Africa
Ryman, Roger John ++	Scottish
Salisbury, Helen Claire	Great Northern
Walton, Maurice ++	Midland

DMB Case Study – Passes

Biss, Christopher	Africa
Brown, Russell Daniel ++	Great Northern
Ejiofor, Sylvester N ++	Africa
Fleming, Shona ++	Africa
Gopalakrishnan, K N	Asia Pacific
Heasman, Toby Andrew ++	Midland
James, Adrian Michael ++	Midland
Kalule, Joseph ++	Africa
Katorobo, Edward M	Africa
Markham, Frank Anthony ++	Great Northern
Muiruri, Jane M	Africa
Ogbedeh, Anselm O C	Africa
Ramarumo, Phoko Maurice ++	Africa
Runcie, Andrew Lawrence ++	Midland

ASSOCIATE MEMBERSHIP EXAMINATION

Modules One, Two and Three – Passes

Badenhorst, Marko Thomas *	Africa
Bamulanze, Henry Fred	Africa
Bel-Boekhold, Nynke Nanette *	International
Benvenuti, Gregory Paul *	Africa
Berwick, Mark William Robert	Asia Pacific
Bonadie, Wayne Anthony *	International
Cameron, Calum	Southern
Cross, Jeremy D	International
Dhont, Joris Aimé André Alfred	International
Goodieson, Jefferey	Asia Pacific
Hamilton, Barry L. *	International
Hamp, Frederick M	International
Ho, Timothy R	International
Hoogenberg, Bjorn	Great Northern
Houck, Jessee Arthur	International
Jayatunga, Mahesh Priyantha	Asia Pacific
Krech, Mark Andrew Roy *	International
MacKeigan, Jill Catherine **	International
Maruna, Mark *	International
Miracle, Robert Evan	International
Monga, Orwell K	Africa
Ntare, Herbert	Africa
Overgaag, Martijn Theodorus Adrianus	International
Pasi, Tapiwa	Africa
Perera, Deyalage Saman Chandrajith	Asia Pacific
Rykse, Nathan	International
Smalberg, Frank Berend	International
Stephenson, William Henry	International
Tate, Charles David	International
Tembani, Andrew	Africa
Tomich, Chad A *	International

AME Module One – Passes

Allan, David John	Scottish
Alozie, Anthony Nnaemeka	Africa
Appleby, Kevin John	Midland
Ashmore, Michael Andrew	Midland
Beccaro, Madeleine Elisabeth Christina	Africa
Bonighton, David Ronald	Asia Pacific
Boverhof, Jason	International
Brogan, Gavin James	Irish
Brooke, Gayna	Great Northern
Burns, Bradley +	Great Northern
Chambers, Thomas Coulter	Scottish
Chou, Phillip K. +	International
Collier, Michael James	Midland
Cone, John James	Africa
Coulson, Adam Nathaniel	Asia Pacific
Coulthread, Michael James	Midland
Cremin, Dave Francis +	Irish

Crompton, Christopher Dale	Asia Pacific
De Jong, Jeroen Paulus Jacobus	International
De Vries, Harro Maxim +	International
Dean, Cameron Scott	Asia Pacific
Dehrmann, Frieda Marie	Africa
Du Plessis, Claire Natalie	Africa
Duffy, Cuan John +	Great Northern
Elder, John Wilson	Asia Pacific
Ellam, Steven	Great Northern
Erasmus, Johan Anton +	Africa
Furgrove, Victoria Louise	Great Northern
Gabb, Leanne Karen	Asia Pacific
Gallimore, Paul	Midland
Gindre, Catherine	International
Hall, Martin	International
Hilbert, Seperatus	Africa
Holgate, Jared Fairfax	Great Northern
Hollingworth, Richard Andrew	Midland
Houghton, Caroline	Southern
Iles, Gregory Scott	Asia Pacific
Imade, Amenaghawon Kingsley	Africa
Jayawickrama, Keembiyage Sujith Janaka	Asia Pacific
Kalpoe, Soereschandre	International
Kapngeywo, Kaps	Africa
Kaupa, Brasty Marme	Asia Pacific
Kenmogne, Maurice	Africa
Kentish-Barnes, Edward	Southern
Kubheka, Lerato Caroline	Africa
Kummer, Corey	International
Lack, Andy John	Midland
Leaning, Robert Charles	Southern
Little, Michelle Diane	International
Marker, Christopher Kenneth	Asia Pacific
Masenga, Ikombe Monley	Africa
Mathews, Mathai Junior	Africa
McGee, Daniel	International
Mitula, Willis Alfayo +	Africa
Morar, Jayshree	Africa
Morley, Shane Kelvin	Asia Pacific
Moshi, Admirabilis Lazard	Africa
Nagandi, Saphan	Africa
Nelsen, Stephen +	Asia Pacific
Norman, Vanessa Audrey	Africa
Nyaki, Julius Stephen +	Africa
Nzowa, Herman Mathias	Africa
Okello, Christopher Oloya +	Africa
Olliver, Gregory Rene Henri	International
Palmer, Scott John	Asia Pacific
Pasea, Delano Edson	International
Persad, Rampaul	International
Pezzutti, Michael Victor	Asia Pacific
Phiri, Lester	Africa
Pillay, Vinosha	Africa
Putter, Gerhard Johannes	Africa
Relph, Mick Simon	Midland
Roberts, Sally Jayne	Africa
Robertson, Rachel Yvonne	Asia Pacific
Ryan, Kelly Patrick	Asia Pacific
Sailakshmi, V	Asia Pacific
Singleton-Jones, Nicola Jayne	Midland
Smith, Christopher Charles	Asia Pacific
Thomas, Shannon	International
Travers, Valerie Elizabeth	Southern
Van Zoggel, John	International
Vincent, Scott F	Asia Pacific
Walker, John	Midland
Walker, Penny	Africa
Weaver, Bradley	International
Welsing, Constantin Alphons	International
Wiggers, Joop F M	International
Williams, Marco Lester +	Africa
Wilson, Steve	Great Northern
Wiseman, Ronald Charles	International
Wright, Brad	International
Wright, Wayne Douglas	Africa

AME Module Two – Passes

Akker, Caroline +	Midland
Alozie, Anthony Nnaemeka	Africa
Amoforitse, Samuel Chuks +	Africa
Ascione, Lydia Stephanie	International
Baldeo, Sangeeta Devi	Asia Pacific
Banda, Stareko	Africa
Beccaro, Madeleine Elisabeth Christina	Africa
Benzaquen, Mark Joseph	International
Botha, Bruce Paul	Africa
Bowen, Robert John	Southern
Challenger, Roy James	Asia Pacific
Crawshaw, Jonathan	International
Dahms, Carl Michael	Asia Pacific
De Jong, Jeroen Paulus Jacobus	International
Dehrmann, Frieda Marie	Africa
Delaere, Sean Albert	Asia Pacific
Duffy, Cuan John +	Great Northern
Edington, Brian	Asia Pacific
Ekpo, Emmanuel Sampson	Africa
Ellis, Richard Warren	International
Finlayson, Adrian Mathew	Asia Pacific
Fowler, Nicholas	Midland
Gabb, Leanne Karen	Asia Pacific
Gatt, Christopher Peter	Asia Pacific
Gindre, Catherine	International
Gleisner, Justin Peter	Africa
Glynn, Geraldine Judith Helen	Midland
Graves, Ian Roy +	Asia Pacific
Hall, Martin	International
Hastie, Joanna Clare	Asia Pacific
Hilbert, Seperatus	Africa
Imade, Amenaghawon Kingsley	Africa
Ivkovic, Dalibor +	Asia Pacific
Kariuki, Samuel Benard Mathenge	Africa
Kazooba, Chriven Kasanga	Africa
Kubheka, Lerato Caroline	Africa
Mackintosh, Peter Lachlan	Asia Pacific
Mackrell, Stewart Douglas	Africa
Maganga, Josephat	Africa
Mandrutiu, Monica	International
Mangali, Nirendra +	Africa
Marshall, Richard Brian +	Great Northern
Mason, Bret	International
Mathews, Mathai Junior +	Africa
Mbenekazi, Nomsa Queen	Africa
McGee, Daniel	International
McGregor, James Allan	International
Mickelson, Leon James	Asia Pacific
Milner, Dean David	Southern
Morley, Shane Kelvin	Asia Pacific
Neal, Martin Alan	Asia Pacific
Nelson, Mark	International
Nischwitz, Ralph	Asia Pacific
Nyika, David	Africa
Okello, Christopher Oloya +	Africa
Okware, Nightingale Janice	Africa

Palmer, Scott John	Asia Pacific
Pearson, Kevin John	Midland
Phiri, Lester	Africa
Putter, Gerhard Johannes	Africa
Ramachandran, Mallaiah	Asia Pacific
Ramshaw, James Edward Michael	Midland
Ryan, Siobhan	Irish
Ryan, Siobhan Mary +	Irish
Serwanga, Richard Harris	Africa
Seward, Samuel Thomas +	Asia Pacific
Singh, Roshene	Africa
Sloan, Stephen	International
Soti, Stephen Martin	International
Sowerby, Natalie +	Great Northern
Stevens, Gary Paul	Southern
Stradiotto, Steven +	International
Sutanadhan, Prinya	International
Tamilarasan, Pichandi	Asia Pacific
Tanner, Brigid Catherine	Irish
Tucker, Wayne Alexander	Asia Pacific
Van Der Poel, Diana Maria	Asia Pacific
Van Der Vyver, Paul +	Africa
Van Rensburg, Lorna Lynne	Africa
Villadelgado, Evangeline	Asia Pacific
Ward, Trevor Rex	Asia Pacific
Weaver, Bradley	International
Weir, Margaret	Asia Pacific
Willcox, Sarah +	Great Northern
Wilson, Ross Andrew	Asia Pacific
Wiseman, Ronald Charles	International
Yusuff, Ibrahim Olanrewaju	Africa

AME Module Three – Passes

Akker, Caroline +	Midland
Amwata, Benson	Africa
Anderson, Claire +	Great Northern
Andrew, Rory Durran Edward	Southern
Audet, Travis	International
Baker, Steven James +	Great Northern
Barker, Ruth Ann +	Great Northern
Belcher, Jed +	Southern
Bentley, Richard Stuart +	Great Northern
Bihl-Kirkwood, Georgia Gladys +	Africa
Cahill, Gemma	Irish
Chambers, Thomas Coulter	Scottish
Chapman, Stephen Leslie +	Great Northern
Crawley, Bernard	Irish
Cremin, Dave Francis +	Irish
Crompton, Christopher Dale	Asia Pacific
Davey, Ian	Midland
Edwards, Gareth Martin	Great Northern
Erasmus, Johan Anton +	Africa
Fowler, Todd Douglas	International
Graves, Ian Roy +	Asia Pacific
Haster, Mark Henk	International
Holle, Stephen R +	International
Ivkovic, Dalibor +	Asia Pacific
Jennings, Belinda +	Southern
Kelly, Nicola Claire +	Great Northern
Markin, Samuel Yankah +	Africa
Martin, Calvin +	Africa
McGroarty, Graeme +	Southern
McKay, Mathew John +	Asia Pacific
McKeown, Padraig Thomas +	Irish
McNally, Edward James	Irish
McPherson, Kevin James Barry	Asia Pacific
Merange, Graham Frank +	Asia Pacific
Mitula, Willis Alfayo +	Africa
Mkaruka, Renatus Kaitira Malembo +	Africa
Mkemangwa, Dominic Galiusa +	Africa
Mkhwanazi, Penelope +	Africa
Nagandi, Saphan +	Africa
Naidoo, Nuresh	Africa
Nwadike, Marcel Okey +	Africa
Nyaki, Julius Stephen +	Africa
O'Hanlon, Ross Patrick	Irish
Okiror, James Charles	Africa
Pillay, Vinosha	Africa
Ryan, Siobhan Mary +	Irish
Scott, Fabian	International
Seward, Samuel Thomas +	Asia Pacific
Sheils, Rory	Irish
Sloan, Stephen	International
Smyth, Audrey +	Southern
Sowerby, Natalie +	Great Northern
Tiddens, Machiel	International
Too, Robert Kibiego +	Africa
Van Der Vyver, Paul +	Africa
Ward, Gregory Andrew	Asia Pacific
Weaver, Anne Louise +	Asia Pacific
Welsing, Constantin Alphons	International
Wicomb, Lynn Raye +	Africa
Willcox, Sarah +	Great Northern
Williams, Marco Lester +	Africa

ASSOCIATE MEMBERSHIP EXAMINATION (DISTILLING)

Modules One, Two and Three – Passes

Kellock, Duncan Robertson Mackenzie	Scottish

AME Module One (Distilling)

Begum, Sameena	Scottish
Cairns, William +	Scottish
Donoghue, Gordon	Scottish
Fyfe, Christopher Martyn	Scottish
Jappy, Michael	Scottish
Sinclair, Derek N	Scottish

AME Module Two (Distilling)

Drennan, Matthew	Scottish

AME Module 3 (Distilling)

Clarke, Robert	Scottish
Haggarty, Karen +	Scottish
Hunter, Stuart Daniel +	Scottish
Irvine, David R +	Scottish
Mercer, Grant +	Scottish
Murray, Phillip Gordon +	Scottish

++ Has passed all modules of the DMB by accumulation
+ Has passed all modules of the AME by accumulation
** Pass with Distinction and J S Ford Award
* Pass with Distinction

INSTITUTE & GUILD OF BREWING
EXAMINATIONS 2002

Question Papers and Examiner's Reports

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 1 – Materials and Wort

Tuesday 11th June 1000–1300

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. Explain how sampling and testing can be used to establish whether a delivery consignment of barley is acceptable for producing malt from barley. **[20]**

2. In the production of malt for brewing, describe the process parameters that can be controlled during **two** of the following stages, and explain the problems that arise if these parameters are not properly regulated:

a) Steeping **[10]**
b) Germination **[10]**
c) Kilning **[10]**

3. Discuss the range of solid adjuncts that are used in a brewery to provide fermentable extract. **[10]**

For **two** adjuncts, describe their composition, principle of manufacture, and effect on brewing. **[10]**

4. With particular regard to the advantages and disadvantages, compare the processes of reverse osmosis and ion exchange for preparation of brewing liquor from borehole water. **[12]**

Describe the techniques available for the preparation and sterilisation of water for use in post-fermentation dilution. **[8]**

5. Give a description of hop constituents that are relevant to brewing and explain why. **[20]**

6. Give an account of the basic principles of design and operation of a lauter tun and a mash filter. **[14]**

What are the respective merits of a mash filter and a lauter tun? **[6]**

7. Outline the chemical changes that take place during wort boiling. **[10]**

Describe briefly the aims and methods of wort clarification. **[10]**

8. Describe the relative contribution of the main effluent streams from the departments of a brewery, including packaging. **[8]**

Write brief notes on **two** of the following:

a) A method of calculating effluent costs; **[6]**
b) Aerobic digestion; **[6]**
c) Anaerobic digestion **[6]**

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 1 – Materials and Wort

181 candidates sat the examination compared to 199 candidates in 2001 and 184 candidates in 2000. 69% of candidates achieved at least a pass compared to 66% in 2001 and 65% in 2000. It is therefore encouraging that the percentage pass rate has improved. Although only 4% of candidates achieved an A-pass, it is pleasing to report that there were some superb papers. It continues to be regrettable that some candidates failed to be able to answer 6 questions. A few candidates also missed parts of a question or misread the question.

Question 1

This question was attempted by 66% of candidates with 88% of these candidates achieving a pass (28% of answers were at A-grade). Most candidates did very well on this question, and described how sampling was done and also the initial investigations to check for contamination, disease, varietal purity etc. More complex tests for dormancy and germination potential were also well described. Surprisingly, few candidates mentioned NIR techniques for water content or nitrogen content, although both parameters were noted as being critical for storage and malt production, and the more complex techniques for measuring these were described. Also, relatively few candidates mentioned micromalting and enzyme analysis as a possibility for testing, although these are time consuming and perhaps not ideally suited for a quick decision on the suitability of a grain consignment.

Question 2

This question was answered by 92% of candidates with 83% of these candidates achieving a pass (16% of answers were at A-grade). Clearly, this was a question that most candidates did well, since it covers the basics of practical malting. Good answers correctly indicated that temperature, air, and water are three key parameters that must be tightly controlled during steeping and germination in order to produce good malt. Additional parameters such as turning the germinating grain or adding exogenous gibberellic acid were also identified by most candidates. For kilning, most candidates recognised the critical importance of regulating air-on and air-off temperature and humidity so as not to irreversibly denature the malt enzymes during the early stages of kilning. The importance of temperature control for the production of flavour and colour was also noted, as was the potential for NDMA production from nitrogen oxides in kiln gases.

Question 3

This question was attempted by 85% of candidates with 62% of these candidates achieving a pass (16% of answers were at A-grade). Most candidates were able to give a good discussion of the range of solid adjuncts that are used in a brewery, for example, maize, rice, barley, wheat, oats, rye and sorghum. A few candidates, however, did not read the question carefully and also provided details of a range of liquid adjuncts that are used to provide fermentable extract. The second part of the question was less well answered. Candidates were aware that major components of these cereals include starch and protein, fewer candidates were able to give typical values for these components in the adjunct they discussed. Even fewer candidates included lipid, fibre or ash as part of the composition of their grains. Knowledge of the composition of cereals and the adjuncts produced from them is important in understanding the reasons for the processing that takes place during their manufacture. For example, the processing of maize prior to use in a brewery removes the embryo which is rich in lipid. The composition and manufacture of adjuncts used to provide fermentable extracts has an effect on how they are used in brewing. Maize and rice will dilute malt proteins and therefore reduce foam stability. However, maize and rice by diluting malt nitrogen (and also polyphenols) may also improve beer chill haze and permanent haze stability. However, if there is over dilution of amino nitrogen then that can cause slow fermentations. Most candidates showed that they were aware of the importance of starch gelatinisation temperatures and the need for starch gelatinisation if malt enzymes are to effectively degrade starch to fermentable sugars during mashing. The high gelatinisation temperatures of maize, sorghum and rice mean that these adjuncts need to be cooked before being added to the mash tun or else pre-treated to gelatinise the starch. AME candidates should know in detail the composition of the adjuncts used in brewing, how they are manufactured and the effect that the composition and manufacturing process has on their brewing properties.

Question 4

This question was attempted by 31% of candidates with 44% of these candidates achieving a pass mark (4% of answers were at A-grade). For many candidates this was clearly the “last” question fallback and answers were often incomplete, with only part of the question being attempted. Reverse osmosis was reasonably well explained by candidates but ion exchange less so. In comparing the two processes the good answers used tables and diagrams which simplified the presentation of data. Answers on the preparation and sterilisation of dilution liquor generally only covered one technique for each topic (probably the one in use in the candidate’s own brewery) and lacked the depth required. For deaeration, CO_2 or N_2 stripping, vacuum stripping of hot liquor, with or without CO_2 or N_2 stripping, and hydrogen scavenge aided by a catalyst are the techniques which might have been described. For liquor sterilisation, the use of UV, chlorine, chlorine dioxide, ozone and sterile filtration were the expected responses.

Question 5

This question was attempted by 86% of candidates with 58% gaining a pass (15% of answers were at A-grade). Almost all candidates described the importance of hop resins. In particular, the fact that soft resins contain α-acids and β-acids and that it is the isomerisation of the α-acids during wort boiling that provides bitterness to beer. Many of the better candidates also stated how the oxidation of β-acids can produce hulupones that can contribute a harsh bitterness. Weaker candidates were aware that there are “essential oils” that contribute aroma to the final beer. However, these weaker candidates were unable to differentiate between hydrocarbons, oxygenated compounds, and sulphur compounds that make up the essential oils. These candidates were, therefore, unable to describe the different character that these different components can contribute to the final product. The timing of aroma hop addition is clearly very important. For example, heavier esters and ketones can be retained to give a fruit/citrus character if added late in the boil. The extent to which these characters will persist depends on kettle design. Also, appropriate hop varieties may be added during maturation or to the cask to impart a hop aroma and taste. Stronger candidates identified the need for careful storage of hops to ensure that they do not become infected or oxidised and thus impart “off-flavours”. These candidates also identified the potential for different types of hop products to be used. For example, hop pellets, isomerised hop pellets, reduced isomerised hop products and extracted hop oils.

While hops provide bitterness and aroma, it is important to note that they can also modify yeast performance, have bacteriostatic properties, can reduce foaming during wort boiling and bind with hydrophobic proteins to enhance beer foam. These effects of hop resins on brewing were identified by only a few candidates. In general, candidates showed that they had a superficial knowledge of hops, hop products and how to use them. Many candidates lacked the detailed knowledge that would have enabled them to identify a processing problem that arose in a brewery due to poor storage or utilisation of their hops or hop products.

Question 6

This question was tackled by 88% of candidates with 78% obtaining a pass (24% of answers were at A-grade). In general, candidates used very clear diagrams of a lauter tun and of a mash filter to explain the basic principles of their design and operation. It was expected that the diagram of the lauter tun would show sprinkler heads for supplying sparge water, rakes, and slotted plates through which the wort is filtered. Modern vessels are filled from the base to avoid aeration and damage to the husk. Filtration gives a bright wort through a shallow bed and the initial cloudy wort is recirculated. The rakes can be used to reduce bed compaction and increase wort flow if it has slowed down. Sparge water is sprayed over the grain and there is careful control of the differential pressure above and below the lauter plates. A typical lauter tun cycle can be described as follows:

> Underletting, filling, re-circulation, first worts, second worts, last worts, weak worts, drain down and grain removal.

Mash filters have numerous small bed depths rather than a single deeper bed. This enables very fast run-off of wort and effective sparging. The filter is constructed of alternate frames to hold the mash and plates to channel wort run-off and sparging. Thin bed mash filters are fitted with expandable membranes which can be inflated to squeeze the mash beds gently and thus improve the yield of extract and provide a drier spent grain with lower effluent loading. Filling filters from the bottom channel produces less mash aeration.

The lauter tun may produce wort of greater clarity, and with lower levels of polyphenols. However, the mash filter has a number of advantages, for example, there are less moving parts and, therefore, less maintenance because the husk is not required for filtering. The grind with a hammer mill provides a finer grind which increases extract and there are less problems with β-glucan. There is improved foam when using a mash filter. The mash filter takes up less space, it is easier to remove the spent grain at the end of the process and the filtering time is reduced so that more brews can be processed in a single day.

Weaker candidates drew diagrams of a mash filter and a lauter tun but failed to discuss the principles of their operation. The question asked that an account be given of the basic principles of both the design and the operation of these two means of mash filtration. Although it is encouraging that clearly labelled diagrams were given by the majority of candidates, it is disappointing how many failed to give clear accounts. In a few instances, comparisons were made between mash tuns and lauter tuns because the question had not been carefully read.

Question 7

This question was answered by 94% of candidates with 80% gaining a pass (20% of answers were at A-grade). The first part of this question was generally well answered with candidates describing the process of α-acid isomerisation, the complexing of proteins and polyphenols to form hot break, Maillard reactions and formation of melanoidins, oxidation of tannins, sterilisation of wort, arrest of enzyme activity, precipitation of calcium phosphate, evaporation, production of DMS, and evaporation of water.

The second part of the question, however, was generally less well answered. Most candidates drew a diagram showing a whirlpool vessel and described how wort is introduced tangentially supplying a centrifugal force which accelerates the movement of trub particles towards the centre of the vessel where they aggregate to form a flock. Other answers described, with generally good diagrams, the operation of typical screw hop strainers. However, many answers failed to mention that settling tanks could be a suitable means of clarifying wort if hop pellets had been used or described the use of a wort centrifuge and its associated problems. For example, a very wet discharge is obtained if the entire kettle volume is centrifuged but a wort centrifuge can be an excellent means of recovering entrained wort from a trub cone. While too many answers focussed simply on the whirlpool vessel there was also a lack of attempts by many candidates to describe why wort clarification is necessary. If there is insufficient trub removal it can lead to a poor yeast performance, unsatisfactory attenuation, potential infection of wort, and the formation of hazes. Furthermore, the resulting product can have an unsatisfactory taste. Effective wort clarification is therefore essential so that good fermentations can be achieved and a high quality product produced. AME candidates need to be clear not only how different procedures are carried out within breweries, but also the aims of the procedures. If the aims of the procedures are not understood, then candidates may not be aware of the causes of processing difficulties within a brewery if the procedures have not been properly carried out.

Question 8

This question was attempted by 49% of candidates, with 44% of these candidates achieving a pass (5% of answers were at A-grade). Good answers compared the effluent streams from the different departments of the brewery in terms of BOD, suspended solids, volume, temperature and pH, whereas a number of poorer answers only listed the sources of effluent across the brewery without any attempt to quantify or compare. The question on methods of charging for effluent was well answered by most candidates, with Mogden Formula predominating but with some answers referring to a "volume only" basis and one answer as an annually negotiated fee! – an acceptable means of charging, provided the parties are in agreement. There were some excellent answers on aerobic and anaerobic digestion, showing in-depth understanding and knowledge of the processes involved, with good diagrams of the typical plants used. The main reason for failure was lack of information and explanation to convince the examiner that the processes were understood; answers were often very simplistic such as "aerobic digestion is carried out by aerobic organisms, aerobically; i.e. in the presence of air". This is factually correct, but more information and explanation of the process would be expected from AME candidates.

Summary

The questions focusing on water and effluent were unpopular with candidates and poorly answered. These are important aspects of the syllabus and are examined to ensure that candidates study the full range of topics in this Module – Materials and Wort. Gaps in the knowledge of candidates are apparent even in questions not directly asking on the topic where the gap is present. For example, production of malt and wort all lead to effluent problems, and good candidates would discuss effluent handling even where a question relates more specifically to other aspects of production. Candidates who have passed the General Certificate Examinations should read widely to enhance their knowledge and understanding of syllabus topics.

There was evidence from a number of papers that candidates were trying to pass on knowledge based on the particular part of the production process with which they were very familiar. In preparing for the AME, candidates should take care to ensure that they cover the whole syllabus. Wherever possible, candidates should ensure that they are reading the *Journal of the Institute of Brewing* and the *Brewer International* on a regular basis, both published by the Institute and Guild of Brewing. The articles in these publications will broaden knowledge, knowledge that will greatly enhance the effectiveness with which examination candidates are able to work in a maltings, brewery, laboratory or related production process.

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 2 – Yeast and Beer

Tuesday 11th June 1400–1700

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. Describe how brewing yeast cells absorb wort carbohydrates and convert them into ethanol. **[20]**

2. Write notes to describe the measurement, control and importance in brewing of **TWO** of the following:

a) beer foam **[10]**
b) wild yeast **[10]**
c) beer colour **[10]**

3. With the aid of a fully labelled diagram, describe the key features of a typical brewery yeast cell, as seen in electron micrographs. **[10]**

Outline the functions of these sub-cellular structures. **[10]**

4. Describe how oxidative reactions throughout the brewing process can influence beer quality. **[20]**

5. Write notes on the properties, occurrence and significance in brewing of **EACH** of the following genera of bacteria:

a) *Pediococcus* **[5]**
b) *Acetobacter* **[5]**
c) *Bacillus* **[5]**
d) *Zymomonas* **[5]**

6. Write an essay on the effects of inorganic ions on beer flavour and quality. **[20]**

7. Explain what is meant by the terms yeast viability and yeast vitality and describe how these parameters can be affected by storage conditions in a brewery. **[20]**

8. Write notes on the significance of **TWO** of the following in beer:

a) non-biological haze **[10]**
b) gushing **[10]**
c) diacetyl **[10]**

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 2 – Yeast and Beer

One hundred and thirty nine papers were entered (two of which were for the Distilling option), with an overall pass rate of 88%. This compares to 173 entries last year (5 for Distilling) with a pass rate of 86%.

The pass rate continues to show a continuing increase over those achieved in recent years (cf 86% last year, 74% in 2000). This year's result is particularly pleasing, since over 8% of candidates were awarded grade A, with a further 27% achieving grade B. The upward trend in the overall quality of presentation also continues year on year.

Unfortunately, some candidates still attempted to answer some questions without heeding the precise wording, with one or two attempting to answer more than the required six questions.

Question 8 proved to be the most popular, with over 97% of candidates selecting it, and achieved the best pass rate (at over 90%); question 6 was by far the least popular question, attempted by only 38% of candidates and achieved the lowest pass rate (73%).

Question 1

83% of candidates attempted this question, with 81% gaining pass marks or above. There were some exceptional good answers, but also several candidates glossed over the details relating to how sugars are actually absorbed into yeast cells.

The better answers detailed the uptake of glucose and fructose (either already present in wort or produced from sucrose by secreted Invertase), followed, in turn by maltose and then maltotriose, all accomplished by the direct effect of specific Permease systems. The sequential nature of the absorption, following the synthesis of the relevant Permeases should also have been addressed. Many candidates also provided clear understanding of the primary control influences, especially the so-called "Pasteur" and "Crabtree" effects, plus details of proposed biochemical explanations for these physiological phenomena.

Most candidates then provided very detailed descriptions of the EMP (Embden-Meyerhof-Parnas) pathway, including several answers that identified the precise enzymic reactions at every stage in the Glycolytic pathway. The level of knowledge displayed in some answers was highly laudable, although the examiner was really looking for a good understanding of the nature of glycolysis, but with some indication of understanding of the principal control features relating to the significance of anaerobic metabolism. Good answers also detailed the importance of ethanol production to regenerate NAD^+ and to "detoxify" yeast cells by elimination of pyruvate.

Question 2

This question was one of the best answered of the paper and appeared to be very popular, with some 88% of candidates tackling it and 86% achieving the pass mark.

Beer foam. Many answers showed good understanding of most features related to foam formation. There were several detailed descriptions of the physical considerations of foam stability, coupled with very detailed assessments of "head-positive" and "head-negative" factors and the control of these materials at all stages in the brewing process, most remembering to stress the importance of preventing foaming during processing, in order to preserve foaming ability into the glass.

There were interesting discussions on the relative importance of beer foam from the consumer's perspective. However, several candidates omitted to describe any methods of foam measurement or provided only cursory answers. Some candidates did provide detailed descriptions, but many challenged the general applicability and accuracy of the various methods. Some candidates also included descriptions of methods for assessing "cling".

Wild yeast. Most answers noted that, by definition, any yeast other than the desired pitching yeast, present at any time during brewing, is rightly regarded as a "wild" yeast. However, information regarding methods for identifying *Saccharomyces* and non-*Saccharomyces* yeasts was particularly relevant (such as lysine agar to distinguish non-*Saccharomyces* genera; also copper sulphate or crystal violet agar to discriminate between culture strains of *S. cerevisiae* and wild strains of *Saccharomyces*). In addition, good answers also attempted to list known wild yeast genera and to describe the consequences of their contamination in brewery fermentations (such as the generation of acidic or estery or phenolic off flavours, the action of "killer" strains, the influence on haze through poor flocculation or, like *S. diastaticus,* causing over-attenuation by utilising dextrins).

Beer colour. Many answers provided clear descriptions of the origins of beer colour, being predominantly from melanoidins formed during malt kilning and wort boiling. Many candidates provided very detailed accounts of melanoidin formation, including Maillard reactions and Amadori re-arrangements, involving the condensation of amino acids and reducing sugars, followed by polymerisations, and also indicated that oxidation of malt and hop polyphenols can also contribute to beer colour. It was often noted that, in most light-coloured beers (that is beers that do not include extracts containing a significant proportion of coloured malts), about one third of beer colour is produced during malt kilning, with the other two thirds produced during wort boiling. From this estimation, it is quite straight forward to define the appropriate methods for controlling beer colour (such as, defining malt specifications and grist recipes relevant to the target beer specification, ensuring materials conform to the appropriate colour standard, ensuring consistency of process conditions during boiling viz. temperature, heating time, stand time, etc, but also controlling oxygen ingress throughout wort production). Comments on use of caramel and other colourants were also relevant.

Good answers included precise descriptions of comparator and spectrophotometric methods for colour determination, indicating their inadequacies regarding assessment of hue and described, in detail, the principles and benefits of the more modern approaches of "3-dimensional" colour measurement or chromaticity.

Question 3

Question 3 proved to be the second most popular question in that over 92% of the candidates replied to this question, and with a relatively high degree of success (over 85% gained a pass grade).

In the main, there were clear diagrams provided, although the examiner was somewhat perplexed by the marked reluctance of most candidates not to use a full page for the diagram. In addition, most provided good identification of the various sub-cellular features (often providing some attempt at approximate dimensions).

Unfortunately, many answers glossed over the second part of the question, apparently ignoring the fact that this section carried half of the total marks. There were, however, some very detailed responses, including acknowledgement that mitochondrial structure is reduced during Fermentation (as opposed to Respiration). One common confusion noted was the association of the Endoplasmic Reticulum with Ribosomes and the role of the latter in protein synthesis.

Question 4

This question proved to be one of the least popular in that only 51% of the candidates attempted it, but with a relatively high degree of success (80% gained a pass grade), indicating a significant level of understanding of the key features of oxidative reactions in brewing.

Several answers tackled this question in a very logical fashion, by firstly defining the scope of the oxidative reactions and identifying that oxygen usually exists in a relatively non-reactive (triplet) state, until, as a result of catalytic reactions occurring during brewing, the formation of highly reactive "superoxides" is stimulated. Reaction then with many wort and beer compounds and lack of various control or preventative measures at key stages in brewing leads to all the problems subsequently associated with beer staling in finished package. These answers then proceeded to list all key brewing stages and outline key oxidation reactions, right from barley and hop storage, all stages of malting, wort production, fermentation, maturation, processing through to, pasteurisation and packaging.

Several candidates identified the somewhat ironic need for oxygen at the start of fermentation (although very few remembered to include yeast propagation) but the otherwise absolute necessity for air-free conditions elsewhere. Good answers also developed the concept of maintenance of reducing power at all times and many referred to the stale flavour associated with the formation of trans-2-nonenal. Other adverse consequences of oxidative effects noted included increased diacetyl production, reduction of bitterness, decreased foam potential, colloidal instability and increased risk of aerobic infection.

Question 5

Somewhat surprisingly, only 59% of candidates answered this question (with a success rate of 75%). Unfortunately, several candidates elected to present answers that did not address all sections of the question, so that relatively few achieved high pass marks. However, there were several very good answers and it appeared that some candidates used this question as the last question to be answered in order to pick up marks as time ran out!

The following information was anticipated:

Pediococcus is a lactic acid bacterium, with cocci occurring in pairs and, classically, in tetrads. It is Gram-positive, catalase-negative and anaerobic. *P. damnosus* is the most common, is resistant to hop acids, can produce extremely high levels of diacetyl. Pediococci can also produce slime and rope. Pediococcal infections have been known as "sarcina sickness", characterised by acid formation and the strong "buttery" aroma of diacetyl.

Acetobacter is Gram-negative (or Gram variable) and the cells are rod-shaped, occurring singly, in pairs or chains and non-motile. *Acetobacter* spp. are obligate aerobes, catalase-positive, oxidase-negative and oxidise ethanol to acetic acid and acetate to CO_2 and H_2O. The bacteria can form rings or film and are present in most pub cellars and always occur when beer spillages are not cleaned up!

Bacillus is not usually a concern in beer, due to the low pH. However, these Gram-positive, catalase positive, aerobic endospore-forming bacteria can cause Brewery problems. The spores are present in malt and in cereal adjuncts and will survive wort boiling. Several species are thermophilic and can produce large amounts of lactic acid in sweet wort held hot for any length of time (as in Brewhouse delays). In addition, some *Bacillus* strains can contribute to nitrosamine formation through their ability to reduce nitrate to nitrite. Finally, it should be noted that several enzymes of value in Brewing are produced commercially from *Bacillus* cultures.

Zymomonas cells are short, plump, Gram-negative rods, occurring mostly in pairs, chains or rosettes. *Zymomonas* strains are anaerobic (but can tolerate oxygen) and can ferment glucose and fructose (but not maltose) and can grow and metabolise in the presence of high ethanol concentrations, even capable of producing up to 15% (v/v) ethanol. The characteristic beer spoilage is the production of acetaldehyde ("green apples") and hydrogen sulphide ("bad eggs"), usually in beer primed with sugar and so is an important contaminant in ale Breweries (often said not to exist in lager breweries). They are often associated with old buildings and can be found in wells and soil associated with breweries.

Question 6

This question was, by far, the least popular, selected by only 38% of candidates, of which 73% achieved the pass standard. Some answers, however, showed that some candidates had a very good understanding of this topic, although very few answers were presented, as the question had requested, in a true, classical essay style.

It is somewhat surprising that more answers did not recognise the direct and indirect influences of inorganic ions on flavour, since there are several references in the literature to the classical effects of sulphate, chloride, sodium, magnesium, iron etc on flavour and the historical records of the influences of regional water compositions on the beer types associated with those regions e.g. Pilsen, Munich, London and Burton-on-Trent. In addition, there are excellent summaries of the effects of ions such as calcium, carbonate and phosphate on the control of pH (that is, the level of hydrogen ions) through brewing and, therefore, major influences on beer quality.

Final, there is a huge catalogue of the influences of ions on yeast growth and metabolism; the roles played by these ionic species being both enzymatic and structural.

Question 7

88% of candidates answered this question, with a pass rate of over 78%.

Here, the examiner was looking for clear explanations of these terms and descriptions of the various methods available for estimating yeast viability AND vitality (NOT either/or which is how some candidates interpreted the question, for some reason). In addition to good outline explanations, some answers included very precise descriptions of actual laboratory procedures.

Several answers, however, provided only inadequate explanations of the influence of storage conditions and failed to appreciate that storage of yeast between fermentations is primarily for the benefit of the Brewer and that storage must be designed to minimise adverse effects on yeast cells. Consequently, the examiner required clear descriptions of ideal yeast handling systems, designed (by controlling time, temperature, alcohol level and restricting oxygen ingress) to preserve yeast integrity in order to maintain vitality to the maximum. Good answers also highlighted the influences of storage conditions on key parameters such as intracellular levels of glycogen and trehalose.

Question 8

This was the best answered question (over 90% of candidates achieved the pass mark) and the most popular with over 97% attempting it; there were some exceptionally good responses, particularly to the section on Diacetyl.

There were many good answers on *Non-biological Haze,* showing a good understanding of all the factors likely to contribute to haze formation and their sources (such as, polypeptides, polyphenols, starch, β-glucan, iso-α-acids, oxalate, metal ions, collapsed foam, filter powder) and also of available preventative measures to stabilise beer against haze formation. There were also several good accounts of the various methods available for measuring and predicting haze development.

Similarly, the topic of *Gushing* elicited some excellent answers; one candidate even pointed out (quite rightly) that gushing was the one beer characteristic about which there could be no argument (when a beer gushes, there is no mistaking it!).

Factors contributing to this phenomenon are well documented and include: physical effects, such as excessive shaking, exposure to very low temperature; chemical factors, such as calcium oxalate content, presence of heavy metals, such as iron, tin, nickel etc, presence of certain oxidation products derived from hop alpha acids (the most potent gushing agent being dehydrated humulinic acid); and microbiological contaminants arising from the microflora of weathered barley, the most notorious being *Fusarium*.

The importance of *Diacetyl* was especially well understood, with very clear descriptions of the production and removal mechanisms involved, plus knowledgeable accounts of Production procedures used to control the levels of vicinal diketones, including the use of "krausening" and modern approaches to accelerated maturation (such as immobilised yeast technology and the addition of commercial preparations of α-acetolactate decarboxylase from *Bacillus* sp.). Finally, good descriptions of the flavour characteristics associated with diacetyl were provided.

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 3 – Packaging and Process Technology

Wednesday 12th June 1000–1300

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. Choose a suitable secondary packaging material for **ONE** of the following forms of primary packaging.

i) Non-returnable glass bottle
ii) Plastic bottle
iii) Can

Describe its function and basic properties and discuss potential marketing and legal impacts. **[10]**

Compare the environmental effects of your chosen packaging with those of other materials. **[5]**

What impact does the choice of secondary packaging have on the operation of the packaging line? **[5]**

2. For returnable bottle **AND** either keg **OR** cask, describe with the aid of suitably labelled diagrams, the principles of the design and operation of the associated packaging plants. **[20]**

3. With reference to the equation below, discuss the influence of pipe diameter, material of construction and presence of fittings on the pressure drop in pipework systems. **[6]**

$$\Delta P = \frac{2L}{d}\rho u^2 C_f$$

where ΔP is the pressure drop
L is the length of the pipe
d is the pipe diameter
ρ is the fluid density
u is the fluid velocity in the pipe
C_f is the Fanning friction factor

Beer is pumped through a 125 mm diameter pipe to a remote packaging plant at a flow rate of 70 m^3h^{-1}. The

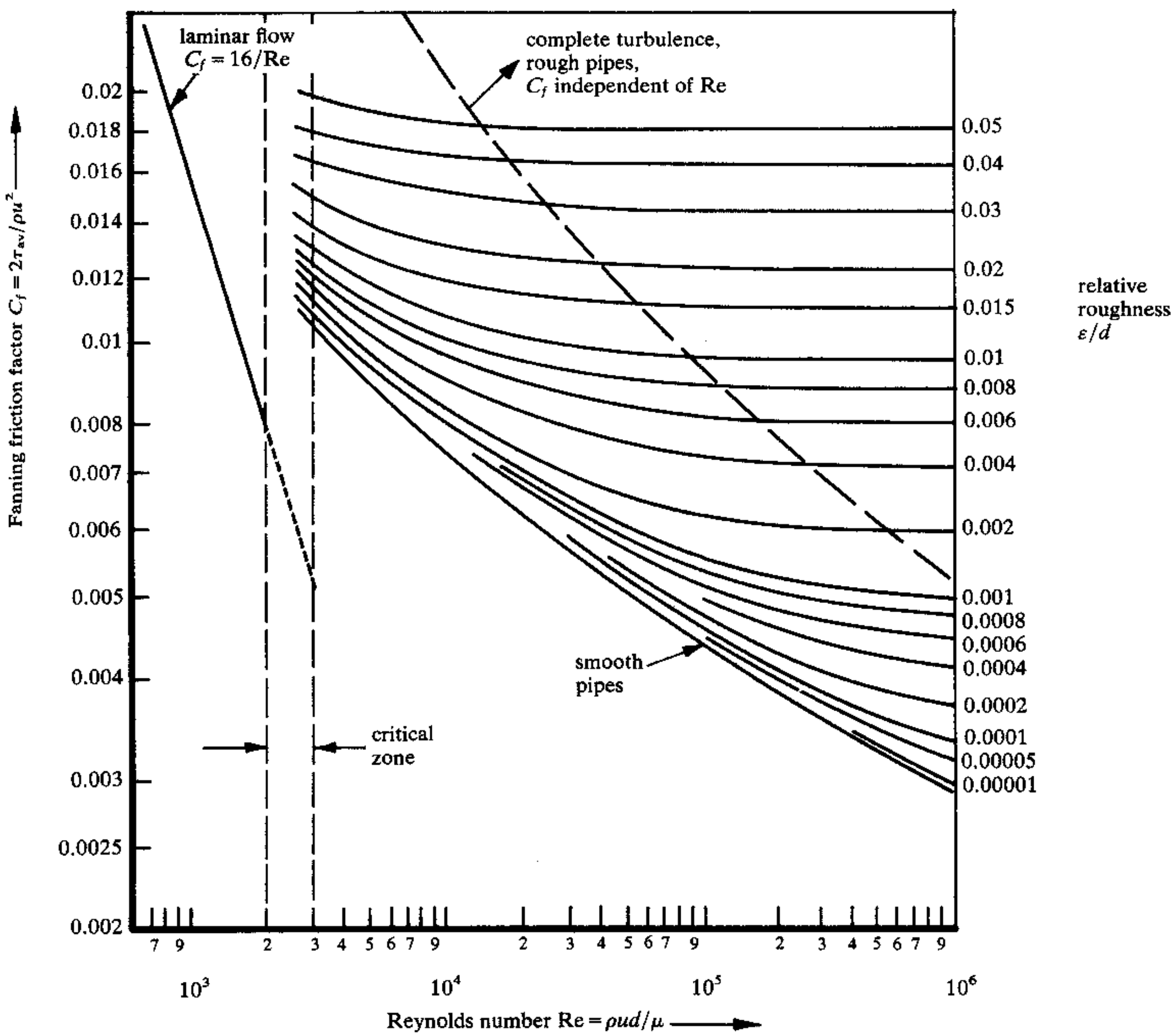

Fig. E.1. Pipe friction chart (Moody chart).

Properties of Ammonia

Saturation values					50 K superheat		100 K superheat	
T [°C]	P_s [bar]	h_f [kJ kg^{-1}]	h_g [kJ kg^{-1}]	s_g [kJ kg^{-1} K^{-1}]	h [kJ kg^{-1}]	s [kJ kg^{-1} K^{-1}]	h [kJ kg^{-1}]	s [kJ kg^{-1} K^{-1}]
–20	1.9	89.8	1420	5.623	1535	6.039	1646	6.379
28	11.0	313.4	1468	5.005	1608	5.437	1733	5.770

Where: T = temperature
P = pressure
h = specific enthalpy (subscripts f and g refer to saturated liquid and gas)
s = specific entropy (subscript g refers to saturated gas)

pipe has an internal roughness, ε, of 0.05 mm and the total length, allowing for all fittings and valves, is equivalent to 150 m. Assuming the beer has a density of 1010 kg m^{-3} and a viscosity of 0.001 Pa s, calculate the pressure drop in the pipe system. **[10]**

Assuming the receiving tank is at the same pressure as the supply tank but is at a height 4 m above it, what total head rise would the pump need to deliver to be suitable for this application? (Acceleration due to gravity = 9.81 m s^{-2}.) **[4]**

(A Moody chart is supplied as Fig. E.1.)

4. Describe the basic principles of the design and operation of a tunnel pasteuriser. **[10]**

With the aid of a suitable diagram demonstrate a typical time course for temperature and pasteurisation effect, in the tunnel pasteuriser, indicating the accumulation of pasteurisation units. **[10]**

5. Explain the basic principles of the design and operation of a two stage plate heat exchanger for cooling wort using water and secondary refrigerant. **[10]**

Wort is to be cooled from 92°C to 10°C using water available at 16°C and secondary refrigerant at 0°C in a two stage plate heat exchanger. If the mass flow rate of both wort and cooling water through the exchanger is 10 kg s^{-1} and the mass flow rate of secondary refrigerant is 20 kg s^{-1}, calculate the heat transfer area required, given the following additional data. **[10]**

Specific heat capacity of both wort and water = 4.2 kJ kg^{-1} K^{-1}
Specific heat capacity of secondary refrigerant = 3.8 kJ kg^{-1} K^{-1}
Overall heat transfer coefficient for the water cooled section = 1100 W m^{-2} K^{-1}
Overall heat transfer coefficient for the refrigerant cooled section = 1000 W m^{-2} K^{-1}
The refrigerant leaves the exchanger at 10°C

6. Beer from a flash pasteuriser is used to fill kegs to give a product containing 4.0 g L^{-1} of carbon dioxide (CO_2) at s.t.p. The kegs are to be stored at 12.5°C and dispensed using an over pressure of 0.8 bar above the pressure required to maintain the CO_2 in solution. What will be the equilibrium concentration of CO_2 in the beer under the dispense conditions? **[10]**

If the beer were dispensed under the same conditions but using a mixed gas (60% vol/vol CO_2: 40% vol/vol N_2) what would now be the equilibrium concentration of CO_2 in the beer? **[5]**

Comment on the importance of having a correct balance of temperature pressure and carbon dioxide content in the beer. **[5]**

Data:
Relative Molecular Mass (RMM) of carbon dioxide is 44.
RMM of water is 18.
Henry's constant for carbon dioxide in beer/water at 12.5°C is 1230 bar(a) mole fraction^{-1}.

Notes:
(i) s.t.p. (standard temperature and pressure) is 0°C, 1.013 bar(a). Under these conditions 1 mol of gas occupies 22.4 L.
(ii) beer can be treated as water for calculation purposes (*i.e.* RMM = 18, density = 1000 g L^{-1})

7. Describe, with suitable diagrams, the basic principles of the closed circuit vapour-compression refrigeration cycle. **[10]**

A refrigeration plant is to be used to extract 15,000 kJ h^{-1} of heat from a cold room containing maturation tanks. If the saturation temperatures for evaporation and condensation of the Ammonia refrigerant are –20°C and 28°C respectively, determine the coefficient of performance of the unit. What flow rate of refrigerant will be required? **[10]**

A table showing the properties of ammonia is presented above.

8. Explain the principles of effective thermal insulation, describing typical materials and reasons for their selection for conditions above and below ambient temperature. **[10]**

Define the following terms:

i) sensible heat **[2]**
ii) latent heat of vaporisation **[2]**
iii) enthalpy **[2]**
iv) saturated steam **[2]**
v) superheated steam **[2]**

ASSOCIATE MEMBERSHIP EXAMINATION (BREWING) 2002

Module 3 – Packaging and Process Technology

A total of 117 candidates sat this examination with almost 79% achieving a pass. This represents an excellent all round performance and suggests that the level of preparedness of most candidates was, as in previous years, very good. Particularly pleasing was the very high number of A grades (24). The full grade distribution was:

A, 21% B, 16% C, 23% D, 19% E, 15% F, 6% G, 1%

Generally, candidates provided concise answers, addressing the questions set without providing irrelevant additional information. Good use was made of diagrams in support of answers and numerical sections were generally laid out in a logical manner with steps in the calculation shown clearly. The following summarises results for each question.

Question 1

This was an unpopular question with only 50% of candidates attempting it. Of these only 67% reached the pass mark, making it one of the most poorly answered questions on the paper. A number of candidates apparently missed the word *secondary* in the first part of the question and therefore discussed the function and properties of primary packaging. Providers of good answers considered the function of the secondary packaging to include containment, protection, presentation and portability, for which properties such as low cost, light weight, durability, disposability/recyclability and attractiveness were useful. Legal and marketing impacts included safety, labelling, design and style. Environmental impacts centred around recycling or disposal and littering and varied depending on the type of secondary packaging chosen. Impact on the packaging line included effects on capacity and efficiency, storage requirements, levels of automation and machine complexity.

Question 2

A more popular question than question 1 (78% attempted it) and generally better answered, with 84% of those attempting it reaching the pass mark. Failure to reach the pass mark was often due to not having read the question correctly, particularly missing the emboldened and underlined **AND.** Good answers included flowsheets (both for bottles and for kegs/casks) of the packaging line with detail of the individual steps in the process, including full description of washing stages. Key steps identified included depalletising/decrating, washing, inspection, filling/capping/crowning, pasteurisation, labelling, recrating/palletising. Discussion of layouts and reference to 'V' curves, concerning packing rates, were also included in better answers.

Question 3

The first of the numerical questions, this was attempted by 78% of candidates with 80% of them reaching the pass mark. Performance on this question was very varied with a considerable number scoring full marks but large numbers scoring poorly. Most candidates knew how to perform the central calculation but many made silly errors like using the surface area of the pipe rather than the cross-sectional area to calculate fluid velocity. Good answers started by determining velocity from the flowrate given then using this in a calculation of the Reynolds number. This, together with the relative roughness (absolute roughness ÷ diameter) enabled the Fanning friction factor to be looked up using the Moody chart supplied. The pressure drop could then be calculated using the equation given, the correct answer being approximately 28,000 Nm^{-2}. This is equivalent to a head of around 2.8 m of beer so that the total head rise required from the pump would be around 6.8 m.

Question 4

This was a very popular question (attempted by 83% of candidates) and was the best answered (91% achieving a pass mark). Most candidates gave a good description of the design and operation of a tunnel pasteuriser. The second half of the question was not generally as well answered as the first. Good answers for the second part included a well labelled graph of temperature against time, showing both spray temperatures and approximate beer temperature, as well as approximate number of pasteurisation units accumulated through the process.

Question 5

Another very popular question (attempted by 91% of candidates) but with only a 64% pass rate. This question tested knowledge of the design and operation of plate heat exchangers as well as including a simple design calculation. Good answers to the first part included sketches showing flow paths and plate design and comments on the principles of counter-current flow; the influence of plate design on turbulence and heat transfer area; the need for pressure gradients from wort to refrigerant to avoid potential contamination if leaks occurred; the use of the heated cooling water for mashing or other purposes and the versatility of plate heat exchangers in terms of being able to change the number of plates and separate them for cleaning purposes when necessary. The calculation required for the second part utilised a heat balance (to determine intermediate wort temperature and final water temperature) along with the convective heat transfer equation to determine areas. A log-mean temperature difference was required for the refrigerant section, while the temperature difference in the water cooled section was constant.

Question 6

This was an unpopular question with candidates, only 56% attempted it, with a pass rate of just 61%. To get the correct answer it was necessary to convert the carbon dioxide concentration given (4 g L^{-1}) to mole faction (= 0.001636). This could then be used in the Henry's law equation to determine the pressure required to keep the CO_2 in solution (2.0127 bar). With the actual pressure being 0.8 bar higher, a concentration of 0.002287 mole fraction (= 5.59 g L^{-1}) would be achieved at equilibrium. If the headspace gas was a mixture with only 60% CO_2 the concentration would be 3.35 g L^{-1}.

Question 7

This was amongst the best-answered question on the paper, with 89% of the 73% who attempted it reaching the pass mark or higher. Almost everyone was able to give a full description of the refrigeration cycle but fewer made the necessary calculations correctly. Just three enthalpy values were required to make the calculation. Prior to the compressor, the ammonia is saturated vapour at –20°C (i.e. with entropy = 5.623 kJ kg^{-1} K^{-1}, from the table given). The compression is then carried out isentropically until the pressure reaches the pressure for saturated liquid at 28°C. Under these conditions the ammonia is superheated and the table suggests that for an entropy of 5.623 kJ kg^{-1} K^{-1} the degree of superheat is about halfway between 50 and 100 Kelvin. By linear interpolation the degree of superheat is 78 K, at which temperature the enthalpy would be 1678 kJ kg^{-1}, i.e. 56% of the way between the values given for 50 and 100 K of superheat. Hence, the coefficient of performance is given by

$$(1420 - 313.4)/(1678 - 1420) = 4.29$$

(see also Engineering Blue Book, p. 147).

Question 8

The last question was attempted by 79% of the candidates with 85% of these passing. Although a straightforward question, a large number of candidates answered it poorly, particularly the definitions of the various heat terms. Good answers to the insulation question included reference to heat transfer and the benefit of low thermal conductivity and large thickness in insulation, along with the beneficial effects of stagnant air pores. The need for a vapour barrier in the case of below ambient systems was identified by most candidates. For the definitions, sensible heat (heat that when added or removed from a body results in a change in temperature) and enthalpy (the amount of heat contained in a body, relative to a specified datum temperature) caused the greatest difficulties.

ASSOCIATE MEMBERSHIP EXAMINATION (DISTILLING) 2002

Module 1 – Materials and Wort

Tuesday 11th June 1000–1300

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. Identify the major diseases and infestations which may occur in the growth and storage of barley and explain how they may they be controlled. **[20]**

2. In the production of malt for malt whisky distilling, describe the process parameters that can be controlled during **two** of he following stages, and explain the problems that arise if these parameters are not properly regulated.

(a) Steeping **[10]**
(b) Germination **[10]**
(c) Kilning **[10]**

3. What do you consider to be the **four** most important items in the specification of malt for a malt whisky distillery? Explain their importance to the procedures in the distillery and the quality of the final product. **[20]**

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

What are the implications of an unacceptably low friability result? **[6]**

5. With the aid of a diagram, describe the procedure for preparation of wort from maize or wheat in a grain whisky distillery. **[20]**

6. Explain the difference in grist preparation and mode of operation between a lauter tun and a traditional mash tun in a malt whisky distillery. **[12]**

What are the advantages and disadvantages of these two mashing systems? **[8]**

7. Over recent years, process water has become substantially more expensive, generating an interest in reducing the water requirements of a distillery without adverse effects on product quality. Discuss **four** possibilities for reducing water consumption in **either** a grain **or** a malt whisky distillery which also operates its own maltings and animal feed plant. **[20]**

8. With reference to either grain or malt distilling, write brief notes on the following:

(a) A method of calculating effluent costs **[6]**
(b) Aerobic digestion **[7]**
(c) Anaerobic digestion **[7]**

ASSOCIATE MEMBERSHIP EXAMINATION (DISTILLING) 2002

Module 2 – Yeast and Beer

Tuesday 11th June 1400–1700

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. Describe how cells of *Saccharomyces cerevisiae* absorb wort carbohydrates and convert them into ethanol. **[20]**

2. Parts of the definition of Scotch whisky are reproduced below. For each quotation, discuss its influence on the manufacturing process and the quality of the final whisky.

i) "Has been distilled at less than 94.8% alcohol by volume". **[5]**
ii) "Has been matured in an excise warehouse in Scotland, in oak casks not exceeding 700 litres capacity, for not less than 3 years". **[10]**
iii) "No substances other than water and spirit caramel have been added. Has a minimum alcoholic strength 40% by volume". **[5]**

3. With the aid of a fully labelled diagram, describe the key features of a typical cell of *Saccharomyces cerevisiae*, as seen in electron micrographs. **[10]**

Outline the functions of these sub-cellular structures. **[10]**

4. Acetaldehyde is more volatile than ethanol and phenols are less volatile. With the aid of a diagram, discuss the effect of the relative volatility of these compounds on the spirit distillation of a strongly peated (phenolic) whisky. **[8]**

Assume that the normal duration of the complete distillation of foreshots (heads), spirit and feints (tails) is 8 hours. Describe and explain the effect on the flavour of the spirit of reducing the distillation time to 4 hours, but maintaining the same spirit/feints cut point of 60% alcohol by volume (abv). **[6]**

What should be the effect on the spirit from the 4-hour and 8-hour distillations of reducing the spirit/feints cut point to 50% abv? Explain your prediction. **[6]**

5. With the aid of a diagram of a type of continuous still with which you are familiar, explain the mode of operation and in particular the procedures required to ensure maintenance of the quality of the spirit. A description of start-up and close-down routines is NOT required. **[14]**

On a supplementary diagram, show how the distribution of ethanol and the principal congeners over the height of the rectifier column determine the choice of spirit plate. **[6]**

6. The compounds or types of compound listed below could be measured in quality analysis of mature whisky. Give a brief account of the analytical method for determination, and explain the relevance to the quality of whisky, of **two** of the following:

(a) butanols and iso-amyl alcohol **[10]**
(b) ethyl carbamate **[10]**
(c) tannins **[10]**

7. Explain what is meant by the terms yeast viability and yeast vitality, and describe how these parameters can be affected by storage conditions and the preparation of yeast for pitching the washback (fermentation vessel). **[20]**

8. Giving the approximate percentage of each compound, what are the principal structural components of oak wood? **[8]**

With respect to these compounds, what chemical changes occur on charring the wood of new and used casks? **[12]**

ASSOCIATE MEMBERSHIP EXAMINATION (DISTILLING) 2002

Module 3 – Process Technology

Wednesday 12th June 1000–1300

Answer any SIX questions

All questions carry the same mark of 20

(The marks allocated to parts of questions are shown in brackets [ ] and you are strongly advised to allocate your time accordingly)

1. With respect to flavour, energy and maintenance aspects, discuss the advantages and disadvantages of worm and shell-and-tube heat exchangers for condensing and cooling of distillate. **[10]**

Wash weighing 12000 kg, collected at 30°C at the end of fermentation, is heated to 65°C in a plate heat exchanger against a counter-current flow of the 7800 kg of pot ale remaining from the previous distillation. What is the outlet temperature of the pot ale? **[4]**

How many heat exchanger plates of area 0.6 m^2 are required to pre-heat 12000 kg of wash from 30° to 65°C in 60 min? **[6]**

Assume for the calculation that both wash and pot ale are pure water, specific heat 4.18 kJ $kg^{-1}K^{-1}$, and the pot ale is stored at constant temperature 100°C.

Heat transfer coefficient of plates = 800 W m^2K^{-1}

2. With the aid of annotated drawings of each type of sieve plate, describe the design of the plates of the analyser and rectifier columns of a continuous grain whisky still. Explain the purpose of each of the features you have described. **[20]**

3. With reference to the equation below, discuss the influence of pipe diameter, material of construction and presence of fittings on the pressure drop in pipework systems.

$$\Delta P = \frac{2L}{d}\rho u^2 C_f$$

where ΔP is the pressure drop
L is the length of the pipe
d is the pipe diameter
ρ is the fluid density
u is the fluid velocity in the pipe
C_f is the Fanning friction factor **[6]**

Wash is pumped through a 125 mm diameter pipe to the still charger vessel at a flow rate of 70 $m^3\ h^{-1}$. The pipe has an internal roughness, ε, of 0.05 mm and the total length, allowing for all fittings and valves, is equivalent to 150 m. Assuming the wash has a density of 1000 kg m^{-3} and a viscosity of 0.001 kg $m^{-1}\ s^{-1}$, calculate the pressure drop in the pipe system. **[10]**

Assuming the receiving vessel, the wash still charger vessel, is at the same pressure as the washback but is at a height 4 m above it, what total head rise would the pump need to deliver to be suitable for this application? (Acceleration due to gravity = 9.81 m s^{-2}.) **[4]**

(A Moody chart is supplied as Fig. E.1.)

4. Describe, with the aid of a diagram, the successive stages of collection and purification of food-grade carbon dioxide from a fermentation. **[8]**

Discuss the advantages and disadvantages of operating this process rather than simply venting off the CO_2. **[6]**

Calculate the theoretical weight of CO_2 which could have been obtained from one fermentation in a washback of working capacity 400,000 litres, which has produced wash of 9.0% v/v alcohol. **[6]**

Atomic weights: H = 1, C = 12, O = 16; density of pure (100%) ethanol = 0.788.

5. Describe, with the help of a flow diagram, the stages in the concentration of spent wash from continuous distillation of a "grains-in" wash to "dark grains" for animal feed. **[14]**

Explain the energy-saving advantages of multiple effect evaporation in the process. **[6]**

6. Discuss the origin of haze-forming precursors in whisky. **[10]**

Explain with the aid of a diagram the construction of typical sheet filters operated with and without filter aid. **[6]**

And discuss the merits of two different types of filter aid in filtration of whisky. **[4]**

7. With the aid of appropriate diagrams, explain the arrangements to provide steam for cereal cooking without de-stabilising a continuous still operated from the same boiler. Also describe a system for energy recovery after cooking is complete. **[12]**

Calculate the weight of steam required to cook 20 t of maize at 140°C (3 bar g).

Initial temperature of maize and 48 t of water feed = 10°C. Assume a perfectly insulated cooker vessel, so the duration of cooking is irrelevant. **[6]**

Calculate the saving, in both energy units and weight of steam, from mixing the maize with 48 t of recycled water at 70°C instead of cold water, at the start of the cooking process. **[2]**

Specific heat of maize = 1.47 kJ $kg^{-1}K^{-1}$;
Specific heat of water = 4.18 kJ $kg^{-1}K^{-1}$;
Latent heat of condensation/evaporation of water at 140°C = 2131 kJ kg^{-1}.

8. Among the requirements for computer control of malt whisky distillation are equipment for temperature, flow rate and density. Explain how these instruments work, and how they could be combined for automatic control of wash and spirit distillations. **[20]**

ASSOCIATE MEMBERSHIP EXAMINATION (DISTILLING) 2002

Modules 1, 2 & 3

Once again we saw the problems for candidates sitting an examination which includes questions from both the malt and grain distilling industries: in many papers there was an obvious difference in standard between answers which were specifically on grain or malt distilling. There are no immediate plans to offer candidates a choice of malt or grain aspects within the same question as in the Certificate examination. So unless candidates from malt distilleries make themselves reasonably familiar with grain distilling operations (and vice versa) they risk being unable to answer well the full quota of questions. It can safely be assumed for all three papers that many questions will be common to both grain and malt distilling. But inspection of recent examination papers will show that it is unwise to expect to answer 6 out of the total of 8 questions in each paper without some knowledge of the "other" side of the Scotch whisky industry. However, it is only fair to state that I do not believe that anyone failed for this reason, but it was the cause of some candidates achieving lower grades than they should have obtained.

Module 1: Materials and Wort

Nine sat this examination, eight from Scotland. Only one person seriously attempted question 1, although two others started it as their last answer. The diseases and infestations which may occur during growth in the field are different from the problems which can arise in silos, especially if parts of the bulk barley have been inefficiently dried and zones of higher moisture content allow the growth of storage fungi. It was expected that sufficient time would be available to discuss the nature and control of microbial and insect pests of growing barley and the equivalent problems during post-harvest storage.

Since the Brewing examiner set question 2, his report should be consulted for comments. There was no standard answer expected for question 3, which everyone answered. My expectation proved correct that each candidate would have different priorities in the choice of malt specifications, but I had not foreseen that extract, fermentability and spirit yield would be presented as three distinct items. I agree that all are important, but they are inter-related. Perhaps they should count as only one, but in an unusually generous gesture I accepted them as a maximum of two parts of a specification. However, one candidate's brilliant idea to duplicate the explanation of the Friabilimeter also used in question 4 scored few marks. With such a wide alternative choice, e.g. barley variety (and/or EC potential, but again only as one item), nitrogen content, 1000-corn weight, NDMA and phenol, any difficulty in answering should have been in choosing exactly which four were the most important, and I would have accepted any reasonable choice. The Scottish candidates explained well the importance of their choice in the context of malt distilling, even if occasionally I rejected an item as a non-valid duplicate. Now, back to question 4 on the Friabilimeter. Although not specifically requested, many of the eight answers did include a drawing and certainly it clarified and simplified the explanation. Future candidates, there is no harm in adding (neat) drawings to descriptions: often a simple sketch is more informative than many lines of written explanation. Most answers demonstrated familiarity with the equipment and its value in supporting malt analyses, although one candidate unfortunately lost 6 marks by not noticing, or deciding to ignore, the second part of the question.

Six of the candidates attempted question 5, with variable results; in fact my initial comments on grain and malt specialisation were partly prompted by this particular question. Some candidates found it difficult to describe the procedure for preparation of wort from maize or wheat in a grain whisky distillery, and I was really surprised that one candidate thought that the malt was put in the pressure cooker with the cereal. As an absolute minimum, it was necessary to explain cereal cooking, subsequent cooling by flashing off the steam, and mixing with ground malt in a mash tun or equivalent vessel.

Seven candidates answered question 6. Those who chose it as one of their earlier answers all gave a good explanation, in words and drawings, of the difference in grist preparation and mode of operation between a lauter tun and a traditional mash tun in a malt whisky distillery, and tabulated the advantages and disadvantages of each. Unfortunately, there were also some disappointing answers from those who answered it later in the examination, perhaps desperate for a final question to answer.

Question 7 on reduction of water consumption was chosen by all but one candidate. It was obvious that the Scottish candidates were fully aware of the current concerns in the industry over the economics, politics and practical control of water consumption, and although a wide variety of ideas was suggested, most were acceptable for answering the question. But I have two complaints: (a) since the question was concerned with **over-all reduction** of water use, the suggestion of drilling a borehole was irrelevant, and (b) some answers included expensive suggestions which would have had minimal impact on water consumption, e.g. re-use of water squeezed out of spent grains. Although other possibilities were also acceptable, explanations of recycling of water, minimising water consumption of condensers, and limiting the losses of liquid water and steam could have provided the requested four examples. Strictly speaking, energy considerations were irrelevant in the context of the question, but several candidates commendably made the valid point that in practice, energy and water consumption and recycling are interrelated. It is my impression that backsetting, where practised, is principally for reduction of effluent load, but that too was accepted as water economy for question 7.

Only three candidates attempted question 8 on effluent treatment, with disappointing results. The first part simply required candidates to remember the different components of the Mogden formula. Although authorities stipulate limits of pH and temperature, these factors do not appear in the equation for calculating the cost of treatment. Volume, BOD/COD and suspended solids are the most obvious factors to identify, but for completeness the handling charge component should also be mentioned. The candidates were obviously all familiar with systems for aerobic digestion of effluents, but I was disappointed by the lack of knowledge of the possibilities of anaerobic treatment (not least for generation of methane as fuel). Although anaerobic digestion is still relatively rare in the distilling industry, it was very disappointing to read that one candidate thought it was the same as her/his previously described aerobic plant but with the air supply turned off.

Unfortunately only seven of the candidates passed, but two of the successful candidates presented papers of a commendably high standard.

Module 2: Fermentation, Distillation and Maturation

There were only two candidates, who both passed with good marks from the same choice of questions 1, 2, 3, 5, 7 and 8. Questions 1 and 3 were shared with the Brewing examination, where the examiner's comments should be consulted. Otherwise, following the precedent of those previous years with small numbers of candidates and therefore some questions which no-one answered, the comments below discuss the expected rather than actual answers.

The first part of question 2 on a scientific explanation of quotations from the Scotch Whisky Regulations principally concerns the operation of continuous stills to ensure the presence of flavour congeners in the new spirit. For the second part some discussion was expected of the effects of the surface-volume ratio of casks and the dampness and relatively low temperature of the Scottish climate on the development of mature flavours. A brief comment on quality standards would suffice for the third part.

Question 4 was another variation on the question which has appeared many times over the years, on the distillation of flavour congeners in the spirit still, and the usual diagram was expected to illustrate the answer. Since faster distillation means less reflux in the still, earlier distillation and higher levels of the low-volatile phenolics of peated malt would be expected, giving higher levels in the spirit fraction. In both the 4- and 8-hour distillations, delaying the spirit/feints cut point to a lower percentage of alcohol would bring a greater part of the period of distillation of phenolics into the spirit cut and therefore increase the peated flavour of the spirit.

Half of the marks for the first part of question 5 would be gained by a satisfactory drawing of a Coffey or similar still. The written description should not only explain the principal process flows but also explain the necessity for, and means of ensuring, constant temperature of the wash entering the analyser column, at as nearly as possible constant flow rate, within the predominant requirement for constant temperature. Although these are most important factors for the essential steady-state operation, the constant recycling rates of hot and cold feints should also be mentioned (especially cold feints, because with its high alcohol content, variation would easily de-stabilise the still). Most of the marks for the second part would be gained by a diagram of flavour congeners, especially those which may reach significant concentrations near the spirit plate: butanol, propanol and congeners of greater volatility than ethanol.

Gas chromatography was the expected analytical method for the higher alcohols specified in question 6, with a brief explanation of their importance as flavour congeners in new-make spirit of grain, malt and blended whiskies. Barley and malt analysis is concerned with cyanide precursors of the suspected carcinogen ethyl carbamate (EC), but in mature whisky it is actual EC which is analysed. Although it is unreasonable to expect a full explanation of the specialist GC/MS analysis, candidates should be aware that such equipment is used and give a brief explanation. Tannins are an important indicator of the progress of maturation and as such are routinely analysed by some companies. Both thin-layer chromatography and HPLC are used and either would have been an acceptable analytical method to describe.

Typical percentages of cellulose, lignin, hemicellulose and tannin in oak wood were expected as the answer to the first part of question 8. The second part required an explanation in chemical terms of degradation of cellulose and hemicellulose to simple sugars, pyrolysis of lignin to the various aromatic lignin degradation products and complex tannins to quercitin and gallic and ellagic acids.

Module 3: Process Technology

Seven candidates sat paper 3, with results varying from acceptable to excellent. All answered question 1, competently discussing all of the expected points: the greater energy efficiency of the shell-and-tube condenser over the worm, the possibilities for energy recovery by separation of the processes of condensation and cooling, the greater maintenance problems of worm condensers, but their claimed flavour advantages. Unfortunately, the calculation half of the question caused some difficulty. Although most candidates were able to determine the outlet temperature of the cooled pot ale, everyone suggested a different total plate area. It was reassuring to see the correct calculation of log. mean temperature difference over the heat exchanger, but after that some candidates' calculations became rather disorganised. Heat-exchanger calculations involving a change of phase, as in condensers, may go beyond the syllabus of the AME examination, but candidates should certainly be able to deal with an example where all streams are liquid.

Five candidates answered question 2. All showed reasonable understanding of plate design in column stills, and one provided a brilliant answer describing all possible designs, which was more information than I had expected for full marks (but, unfortunately, you can not score more than 20 marks for an answer!) As usual for questions concerning plant design, marks were deducted for poor-quality drawings. Question 3 also appeared in the Brewing paper, so the comments of the Brewing examiner should be consulted.

For answering the unanimously popular question 4, most candidates sensibly used a simple flow diagram rather than attempting to draw the actual towers, compressors, etc. used in CO_2 purification, and with a satisfactory description gained full marks for that section. Although there was no standard answer to the second part, all candidates seemed aware of the potential advantages of restricting release of CO_2 to atmosphere, but that the considerable energy requirements of the plant can cause a significant CO_2 production anyway, and were also aware of present over-production.

In question 5, also attempted by all candidates, even more marks were awarded than in question 4 for a neat flow diagram of the succession of the unit operations and a brief explanation of their purpose in the drying of spent wash. The second part required candidates to explain why multiple-effect evaporators saved energy in comparison with single-effect systems. Some candidates sadly lost marks by not mentioning energy despite providing neat drawings of the equipment. Also, it was obvious that some candidates were disadvantaged by their lack of practical experience of the equipment in the question. However, that prompts the reminder that candidates are expected to have at least a theoretical knowledge of all processes listed in the syllabus even though relevant equipment does not exist in their own distillery.

Question 6 was unpopular in two senses: chosen by only 3 candidates, and all answered it last. It was expected that haze-forming potential from all three of foreshots, maturation and reduction would be discussed at a level appropriate to the award of 10 marks. Since filter aid is not used by all companies, question 6 is another example of the need for knowledge of operations outwith the routine practices of the candidate's own company. Diatomite, celite, cellulose and activated carbon are all possible filter aids of which candidates could reasonably be expected to have read and remembered something about at least two.

Question 7 was also an unpopular question. Perhaps the malt distillery candidates were unaware of the need to supply steam to the cooker from an "accumulator" rather than directly from the main boiler, but that is a fundamental part of grain distilling operation which, I suggest, all AME candidates should know. Boiler steam is fed at constant rate to maintain the high temperature of a cylinder of hot water under pressure, from which steam can be flashed as required to operate the cooker. Later, flashing-off the contents of the cooker generates steam for various energy-requiring processes, and, incidentally, the transfer of latent heat to the steam cools the cereal mash. For any future candidates practising on the calculations, note that the pressurised contents of the cooker remain in the liquid phase throughout cooking, so data for latent heat are not required. I was also surprised that only four candidates attempted question 8, since there have been many publications over recent years on instrumentation and the possibilities for automatic control of distillation. And I agree with the candidates who pointed out that the specified instruments alone would be insufficient to control a wash still: detection of frothing would also be necessary.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 1 – Materials and Wort Production

Tuesday 11th June 1000–1300

Answer any FIVE questions

All questions carry the same mark of 20

1. The term 'a well modified malt' has often been used to express a certain quality of malted barley. Write an essay on what degree of modification you as a brewer require of malt in your brewhouse for different styles of beer, and, how the maltster may achieve your requirements.

2. Your company is building a new 2 million hectolitre brewery on a green field site. Produce a design brief for intake, handling and storage of malted barley, solid adjunct and liquid adjunct. Include in your design equipment for preparation of malt and solid adjunct prior to the milling stage. State all assumptions and also describe the stock control system you would employ.

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

4. Review recent developments in the growing and marketing of hops. Discuss the ways hops may be stored

and techniques that may be used to enhance their storage life.

5. Produce notes suitable to train operators in all aspects of conditioning prior to milling and mashing-in of barley malt. Include how you would ensure process consistency and safe operations for both product and operator.

6. Describe in detail the principles and design of **two** types of equipment to separate mash into wort and spent grains. Your company's marketing department is keen to emphasise the traditional nature of your brewing plant and its authenticity for the particular styles of beer you produce. How would these considerations affect your choice of new mash separation equipment?

7. Discuss energy usage in a brewhouse and options available to a brewer wishing to reduce energy costs. Outline an operator training programme to ensure that brewhouse personnel are fully aware of the purpose and benefits of reducing energy consumption.

8. 'Problems with flavour stability and non-biological haze stability are better dealt with in the brewhouse than on the packaging line'. Discuss this statement and describe some of the factors which can be controlled in the brewhouse to improve both the flavour stability and non-biological haze stability of long shelf-life packaged beer.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 1 – Materials and Wort Production

There were 29 candidates registered for this examination, although only 22 papers were returned. 12 (55%) candidates achieved a pass mark. This success rate should be compared with previous years' results, 2001 (68%), 2000 (68%), 1999 (74%), 1998 (57%), 1997 (69%) and 1996 (65%).

The standard of the papers this year was very disappointing and the overall pass rate was well below the average. There were few good papers submitted and several downright poor papers. As in last year's exam there was a surprising amount of inconsistency within individual papers with some questions being answered very competently whilst others were answered very sketchily.

Too many candidates were badly prepared and should not have been sitting the exam. Some candidates obviously ran out of time and answered their final question either badly or not at all; one candidate answered six questions: only the first five were marked.

Question 1

This question was attempted by 9 (41%) of the candidates with only 2 achieving a pass mark, and they only just gained the minimum pass mark. The standard of answers for this question was frankly lamentable. Germination of barley is essentially the first step on the process of producing beer and few candidates were able to describe the physical and biochemical changes that barley grains undergo as the process of modification proceeds.

A good answer would have included a definition of the term 'modification' and a full description of the biochemical and physiological changes that occur as the fist stages of germination get under way. A description of the enzymic changes and the breakdown of cell walls and protein matrices which lead to the observable changes in the friability of grains followed by some of the ways in which maltsters may influence this process would have developed the theme of the essay. Discussion about the use of such agents as bromide, gibberellic acid and abrasion would have gained extra marks.

The laboratory analyses that are used to measure modification were hardly mentioned. A discourse about these analyses and their significance for the brewing process would have been an important aspect of this essay.

Question 2

This question was attempted by 8 (36%) of the candidates, with 5 (63%) achieving a pass mark. In general this question was answered well although as in previous years, many candidates failed to specify all of their assumptions. The logic of many of the calculations was difficult to follow, though an acceptable answer was often achieved at the end.

Lead times for malt delivery and the number of days/weeks storage capacity was often given limited attention. I encourage candidates to describe the conditions pertaining to their own place of work but this must not be at the expense of understanding that in different companies and countries different circumstances may apply.

Question 3

This question was attempted by 15 (68%) of the candidates with 11 (73%) achieving a pass mark. This question was competently, if not brilliantly answered by most candidates. The central importance of calcium in the brewing process was well understood. There were several good expositions about water hardness and its significance for the brewing process. The effect of other ions on flavour was fairly well described but the negative impact of ions such as iron or nitrate was often ignored.

The specification part of the question was answered badly with many candidates giving a specification for ales and lagers that were remarkably similar! Also a specification implies a midpoint value as well as a range, many answers did not included a range value.

Question 4

This question was attempted by 15 (68%) candidates with 10 (67%) achieving a pass mark. The standard of the answers to this question was much improved on those to similar questions set in previous year's exam. This is possibly because this question in various guises comes up each year. The first part of the question is easy to answer if candidates only take the trouble to read articles on this topic in the various brewing journals. Several papers however showed an unexpected lack of knowledge about processing and storage of hops.

Question 5

This question was attempted by 11 (50%) candidates with 5 (45%) achieving a pass mark. This question was answered unsatisfactorily. Many candidates failed to read the question carefully and as a result did not appreciate what information I was trying to elicit. For example, some answers contained notes about product safety, some about operator health and safety, few included both, despite being mentioned in the question. In some respects this was a complex question, but the use of a tabular format for the answer would have made it easier to get all the information on paper in a clear and logical way

Question 6

This was the most popular question of this year's exam with 18 (82%) of the candidates attempting it and 16 (89%) gaining a pass mark. This was the best-answered question of the whole exam. All candidates had good grasp of the construction and operation of the equipment they choose to describe.

How candidates tackled the second part of the question was a good indication of their understanding of the larger picture of the brewing industry worldwide. For some brewers and their marketing departments the concept of authenticity is not relevant; one candidate in just such a brewery adroitly answered this part of the question by indicating his awareness of the pressures on brewers elsewhere but firmly underpinning his/her answer with local knowledge.

Question 7

This question was attempted by 16 (73%) of the candidates with 7 (44%) obtaining a pass mark. Another question answered with little competence. There is so much information, from the very small and sometimes quite trivial, to very large and often expensive, to be squeezed into this answer and yet many candidates seemed to be struggling to find things to write about.

As in last year's exam, some candidates dreamt up grandiose schemes for replacing equipment with up to date energy efficient models, without any thought given to the capital cost and the depreciation charge either of the new equipment or the old equipment so recently sent to the scrap yard. In a question like this there is clearly room for capital investment but it has to be appropriate and cost effective. There is also room for the small-scale activity such as switching off unnecessary lights and pumps and installing insulation. Too few candidates mentioned the energy audit, an excellent way of getting all personnel in the brewhouse to think 'saving energy'. Another aspect given scant attention was the operator training programme, one more vital part of the armoury in the war against waste.

Question 8

This question was attempted by 15 (68%) of the candidates with 9 (60%) gaining a pass mark. There were two factions who answered this question, those who answered it competently and those who answered it very badly and there were not many in between. The formation of the protein–polyphenol complexes during the kettle boil was well described though more detail should have been forthcoming. Extra marks could have been gained by discussing the contribution of polyphenols from hops, the use of kettle finings, and the importance of monitoring hot breaks. Precipitation of oxalates and phosphates was not often touched on. Other aspects of the problem, such as monitoring quality of raw materials against specification, was mentioned only occasionally.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 2 – Fermentation and Beer Processing

Tuesday 11th June 1400–1700

Answer any FIVE questions

All questions carry the same mark of 20

1. Your brewery is expanding its fermentation capacity in order to cater for a 25% increase in volume of existing ales and lagers currently produced. The batch size of wort produced is 500 hl. With the aid of diagrams, describe in detail the design of suitably sized fermentation vessels you would install.

   Assuming that existing services and utilities are fully utilised, what additional plant, equipment or systems would you need to install to ensure that these vessels are completely functional?

2. Laboratory reports indicate a low level of infection in beer in fermenter by *Lactobacillus* and *Pediococcus*. Higher levels are seen in conditioning tank. What are the possible consequences of failing to control this infection? Describe in detail the means by which you would investigate the source(s) of this infection and the steps you would take to eliminate it.

3. It has recently been reported that the first, full-sized brews pitched with the growing yeast culture from your culture plant have been slow and sometimes incomplete. Discuss the possible causes and consequences of this discovery, and describe how you would remedy the situation.

4. The CIP plant in the conditioning department of your brewery requires replacement after many years' service. In that time, the vessel population has grown to include 50 tanks of 800–2400 hl. Capacity, some fitted with fixed spray balls and some fitted with rotating-jet cleaning heads. With the aid of suitable diagrams describe in detail the design and operational parameters of a new CIP plant capable of cleaning these tanks and associated mains. As this plant is required to be as environmentally friendly as possible, highlight and explain which design and operational features you have included to meet this need.

5. Your brewery produces a significant volume of a global lager brand. Recently, reports from headquarters have indicated a flavour shift from the ideal profile. In respect of the process from wort collection through to Bright Beer Tank, describe the possible causes of flavour changes and the nature of the change due to each cause. How would you ensure your product returned to the ideal flavour profile?

6. It has become apparent that the operating costs of the filtration department in your brewery, including the costs of utilities and services provided, are significantly

higher than those of breweries of similar size. Describe the measures you would take to reduce those costs in both the short and long term time scales. How would you ensure that product quality was not compromised by any of the measures you propose?

7. There has been a recent rise in the average level of dissolved oxygen in beer in Bright Beer Tank (BBT), and the number of defects has also risen. Describe the possible causes and consequences of this problem, and the corrective action you would take to prevent recurrences. Include in your answer the levels of dissolved oxygen you would expect to see at each stage of the process after fermentation is complete. One method of reducing the level of dissolved oxygen in beer in a BBT is to gas-wash it with nitrogen. What are the consequences of gas washing beer in a BBT with nitrogen to reduce dissolved oxygen?

8. You have been asked to prepare a paper for your company reviewing beer clarification technology for the preparation of bright, sterile beer from unfiltered, conditioned beer. Using short notes and diagrams where appropriate, compare and contrast the techniques and technology currently available, and provide an insight into emerging developments that may become practical installations within the current decade.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 2 – Fermentation and Beer Processing

Thirty-one candidates submitted scripts for the paper. Twenty gained pass grades, a pass rate of 65%, which is similar to last year. There was one good paper at grade B, eight at grade C but several papers that were borderline passes. There were a few candidates who failed the paper with 2 fair answers but lacked the depth of experience to succeed in other answers.

There were some areas of examination technique that let people down. Several papers showed clear evidence of the last one or two answers being rushed in note form or barely even started, whereas earlier answers had been over-elaborate. In a few cases candidates had failed to read the question fully and produced incomplete or partly irrelevant answers. Candidates should also take care to answer the question in the way signalled – i.e. when asked for "discussion" or "describe in detail", then do just that, and save the brief notes for questions that ask for them.

Several candidates failed to gain good marks when answering a question about what corrective action to take with "check…", and then failing to follow that up with action. The use of the words "optimise" or "use best practice" on their own gain no marks because the candidate has failed to demonstrate what exactly "optimum" or "best practice" procedures are.

Question 1

23 candidates attempted this question with 15 passing (65%).

Most answers started well with a justification of the vessel capacity, balancing filling time, brand flexibility and cost/space considerations. Many better answers quoted dimensions, but there were some sorry mismatches with the stated capacity, and some curiously shaped vessels. Candidates were expected to show between the text and the diagram all the essential design features such as material of construction, cooling systems, temperature and contents measuring systems, pressure and vacuum protection, CIP and venting systems, and insulation. Several answers failed to enter into sufficient discussion following bare outline drawings and so scored modestly.

25% of the marks were available for describing the extra utilities and services needed. Few marks were gained for extending pipework from existing systems as the question stated they were fully utilised. Increasing capacities or providing stand-alone facilities for CIP, refrigeration, PLC controllers, electricity and CO_2 collection plant, etc. were equally justifiable depending on the circumstances described.

Question 2

20 candidates attempted this question with 14 passing (70%).

Describing the consequences of failing to control such an infection attracted 20% of the marks. Most candidates successfully listed diacetyl and acidic flavours and the ultimate sales impact, and other possibilities such as unfilterable haze, rope and the potential loss of trade to bulk customers were also covered.

A thorough investigation process should involve reviewing existing knowledge of results and procedures, and sampling and testing all process inputs and outputs from FV onwards. Candidates who drew a flow chart and annotated such points gained good marks in an economical manner, and the few who really understood and outlined the laboratory methods involved also benefited. Auditing operating procedures is also a valid investigatory tool. Immediate palliative measures such as acid-washing of yeast, pitching only with clean yeast where possible, increasing cleaning times, strengths or scope can be implemented pending results, and then focus in on plant or procedures identified in the survey. Candidates describing scenarios from their own experience gained extra marks, while poorer answers stopped at the checking and testing stage and described few corrective actions.

Question 3

19 candidates attempted this question with 11 passing (58%).

Description of the possible causes and consequences of this problem earned up to 40% of the marks. Issues such as temperature shock, dilution shock, nutritional deficiency, growth phase, shear damage at transfer and competing infection should have featured. Consequences including poor flavour, poor yeast crop, poor yeast health to ferment subsequently, vulnerability to infection and the possibility of mixed-strain imbalance could have been described.

Many of the better answers then included a description of a yeast propagation regime and the ideal process leading up to the final stage, putting into context the remedies then suggested to the possible causes outlined earlier. The process to manage temperature and nutrition acclimatisation, to time the transfer at the right cell count in the logarithmic growth phase should have been fundamental to a good answer. Re-engineering to provide low-shear transfer conditions and hygiene measures in the culture plant and recipient FV were further measures to address possible problems from above. Again, weaker answers talked about "checking" and little "doing", while others "optimised" the process without description.

Question 4

18 candidates attempted this question with 12 passing (67%).

This question, like question 1, required candidates to show between the text and the diagram all the essential design features such as tanks, pumps, mains, control instrumentation and chemical dosing. There should also have been description of the operating parameters such as cycle times, chemical type, strength and temperature, and control mechanisms. Better answers showed consideration of the plant sizing and the number of simultaneous cleans required. Most candidates appeared to recognise the differences in flow and pressure requirements of the different spray heads present, but not all addressed it in their answers by providing different delivery pumps or using variable speed drives. Equally valid were suggestions to replace all spray balls with rotary jets and simplify the issue.

The identification of environmentally friendly features was worth 20% of the marks. Aspects expected were economy of liquor through burst rinsing and re-use, reclamation of as much detergent as possible, secure bunding for chemicals, minimal use of heat and chemical compatible with good cleans, consideration of minimum impact chemicals, recycling any drums used, etc. The use of acid to avoid CO_2 loss with caustic detergents was a worthy consideration.

Question 5

23 candidates attempted this question with 15 passing (65%).

This was one of the most popular questions but was only answered averagely. With such a wide-ranging subject, the more complete answers were those that used either a process flow-chart or a table (or both) to illustrate the parameters affecting flavour, the nature of the effect and potential corrective action. Most answers covered the areas of yeast management and fermentation control in some detail, describing the basic biochemistry of ester, higher alcohol and other flavour development and the process variables that could change their concentrations. Better answers covered the elements of wort composition relevant to this paper, namely oxygen and zinc levels, the adverse effects of later ingress of oxygen and microbial infection, and the effects of process additions and possible contamination. Extra marks were gained by those who identified not only individual corrective actions but also a holistic approach to regular in-process tasting and discriminatory taste panels to oversee the end product.

Question 6

14 candidates attempted this question with 5 passing (36%).

This was the second least popular and the poorest answered question. Many answers mentioned costs of kieselguhr and other materials, some utilities such as CIP chemicals and refrigeration, and labour as key costs. Surprisingly few dealt with beer losses, or considered other utilities such as effluent, liquor (deaerated or otherwise) and CO_2.

Complete answers would have featured short-term measures such as a losses audit and improvement programme for improving tasting on and off, saving first and last runnings, identification and correction of leaks and means of addressing losses of product and efficiency caused by rework. Material savings through better pre-filter solids reduction exercises, tight control of kieselguhr dosing and minimising stabiliser and head additive usage should have been considered along with tests to ensure haze, stability, etc., were not unduly affected. Unnecessary chilling of beer for short shelf-life keg beer, good insulation of plant and mains, minimising washouts and sterilisation regimes are all utility savings to follow-up in a similar way.

Longer term measures could include automation projects for routing, powder handling, filter plant changes if plate and frame units are installed, reclaim systems for PVPP if single-use systems are present, consideration of additions or dilution to bright beer instead of rough, etc.

Question 7

27 candidates attempted this question with 18 passing (67%).

This was the most popular question, tackled by all but 4 candidates, and answered moderately well. Some candidates chose to answer the question as asked, by identifying causes, then consequences, then specifying remedial action. Others covered all aspects together in tabular form or process-flow charts. These were equally acceptable. Potential causes should have covered leaking pumps and joints, bad tank emptying and filling practices, air in mains and hoses, liquid and gas additive systems, centrifuge seals, air in filters. Several candidates failed to list consequences such as stale flavour development, promotion of haze instability, possible triggering of diacetyl flavour and lost time and efficiency while problems were rectified. Suggested levels of DO_2 in the process were largely acceptable, but a few candidates clearly confused ppb for ppm and vice-versa.

The start of the corrective action process should involve assessing known data and gathering further information from on-line surveys. Remedial measures can then be targeted on any of the potential causes identified earlier. Creating and preserving an inert atmosphere in pipes and tanks covers several issues. Mending leaking pumps, joints and faulty low level probes and centrifuges have their part to play, and reducing discharge frequency of the latter can also help. Proper monitoring of CO_2 (collected or bought) and deaerated liquor, and rectification of oxygen contamination are also essential.

Measures such as gas-washing and addition of SO_2 or ascorbic acid are not designed to prevent recurrence and so gained no marks for those who suggested them.

The question on nitrogen gas-washing was worth 20% of the marks. Answers should firstly have considered the problems of gas-washing per se, namely fobbing and losses, removal of flavour volatiles and creation of particles of collapsed foam. The additional problems of nitrogen are the softening of the flavour, removal of CO_2 and possibly creating a beer difficult to control on the filler. The effect on beer foam is a balance between positive, through the finer bubble structure created, or negative if head potential is lost through excessive fobbing.

Question 8

10 candidates attempted this question with only 4 passing (40%).

Most answers began with a comparison of the plate and frame, candle and screen filter plants currently used to clarify beer. The relative degree of automation, capital and running costs, degree of first and last runnings, turn round time and discharge capabilities should all have been included. Brief notes on the use and mechanism of kieselguhr depth filtration gained extra marks, as did the possibility of using silica hydrogels in conjunction. Very few candidates then went on to consider the production of sterile beer from this filtered product, where discussion of the use of cartridge membrane filters singly, or in series, coupled with commentary on material of construction and pore-size ratings, would have gained good marks.

The final 25% of the marks came from discussion of emerging technology. Cross-flow filtration featured in some answers, where a brief description of the process was expected together with a comment on its current limitations and progress towards practicality for mainstream beer clarification. Top marks would have resulted from the inclusion of regenerable filter aids, ultra-centrifugation and new candle-filter technology in the discussion.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 3 – Packaging and Beer Dispense

Wednesday 12th June 1000–1300

Answer any FIVE questions

All questions carry the same mark of 20

1. Capital expenditure has been approved to allow the speed of your bottling line to be increased by 50% through phased replacement over a two year period, allowing the labeller to be replaced in year one and the filler in year two. The existing major items, depalletiser, pasteuriser, packer and palletiser can cope with the increase.

Detail and justify the areas of design, installation and coordination you would prioritise in order to successfully achieve the required increase in throughput. List assumptions and illustrate with diagrams as appropriate.

2. Kegging and canning production units in your plant receive good quality bright beer, but suffer from sporadic poor microbiological performance in process.

Describe the areas you would investigate in order to find the source or sources of the problem.

What regular QA checks and process controls would you put in place to ensure that there was no recurrence of the problem?

3. Your keg or cask population has not been renewed for several years.

Stating your assumptions, how would you sample and analyse the population to assess the quality of the kegs or casks?

Your sampling has highlighted that 20% of your keg or cask population needs to be replaced in the next financial year.

From a technical standpoint, how would you assess potential suppliers and how would you design and implement the replacement programme?

4. What are the environmental issues involved in the canning or bottling of beer?

What steps could you take to minimise the environmental issues of your canning or bottling process?

5. Outline the key utility requirements of a returnable bottling line.

Discuss what controls are required to ensure that the supply of utilities poses no risk to product quality or continuity of supply.

6. Your organisation is to trial a new dispense tap which is expected to give a more consistent head on keg lager.

You have been asked to organise the trial. On what basis would you select outlets in which to conduct the trial and what measurements would you make before, during and after the trial?

7. For each of the following pieces of on-line packaging equipment devise a start-up procedure, stating why each operation and check would be needed.

i) Palletiser for full packs
ii) Bottle crowner or can seamer
iii) Keg or cask weigher
iv) Package coder for bottle or can.

8. The financial performance of your packaging plant has begun to deteriorate significantly against budget.

Production volume is split equally between keg and can products.

Describe the information required to assess and control the financial losses. Using this information and stating the assumptions made, discuss the areas you would target for savings.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 3 – Packaging and Beer Dispense

In 2002, 34 candidates sat the examination of whom 16 (47%) achieved the pass standard. This represents a very similar percentage to last year.

Although many of the passes were at the D grade it was pleasing to note that one candidate achieved a pass with a B grade.

Poor answers dealt with the questions in general terms with little or no detail. Conversely, good answers included relevant process values and detail and displayed good insight without straying from the question asked.

Those candidates who performed well were able to give good answers across a range of questions whilst those failing to reach the standard often could answer well in only one or two areas at most.

Examination technique could have helped a few of the candidates by focusing on the question asked rather than answering with a general discussion. Also timing the examination to ensure that attempts are made at the required five questions will usually bear dividends as generally it is easier to pick up the first marks in a question than those to complete a top answer.

Question 1

Along with question 6 this was the second least popular question with 14 (41%) candidates answering and was the most poorly answered with 3 (21%) achieving a pass. The answers to the question ranged from the very limited to one excellent example.

Good answers to this question included reference to the three areas of design, installation and co-ordination asked for. Plant specification as well as ancillary line equipment and plant (e.g. inspection/accumulation) were dealt with in addition to utility and warehouse issues. Other areas dealt with were project planning, training and materials supply,

Poorer answers centred on the general principles of bottling line design without addressing the specifics asked for in the question. The high number of poor answers was disappointing given the fundamental relevance to packaging of this topic.

Question 2

This was the most popular question with 32 (94%) candidates answering of whom 16 (50%) achieved a pass mark. Most answers were around the pass mark with only a few very poor/very good answers.

Poorer answers focused almost entirely on pasteurisation (assuming the issue was in final pack) though the question asks about poor performance in process. Some candidates gave more detail by describing risk areas on a keg racker (and bottle washer!). Poor answers also gave very little detail related to the QC and process control put in place being restricted to general statements of the type ‘an audit programme would be initiated’ or ‘laboratory tests would be carried out’.

Good answers examined a wide range of potential sources of infection from materials and plant and from lack of correct procedures. Testing methods, record analysis and fresh sampling investigative approaches were discussed. Good scripts also included sensible process controls on key equipment and QC tests on materials, plant and in-process beer.

Question 3

Of the 15 (44%) candidates who answered this question 6 (40%) achieved the pass standard. Most answers were around the pass mark with only a few very poor/very good answers.

Most answers included some detail of the types of analysis required to assess containers but better answers were distinguished by including the need to sample a range of container sizes and discussing timings and sample size issues.

Similarly most answers included a basic introduction programme whilst better answers included reference to acceptance trials, double washing and logistics issues.

Poor answers avoided supplier assessment by merely recommending using an existing supplier. Good answers dealt with relevant technical details related to the potential supplier’s quality systems, plant and capabilities to meet specification.

Question 4

This was the second most popular question with 29 (85%) candidates answering of whom only 9 (31%) achieved the pass standard.

Good answers to this question included a range of environmental issues including energy usage, materials usage and wastage, effluent quantity and make-up and noise. Many more limited answers focused almost entirely on wastage issues with little or no reference to other issues.

Minimisation of the issues was limited to those identified but examples of good approaches considered materials down-gauging, energy efficiencies, chemical substitutions and effluent treatments.

Question 5

Another popular question with 27 (79%) candidates answering. It was easily the best answered question with 19 (70%) passing of whom 6 were within the A grade.

Good answers firstly identified the utility requirements and their points of use. Systematic review of maintenance, process control and HACCP type approaches to these points of use scored well.

Poor answers only identified one or two utilities and presented a fragmented approach to their control.

Question 6

Along with question 1 this was the second least popular question with 14 (41%) candidates answering and was fairly poorly answered with 6 (43%) achieving a pass.

Good answers on outlet selection discussed the range of cellar and bar conditions that might be encountered and the relevance of these various conditions (e.g. gas types, temperatures, hygiene, throughput, staff attitude) to the trial. Poorer answers merely stated one or two selection criteria with no reasons for the selection.

Measurements, issues with the measurements and their relevance were well discussed in the better answers and these went beyond the standard dispense checks to include trade and consumer interviews and any pickup or drop-off in sales. Poorer answers were restricted to a few checks on product temperature and dispense speed and in some cases no measurements of the head were made.

Question 7

This question was answered by 13 (38%) candidates and was the least popular on the paper. Of those who answered 7 (54%) achieved the pass standard. Most answers were around the pass mark with only a few very poor/very good answers.

In each of the four cases a systematic approach to the start-up procedure scored well. The types of activity required to be mentioned were safety, quality, legal, logistical and operational.

Good answers had sufficient detail in these areas to demonstrate a working familiarity with each of the pieces of equipment. Poorer answers again either generally lacked detail or dealt with only one or two of the activities.

Question 8

A moderately popular question with 24 (71%) candidates answering and 11 (46%) achieving the pass standard. There was a wide spread of answers across the marking range.

Good answers looked at a variety of cost elements in a packaging department budget and detailed how to measure performance against budget (fixed/variable costs, cost/man, cost/hl).

Poorer answers only mentioned a few elements such as overtime and materials costs, also savings were targeted by cutting out expenditure without any evaluation of risk.

Good answers included a wider range of elements such as rework rate, plant efficiencies and utility costs and discussed a range of strategies to target costs (e.g. shift patterns, procurement issues, multi-skilling and maintenance/re-investment in old plant).

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 4 – Central Functions

Wednesday 12th June 1400–1700

Answer any FIVE questions

All questions carry the same mark of 20

1. Your company has just purchased a new brewery, which is capable of producing one million hectolitres of beer per annum. It only operates for five days a week. It produces one type of beer, but it packages this beer in two different keg sizes and three different bottle sizes in identical volumes.

Stating your assumptions and justifications, construct an annual operational budget for this plant. The budget should be calendarised and phased, with the reasons for any periodic variation identified.

All assumptions need to be documented.

2. The absence rate for your brewery, due to industrial accidents is 20% above the average in the brewing industry. Provide an analysis of the possible reasons behind this performance and recommend a way of improving the situation.

Your manager needs to be able to measure the performance improvement and to report on the progress being made. Recommend a method of demonstrating that improvement is occurring.

3. Your brewery is to introduce a new bottled beer. If its introduction is successful, your bottling capacity will need to be doubled from its existing level in two years. The bottling line mechanical efficiency is 45%.

Capital finance is limited and the survival of your company is dependent on the success of this product. You have been asked to identify the potential areas for improvement to achieve this success. Identify the assumptions that you have made in determining your recommendations.

4. The board has asked you to consider the construction of a new brewery. It will produce 2 million hectolitres of lager type beer and will package in kegs and bottles in the ratio of 70:30.

Determine the type and size of utilities plant to specify to match this demand (excluding water supply)

You need to list all of the assumptions that you have made.

5. You have received a number of customer complaints of an off flavour in your brewery's canned beer. The problem is not apparent at the time of packaging, but is recognisable within one week of storage.

Provide a detailed action plan to manage the short term needs of beer in the brewery, distribution system and on sale.

Detail a systematic investigation to identify the source of the problem.

6. Your brewery has decided to chill beer to 2 degrees Centigrade on line to the filling machine. The beer flow rate is to be controlled to 350 hectolitres per hour during normal running and the temperature variation is ±0.5 degrees Centigrade.

Specify the equipment and cooling medium to be used to achieve this requirement. All safety and environmental aspects must be considered and discussed in determining your specification.

Listing your assumptions, detail operational procedures for the control of the system.

7. Considering the maintenance philosophy that is in place within your brewery, write a report, which critically assesses the utilisation of skilled labour, maintenance costs and their impact on whole brewery performance.

Recommending changes, which will give measurable improvements in performance, identify performance measures that will support your conclusions.

8. Your brewery has been given new targets for determining the capital investment levels that can be requested. It has been determined that 80% of projects need to be economically justified, whilst the other 20% could be justified on a more qualitative basis.

Using information with which you are familiar, describe three projects (one from the former category and two differing ones from the second category) explaining in detail the justification for each.

Describe how the projects would be judged as a success.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 4 – Central Functions

There were 28 candidates for this examination, with 15 passing (53%). The pass rate was similar to last year, with the quality of the answers at a similar level. There is still a lack of practical engineering knowledge displayed in the answers.

The answers were generally adequate on the theoretical reasons for tackling the subject, but the depth of experiential understanding was below that expected at this level. There is a lack of first hand experience evident in the answers given.

It was not apparent that the candidate preparation was adequate to tackle the level and needs of this examination.

Question 1

6 candidates with only 2 achieving the pass level answered this question.

The better answers to this question had assumed the type of brewing which was to be tackled, considered the level of losses anticipated, identified the demand pattern, stated the raw material and utilities usage rates and clarified labour working patterns. These assumptions had been used to construct a budget, which had both fixed and variable elements.

This operational budget had considered raw material needs, utility needs, labour, maintenance and waste removal. There was also a need to consider the storage needs of the final product.

The marks were shared equally between the ability to identify the assumptions involved in preparing the budget and the translation of these assumptions into meaningful values.

Question 2

This was question was attempted by 26 candidates, with 12 candidates passing (46%).

This question asked for an analysis of the reasons for the poor performance of this brewery. The better answers considered both the concentration on the potential hazards that were encountered in a brewery and the ways that these hazards could be tackled physically. The better answers considered the available information and considered how the facts could be used to elicit an improvement.

The area of performance improvement measurement was tackled very subjectively. The better answers looked for factual objective measures to demonstrate that improvement had taken place. These measures varied from the simple measurement of accident occurrences to more complicated departmental statistical information, which considered hazard clearance rate, risk assessments and accident investigation analysis.

Question 3

There were 16 candidates who attempted this question, of which 8 passed (50%).

It was envisaged that this question would identify some key assumptions about the current performance of the line, which would expose the potential opportunities for improvement without necessitating capital investment. The better answers clarified the understanding and definition of mechanical efficiency, stated the current line utilisation and highlighted the potential areas for further investigation.

In seeking improvement, there was a need to understand the current position with regard to operator performance and competence, machine performance and the support functions, which would be responsible for the line capability. The better responses looked at critically assessing the current position and then recommending the processes, which could address these shortcomings.

The poorer answers still retained a focus on investing in improving line performance before assessing the current position.

Question 4

Of the 15 candidates that attempted this question, only 5 achieved the pass mark (33%).

There was a need to identify the usage rates that would be anticipated for each of the utilities, so that an approximate sizing of the plant could be undertaken. This was needed to consider not only primary fuel needs but also the secondary requirements such as refrigeration.

Justification of the sizing and numbers of machines needed consideration as did the pressures and flow rates that would be envisaged. The heating systems needed to consider the complete loop.

The electrical aspect of the answer needed to consider the voltage levels involved in distribution together with power factor considerations to examine the depth of knowledge in this area.

Question 5

Of the 17 attempts at this question, 11 people succeeded in achieving the pass mark (65%)

The protection of the customer and the brand were the considerations, which were of primary importance in the answers. The better responses focussed on the removal of the problem from the trade and a formal management of this process. The institution of a cross-functional technical resource to use both sensory and analytical techniques to systematically investigate the potential causes within the brewery was a considered method of addressing the issue within the brewery.

Again, the better answers involved the utilisation of available information to assist in the formulation of a structured investigation. The value of communicating with the appropriate people and in a clear and informed manner was visible in the better answers.

Question 6

There were 7 successful candidates from the 17 who attempted this question (41%).

All candidates provided a drawing of the heat exchanger installation, with the better answers noting the important elements in the circuit. Identification of the cooling medium to be used and the method of determining the selection and monitoring of the coolant were provided in some answers. There was reference to the protection of product in the answers, although only in a few cases was there a consideration of how any contamination could be detected.

There was some consideration of the potential impact of product flow stopping and coolant flow not being reduced, although fuller consideration needed to be given to the stabilisation of the flow and temperature.

Question 7

13 of the 21 candidates successfully passed this question (62%).

There was a need to analyse the skilled labour utilisation and costs. It was necessary to identify the type of maintenance currently being conducted and whether it was organised on an integrated or functional basis. This consideration needed to be supported by understanding the amount spent on engineering in terms of labour and materials.

The improvements in utilisation could be achieved by possible organisation structure changes, maintenance technique changes and critical plant analysis.

There would need to be measures in place so that improvement could be objectively assessed. These may include labour utilisation and machine efficiency or interference.

Question 8

There were 10 candidates from the 20 who attempted this question who successfully passed (50%).

It was envisaged that the successful economically driven projects would clearly outline the economic savings that would be driven out of the capital investment. There needed to be an objective financial measure that would be used to validate the success of the project. The identification and explanation of the financial parameters were present in the better answers. The clarification of what would be acceptable as a value in each of these financial measures was provided in some answers. It was also considered that a review on completion of the project would verify the initial figures used to justify the project.

The non-economic projects needed to highlight the objective measures that were necessary to justify the project, and an analysis of the implications of not conducting the project needed to be provided.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 5 – Case Study

Thursday 13th June 1000–1300

Answer ONE of the following questions

1. Due to economic factors it has become necessary for your brewery to focus on water usage and effluent.

Describe with the aid of a flow chart, the following:

i) Critical water usage points in the brewery.
ii) Ratios to output or specific usage expected.
iii) Major points of effluent generation including volumes and or ratios.

From this analysis and stating your assumptions, identify how these factors may be improved and how any improvement could be measured and costed, and illustrate your expected savings.

2. Your company has just purchased a brewery in a geographical region with an underdeveloped infrastructure and has sent you to supervise the introductory production of your premium lager brand in bottle.

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

Describe the likely causes of these flavour issues and how you would evaluate the whole production process to ensure flavour stability and consistent profile, including likely costs and environmental impact.

DIPLOMA MASTER BREWER EXAMINATION 2002

Module 5 – Case Study

This year 21 candidates sat the paper and 14 passed (66.67%), a good effort by recent standards. 10 candidates chose question 1 and 80% of those achieved a pass, 11 candidates chose question 2 and 55% of them passed.

In general candidates seemed better prepared this year and scripts showed signs of improved technique as well as more careful consideration of the questions as asked. There is however still a tendency to try and answer a question hoped for rather than the one asked.

Question 1

The question was looking for a clear flow chart giving an overview of the whole Brewery site including services with some of the better scripts giving supporting charts of key areas such as treatment plant.

In general the question was adequately answered with most candidates having a good knowledge of water requirements in the brewing process and small pack. Large pack and services were less well covered and system descriptions often lacked detail and values.

The use and creation of flow charts was variable, the better charts helped candidates to comfortable passes and prompted some good structured analysis and data tables.

Knowledge of the order of capital plant costs was patchy and few candidates highlighted the cost benefits of bore hole against local water company supply.

Question 2

This question was structured to lead the candidate through brewing, packaging, storage and distribution using flavour as the guide.

Outpouring of information, procedures and descriptions, but no focus on links with the specific flavour described in the question was a common error. Getting knowledge on paper without structure, plan or relevance is a weakness of technique frequently seen and more time spent in planning or the use of charts and tables would have been useful.

Knowledge of the brewing process was stronger than packaging and distribution with only the better candidates able to link all stages to the flavour issues.

Few candidates investigated the full use of tasting both through the process, as well as materials, services, gasket glues, etc. Too much emphasis was placed on the ‘safe options’, breweries can be cleaned by means other than fully automated CIP sets, it is the cleaning which is important and the control of chemicals, not the cycle times or the electronics.

Many candidates did not seem to want to consider flavour issues, and produced a large amount of text on other brewing issues, particularly haze which gained no marks.