Institute of Brewing & Distilling Examinations 2005

CHAIRMAN'S REPORT

At the beginning of 2005, the name change to The Institute of Brewing & Distilling became effective. At the same time, changes to our qualification titles were also introduced, so that in 2005, for the first time, we have had candidates achieve the qualifications of Master Brewer (M.Brew.) and the IBD Diplomas in Brewing (Dipl.Brew.) and Distilling (Dipl.Distil.).

In addition, as my predecessor (Jim Robertson) informed in his report last year, the Board of Examiners has been organised into sub groups looking after the examinations for the General Certificates, Diplomas (formerly AME) and Master Brewer (formerly DMB). Also this year, we have established a Distilling examination group (chaired by Brian Eaton), which will be responsible for all Distilling exams from next year. Other changes to examination structures are also planned, but more about these later.

If we consider the results for this year's examinations, we see something of a mixed bag, in terms of overall performance. There does appear to be a general decline in average performance across all of the IBD exams, continuing the trend seen in recent years, especially at the higher levels of qualification. On the positive side, there were some clearly outstanding performances in all the examinations at the General Certificate level, at Diploma level and at Master Brewer. I would like to pass on my personal congratulations to all who attained qualification, especially those achieving distinctions and awards. In particular, I should like to congratulate Beverly Ward (Lion Breweries) for obtaining the GCBP Worshipful Company of Brewers award, Carol More (John Dewar &Sons Ltd) for the GCD Scotch Whisky Association award, Jeff Bird (Molson) for obtaining the JS Ford prize (Dipl. Brew.), Gordon Donoghue (Diageo) for the Diploma in Distilling award and Stephen Gilsenan (Diageo) for achieving the JS Hough award (Master Brewer examination with Honours).

I would like to draw attention to the individual examiners' reports, which contain descriptions of ideal answers, sound advice on examination technique and detailed analysis of the year's papers. Access to the reports can be achieved via the IBD web site, in the Journal (JIB) or by application to the IBD Examinations Administrator at Clarges Street.

However, I would like to summarise examination performances in some detail here. Firstly, GCBP in May 2005 produced a slightly disappointingly low pass rate (43.7%), with a decline in pass standards compared with previous years (e.g. no distinctions). The May 2005 GCD had a record number of entrants (104), but again achieving a lower pass rate than previously and fewer distinctions, although at a significantly higher pass rate (63.5%) than GCBP.

The results for the Diplomas this year were also mixed. Overall 95 candidates achieved the Diploma in Brewing. Of the individual modules, there was a welcome increase in the pass rate for module 3, (66.5% of the 200 candidates). However, the pass rate for module 1 (67% of 211 candidates) was the lowest since 2002 and for module 2, the pass rate was even lower (at 53% of 164 candidates), the lowest since 1999.

By contrast, this year saw an increase not only in numbers sitting the Diploma in Distilling examinations, but an impressive 83% of the 34 candidates passed overall (91% pass for module 1, 80% for module 2 and 86% for module 3). In addition, 12 candidates were awarded the full Diploma.

All Diploma examiners commented that the overall pass performance was also lower than previously, in terms of numbers (and percentages) of grades A and B.

For the Master Brewer examinations, the highest number of entrants for several years was recorded, being some 25% higher than last year. In total, 8 candidates were awarded their M.Brew. Overall pass rates and pass performances were pretty much the same as recent years.

As in previous years, examiners commented on the need for candidates to concentrate their efforts in answering the exam questions by paying particular attention to **preparation, organisation and precision.** Since all written exams now allow 15 minutes reading time, prior to starting, there really is little excuse for lack of preparation of answers.

With regard to proposed examinations changes for the coming year or so, details have already been posted that the GCBP qualification will be split into 2 new qualifications, a General Certificate in Brewing (GCB) and a General Certificate in Beer Packaging (GCP), both accredited by City and Guilds to the same NQF level 2 as the GCBP. Further, it is planned that the new exams will follow a Multiple Choice Question format and will be available as on-line exams. This means that the exams can be taken all year round, rather than twice a year (May and November) as current. Full details will be sent out in the new year and it is planned to install trial exams on the IBD wed site in January/February 2006, so that candidates can familiarise themselves with the new exam format and practise answering exam papers. The new syllabi for both exams are

Publication no. G-2005-1316-423

published and available from the IDB examinations department.

We have also expanded the General Certificate in Distilling to include (as elective options) Rum production and Brandy production. This new qualification (to be called GCDi) will be available in the same format as the current GCD exam (which is targeted specifically to Grain distilling) from May 2006. It has also been accredited to NQF level 2 as the current GCD, which it is proposed will be replaced by the Grain distilling elective of the new exam in the future. For now, both exams will be available to candidates. In the future, it is proposed that the GCDi will also adopt the on-line, MCQ format.

The new Distilling group is also working up a new syllabus for an expanded Diploma in Distilling (like the new GCDi) to include elective options for Rum and Brandy production (in addition to Grain distilling). It is hoped that this new qualification will be available for examination from June 2007.

Finally, we have also announced that the examination format of the Diploma in Brewing Module 3 (Packaging and Process Technology) will be modified with effect from June 2006. The exam paper will be set out in 2 sections: – 3A Packaging Technology and 3B Process Technology, with candidates asked to answer 3 questions (from a choice of 5) from EACH section. The new syllabus format has been published (available from IBD Examinations Department), but candidates are advised that the overall syllabus content for Module 3 has NOT been changed, merely re-arranged into 2 sections to reflect the new exam format. Candidates are also advised that Course Revision notes (in CD-ROM) format are now available for ALL Dipl. Brew. modules (1,2, 3A and 3B) and are automatically sent to all those registering for the appropriate examination.

During the year we have seen the departure of Gavin Hock to pastures new (in Tadcaster) and the appointment of Rekha Sandal as the Examination Administrator. I am sure I can wish them both well in their new roles on behalf of the Board of Examiners.

So, in completing my first report as Chairman of Examiners, can I express my thanks to all the examiners, moderators and the Clarges Street examinations team for their efforts and support this year and I look forward to the coming year with its associated new exam structures, and wish all prospective IBD examination candidates all success in their pursuit of IBD qualifications.

Dr David G Taylor
July 2005

INSTITUTE OF BREWING & DISTILLING EXAMINATIONS 2005

Dipl.Brew, Dipl.Distil and M.Brew

The Board of Examiners for the 2005 series of Dipl. Brew, Dipl.Distil and M.Brew Examinations consisted of the following members:

Dr D Taylor (Chairman), Dr A Barker, Dr G N Bathgate, I Bearpark, P Brookes, Dr J Brown, Dr J Bryce, P K A Butterick, Dr I Campbell, R Cooper, J Dodd, J B Eaton, B Ferguson, T Heywood, D Hollin, C Hughes, R F Illingworth, C McCrorie, Prof G H O Palmer, B Peachey, M R Partridge, Dr G Philliskirk, J I C Robertson, H Salisbury, Dr K A Smart, I B Smith, J Shardlow, J R Stead, D Thomas, W T Morris.

The examinations were held in the following worldwide Examination Centres:

UK & Ireland
- Coors Brewers, Burton-on-Trent
- Guinness UDV, Dublin
- Guinness Social Club, London
- Heriot Watt University, Edinburgh
- Inbev UK Ltd, Magor
- Manchester Business School, Manchester
- Speyside High School, Aberlour

Australia
- Murdoch University, Murdoch
- Queensland University of Technology, Brisbane
- University of South Australia, Adelaide.
- University of Tasmania, Tasmania
- University of Melbourne, Melbourne
- University of Technology, Sydney

Barbados
- Ministry of Education, St. Michael

Botswana
- The British Council, Gaborone

Cambodia
- The Royal University of Phnom Penh

Cameroon
- The British Council, Yaounde

Canada
- McGill University, Montreal
- University of Calgary
- University of Toronto, Ontario

Ghana
- The British Council, Accra

Grenada
- Ministry of Education, St George's

Guyana

India
- The British Council, Chennai
- The British Council, Mumbai

Jamaica
- The University of West Indies, Kingston

Kenya
- University of Nairobi

Malawi
- The British Council Offices, Lilongwe

Malaysia
- The British Council, Kuala Lumpur

Myanmar
- The British Council, Yangon

New Zealand
- University of Otago, Auckland

Nigeria
- Guinness Nigeria Plc, Lagos
- Nigerian Breweries Plc, Ibadan

Papua New Guinea
- University of Papua New Guinea, Port Moresby

Russia
- The Kaluga Brewing Company

Seychelles
- Ministry of Education & Youth, Mahé

Singapore
- The British Council

South Africa
- Ibhayi Brewery, Port Elizabeth
- SAB Prospecton Brewery, Durban
- The Technical Training Institute, Rivonia
- University of Cape Town, Rondebosch

St Lucia
- The University of the West Indies & Distance Education Center

Suriname
- Surinaamse Brouwerij, Paramaribo

Tanzania
- Tanzania Breweries Ltd, Arusha
- University of Dar es Salaam

The Netherlands
- Heineken, Zoeterwoude

Trinidad
- Carib Brewery, Champs Fleurs

Uganda
- Hotel Equatoria, Kampala
- The British Council, Nakase

USA
- Coors Brewery, Golden, Colorado
- University of California, Davis

Zambia
- The British Council, Lusaka

Diploma in Brewing (Dipl.Brew), Diploma in Distilling (Dipl.Distil) and Master Brewer (M.Brew)

Five hundred and seven candidates sat part or all of the Institute's Examinations (439 in 2004), at 52 centres (52 in 2004) around the world.

Seventy-two candidates sat part or all of the M.Brew. Eight candidates accumulated passes in all modules.

Four hundred and two candidates sat part or all of the Dipl.Brew. Ninety-six candidates accumulated passes in all modules.

Thirty-three candidates sat part or all of the Dipl.Distil. Twelve candidates accumulated passes in all modules.

The number of candidates who sat each module of the M.Brew, Dipl.Brew and Dipl.Distil is as follows:

- Dipl.Brew Module 1 – 211 (206 in 2004)
- Dipl.Brew Module 2 – 163 (157 in 2004)
- Dipl.Brew Module 3 – 200 (172 in 2004)
- Dipl.Distil Module 1 – 11 (11 in 2004)
- Dipl.Distil Module 2 – 10 (16 in 2004)
- Dipl.Distil Module 3 – 14 (4 in 2004)
- M.Brew Module 1 – 31 (28 in 2004)
- M.Brew Module 2 – 29 (23 in 2004)
- M.Brew Module 3 – 25 (14 in 2004)
- M.Brew Module 4 – 22 (16 in 2004)
- M.Brew Module 5 – 17 (18 in 2004)

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

	UK and Ireland	Overseas
Total number of Dipl.Brew candidates – 402	103 **26%**	299 **74%**
Total number of Dipl.Distil candidates – 33	33 **100%**	0 **0%**
Total number of M.Brew candidates – 72	29 **40%**	43 **60%**

The successful candidates from the 2005 Examinations, who meet all IBD criteria, are listed as follows:

MASTER BREWER EXAMINATION

M.Brew Modules One, Two, Three, Four & Five – Passes

Gilsenan, Stephen**	Irish

M.Brew Module One – Passes

Andrew, Rory Durran Edward	Southern
Croker, Jenna Catherine	Southern
Davies, Robert Edward	Irish
Hollingworth, Richard Andrew	Midland
Kariuki, Samuel Benard Mathenge	Africa
Kiyingi, Stephen	Africa
Mbogo, George	Africa
Meti, Basavaraj	Asia Pacific
Muriithi, Bernard G	Africa
Nisbet, Robert Patrick	Southern
O'Halloran, Gavan Brendan	Southern
Ramshaw, James Edward Michael	Midland
Smyth, Audrey	Southern
Steytler, Lauren Carol	Africa
Stradiotto, Steven	International
Wafula, Peter	Africa

M.Brew Module Two – Passes

Andrew, Rory Durran Edward	Southern
Croker, Jenna Catherine	Southern
Harrington, Fiona	Great Northern

Hussey, Tracy Colette	International
Kobia, Athanasius	Africa
Mbogo, George	Africa
McCoard, Brenda Helen	Southern
McFarlane, Angus Black	Africa
Meti, Basavaraj	Asia Pacific
Muriithi, Bernard G	Africa
O'Halloran, Gavan Brendan	Southern
Okello, Tobias	Africa
Ramshaw, James Edward Michael	Midland
Reid, Christopher	Irish
Sheils, Rory	Irish
Tanner, Brigid Catherine	Irish
Wafula, Peter	Africa

M.Brew Module Three – Passes

Brennan, Martin ++	Southern
Burn, Ian	Great Northern
Chisholm, Christopher Brian ++	Great Northern
Eppard, Tobin Lee	International
Ganesh Ramu, Adesanatti V ++	Asia Pacific
Gopalakrishnan, K N ++	Asia Pacific
Hardie, Alan James	Great Northern
Jones, Catherine Lindsay	Africa
Lees-Jones, Michael Christopher	Great Northern
Mbogo, George	Africa
McEwan, Roderick Nairn	Scottish
Steytler, Lauren Carol	Africa
Tamilarasan, Arumugam	Asia Pacific

M.Brew Module Four – Passes

Bentley, Shona Dianne ++	Africa
Eppard, Tobin Lee	International
Fitzgerald, David John ++	Irish
Groeneveld, Steven Craig ++	Africa
Harrington, Fiona	Great Northern
Lees-Jones, Michael Christopher	Great Northern
Mandu, Richard Wananda	Africa
Mpholo, Victor Bosilo	Africa
Mwova, Nicholas M	Africa
Odendaal, Johan Danie	Africa
Peters, Ann Margaret	Southern
Slade, Gregory Keith	Africa
Subramanya, P G	Asia Pacific
Tamilarasan, Arumugam	Asia Pacific
Viljoen, Clint Robert	Africa

M.Brew Case Study

Adadevoh, Eric Sewonu	Africa
Bentley, Shona Dianne ++	Africa
Brennan, Martin ++	Southern
Ebikade, Samuel U	Africa
Fitzgerald, David John ++	Irish
Ganesh Ramu, Adesanatti V ++	Asia Pacific
Odendaal, Johan Danie	Africa

DIPLOMA IN BREWING EXAMINATION

Dipl.Brew Modules One, Two and Three – Passes

Ambrosio, Shannon Michael	International
Aumais, Mathieu	International
Bernier, David	International
Bird, Jeffrey Adam*	International
Brazil, Camelo	Irish
Coors, Peter Joseph	International
Delamont, Peter Gerald	International
Eaton, Jr, Jeffrey M	International
Erhabor, Iyobosa	Africa
Gjerdingen, Kari Lynn	International
Hagdorn, Andrew G	International
Hamel, David	International
Hayward, Monika	International
Iyogbon, Hamilton Ehidiamhen	Africa
Jackson, Uduak Linus	Africa
Kent, Eamonn A	International
Kuntz, Robert James	International
Nickel, Jeffrey Scott	International
Ogu, Solomon Sila	Africa
Segawa, Toshinori	International
Smith, Derek A	International
Stoneburg, Michael Paul	International
Taylor, Whitney Lynne	International
Timmer, Maarten Hendrik	International
Utuk, Utibe-Abasi Edet	Africa
Van den Berg, Julia Maria	International
Winthagen, Marc H	International

Dipl.Brew Module One – Passes

Abel-Reitzin, Deon	International
Adoga, Inalegwu	Africa
Aiken-Clarke, Angela	International
Arsenault, Gabriella	International
Asante, Prince Kwame	Africa
Assur, David	Scottish
Atwine, Alison	Africa
Balami, Daniel Gombe	Africa
Barraclough, Jayde	Asia Pacific
Bloemen, Herman Hendrik Jan	International
Bradshaw, Khalil S.	International
Brown, Scott David	International
Bryan, Hazel Jayne +	Southern
Chng, Ronald Wee Hwa +	Asia Pacific
Claffey, Joseph	Irish
Collins, Damien	Irish
Connor, Paul Anthony	Asia Pacific
Crankshaw, Alan Gavin	Great Northern
Cremer, Haiko Adriaan	International
Day, Darren Warren	Asia Pacific
Destree, Brian J	International
Edwards, Gareth Martin +	Great Northern
Edwards, Sharon Anne	Southern
Elks, Jonathan William	Midland
Ely, Kevin James	International
Fahey, Lisa	Irish
Fahey, Simon J	Asia Pacific
Floore, Robertus Bernardus Petrus	International
Fuyane, Mothogobeng Zandile	Africa
Gasparini, Matthew J	International
Govender, Kalayvanie	Africa
Grant, Alice	Irish
Grant, James	International
Grant, Paul Matthew	Irish
Guerrero, Ana Silvia	Asia Pacific
Harper, Eric A	International
Heary, Aaron Joel	Asia Pacific
Heary, Daniel Israel	Asia Pacific
Hoohlo, Mbangose Pinki	Africa
Ilozumba, Henrietta Chinenye	Africa

Imrie, Yvonne	Southern
Jansson, Petra Maria Nella	International
Jordan, Michael J	International
Kase, Edward	Asia Pacific
Kearsley, Eve	Midland
Kelly, Robert Patrick	Irish
Kilcullen, Stephen	Irish
Kirkton, William James	Midland
Koay, Beng Guat	Asia Pacific
Koudriavtsev, Pavel +	International
Laing, Sarah Elizabeth	Asia Pacific
Lawrence, Mickellia Guvannie	International
Litchmore, Anthony	International
MacKendrick, Richard Angus	Asia Pacific
Madden, Stacey	Asia Pacific
Marshall, Lisa J	Midland
Masend, Joseph	Africa
Mauger, Peter Rodney	Asia Pacific
May, James Caleb	International
Mbwele, Shukran Essau	Africa
Medlyn, David Wallace +	Asia Pacific
Moloi, Neo Semousu +	Africa
Molotchnikoff, Thierry Gautrin	International
Monosi, Busisiwe Beryl	Africa
Moore, Jane Claire	Midland
Morgan, John	Midland
Morgan, Mark	Southern
Morisey, Matthew Lloyd	Asia Pacific
Moser, Darren M	International
Mudoh, Mbachan Richard	Africa
Nagganya, Proscovia	Africa
Needham-Brooks, Olwen	International
Nwachukwu, Evelyn Udochukwu	Africa
Nyambo, Evarist Beno	Africa
Okiring, Francis Onyimo	Africa
Oloyede, Oyebode	Africa
Parkinson, Leslie	Asia Pacific
Parrell, Joseph Michael	International
Petersen, Susan Margaret	Asia Pacific
Platz, Phillip J	International
Quelhas, Michael	International
Quinn, John Gerard	Irish
Rance, Alison Jane	Great Northern
Reynolds, Phillip	International
Ricketts, Krista	International
Rodina, Natalia	International
Schofield, Vanessa Helen	Asia Pacific
Sheehan, Christopher Alan John	Asia Pacific
Small, Stephanie Ann	International
Snyder, Craig P	International
Sorokina, Elizaveta	International
Strawbridge, Martin	Southern
Tapsi, Prasad	Asia Pacific
Taylor, Joshua Fraser	Southern
Torcaso, Luciano Adam	Asia Pacific
Travis, Brooke	Asia Pacific
Turley, Daniel Timothy	Asia Pacific
Ubrufih, Jennifer Ovue	Africa
Van Der Merwe, Marlize +	Africa
Vaughan, Anne	International
Vela, Gia	Asia Pacific
Wadyka, Daniel H	International
Walker, Hayden Peter	Asia Pacific
Wallis, Geoffrey Damon	Irish
Ward, Beverly Lorraine	Asia Pacific
Wardman, Rhona Jean	Asia Pacific
Weaver, Andrew	Southern
White, Christine S.	International
Wright, Wayne Anthony	Southern
Wyers, Eric J	International
Wynnyk, Gregory David	International
Yates, Elisabeth Anne	Southern

Dipl.Brew Module Two – Passes

Adoga, Inalegwu	Africa
Batten, Darren Morgan	Southern
Baxter, David James Connel +	Great Northern
Bloemen, Herman Hendrik Jan	International
Broadbent, Jonathan Paul	Midland
Butler, Maria Patricia	Scottish
Clem, Anthony Robert	Asia Pacific
Cousins, Winston Anthony	International
Craig, Andrew	Scottish
De Jager, Maret	Africa
Dempsey, Alan	Irish
Denny, Richard Charles	Midland
Dineen, Johannah Pauline	Irish
Faulknor, Steve	Asia Pacific
Floore, Robertus Bernardus Petrus	International
Gorringe, Elizabeth Louise	Southern
Hall, Nick +	Asia Pacific
Hayes, Keith +	Great Northern
Ho, Jonathan	Asia Pacific
Jordan, Matthew G. C. +	Great Northern
Koay, Beng Guat	Asia Pacific
Kwarciak, Dominika	Great Northern
Langenbacher, Simon Leonard	Asia Pacific
Lee, Eung-Gwan	International
Lee, Kek Wee Kenneth +	Asia Pacific
Ludwig, Karl	Africa
Matete, Mujungu Douglas	Africa
Matthews, Carol	Africa
McLean, Kevin Ian Maurice	International
Medlyn, David Wallace +	Asia Pacific
Nair, Jayalalitha +	Africa
Nic Phiarais, Blaise Patricia	Irish
O'Donnell, Jenny Nita +	Asia Pacific
O'Halloran, Catherine Louise	Great Northern
Oates, Neil Anthony	International
Oosthuizen, Michael	Africa
Parker, Drew Michael	Asia Pacific
Platz, Phillip J	International
Reeves, Felicity	Southern
Roberts, Mark Richard	Asia Pacific
Rodina, Natalia	International
Rossetti, Samual John	Great Northern
Ryan, Michael John	Asia Pacific
Saha, Surajit	Asia Pacific
Seabela, Setebe Willy	Africa
Sheehy, Megan Frances	Asia Pacific
Strawbridge, Martin	Southern
Tapsi, Prasad	Asia Pacific
Thompson, Kerryn	Asia Pacific
Van Rijn, Kees	International
Van Schalkwyk, Marna	Africa
Vaughan, Anne	International
Ward, Beverly Lorraine	Asia Pacific
White, Christine S.	International
Wijngaard, Hilde Henny	Irish
Yetman, Gerri	International
Zervoudakis, George	Asia Pacific
Zimmermann, Janie	Asia Pacific

Dipl.Brew Module Three – Passes

Adeyoyin, Abayomi +	Africa
Akinwale, Oluwaseun Mobolaji +	Africa
Aleshinloye, Olawale Abiodun +	Africa
Alozie, Anthony Nnaemeka +	Africa
Appleby, Kevin John +	Midland
Arizon, Vanessa Audrey +	Africa
Ashoka, Ragihalli Ramachandraiah +	Asia Pacific
Aspeling, Lindsey-Ann	Africa
Atwine, Alison	Africa
Baldeo, Sangeeta Devi +	Asia Pacific
Basmanov, Vasily +	International
Baxter, David James Connel +	Great Northern
Bennett, Craig Douglas +	Great Northern
Boamah, Bejisa	Africa
Bonighton, David Ronald +	Asia Pacific
Bowman, Robert	International
Brooke, Gayna +	Great Northern
Bryan, Hazel Jayne +	Southern
Cantwell, Ron William	International
Charles, Donaldson +	International
Chilume, Leonard-Bathoni +	Africa
Chng, Ronald Wee Hwa +	Asia Pacific
Coe, Margaret Emily +	Asia Pacific
Collier, Michael James +	Midland
Denny, Richard Charles	Midland
Destree, Brian J	International
Durant, Trevor Michael +	Great Northern
Fox, Christopher James +	Asia Pacific
Francis, Devon Milton +	International
Frieslaar, David	Africa
Garson, Keith James	Scottish
Giles, Christopher John +	Southern
Glover, Justin David	Midland
Govender, Kalayvanie	Africa
Grant, Paul Matthew	Irish
Green, Graham +	Africa
Hall, Martin +	International
Hall, Nick +	Asia Pacific
Hands, Christopher Philip +	Great Northern
Harbottle, Brett Cameron +	Asia Pacific
Harper, Eric A	International
Hignett, Jason Satch +	Asia Pacific
Huey, James Stanley +	Irish
Hughes, Samantha Jane +	Great Northern
Ivie, Mark	International
Jansson, Petra Maria Nella	International
Jordan, Matthew G. C. +	Great Northern
Kabila, John Ilunga +	Africa
Kalpoe, Soereschandre	International
Kelly, Richard	International
Kelly, Robert Patrick	Irish
Killerlane, Colm	Irish
Koudriavtsev, Pavel +	International
Lack, Andy John +	Midland
Libazi, Pilasande Bulelwa +	Africa
Limanek, Seth P	International
Mahesh, Rajamanickam	Asia Pacific
Malan, Roux Daniel	Africa
McGregor, James Allan +	International
Mickelson, Leon James +	Asia Pacific
Mokhatla, Likhetho David +	Africa
Morgan, John	Midland
Morley, Shane Kelvin +	Asia Pacific
Moser, Darren M	International
Naoumova, Ekaterina +	International
Nong, Khutso Betweenia	Africa
Nsubuga, Edward +	Africa
Ntabejane, Violet Nkamoheng +	Africa
O'Keeffe, Rory +	Southern
O'Sullivan, Tadhg +	International
Ogunsola, Olusoji Oladapo +	Africa
Okware, Nightingale Janice +	Africa
Oloyede, Oyebode	Africa
Parkinson, Philip James	Midland
Pasea, Delano Edson +	International
Pavlov, Sergey +	International
Pearson, Kevin John +	Midland
Pilotti, John Powaseu	Asia Pacific
Pitso, Gabriel +	Africa
Porro, Cristina Shino +	Great Northern
Quelhas, Michael	International
Quinn, John Gerard	Irish
Robinson, Ciara	Irish
Rose, Maggie	Midland
Scade, Andrew John +	Asia Pacific
Scheepers, Eugene	Africa
Short, Alan	Great Northern
Siaw, Yon Miaw +	Asia Pacific
Singh, Roshene +	Africa
Singleton-Jones, Nicola Jayne +	Midland
Snyder, Craig P	International
Sorokina, Elizaveta	International
Tillson, Jonathan +	Southern
Ugwoke, Christopher Chika	Africa
Van Der Merwe, Marlize +	Africa
Velmurugan, Subramanian	International
Versfeld, Frederick Bryan	Africa
Wadyka, Daniel H	International
Walmsley, Robert Andrew +	Great Northern
Wilkinson, Kevin	International
Wood, Grant Evans +	International
Woodall, Sarah Jane +	Great Northern
Young, Melanie Anne +	Asia Pacific

DIPLOMA IN DISTILLING EXAMINATION

Dipl.Distil Module One – Passes

Beaumont, Vincent H.	Irish
Clarke, Robert	Scottish
Collins, Sharon	Scottish
Dean, Ian Stuart	Scottish
Donegan, William	Irish
MacKay, Ian Charles	Scottish
Morehead, Peter	Irish
Nation, Brian Gerard	Irish
O'Gorman, Kevin	Irish
Wood, Timothy John	Scottish

Dipl.Distil Module Two – Passes

Anderson, Alasdair John	Scottish
Cameron, Victor Alexander	Scottish
Campbell, Kirsteen Anne	Scottish
Collins, Sharon	Scottish
Darlington, Eliot John William	Scottish
Grant, Gordon Iain +	Scottish
MacDonald, Andrew	Scottish
Ogilvie, Ewan Robert	Scottish

Dipl.Distil Module Three – Passes

Ballard, Nicholas Thomas +	Scottish
Bruce, Gordon John +	Scottish
Cairney, Helen +	Scottish
Corbett, Neal Anthony +	Scottish
Donoghue, Gordon +	Scottish
Grant, Gordon Iain +	Scottish
Hardy, David +	Scottish
Hughes, Robert +	Scottish
McCallum, Kirstie	Scottish
Millar, John P +	Scottish
Robertson, Stuart Torrance +	Scottish
Sutherland, John More +	Scottish
Tweedie, Alexander Robert +	Scottish

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

INSTITUTE OF BREWING & DISTILLING EXAMINATIONS 2005

Question Papers and Examiner's Reports

DIPLOMA IN BREWING EXAMINATION 2005

Module 1 – Materials and Wort

Tuesday 7th June 0930–1230 hrs

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.)

The examination was sat by 211 candidates compared with 206 candidates in 2004, 216 candidates in 2003, 181 candidates in 2002 and 199 candidates in 2001. This is therefore the third occasion on which more than 200 candidates have sat the Diploma I examination. The pass-rate for the examination this year was 67%. This compares with a pass-rate in 2004 of 78%, 2003 of 72%, 2002 of 67% and 2001 of 66%.

The grade distribution was as follows (2004 in parentheses):

A, 1% (4%) B, 6% (18%) C, 23% (30%) D, 37% (26%)

E, 14% (16%) F, 14% (3%) G, 5% (3%)

There has been a drop in pass rate back to the levels of 2001/2002. This is disappointing and was reflected in the lower grades achieved overall this year. It is important that candidates entering the examination have a thorough grasp of the whole syllabus. Candidates have 3 hours to answer 6 questions. While most candidates answered 6 questions, it was apparent that weaker candidates were struggling to answer questions on the whole syllabus. The examiners are aware that time to answer questions is limited and that it may not be possible for time reasons to include all that a candidate wishes to write. Clearly labelled diagrams can save many words of explanation, and not only gain more marks but save time. Remember, it is important to write legibly, marks cannot be awarded by the examiners for writing that cannot be read. In summary, candidates should **make every effort to get across the main points and demonstrate an understanding of the question.** The comments below should help candidates to see what the examiners were looking for. High marks could have been achieved without mentioning every point, and marks could also have been given for discussing relevant information beyond that given below.

Question 1

Describe the principle structures of chitted barley (use labelled diagrams as part the role of endogenous gibberellic acid in the modification of the grain during malting of your description). Explain the biological function of these structures. [12]

Explain the role of endogenous gibberellic acid in the modification of the grain during malting. [8]

This question was attempted by 193 candidates (91%) with 71% achieving the pass mark.

The answer to this question must include a labelled diagram showing a longitudinal section through a barley grain during early germination, indicating the embryo, endosperm, husk, testa/pericarp, aleurone, micropyle, coleoptile, coleorhiza and scutellum. Additionally, a brief written description of these components and their significance should be given. The embryo is the potential future plant and upon germination produces gibberellic acid that activates gene expression and protein export from the aleurone. The aleurone produces hydrolytic enzymes to degrade cell walls, proteins and starch in the endosperm. The endosperm stores starch and protein (which after hydrolysis are the key requirements for brewing). A sketch of the cellular structure of the endosperm should also have been given, with a description of the starch grains (large 10–25 µm, small 1–5 µm), and their composition (amylose/amylopectin). The starch grains are imbedded in a protein matrix.

Candidates should indicate that gibberellins are produced in the barley embryo during germination and are transported via the scutellum through to the aleurone. Gibberellic acid initiates the *de novo* synthesis of hydrolytic enzymes from primarily the aleurone but also the scutellum. Beta-glucanases and glucan solubilases, and the proteases, serve to expose the starch grains in the matrix of the endosperm, and provide a source of nitrogen for yeast growth. Alpha amylase and limit dextrinase break down the starch during malting and mashing. Additionally, the proteases release and activate beta-amylase, which is already present in the endosperm, and they help to activate limit dextrinase. As a consequence of the mechanics of enzyme release and activation, modification of the endosperm follows a distinct pattern over time.

The majority of the candidates attempted this question, and most did reasonably well. However about half of the candidates drew a mature, non-germinated grain. The understanding of plant anatomy was variable, with some particularly peculiar looking embryos and scutella, the latter frequently being shown as a disembodied line. The scutellum is an integral part of the embryo, and not a semi-permeable membrane or a single layer of cells, as was sometimes stated. The difference between starch grains and starch molecules was occasionally confused. Many candidates mixed up endogenous and exogenous, and explained how gibberellic can be added to grain during steeping and chitting. A number of candidates assumed that beta-amylase is also released directly from the aleurone.

Question 2

What are the quality specifications of malt for brewing? [8]

Explain the brewing significance of these specifications. [12]

This question was attempted by 197 candidates (93%) with 72% achieving the pass mark.

The answer should include the general specifications of malt for brewing with indications of the numerical ranges within which the parameters might be set. Quality specifications for brewing malt include the following: lack of infection, moisture content, hot water extract, cold water extract, diastatic power, total nitrogen, total soluble nitrogen, free amino nitrogen, fermentability, colour, friability, homogeneity, β-glucan and β-glucanase levels, SMM levels, lack of herbicide or pesticide residues. The absolute malt specifications depend on the type of beer to be produced.

The significance of the individual specifications to brewing is as follows: friability and homogeneity of modification is important for optimum extraction during malting, as under- or over-modified malts yield less extract, and under-modified malts can cause processing problems. Microbial infection can lead to problems during fermentation and storage. Moisture content must be low enough to permit storage of the malt with no spoilage. Cold water extract relates to hydrolytic enzyme activity during malting. Hot water extract relates to the amount of soluble material that can be extracted from malt (specific gravity); this is a function of optimal grain modification and enzyme activity. Diastatic power is a function of the sum of the hydrolytic enzymes that convert starch to sugars, and must be adequate in order to produce a fermentable wort. Total soluble nitrogen (proteins, peptides and amino acids) provides a potential source of nitrogen for yeast during fermentation. Fermentability is an indication of what proportion of the extract is utilisable by the yeast for conversion to alcohol. β-Glucan is a cell wall component that can cause problems during filtration and beer storage, and β-glucanase is the enzyme that will degrade β-glucan. SMM is a precursor for DMS which produces an off flavour in some beers and a desirable flavour in some lagers. Colour and flavour is generally a function of kilning temperature, some beers (stout) require very strongly coloured malts whereas others require much less colour.

Nearly all candidates answered this question. Most candidates did very well on this question and provided an answer in tabular form, with units and acceptable ranges for the specifications. Some answers even included the parameters for different types of brew. However, some candidates mistakenly included the agronomic and grain specifications for the farmer and maltster. The better answers gave a brief indication of the methodology for each specification. Although radioactivity is not a desirable trait in malt, it is not generally assayed for, as was assumed by one candidate!

Question 3

Briefly outline the pests and diseases to which hops are susceptible. [6]

Give a detailed account of the hop constituents relevant for brewing and explain the reasons for their relevance. [14]

This question was attempted by 162 candidates (77%) with 57% achieving the pass mark.

Pests and diseases to which hops are susceptible

Some of the pests and diseases are specific to hops and so found only where hops are grown. To minimise pesticide/fungicide residues in beer, the use of resistant varieties and biological control offer useful approaches to disease control. Most answers covered the majority of pests and diseases except those of viruses which were often missed out. Weaker candidates were unable to make any comment on the symptoms of the diseases.

Damson-hop aphid. Overwinters on species of *Prunus* and migrates to hops from late May. If not controlled during vegetative part of hop growth, plants can be completely defoliated. If they establish within the hop cone, their secretion of honey-dew attracts fungi causing further damage and discolouration. Biological control can be effective if the infection is not severe.

Red spider mite. Pest with a wide range, favours hot and dry conditions. Thus pest D has developed resistance to pesticides. It can cause silvery speckling of leaves and cones which may turn reddish brown. Severe attacks will cause loss of crop.

Powdery mildew. Long established disease, fungicides need to be used before flowering. Disease first appears as white pustules on the leaves. Serious losses if cones are attacked. Perithecia are principal source of infection in the Spring.

Downy mildew. This is widespread in Northern Hemisphere. Fungus survives in rootstock of infected plant and moves into developing buds in the Spring turning the buds into short, stunted shoots ("spikes") that become covered in black spores (conidia). Can seriously damage vegetative growth and developing cones if they become infected. Control by copper fungicides and more recently by systemic fungicides.

Verticillium wilt. Infects plant roots through soil and diseased plant debris. Stress is on control through good husbandry and use of resistant cultivars.

Viruses. Commercial hop gardens are planted with vegetatively propagated material and are therefore liable to accumulate virus infections.

Hop Mosaic Virus – infects a wide variety of plant species. Transmitted by nematodes. Plants have reduced number of shoots and leaves. Control by using uninfected plants and reducing nematodes in the soil.

Prunus Necrotic Ringspot Virus – may reduce α-acid production of hops. These losses can be avoided by using virus free cultivars.

Hop Latent Viruses – no symptoms of infection in a commercial hop variety. Perhaps reduces α-acid content of cones.

American Hop Latent Virus – may be present on hops in the USA, but its effects are unclear.

There are many hop constituents relevant for brewing. While almost all answers described the relevance of hop resins the weaker answers often failed to mention essential oils or tannins. The best answers discussed how whole hop constituents can change during storage and the implications of these changes for brewing.

A. Hop resins. There are two types, hard resins (insoluble in hexane) and soft resins. The soft resins contain α-acids and β-acids. α-Acids consist of humulone, adhumulone and co-humulone. The β-acids consist of lupulone, adlupulone and colupulone. The isomerisation of α-acids during wort boiling provides bitterness to the beer. Utilization of α-acids will depend on wort pH, gravity of the wort, and vigour of the boil.

Utilization of α-acids is often significantly less than 40%. Pellitised hops (type 90 pellets) are made by milling and compressing whole hops into pellets. Type 45 pellets have some vegetable matter removed. Utilization of α-acids can be significantly increased by the use of isomerised hop extracts. Hop extracts have greater stability and lower levels of tannins/polyphenols. Extraction of α-acids from hops can be carried out and these hop extracts can be added directly to the 'kettle'. Hop pellets and extracts can be preisomerised to increase the utilization of α-acids. Reduced hop extracts have been produced. Beers produced with these reduced extracts do not produce 'light-struck' off-flavour (e.g. 3MBT) because the free side chain of iso-alpha acid cannot bind with a free sulphur radical, therefore 'light-struck' off flavour is not produced. Hop oils can be extracted and added post-fermentation in the form of an emulsion.

The oxidation of β-acids can produce hulupones that can contribute bitterness; however, this is regarded as a harsh bitterness. Approximately 1% of β-acid may be isomerised producing harsh bitterness.

B. The essential oils contribute aroma to the final beer and make up 0.9% of the hop cone. They are made up of three groups, the hydrocarbons, oxygenated compounds, and sulphur compounds. Essential oils will be lost during wort boiling unless they are added in the last 5–20 minutes of the boil. Very few, if any hydrocarbons, will survive the wort boiling process.

Late hop character is often described in 'floral' of 'citrus' in flavour. Hops can also be added to beer after fermentation to give beer a dry hop flavour often described as 'resinous', 'spicy', or 'citrus'.

C. Tannins can precipitate with protein during wort boiling – hot trub. They can also increase the reducing power of beer leading to resistance to oxidative staling. However, they can lead to chill hazes and bitter tastes in the final product.

D. Changes in quality can occur during storage of whole hops.

1. Soft resins produce hard resins. There is a relationship between the percentage (α + β) lost, determined from the HS1 (Hop Storage lndex), and the formation of hard resin. 15–20% of brewing value of hops, based on the α-acids at harvest, can be lost during two years storage at ambient temperature.
2. Oxidative cleavage of acyl side chains of hop resins releases isobutyric, isovaleric and 2-methylbutyric acids which lead to development of a 'cheesy' aroma.
3. Fall in α-acid and loss of bittering potential is partially offset by oxidation of β-acids to hulupones with harsh bitterness.
4. Hop oils can show increases in volatile acids over three years from 1–3% to 20%.
5. Change in 'hoppiness' from oxygenated oils differs on storage between different varieties of hops. Generally, the fraction of hydrocarbons in oils decreases while the level of oxygenated compounds increases.
6. With greater than 12% moisture, hops are very susceptible to deterioration. Discoloration can occur and there are dangers of microbial infection.

Question 4

Explain the operation of both a roller dry mill and a hammer mill (use labelled diagrams as part of your explanation). [10]

Discuss the merits of these mills with respect to the typical ranges of particle sizes produced and subsequent use of these grists in brewing. [10]

This question was attempted by 171 candidates (81%) with 54% achieving the pass mark.

The aim of milling is to convert malt into a form so that conversion can occur in the mash, and subsequent separation of wort from solids can be achieved. Milling achieves size reduction and particle size control. Most answers provided a description of both a roller dry mill and a hammer mill. However, many answers provided very scanty detail of operation with candidates failing to give a clear explanation of how the mills operated. Questions need to be carefully read.

Roller mills require an even feed onto the rolls to avoid uneven grinding and variable wear on the rollers. Therefore, feed rollers feed corns to the grinding rollers. To avoid damage from stones, one in each pair of rollers is spring mounted.

Rollers are mounted so that the roller gap can be adjusted. This is now often achieved by computer control.

Rolls for initial crushing are at least 25 cm diameter and run with a peripheral speed setting of 2.5–4.0 m/s. Smaller rolls on higher speeds result in reduced crushing. The rollers that grind the large and then the small grits rotate at successively higher speeds by a ratio of 2:1 adding shear to the crushing action. All rolls with 4 or more rollers are equipped with screens between the sets of rollers. These separate off the fine particles which would reduce the effectiveness of subsequent milling.

A two row mill is low cost but only functions satisfactorily with well modified malt. A second pair of rollers allows cyclindrical sieves or beaters below the first pair of rollers to divert husk, fine grits and flour. The grind of the coarse grits by the second set of rollers is thus improved. This mill is normally used by breweries using well modified malt in a mash tun.

A six roll dry mill can handle a wide variety of malts and produce coarse and fine grits, even fine grists suitable for a mash filter. Paired screens below each of the first set of two rollers divert various factions to the appropriate set of rolls or direct to the mill outlet.

The hammer mill is based on the principle of flat flails attached to a rapidly rotating shaft (rotation is typically 2,500–5,500 rpm. Corns are broken into successively smaller particles through a series of impacts. Fixed bars projecting into the grain space can increase the frequency of these impacts. Size and shape of the screen define the particle size leaving the mill, although rotational speed and feed rate can alter the particle sizes to some extent. Clearance between sieve and hammers is not critical, some designs allow direction of rotation to be reversed to even out wear on hammers. The capital cost is lower than roller mills, but power consumption can be more than 3 times higher. The husk is not preserved.

Different grist particle size profiles suit different mashing systems. The mash tun has a deep floating bed, the lauter tun has a thinner raked bed, and the mash filter has a short pressurised filtration path. There is more lipid oxidation of grist with a roller mill. Therefore, hammer milled grists with a mash filter produce brighter worts than fine milled grists with a roller mill.

The spectrum of particle size distribution in a ground malt grist is measured using standard screens. The precise proportions of fractions will vary – but, for example, for a six-roller hammer mill, values might be husk 15%, coarse grits 30%, fine grits 45%, flour 10% whereas for a hammer mill values would be in the range of husk 5%, coarse grits 15%, fine grits 40%, and flour 40%.

The answer might have discussed the extraction of malt components in terms of whether the brewery would use a mash tun, lauter tun or mash filter. For example roller mill grinding of a less well modified lager malt would involve malt conditioning to help protect the husk, preservation of husk during grinding, but an attempt to achieve finely ground starch to provide extract.

A course grind can lead to reduced extract, easier wort separation, but with less well modified malt, hard ends can survive and so starch can pass to the copper. A finer grind can produce more extract, but slower wort separation (e.g. lauter tun) with greater extraction of undesirable tannins, silicates, and lipids which may become oxidised.

Question 5

Outline the basic principles of single temperature infusion mashing and temperature-programmed mashing, and discuss the respective merits of these mashing regimes. [20]

This question was attempted by 172 candidates (82%) with 71% achieving the pass mark.

A single temperature mash as the name suggests is carried out at a single constant temperature of around 65°C. The temperature for mashing is a compromise for α and β-amylase activity, and for barley starch gelatinisation, which is essential for fast access of hydrolytic enzymes to the substrate. This method will generally give wort of lower fermentability and lower extract compared to temperature-programmed mashing. This temperature may well inactivate proteases thus the malt used must have had adequate proteolytic breakdown during malting. High molecular weight proteins will still be present which can give later haze problems and FAN levels can be low. Single temperature mashing requires the use of well-modified malt and low adjunct levels, since there is no opportunity for a stand for proteolytic or β-glucanase activity. Single temperature mashes tend to be thicker, since this provides some protection for the enzymes from heat degradation. Run-off times from lauter tuns are often 4–6 hours, and since mash mixing, conversion and run-off usually take place in a single vessel, utilization of plant is poor and brewhouse output is lower than for temperature programmed mashing.

In contrast, temperature programmed mashing uses a number of pre-determined stand temperatures and times. It can also use under-modified malt, a high level of adjunct and thinner mashes. The stands can be achieved by two methods: by heating the mash, normally by steam jackets whilst stirring with a low shear agitator, or by decoction mashing. Decoction is the removal of a portion of the mash, heating up in a separate steam heated agitated vessel and then returning it to the main vessel. This can be repeated several times to achieve the desired temperature stands. Historically, decoction mashing probably gave the most desired temperature profile, since volume measurement was easier than temperature measurement. However, with modern temperature control systems, the former method is now preferred and the thin mash facilitates good heat transfer and enables simple mashing-in equipment to be used. Decoction is still a benefit where adjuncts are used with a high gelatinisation temperature, thus requiring pre-cooking before addition to the main malt mash.

The stands are at temperatures optimal for specific enzyme activity. Most regimes will have a stand at 45–50°C for proteolytic enzyme activity, allowing a higher amount of Free Amino Nitrogen (FAN) to be formed that is beneficial in fermentation. A stand at this temperature also allows β-glucanase to degrade β-glucan, particularly from undermodified malt. β-Glucanase is temperature sensitive and if the glucans are not dealt with at this point, they could be solubilised by the relatively heat stable β-glucan solubilase enzyme later in the process when β-glucanase is deactivated. This leads to gel formation and run-off problems. The β-glucanase activity is probably more important than the proteolytic activity since most proteolysis will have been completed in malting. There can be a danger of too much proteolysis and a negative effect on head formation in the final bear. The next stand is determined by the required sugar spectrum in the wort. A saccharification stand at 60–65°C favours β-amylase activity, with the production of maltose. However, α-amylase is also active at this temperature and their combined activity is important in providing fermentable wort with a good yield. Temperatures of 70–75°C favour α-amylase activity and liquefaction, with β-amylase being heat deactivated rapidly. This produces a more dextrinous wort with lower maltose, and could be the requirement in producing a full mouth feel, low alcohol beer. Variation and combinations of stand and stand temperatures allow the brewer to achieve the desired balance of dextrin and fermentable sugars in the wort. The final mashing temperature of 75–78°C, is a stabilization stand, at which most enzyme activity is halted and the composition of the wort is "frozen".

Answers were generally based around diagrams showing the relationship between time, temperature and enzyme activity. It is important for candidates to remember that germinating barley in the field rarely encounters a temperature above 20°C but still manages to successfully mobilise the endosperm reserves. Some of the diagrams became overly complex, especially when decoction mashing was included, with little in the way of explanation.

Question 6

Give an account of the range of brewhouse adjuncts. [12]

Describe the effect of brewhouse adjuncts on

fermentability, [4]

beer flavour and stability, [4]

and brewhouse capacity. [4]

This question was attempted by 185 candidates (88%) with 65% achieving the pass mark.

Good answers included a definition of adjuncts and a comprehensive list with gelatinisation temperatures along with a description of the adjunct's particular use. In the second part of the question, there was a choice of two from three parts and the choice was evenly split amongst candidates.

Definition of adjunct: adjuncts are an additional source of carbohydrate extract used to partially replace or supplement malt. They are used to reduce the overall material costs and to utilise indigenous sources of extract.

Examples of adjuncts include:

Malt.
Raw barley.
Raw wheat.
Maize grits.
Hydrolysed starch syrup e.g. barley, wheat and maize syrups.
Semi-refined cane sugar.
Caramels.

Common cereal adjuncts:

Barley – a replacement for malt, potentially producing a similar beer to standard malt.
Wheat – rich in glycoproteins, used to improve foam stability.
Maize – rich in oils, acts as a nitrogen diluent.
Rice – very low in oils, gives a light dry and crisp flavour to beer.
Sorghum – sometimes used as a direct replacement for malt.
Oats and Rye – may be blended with malt to produce speciality beers.

Processed solid cereal adjuncts include:

Torrified cereals – act as wort nitrogen diluents.
Micronised cereals – act as wort nitrogen diluents.
Flake cereal.
Cereal flour.
Cereal extrusion.

Other solid adjuncts include dried starch from potato, the man made cereal triticale (rye × wheat) and speciality malts such as white malt, wheat malt, caramelised and chocolate malts.

Adjuncts such as maize, rice and sorghum have a higher gelatinisation temperature than malt and must be gelatinsed before addition e.g. torrified or micronised. Barley and wheat have a similar gelatinisation temperature to malt. Addition is usually to the mash. Liquid adjuncts are generally added to the kettle. Colouring products, such as caramels, and enzymes are also often regarded as brewing adjuncts.

Adjuncts can be used to adjust the fermentability of a wort which depends on the decrease of hydrolysis in processing or during mashing. Hydrolysed starch based syrups can be produced with a range of fermentabilities which can be used to adjust wort fermentability. Adjuncts are an efficient means of extending brew length and increasing the gravity of the wort.

Adjuncts effect flavour by:

(i) Diluting the flavour to give a lighter, smoother beer in the case of bland adjuncts, such as cereals.
(ii) Contributing their own distinctive character to the beer in the case of flavoursome adjuncts.
(iii) Altering the carbohydrate and nitrogen ratios of the wort, thus affecting fermentation products in the case of adjuncts low in nitrogen.
(iv) Liquid adjuncts can be added after primary fermentation as primings to increase the sweetness or body/mouthfeel or provide a source of extract for a secondary fermentation.

The effects of adjuncts on stability are:

(i) Enhance foam stability by providing additional glycoproteins and polypeptides in the case of wheat and barley.
(ii) Reduce foam stability through diluting malt proteins (and possibly contribute foam negative lipids) e.g. maize, rice and liquid sugars and syrups.
(iii) Improve chill haze and permanent haze stability by diluting malt nitrogen and polyphenols e.g. maize, rice and sugars and syrups.
(iv) Improve beer stability and shelf life, especially when maize and rice adjuncts are used.

The use of adjuncts can result in increased brewing capacity through shorter brewing cycles and more uniform wort quality. Other benefits may include easy handling and usage, cleaner fermentations with improved yeast heads, improved hot and cold breaks and shorter maturation times. Liquid adjuncts in particular may improve high gravity brewing, lower lauter tun loadings and hence lead to faster run off for the same brew length, shorter brewing cycles, space saving in vessel sizes and material storage, and reduced brewhouse labour costs.

Question 7

Outline the key inorganic components of brewing liquor and discuss their relevance to the brewing process. [20]

This question was attempted by 87 candidates (41%) with 47% achieving the pass mark.

Good answers included a comprehensive list of the inorganic ions and a description of their effect. The majority of candidates noted the importance of calcium in lowering mash pH. Excellent answers discussed the importance of water source and effects on brewing of altering the brewing liquor ion content. A few candidates misinterpreted the question and discussed the attributes of potable water.

The mineral content of brewing liquor has long been recognised as making an important contribution to the flavour of the beer. Indeed breweries were generally founded in areas with distinct water.

Key inorganic components include:

Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Fe^{2+}, Zn^{2+}, Cu^{2+}, Mn^{2+}, NH_4^{+}, CO_3^{2-}, HCO_3^{-}, Cl^{-}, SO_4^{-}, NO_2^{-}, NO_3^{-}

Calcium, Ca^{2+}. Calcium is responsible for the fall in pH during mashing, boiling and fermentation by reacting with buffering compounds such as phosphates to form an insoluble compound which releases H^{+}, causing a drop in pH. A minimum concentration of 40 ppm calcium ions is necessary in finished beer. Failure to add sufficient calcium will result in higher wort and beer pH, and poorer fermentation and quality. Calcium also has other beneficial effects including: protection of alpha amylase from thermal degradation, improvement of protein precipitation during the boil, limitation of colour formation during the boil, improvement of yeast flocculation, removal of oxalates, and stimulation of proteolytic and amylolytic enzyme activity.

Magnesium, Mg^{2+}. Magnesium ions have similar reactions to calcium. However, they are more soluble and therefore the effect on wort pH is less. Magnesium also provides the beer with a slightly bitter or sour flavour. Magnesium acts as a cofactor for certain fermentation enzymes.

Sodium, Na^{+}. At low concentrations sodium gives a sweet flavour to beer, but at higher concentrations (~150 ppm) it gives a salty flavour. At low levels (75–150 ppm) it adds palate fullness.

Potassium, K^{+}. Potassium gives a salty flavour, but it is not normally added to beer. An essential co-factor for some enzymes.

Iron, Fe^{2+}. Iron has a negative effect on mashing by preventing saccharification and enfeebling (weakening) the yeast, leading to bland beers without palate fullness. It should be absent from brewing water. Iron in packaged beer acts as a catalyst in the auto-oxidation of polyphenols accelerating the production of irreversible hazes in beer. It also imparts a metallic taste.

Zinc, Zn^{2+}. At high concentration, zinc has a toxic effect on yeast, inhibits amylase activity and contributes to beer haze. In trace amounts it acts as a yeast nutrient. The requirement for zinc is strain dependant and if limited can lead to defective fermentations.

Copper, Cu^{2+}. At high levels (10 ppm) copper is toxic to yeast. At lower concentrations it acts as a catalyst in the auto-oxidation of polyphenols accelerating the production of irreversible hazes.

Manganese, Mn^{2+}. At levels of 0.5 ppm or above manganese may inhibit fermentation. It is required at low levels (0.2 ppm) to act as a cofactor to yeast enzymes.

Ammonium, NH_4^{+}. Ammonium salts may be used as a source of metabolic nitrogen for yeast in laboratory fermentations. It is generally regarded as an indicator of contaminated water (produced by putrefying organic matter).

Carbonates/bicarbonates, CO_3^{2-}, HCO_3^{-}. These ions absorb H^{+} ions preventing a fall in pH. The increase in wort pH has an adverse effect on mash enzymes and run off. Carbonates are about twice as effective at raising the wort pH as calcium ions are at lowering it. Carbonates form scale on heating surfaces. Levels in brewing liquor should be lower than 20 ppm.

Chloride, Cl^{-}. At levels up to 300 ppm chloride increases palate fullness and gives a generally more mellow flavour to a beer, as well as improving clarification and colloidal stability. Chloride can inhibit yeast flocculation and may lead to slower fermentations and poor beer quality (above 500 ppm).

Sulphate, SO_4^{-}. Sulphate ions produce drier more bitter flavours in beers. They are also a source of SO_2 and H_2S that can be formed by the yeast during fermentation or when acted upon by bacteria. They also reduce mash pH and give the beer a dry sulphury flavour.

Nitrite, NO_2^{-}. Nitrite is poisonous for yeast and can react with tannins to give a reddish tinge to beer. Wort nitrite can contribute to N-nitroso compounds in beer. It is generally regarded as an indicator of polluted or contaminated water.

Nitrates, NO_3^{-}. In conjunction with microbial contamination in wort and beer, carcinogenic non-volatile nitrosamine compounds (ATNC's) may be formed. It is recommended that the total ATNC level in beer should be less than 10 ppb.

Question 8

Describe the relevance of pipework and fittings design in brewhouse hygiene. [8]

Outline the principles of CIP (cleaning in place). Describe the approaches to detection and quantification of residual surface contamination. [12]

This question was attempted by 76 candidates (37%) with 67% achieving the pass mark.

The standard of answer was generally good, with many including diagrams of CIP circuits. The majority of candidates noted the importance of avoiding dead legs in pipework. Good answers also included discussion of flow through pipework. The principles of CIP were not generally given correctly. Good answers for detection and quantification of residual surface contamination included ATP testing and swab/plate analysis. Some answers included use of pH testing for residual detergents.

The following considerations must be made in plant design for brewhouse hygiene:

(i) The plant capacity needs to be large enough to allow time for cleaning.
(ii) The parts of the plant where very high standards of hygiene and sterility are required should be capable of being cleaned hot.
(iii) The materials of construction should be capable of withstanding strong detergents like caustic soda.
(iv) The plant design should either allow access for manual cleaning or more commonly, ensure that detergent can flow over the surface at the speed required to give a vigorous clean.
(v) There should be as few encumbrances in vessels as possible.
(vi) Vessels must drain well.
(vii) There must be no "dead legs" in the pipework.
(viii) Pipes must be designed for fast flow of detergent during cleaning.
(ix) Spray heads must be sited in the correct position.

The choice of material that the plant is made from needs to allow for the detergents and sterilants that are going to be used. Most modern plants are constructed of a suitable quality of stainless steel; however, pump glands, sensing equipment, hoses and valves must also be compatible with what might be very corrosive substances.

Pipes and mains in modern breweries are designed to be cleaned in place, they have smooth bends and no "dead legs". Flow of cleaning fluids is fast through all the pipework (an ideal is 2 metres per second). A pipe circuit for CIP should consist of pipes of the same diameter otherwise the flow in the larger diameter pipe will be too slow.

Valves in modern breweries are designed so that they can be cleaned in place as part of the pipework cleaning cycle. A "butterfly" valve is easy to clean (it has hygienic glands to house the spindle and there are no areas where soil can hide), whereas a "plug" valve is difficult to clean (the housing surrounding the plug hides soil which can only be removed by dismantling).

Cleaning in place has replaced older methods where the plant was dismantled for manual cleaning.

The detailed features of a CIP system to be considered are:

(i) The CIP could be a "recovery", "partial recovery" or "total loss" system.
(ii) The CIP programme or sequence of cleaning elements.
(iii) Tank CIP choice of spray head.
(iv) Flow rates, delivery and return.
(v) Choice of cleaning/sterilising materials.
(vi) Automation and monitoring.
(vii) Running costs.

The standard CIP cleaning and sterilising programme is:

(i) A rinse to remove as much soil as possible and flush this to drain.
(ii) A detergent recirculation to clean the plant.
(iii) A rinse to remove traces of detergent.
(iv) A sterilisation to destroy any remaining micro-organisms.
(v) A final rinse if it is decided that no sterilant should remain in the plant.

Sensors may be used to detect detergent/sterilant strength on the return line. Automated recording of cycle times, detergent strengths and temperatures by monitoring equipment is possible. As a general rule of thumb – plants used for hot processes e.g. mashing and pasteurisation, are cleaned hot. Those for cold processes may be cleaned cold.

Methods used to monitor plant hygiene include:

(i) ATP Bioluminescence e.g. Microstar, Biotrace.
(ii) Plate methods.
(iii) Biochemical and nutritional kits.
(iv) Microcolony.
(v) Direct Epifluorescence Filter Technique.
(vi) Impedimetric techniques.
(vii) Microcalorimetry.
(viii) Spectrophotometry.
(ix) Flow cytometry.
(x) Immunoanalysis.

Generally, (i) and/or (ii) are the methods of choice.

DIPLOMA IN BREWING EXAMINATION 2005

Module 2 – Yeast and Beer

Tuesday 7th June 1400–1700 hrs

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.)

One hundred and sixty four candidates submitted scripts for the paper. Eighty seven candidates achieved a pass giving a pass rate of 53%, of the 77 candidates who did not pass, 19 achieved a percentage of less than 25%. There were no A grade passes, 6 B grade passes, 9 C grade passes and 77 grade D passes. Of those that failed a small proportion achieved good individual marks for some questions but failed to answer the requisite number of questions overall causing failure. One candidate returned a paper with no answers to any question attempted.

The examination was moderated and all candidates achieving a low D pass or an E grade fail (equating to 35–44%) were remarked by the moderator.

The examiner and moderator were generally disappointed with the quality of the answers given by the vast majority of the candidates. Examination technique was a clear cause of some failures, where candidates concentrated their efforts on answering one or two questions in greater depth than was required, and in so doing left little time to adequately provide responses to other questions. Other evidence of poor examination technique was evident where candidates failed to answer the question asked altogether.

Candidates did not always demonstrate a sound knowledge of more than one means of measuring yeast or beer quality attributes and this certainly limited the level of credit that could be awarded for an answer.

Question 1

Outline the methods by which brewing yeast strains may be preserved in the laboratory as pure cultures. [10]

Describe the techniques that may be employed to assure yeast identity and genetic stability. [10]

This question was answered by 101 candidates. 37 candidates passed this question.

Most candidates were able to answer the first part well and demonstrated their knowledge of several examples of storage techniques. Most candidates did not cite slurry and pressed cake storage methods and some failed to mention slope or plate storage techniques. Where candidates listed but did not give further details of the techniques employed, less credit was given. The second question was less well answered with a some candidates omitting to provide an answer altogether. Some attempted an answer concerning propagation but gained no credit since this was not the question asked. Model answers considered karyotyping, restriction fragment length polymorphism, PCR, phenotypic differences and petite tests. The latter of these tests was surprisingly only mentioned by a few candidates.

Question 2

Discuss the rationale for monitoring yeast viability. [4]

Define the terms yeast viability and yeast vitality. [4]

Describe the methods which may be used to quantify yeast viability and yeast vitality. [12]

This question was answered by 139 candidates. 77 candidates passed this question. One candidate achieved full marks for this question.

Few candidates demonstrated an understanding of the rationale for yeast viability. Model answers should have cited pitching rate determination, prevention of overpitching with dead cells to prevent autolysis impacts on fermentation performance and beer quality and monitoring of yeast handling effectiveness. Most candidates could define yeast viability and vitality but there was significant variation in the responses concerning techniques which could be employed. Those that could have been cited include: plate and slide counts, brightfield and fluorescent stains, capacitance, ATP, adenylate kinase, ICP, acidification power, glycolytic flux, glycogen, trehalose and fermentation performance.

Question 3

Describe the influence of oxygen and oxidative reactions on:

(a) Yeast metabolism during fermentation [5]

(b) Beer flavour formation and stability during fermentation and maturation [15]

This question was answered by 81 candidates. 10 candidates passed this question. None of the candidates that passed this question achieved an A grade for their answer.

For most candidates who attempted this question, it was clearly the last question attempted on the paper. Most answers were very short and of those that attempted the second part of the question, responses concentrated on beer flavour stability. Some of those that attempted part (a) and (b) appeared to divide their time equally between both parts despite the difference in marks allocated.

In general the answers for part (a) were poor. Model answers could have concentrated on the absolute requirement for oxygen in the synthesis of unsaturated fatty acids and sterols and their impact on plasma membrane function and growth respectively. Candidates who mentioned the relevance of oxygen and glycogen utilisation did receive credit for their answers.

The role of oxygen and oxidative reactions in beer flavour formation and stability was also poorly answered. The impact of oxygen on ester, higher alcohols, acetaldehyde, organic acids and short chain fatty acid synthesis should have been discussed. Very few candidates highlighted the role of linoleic acid as a precurser to trans-2-nonenal formation and its relevance to beer flavour stability. The contribution of aldehydes to beer flavour stability was also largely missing from answers provided. Candidates could have mentioned the impact of oxygen presence on the beer flavour stability via aerobic spoilers that form acetic acid, but none did so.

Question 4

Write notes on TWO of the following flavour topics:

(a) total diacetyl formation and reduction [10]

(b) ester formation [10]

(c) the relative uses of difference and descriptive taste testing methods [10]

This question was answered by 153 candidates. 96 candidates passed this question. 7 candidates achieved a grade A pass to this question.

For the first part the candidates were requested to write notes on the formation and reduction of total diacetyl, however few recognised that the word "total" required non yeast formation to be considered. Furthermore whilst most could provide a reasonable explanation of formation, far fewer could adequately describe reduction.

For the second part, ester formation was considered. Most candidates could adequately describe the metabolic pathways involved in the synthesis of esters but few highlighted the process parameters that affected the formation of these flavours.

The final part was answered by most who attempted this question. However, answers concentrated on difference tests and little evidence of sound knowledge of descriptive tests was apparent.

Question 5

Describe the mechanism of yeast flocculation and its significance in brewing. [12]

Describe the theory and practice of one other method of yeast separation from beer. [8]

This question was answered by 128 candidates. 40 candidates passed this question and no grade A responses were provided.

Candidates who answered this question were required to outline the mechanism and significance of flocculation for the brewer. They were also required to consider an alternative method of yeast separation from beer. Whilst the first part was reasonably well answered, very few candidates considered the significance of flocculation for the brewer and even those concentrated on the need to clarify the beer rather than generate sufficient yeast crop for harvest. Most candidates made a reasonable attempt at suggesting alternative means of separation.

Question 6

Write notes on

(a) the principles of beer foam formation and methods for measuring its stability; [10]

and

(b) the principles of beer colour formation and methods for measuring this parameter [10]

This question was answered by 142 candidates. 84 candidates who answered this question achieved a pass, and of those 11 achieved a grade A pass.

This question was reasonably well answered by most candidates. The first part concerned the formation and measurement of beer foam. Model answers discussed the four stages of foam development: bubble formation, drainage, coalescence and disproportionation together with foam positive and negative effectors. Those candidates who scored highly, considered more than just the Rudin and NIBEM means of measuring foam stability.

The second part of the question concerned the principles of colour formation. Credit was given for describing colour development from malting through to maturation, including additions to achieve colours required for specifications. Most candidates demonstrated a sound knowledge of methods for measuring colour.

Question 7

Describe the occurrence and quality significance of the following spoilage organisms of wort and beer:

(a) The wild yeast *Saccharomyces diastaticus* [5]

(b) *Pectinatus* spp. [5]

(c) *Lactobacillus* spp. [5]

(d) *Pediococcus* spp. [5]

This question was answered by 76 candidates. 22 candidates passed this question and of those 2 candidates achieved a grade A pass.

This question was on the whole poorly answered. Most candidates failed to identify the stage at which the organisms occurred. Model answers supported this information with phenotype information. Few candidates recognised that *Saccharomyces diastaticus* utilises dextrins leading to over attenuation and a reduction in mouthfeel. Very few could correctly describe the occurrence and consequences of *Pectinatus* spp. The influence of *Lactobacillus* and *Pediococcus* on process and beer quality was more widely stated.

Question 8

Why is it necessary to maintain good hygiene standards in fermentation vessels and yeast storage tanks? [5]

How can good hygiene standards be achieved using cleaning in place in fermentation vessels and yeast storage tanks? Include examples of systems and chemicals that may be employed. [10]

Outline the procedures available for monitoring the effectiveness of such cleaning systems. [5]

This question was attempted by 124 candidates. 83 candidates passed this question, and of those 4 achieved a grade A pass.

This question was answered very well by most candidates who attempted it. Most understood the need for good hygiene standards in fermentation vessels and storage tanks. The response to the second part of the question was more variable with model answers providing a description of plant from schematics to spray ball descriptions, recoverable and non-recoverable systems, flow rates, chemicals and their actions and antagonisms. Some answers provided examples of CIP regimes. The final part of the question was generally well answered, although many concentrated on the microbiological stability measurements and not on systems and chemical checks.

DIPLOMA IN BREWING 2005

Module 3 – Packaging and Process Technology

Wednesday 8th June 0930–1230 hrs

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.)

A total of 200 candidates sat this examination, an increase of 16% on 2004. The examination was passed by 66.5% of candidates which was an improvement on last year's result of 60%

The grade distribution was as follows:

A, 4.5% B, 13% C, 20.5% D, 28.5%

E, 21.5% F, 7% G, 5%

The level of preparedness was generally good, with more top end (A and B) passes than in the previous year. There were however candidates who had not prepared in sufficient detail and also candidates who had clearly decided to prepare for only the process technology questions or for just the packaging questions. As a result, quite a number (40%) of the failed candidates had answered 5 or less questions. Of those candidates who passed, only 2 candidates had answered less than the full 6 questions, so it is clear that it does make it more difficult to achieve a pass mark if the full complement of questions is not attempted.

It was comforting that there were very few instances this year of candidates presenting information that was not relevant to the question.

Diagrams in support of answers were generally good: large, clearly labelled and annotated. However there were a few occasions when candidates tried to answer a question without using diagrams when specifically asked for in the question. Graphs should always have their axes labelled; otherwise they are meaningless.

Again it needs stating that candidates are advised to show all workings in calculations since only one mark is normally deducted for an arithmetic error provided the method of tackling the problem is clearly visible to the examiner from the workings.

Question 1

Describe the precautions that need to be taken to minimise the pick-up of oxygen from bright beer tank to final bottle and can. [10]

Explain in detail how the filling and closing operations for cans and glass bottles differ in these measures to minimise oxygen pick-up. [10]

This question was attempted by 176 candidates (88%) and was one of the three most popular questions. It was also well answered, with 80% achieving the pass mark.

Since this question was asking about control of oxygen pick-up from bright beer tank to final package, a discussion of the measures required at filtration and dilution was not relevant, yet quite a few candidates chose to present such information. This is wasted effort.

From BBT to Filler, the following are measures and procedures that would be expected if tight control of dissolved oxygen is to be achieved: –

- Pure CO_2, N_2 or CO_2/N_2 atmosphere in bright beer tanks, sterile beer tanks and filler bowl.
- Check and ensure high CO_2, N_2 purity.
- Pack mains with water, preferably deaerated, or inert gas.
- Minimise leaks – at pump seals, fittings, pipe unions etc.
- Gentle beer movement into tank and filler bowl.
- Vent and purge Filler bowl gas to maintain high purity of gas in the bowl

Special precautions for bottles

- At least single evacuation and CO_2 counterpressure, preferably double evacuation and counterpressure.
- Long tube fill from base of bottle, displacing gas slowly and without turbulence – but slow
- Short tube faster – more risk of oxygen pick-up.
- Foam the beer up the bottle neck between filler and crowner. Several techniques available: jetter (hot or cold), gas jet, vibration, tapping. Need to ensure that foam reaches the top of the neck just before crown application.
- Purging of crowns and crowner with inert gas atmosphere
- Consistent fill heights and constant headspace.
- Oxygen scavenger in the crown seal
- Correct crimp on the crowner to avoid leakage/ingress.

Special precautions for cans: –

- CO_2 blanket gas on the filler infeed starwheel.
- Evacuation not possible due to can weakness, therefore flush and counterpressure.
- Swirl fill onto can wall – quiet fill.
- Either: bubble break with gas on filler-seamer transfer to collapse air-rich bubbles.
- Or: CO2 knife on filler-seamer transfer
- Undercover gassing on seamer with CO2 or N2.

Question 2

Explain, with reference to the relevant physical principles, how the level of carbonation in beer is affected by beer temperature and pressure. [5]

Describe three methods by which the carbonation level of beer can be deliberately increased, and their respective merits. [9]

Explain how CO_2 supersaturation can occur, what are its effects and what are its threats to beer quality. [6]

This question was a very popular question and was attempted by 173 candidates (87%) with 61% achieving the pass mark.

The first part of this question asked for an explanation of the physical principles governing the carbonation of beer.

A large number of candidates quoted the ideal gas laws, Boyles law, Charles law and such like relationships between pressure, volume and temperature in the gas phase. Whilst these might explain how the partial pressure of CO_2 in the gas phase might change they do not explain carbonation.

The rate of carbonation is proportional to the volumetric mass transfer coefficient, KL, the transfer area A and the concentration driving force (CEQ – C) where CEQ is the equilibrium value and C is the concentration at a given time.

$$V\,dc/dt = KL\,A\,(CEQ - C)$$

CEQ is related to the partial pressure of CO_2 by Henry's Law.

$$PCO_2 = H \times CO_2$$

Both equations above are for a constant temperature. Most candidates who quoted Henry's law were able to explain that increasing pressure would increase the amount of CO_2 dissolved. Also with Henry's constant increasing with increasing temperature, CO_2 solubility will decrease with increasing temperature.

The transfer area, A, influences carbonation. Carbonation in a tank or keg will be slow due to a small transfer area compared with the beer volume, but if very small bubbles are injected, the transfer area will be high and the rate of transfer much faster. Agitation of the beer will also increase the rate of transfer by increasing the mass transfer coefficient KL.

The methods of carbonation of beer are: –

- Batch sparging of a volume of beer, say from the base of a tank.
- Top pressure application CO_2 to a tank or keg
- In-line injection
- Diffusion across a semi-permeable membrane.

This part of the question was well answered, with most candidates able to describe three methods, often with supporting sketches, and their relative merits as a means of increasing carbonation.

The final part of this question asked for an explanation of supersaturation. A lot of candidates confused supersaturation with overcarbonation. Overcarbonation is an increase in the carbonation level of beer above the required or specification level but the level of carbonation will be at, or below, the equilibrium value for the applied pressure and temperature.

Supersaturation occurs when the carbonation level is **above** the equilibrium value, either due to an increase in temperature or a decrease in pressure. There is the potential for CO_2 breakout. This is generally to be avoided in beer processing. However, once dispensed into a glass, bubble formation occurs at nucleation sites and helps with foam generation. Controlled fobbing/foaming between bottle filler and crowner is used as a means of removing air from the bottle headspace and is also beneficial. Uncontrolled fobbing can cause loss of head proteins through denaturation and haze from the collapsed foam.

Question 3

Define the terms *repeatability, r*(95), and *reproducibility, R*(95), when applied to the analysis of packaged beer and discuss their relevance to packaging operations. [6]

Explain the difference between the *accuracy* and the *precision* of a set of results of measurements made on packaged beer. [4]

The table below contains laboratory measurements of the contents of 20 bottles of 500 ml nominal capacity taken at random from a beer bottle filler. If the tolerable negative error (TNE) for 500 ml nominal bottles is 15.0 ml, calculate the mean of the data and describe what actions should be taken. [10]

Bottle Contents ml			
469	475	485	498
500	501	501	502
503	503	504	505
506	507	508	509
509	510	512	513

This was one of the three least popular questions, being attempted by only 111 candidates (56%). The question was poorly answered by the majority of those attempting with only 34% achieving the pass mark. This is surprising considering that half the available marks were for defining repeatability, reproducibility, accuracy and precision. These topics are in the syllabus for all three Dip Brew modules.

Repeatability (r95) is the maximum difference between two results, simultaneous or in rapid succession, in one lab by one operator to clearly specified procedures, calculated to a defined probability level of 95%.

Reproducibility (R95) is the maximum difference between results by two different laboratories to the same standard method on identical test material, calculated to a defined probability level of 95%.

Very few candidates attempted to explain their relevance to packaging.

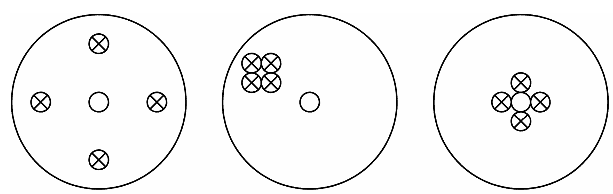
Repeatability is of importance when setting beer specifications since there is no point in setting a specification tighter than r95 for that parameter. It is also of importance when comparing beers, for example if measurements are made on two beers and the results recorded are greater than r95 apart, then it is safe to assume that there is only one chance in twenty that the beers are the same.

Reproducibility is of importance when beer is being transferred between breweries, for example for contract packaging when two labs are making measurements on the same beer and trying to achieve agreement between their results.

Accuracy is the closeness between the mean of a set of results and the accepted "true" value.

Precision is the closeness of agreement between results obtained by applying the same method.

Many candidates demonstrated the above by diagrams and these are very useful tools in explaining the concepts.



Accurate Precise Accurate and Precise

Most candidates correctly accomplished the calculation of the mean of the fill data, but the actions to be taken in reaction to this information were less well presented. It was surprising how many candidates were more concerned about giving away one ml on average per package, and its cost, than contravening contents legislation with underfills!

No samples should be less than twice the TNE, that is < 470ml, and no more than 2.5% of samples can be less than one TNE, that is < 485 ml

If this batch of samples has just been taken and analysed with these results, the immediate action should be to stop filling and stop creating more "defective" packages. All batches (lots) since the last satisfactory check should be quarantined and checked. Satisfactory batches can be released for sale: Non-conforming batches need to remain quarantined and their future discussed. The results of these checks on the quarantined batches will determine if further action is required, such as recall of product from the distribution chain or trade.

The filler/crowner should be checked for visual defects – missing or damaged filler tubes etc, and then restarted, with a "full-round" set of samples taken. Faulty heads are checked, repaired and the process repeated until a satisfactory "full-round" is achieved. Production can then re-commence with a return to normal sampling and checking regimes.

Question 4

Describe using diagrams the principle of operation of a plate heat exchanger in both co-current and counter-current flow, showing the temperature profiles for each flow type. [5]

Explain why counter-current flow is the best design choice for the cooling of wort from whirlpool to fermenter, and in what circumstances would co-current flow in a plate heat exchanger be beneficial? [5]

A plate heat exchanger is used to cool wort from 98°C to 18°C. The wort passes through it at a flow rate of 360 hl h^{-1}. Cooling water at 8°C flows counter-current into the plate heat exchanger at a flow rate of 400 hl h^{-1}. Calculate the number of plates required if each plate has an area of 0.6 m^2.

Density of wort = 1080 kg m^{-3}

Density of water = 1000 kg m^{-3}

Specific heat of wort = 4.0 kJ kg^{-1} K^{-1}

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

Heat transfer coefficient = 3000 W m^{-2} K^{-1} [10]

Sharing next to the top spot of most attempted question, 176 candidates (88%) had a go at question 4 on heat exchange and heat exchangers and it was passed by 64%.

The description of a plate heat exchanger was quite well tackled and the key points made: narrow flow area, thin plates (stainless steel or titanium), embossed for increased turbulence and good heat exchange, gasketed at perimeter. Many candidates drew detailed diagrams of plates and/or a heat exchanger.

The temperature profiles were mostly well drawn although quite a number of candidates showed impossible situations, for example with cooling water leaving at a higher temperature than the incoming heating fluid. The diagrams need to be correct.

Counter-current is selected for wort cooling to achieve the maximum recovery of high grade (high temperature) hot water for the minimum water flow. It is not uncommon to achieve water:wort flow ratios of 1.1:1 or better. It is also easier to achieve the required fermentation temperature, making best use of the low temperature of the cooling water without excessive refrigerant usage. For the same load, the heat exchanger will be smaller than for co-current.

Co-current flow is used in several circumstances: –

- where the fluid being cooled is likely to freeze if hit with the very cold refrigerant. Co-current flow puts the coldest refrigerant against the warmest fluid.
- where one fluid is changing phase without temperature rise.
- where pressures need to be balanced since both fluids will be at their highest pressures at the same end of the exchanger.

The calculation was a straightforward use of the equation $Q = U \times A \times \Delta TLMTD$.

A heat balance between the wort and water is used to calculate the water outlet temperature (82°C) and then the heat load Q can be calculated from the heat pick up of the water, (or from the heat loss of the wort) using $Q = G \times Cp \times \Delta T$.

For the heat exchange between the two fluids, the log mean temperature difference has to be used since the temperature difference between the two fluids is varying across the heat exchanger. A mark was deducted if the mean temperature difference (13°C) was used. The ΔTLMTD was 12.77°C.

Substituting for Q, U and ΔTLMTD in the equation $Q = U \times A \times \Delta TLMTD$, gives the area as 90.21 m^2 and with each plate being 0.6 m^2, 150 plates are required.

Question 5

Write short notes on *three* of the following materials, explaining how and why they are used as secondary packaging for beer (4 marks each):

(i) corrugated board.
(ii) paperboard.
(iii) plastic film.
(iv) Hicone® carrier. [12]

Discuss the recovery, recycling and reuse of packaging materials. [8]

Not a popular question, with only 110 candidates (55%) attempting an answer, but those that did, realised that this was not a difficult question and the pass rate was high at 75%.

Corrugated board and paperboard are very similar in their function as secondary packaging materials: to protect (better cushioning with corrugated board), to collate and create an easily handle able pack, to inform and advertise by printing onto its surface and to protect from lightstrike. They are both relatively cheap packaging.

Paperboard (> 250 g/m^2) is made from up to 8 layers compressed together and can be surface treated to improve printability or water resistance by coating with clays, starches, wax, polythene or rubber/cellulose polymers.

Corrugated is used for boxes and trays and can be double or triple layered for strength. Can also be varnished to improve water resistance.

Both corrugated and paperboards are easily recyclable and occasionally returnable and reused.

Plastic film provides protection from dust and rain, makes a secure pack and enhances appearance. It makes pack handling easier and it can be applied to primary packs directly or as a protective layer around corrugated or paperboard. Usually applied by shrinking onto the pack with heat. It can be printed for advertising purposes. It is cheap but is not easy to recycle, although recovery for burning is feasible.

Hicone® is made from extruded polythene and is used to collate primary packs into 4's, 6's by application to the neck or body as a web. It is minimalist, low cost packaging with only one pallet box of Hicone® carriers capable of packing over 700,000 cans. Problems of discarded carriers causing damage to wildlife have been overcome by including a UV light retarding compound into the plastic formulation. It has the same recycling issues as plastic film.

A discussion of the environmental impact packaging materials required a definition of the terms recovery, recycling and reuse.

Recovery encompasses the removal from the domestic and industrial waste streams of packaging materials for any purpose: reuse, making into new articles or burning for energy.

Recycling covers the recovery of packaging materials for making into new articles, not necessarily the same article as that recovered. For example, empty aluminium cans might be recycled into structural aluminium products such as greenhouse frames.

Reuse describes recovery for use in its original form: for example returnable bottles.

In most countries, glass is the most recycled material due to its being melted and reformed time and time again without loss of the properties that make it such a good packaging material. It is also cheaper to make new bottles from recycled glass (cullet) than from new raw materials.

Food and beverage cans are rarely recycled into food cans due to the risk of contaminants.

A first step in packaging design is minimising the amount of material used.

Question 6

With the use of labelled diagrams, describe the design and operational characteristics of *four* of the following types of valve and their typical use and suitability for brewery applications (3 marks each).

(i) globe valve
(ii) gate valve
(iii) butterfly valve
(iv) ball valve
(v) diaphragm valve
(vi) mix-proof double seat valve [12]

For *one* of the above valves, explain, with the use of labelled diagrams, how the valve could be installed and interfaced to a control system for automatic operation. [8]

73% of candidates (145) attempted this question and the pass rate was high at 79%. The diagrams and descriptions of valves were well presented in most answers but few candidates did a particularly good job of integrating a valve into an automatic control system.

The key points that were expected on the valves were as follows: –

1. Globe Valve

- 3 designs: single seat, double seat and 3-way
- Single seat: gives tight shut-off
- Double seat: increased flow capacity, balanced but difficult to get both seats to shut-off together.
- 3-way: used for diverting and mixing flows.
- Usually a one piece cast body
- Linear movement of the plug, varying the flow area – good for control
- Costly
- Non-hygienic, therefore used for utilities such as steam. For example the crown head valve on a steam boiler is often an angled globe valve.

2. Gate Valve

- The gate or disc moves at right angles to the flow, often by means of a screw thread.
- The gate provides a good shut-off, but is not good for control since small lateral movements of the gate can cause large flow area changes.
- Solids in the flow or infrequent valve operation can lead to blockage of the valve seat and failure to achieve this tight shut-off.
- Low pressure loss when fully open
- Medium cost, but depends on materials and pressure rating.
- Non-hygienic, therefore used for utilities such as water services.

P.S. A number of candidates described a slide valve, as commonly used on malt and grist conveyors, instead of the gate valve. There are similarities and such answers were not heavily penalised.

3. Butterfly Valve

- A stainless steel disc or wafer on a vertical shaft rotates within the pipeline, sealing onto a soft annular "rubber" seal. A 90° movement open to closed.
- Tight shut-off but poor for control, with most of the flow reduction achieved over the last few degrees of disc movement to the closed position. Better control by modifying the disc profile and offsetting the valve spindle from the pipe centreline.
- Easy to install and maintain.
- Low cost and lightweight
- Can be used in a 3-valve formation as "block-and-bleed".
- Hygienic – very common valve for all beer tank and pipeline duties, but also for CIP, utilities and most other low to medium pressure applications.

4. Ball Valve

- A stainless steel ball with a central full-bore hole, held in an elastomer seat, rotates though 90° within the pipeline.
- Negligible pressure loss when fully open.
- High shearing action when closing minimises clogging and makes valve suitable for slurries and viscous fluids.
- Non-hygienic – back of the ball is out of the cleaning flow – not for process applications.
- Very high pressure shut-off is achievable. Not good for control – same problems and modification possibilities as the butterfly valve.
- Used for gases, particularly at high pressure, and utilities.

5. Diaphragm Valve

- A "rubber" diaphragm, backed by a shaped plug, closes across the pipeline, usually by screw action, and seals to give a tight shut-off.
- Inert diaphragms used for food applications.
- Positive shut-off, even on solids and slurries.
- Hygienic – used on all process fluids such as wort, yeast, trub etc.
- Failsafe – if diaphragm fails, the valve bonnet will contain the leakage, but then not hygienic. Diaphragm integrity is therefore important for successful operation.

6. Mix-Proof Double Seat Valve

- Two fluids, crossing at right angles, are separated within the valve by two valve seats.
- A leakage path to atmosphere from between the seats provides a "tell-tale" if either seat fails.
- Prevents cross-contamination of fluid streams e.g. beer and CIP fluids
- A shut-off valve only – not used for control.
- Often assembled into large multi-valve manifolds for specific duties such as routing into and out of a tank farm.

P.S. Without practice, this valve is not easy to draw and it was commented that, for just 3 marks, was it worth the effort? Candidates had the choice!

The second part of this question was looking how a valve can be integrated into a control system. Many answers failed to consider the most essential components, such as the actuator, and instead delved into control theory. The question was looking for diagrams and explanation of the following components: –

Actuator – type: pneumatic/electric, fail-closed/fail open, valve position feedback from microswitch or proximity switch.
Air solenoid valve if pneumatic and on-off
I/P converter if pneumatic and control

Question 7

Sketch a pressure-enthalpy diagram for water/steam, and use it to indicate the following:

(i) dry steam
(ii) wet steam
(iii) dryness fraction
(iv) superheated steam
(v) sensible heat
(vi) latent heat [6]

Calculate the energy required to raise the contents of a cereal cooker from 20°C to 100°C, and the amount of steam required (kg) if dry saturated steam, condensing in a jacket at 120°C, is used to carry out the heating duty.

Cereal charge – 5 tonnes at 20°C

Mash water charge – 10 tonnes at 20°C

Specific heat of cereal – Cp = 1.65 kJ kg^{-1} K^{-1}

Specific heat of water – Cp = 4.18 kJ kg^{-1} K^{-1}

Latent heat of dry saturated steam at 120°C = 2201.6 kJ kg^{-1} [2]

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Latent heat of dry saturated steam at 120°C = 2201.6 kJ kg^{-1} [8]

Calculate the saving in energy if hot water at 80°C is used for mashing. [4]

By far the least popular question in the paper, attempted by only 87 candidates (44%) but well answered with 64% achieving the pass mark.

The first part of the question required a piece of textbook replication by drawing and annotating the pressure-enthalpy diagram for water/steam. Most candidates made a good job of this.

Calculation of the dryness fraction of 0.7 required the calculation of the enthalpy at the point B on the diagram such that AB/AC = 0.7. Now AC = 2675 – 418 = 2257 kJ kg^{-1} and A = 418 kJ kg^{-1}. Therefore B = 0.7 * 2257 + 418 = 1998 kJ kg^{-1}.

The energy required to raise the contents of the cereal cooker requires the application of $H = M \times C_p \times \Delta T$ to both cereal and water charges.

For Cereal, $H_{cereal} = 500 \times 1.65 \times (100 - 20) = 660$ MJ

For Water, $H_{water} = 10{,}000 \times 4.18 \times (100 - 20) = 3344$ MJ

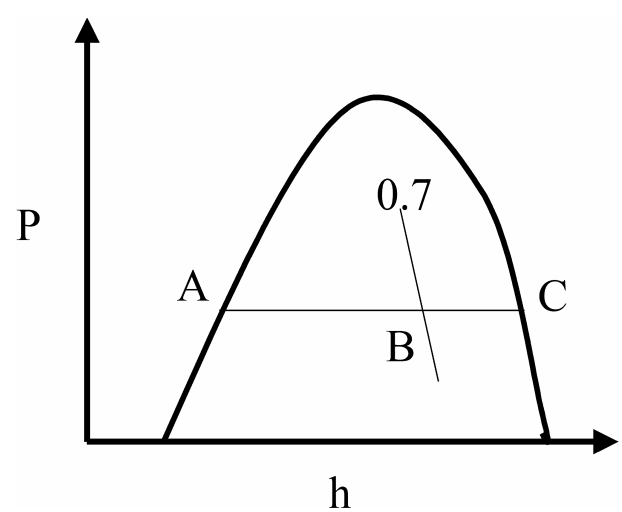
Total H = 4004 MJ.

This is provided by the condensing steam at 120°C.

Steam required = 4004/2201.6 = 1818.7 kg of steam.

If the water is at 80°C instead of 20°C, the saving in energy will be 10,000 × 4.18 × (80 – 20) = 2508 MJ.

Those who had difficulty with this question tended to make mathematical errors and these were not unduly penalised in the marking.



Question 8

Explain the process of pasteurisation with reference to the lethal death rate of organisms and pasteurisation units. [4]

What other factors affect the lethal death rate of an organism? [4]

Describe the equipment used and the process of:

(i) flash (bulk) pasteurisation of beer.
(ii) tunnel pasteurisation.

Your answer should include flow diagrams of typical equipment and the temperature profiles through the process. [12]

The most popular question 125 candidates (92%) and well answered with 68% reaching the pass mark.

An explanation of the process of pasteurisation should start with a statement that it is a process in which elevated temperature is used over a prescribed time to destroy undesirable organisms in a product, preferably without affecting the flavour.

Organisms differ in their resistance to heat and Del Vecchio showed that there was a time/temperature relationship to the lethal death rate of an organism. The pasteurisation effect was the lethal rate multiplied by the time of heat application. By trial and error, a time of 15 minutes at 60°C was found to be successful in brewery trials, following on from Pasteur's work on wine.

The pasteurisation unit (PU) was defined as the effect of one minute at 60°C.

The time to kill all organisms in a sample is not easy to measure, but the time to reduce the population by 90% (to one tenth of its original value) was more convenient and was called the decimal reduction time (DRT).

Del Vecchio's lethal death curve was a logarithmic relationship between temperature and rate of kill and linear between time and rate of kill. He showed that there was a tenfold increase in kill rate (or a reduction of the DRT by a factor of 10) for every 7°C (12.5°F) rise. This is known as the Z value for an organism. Very heat resistant organisms will have a high Z value.

The lethal effect in PUs therefore could be expressed as $10^{(T-60)}/7 = 1.392^{(T-60)}$

Other factors affecting the lethal death rate of an organism, other than time and temperature, are: –

- pH of the media – Z values are lower at lower pH.
- Cell density – i.e. contaminant level.
- Organism type and age.
- Beer type. Alcohol enhances lethal effect, so low alcohol beers will require more PUs.
- Similarly, CO_2 enhances lethal death rate.
- Growth phase versus stationary phase. In the latter, there are more fatty acids with a higher melting point.

The last part of this question required a description, with diagrams, of bulk and tunnel pasteurisers and their respective temperature profiles. This part of the question was well covered by most candidates. However there were some very unusual sketches of bulk pasteurisers without any regeneration sections. The Regeneration Section is key to efficient bulk pasteurisation and it is where the pasteurised hot beer heats up the incoming non-sterile beer. Regeneration of 98% is feasible. Without regeneration, it would be economically disastrous in terms of energy usage for both heating and cooling.

DIPLOMA IN DISTILLING EXAMINATION 2005

In 2005, 34 candidates sat the examination, yet another increase on previous years. As usual, most candidates attempted only one module, and only one candidate chose to sit two. Averaged over the three modules, an impressive 88% of the candidates passed. Perhaps it is unfair that I make few comments on the many good answers, although here it is appropriate to congratulate the 12 candidates who have now completed the three modules to gain the IBD Diploma in Distilling. But, just as newspapers concentrate on the bad news, the following comments are largely a distillation of the more annoying mistakes over the three modules, in the hope that by bringing them to their attention, future candidates will not make the same mistakes again.

Module 1 – Materials and Wort

Tuesday 7th June 0930–1230 hrs

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.)

Of the 11 candidates who sat this examination, 10 (91%) passed: 5 at grade B, 1 at grade C and 4 at grade D. This is a welcome improvement on the poor results in this module in 2004. I have no general comments to make on the examination as a whole, but various common mistakes are discussed in the context of the relevant questions.

Question 1

Draw a linear cross-section of barley grain after 24 hours of germination, identify the principal structures and explain their biological functions. [14]

Explain the role of endogenous gibberellins in the modification of the endosperm. [6]

The main part of question 1 required an explanation of the biological functions of the structures drawn in a cross-section of a germinating barley grain. Of course in the context of a distilling examination the relevance of these structures to the malting process is important, but it was surprising how many candidates did not consider that the real biological function of the developing embryo is to create a new plant. However, relating structures to malting activity was better than no reference to biological function at all. Most drawings were of good quality, but some showed the endosperm with out-of-scale cells, large enough to show the starch granules. It would have been better to have a separate drawing on that larger scale alongside the grain to show a typical embryo cell. A separate discussion of endogenous gibberellins was expected, which should have been obvious from the separate allocation of marks, but this year I noticed for the first time a tendency for candidates to combine separate parts of the question in a single answer. While there may be some logic in this approach to question 1, it caused some difficulty in marking. However, 7 of the 10 answers explained both parts of the question (either separately or combined) sufficiently competently to score a pass mark.

Question 2

With respect to the production of malt for either grain or malt distilleries (specify which), describe the process parameters to be controlled during *two* of the following stages, and explain the problems that can arise if these parameters are not properly regulated.

(a) Steeping [10]

(b) Germination [10]

(c) Kilning [10]

In question 2 candidates could discuss the important process parameters of a choice of two of the stages of the malting process, for either grain or malt whisky malt. Time and temperature are obviously important for all three of steeping, germination and kilning. Aeration/air rest and final moisture content were also expected in discussion of steeping; aeration, humidity and agitation to prevent matting must be controlled in germination. The choice of grain or malt distillery applied particularly to kilning so different drying regimes (or not, in the case of green malt) and peating of malt distillery malt could be explained, preferably with the aid of a graph of the temperature/moisture programme. One failed, but the standard of the other 10 answers ranged from good to excellent.

Question 3

Discuss the relevance of the following analyses to the malt specification for a malt whisky distillery:

(a) Fine/coarse extract difference. [4]

(b) Friability. [4]

(c) Diastatic power. [4]

(d) Fermentability. [4]

Discuss briefly the advantages and disadvantages of analysis by comparing:

(i) (a) with (b). [2]

(ii) (c) with (d). [2]

"Discuss the relevance of the following analyses to the malt specification", did not require a description of the method itself. In other words, the question actually was "How relevant are these analyses to determining the quality of malt?" Therefore answers restricted to descriptions of equipment and typical analytical values scored few, if any, marks. One possible approach was assessment of each method with respect to usefulness in predicting spirit yield and/or quality, but precision, sensitivity and speed or ease of analysis are also important. As in question 1, some candidates confused the marking system by combining the answers to subsections, particularly concerning the short final part, where comparison along the following lines was expected. Fine/coarse difference is relatively precise but cumbersome and time consuming; Friability is less precise but quick and more sensitive to poor modification especially if the sample is non-homogeneous. Similarly, DP is more precise but measures only enzyme activity; Fermentability, related to both enzyme activity and wort composition, is more meaningful. If statements along these lines could be picked out, appropriate marks were awarded, but future candidates should take note that not to identify clearly the different sections of a question risks losing marks. So for various reasons there were few really good answers and only 6 out of the 10 passed.

Question 4

With the aid of a flow chart, describe the intake controls from arrival of a vehicle-load of kilned malt up to the start of milling. A detailed description of laboratory procedures is not required. [20]

Question 5

With the aid of a sequence of diagrams showing one section of a mash filter, explain the filtration operation. [12]

Discuss briefly the advantages and disadvantages of the mash filter compared with a traditional malt whisky mash tun. [8]

Question 4 generated some very comprehensive flow charts, descriptions of the successive steps of processing of a batch of malt, and reasons for these stages. Some artistic individuals, perhaps not sharing my concept of "flow chart", illustrated the processes with outline drawings of vehicles and equipment, but rectangles showing the words "lorry", "de-stoner" or whatever would have sufficed. Eight candidates answered this question, producing the best answers of the examination, perhaps based largely on personal experience. On the other hand, few candidates would have seen a mash filter in operation (question 5), which could account for some strange drawings. However, the sequence of drawings required for the answer has been available in the literature for many years and was well reproduced in most answers, and all but one explained the process well enough in words to score at least a pass mark

Question 6

Discuss the advantages and disadvantages of maize, wheat and unmalted barley as cereals for the production of grain whisky. [20]

This question was concerned with the use of maize, wheat and barley as unmalted cereals for grain whisky production. Although barley is unlikely to be used at present in

Scotch grain whisky production, some comment was expected on its disadvantages (cost, glucan, husk, to name but three). Most candidates gave a reasonable account of advantages and disadvantages of each cereal with regard to extract, N and lipid content, gelatinisation temperature and problems with cooking, fermentation, distillation and co-product processing, but unfortunately 3 of the 9 answers just failed to achieve a pass mark.

Question 7

Discuss briefly, giving reasons for their importance, the required properties of water for each of the following purposes in a whisky distillery. Answer on the assumption that different sources of water are available for each duty.

- **(a) Malt mashing. [5]**
- **(b) Cooling of wort and distilled spirit. [5]**
- **(c) Reduction of new spirit and whisky. [5]**
- **(d) Preparation and use of detergent or sterilant solutions. [5]**

Many of the answers to question 7, on quality standards for water supplies, named more than the absolute minimum of necessary characteristics, but if the information was relevant, or correct in that context, there was some benefit in marks. For mashing, low levels of hardness salts and microbiological contamination are preferred, and chemical (e.g. fertiliser or pesticide) residues and flavour taints are unacceptable. The essential requirements of cooling water are consistent low temperature, reliable supply and absence of hardness salts or soil which would foul heat exchangers. Reduction water must not only meet the chemical and microbiological standards of drinking-water, haze-forming metal ions are also unacceptable. And unless similar standards apply to water for preparing detergents and sterilants, these solutions are contaminated, precipitated or otherwise adversely affected. Eight answered this question, some very well, but unfortunately one did not reach the pass mark.

Question 8

Describe the laboratory methods for *two* of the following analyses:

Total Nitrogen of barley. [10]

Diastatic Power of grain distillery malt. [10]

Chemical Oxygen Demand of distillery effluent. [10]

Since only two candidates attempted question 8, on descriptions of a choice of two common laboratory methods, it would be unfair to comment on actual answers. For all three named analyses, answers should have followed the same basic principle: describe the preparation of the sample (including accurate dilution in the case of COD), name the reagents, explain the reaction(s) involved in the analysis and conclude with the method of reading and assessing the results.

DIPLOMA IN DISTILLING EXAMINATION 2005

Module 2 – Fermentation, Distillation and Maturation

Tuesday 7th June 1400–1700 hrs

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.)

In this module also, performance was better than last year, at least in the sense that the 80% pass rate was a substantial improvement on 69%. However, grades were lower than we have been accustomed to: no-one achieved grade A or B, there were only 3 at grade C and 5 scored grade D. Also, it was disappointing to see the poor answers to questions 1 (on metabolic pathways) and 3 (on detection of microbial contaminants). Of course candidates are entitled to choose the six questions they expect to answer best, but since biochemistry and microbiology are fundamental to the content of Module 2, it was surprising that these two questions were relatively unpopular, and were answered so badly when they were chosen.

Question 1

Give an account of the formation of higher alcohols and esters during fermentation by *Saccharomyces cerevisiae,* and discuss the factors influencing their formation. [20]

So, 7 of the 10 candidates attempted question 1 and all scripts showed a very poor understanding of the biochemistry of higher alcohol and ester formation; only one achieved a pass mark. It was unnecessary to start with the uptake of fermentable sugars, as some did, and a brief outline of the Embden-Meyerhof-Parnas pathway was sufficient to explain the origin of pyruvate and acyl coenzyme A molecules. The main parts of the answer should have been (for higher alcohols) the biosynthesis of keto-acids for transamination to amino acids but decarboxylation to higher alcohols instead and (for esters) the recycling of acetyl and higher acyl CoAs and esterification of the resulting acetyl/acyl groups with ethanol or higher alcohols. Since only those relevant to distilling fermentations were expected, factors influencing the formation of these flavour congeners would include pitching rate, temperature, availability of α-amino N and oxygen and characteristics of individual yeast strains. And of course a good answer would have supplemented the written explanation with diagrams of the relevant pathways.

Question 2

Describe the procedures for inoculation of distillery wort with pressed yeast, yeast cream and dried yeast. [10]

Compare the advantages and disadvantages of these three forms of yeast in a whisky distillery. [10]

Everyone chose question 2 on comparing pressed yeast, yeast cream and dried yeast, which was well answered by all candidates. All gave good descriptions of the pitching procedures with the three different forms of yeast and for good measure many sketched the layout of the equipment and/or described the CIP procedures to prevent microbiological contamination in yeast vessels and associated pipework. Although the second part could have been answered as an essay, many candidates presented, very effectively, a comparison of advantages and disadvantages in tabular form.

Question 3

Describe the methods available to detect and quantify the possible spoilage micro-organisms of distillery wort and on the inner surfaces of washbacks. [20]

This question was answered by only 6 candidates, none of whom achieved a pass mark. The original sources of contamination or the micro-organisms involved could be acceptable information if added in the correct context, but in some of the poorer answers, that was all. Essentially the answer had to be an account of the methods for microbiological examination of wort and the inner surface of a washback: how to detect the presence of micro-organisms and determine how many. Even at the lowest likely level of contamination of unpitched wort a standard plate count will probably detect a significant bacterial count, but in practice the count of specific types of bacteria (e.g. lactobacilli) is more important. Plate count, dip slide, membrane filtration or enrichment with appropriate media are traditional methods but PCR or immuno-fluorescence could also be mentioned. Swabbing an easily accessible area or membrane-filtering a sample of final rinse water are suitable for testing washback surfaces, with a choice of traditional culture, or for immediate results bioluminescence, to estimate the level of contamination. Since the test is to confirm efficient cleaning and sterilisation after fermentation, residual culture yeast is probably a better indicator of unsatisfactory operation than any specific contaminant.

Question 4

Explain, with an account of the laboratory procedures, the difference between yeast hybridisation and transformation for modification of the properties of yeast. [16]

Comment briefly on the acceptability or otherwise of hybridisation and transformation for distillery yeast. [4]

Since, so far as I know, all modern distilling yeast strains were obtained by hybridisation, I was surprised that no-one was sufficiently aware of the procedure to attempt question 4. Yeasts created by introduction of specific genes are unacceptable in Scotch whisky distilling (which would be discussed briefly as the final section). However, the major part of the answer would be an account of the mating of yeasts of suitable properties and recovery of the desired hybrids, and comparison of that perfectly legitimate procedure with the use of plasmids to introduce new genetic properties by transformation.

Question 5

With the aid of a diagram, discuss the effect of the relative volatility of flavour congeners during an 8-hour malt whisky spirit distillation in which the cut from spirit to feints occurs at 60% alcohol by volume (abv). [10]

Discuss the effect on the flavour of the spirit of the following changes:

Delaying the spirit/feints cut point until the strength of the distillate being condensed at the time has fallen to 50% abv. [5]

Reducing the distillation time to 4 hours but maintaining the spirit/feints cut point at 60% abv. [5]

Usually I complain that candidates neglect to provide diagrams as useful visual aids to supplement the text of their answers. This time the converse applied to question 5, some of the answers showing only diagrams of relative volatility of congeners and the amounts in the vapour over the course of a spirit-still distillation. Since the question requested a discussion as well, marks suffered from its absence. However, everyone was clearly aware of the distribution of flavour congeners of different volatility over the course of a spirit distillation. This awareness was confirmed in the second part of the question; all candidates predicted all or most of the likely effects of changing distillation parameters. Changing from 60% to a 50% abv spirit/feints cut point should increase the amount of the less volatile congeners in the spirit, and of course would result in a lower final % abv, although it is unlikely that the final strength would be less than the common 63% target for maturation. By 60% abv, the strength of the distillate is falling rapidly, so the additional volume distilled between 60% and 50% is relatively small. An important effect of halving distillation time is a loss of reflux, which has implications not only for distillation of the congeners of the earlier parts of the question, but also for reactions between sulphur compounds and the still surface. Although not all candidates thought of that, all answers correctly predicted an increased amount of the less volatile congeners. So although there were no outstanding answers, all 10 candidates passed in this question.

Question 6

Sketch graphs of the distribution of ethanol and the principal flavour congeners in the rectifier column of a grain whisky still. [5]

Discuss the effect of each of the following changes, occurring singly, on the strength and flavour of the spirit and the distribution of congeners over the height of the rectifier:

Increased removal of iso-amyl alcohol. [5]

Increased reflux from the top condenser. [5]

Increased alcohol content of the wash. [5]

This question was a continuous distillation version of question 5, concerned with the distribution within the rectifier column of the volatile flavour congeners of grain spirit, and requiring discussion of the effect of changed operating parameters on spirit quality. These effects may be less predictable than in malt whisky distillation, but reasoning along the following lines was expected. It is known that removing more iso-amyl alcohol from the lower levels of the rectifier will bring the other congeners further down the column, so the concentrations of butanols and propanol at the spirit plate should fall. More volatile congeners, e.g. acetaldehyde and diacetyl, should also move down to increase the concentration at the spirit plate, but this could be counteracted by improved fractionation of ethanol since there is less iso-amyl alcohol at the base of the column. However, these high-volatile congeners would certainly be increased in amount by increased reflux from the top condenser. Increased ethanol content in wash could result in a higher % abv at the spirit plate, requiring care not to exceed the legal maximum (also a possibility when iso-amyl alcohol removal and top condenser cooling were changed). But increased ethanol content also reduces reflux and fractionation, perhaps causing unacceptable levels of higher alcohols at the spirit plate. Nine candidates attempted this question and 5 passed, some with excellent answers.

Question 7

Name the *four* principal structural compounds of oak wood, state the approximate percentage of each, and explain their contribution to the maturation of whisky. [20]

This question on maturation was answered by all 10 candidates, of whom 7 achieved a pass mark. I had expected cellulose, hemicellulose, lignin and tannins to be discussed as the four principal components of oak wood, but lactones were accepted instead of tannins or hemicellulose. Some answers wrongly dismissed cellulose and hemicellulose as ineffective in maturation, but they release sugars and their derivatives on charring (which some candidates failed to mention), contributing sweetness and colour to the maturing whisky. Also, the resulting layer of activated carbon performs a useful function in absorbing undesirable flavour notes. But lignins and tannins were rightly claimed to be the principal contributors to maturation, particularly after charring. Unfortunately some scripts gave little information on the guaiacyl and syringyl lignin degradation products and their reactions with ethanol and other constituents of the spirit over the course of maturation. Chemical formulae would have been useful in the answers, but in their absence (complete, unfortunately), at least their names were expected for a good mark.

Question 8

Describe the procedures for *one* type of Difference Test and *one* type of Descriptive Test for sensory assessment. [10]

Compare the relevance of these two types of test for assessment of new-make grain spirit, new-make malt spirit and mature whisky. [10]

Most candidates answering question 8 on sensory assessment chose to describe the three-glass "triangular" difference test and the plotting of sensory characteristics in the form of a "spider diagram", but often without the helpful sketch of a typical result. Although some of the answers became rather involved in minor details of company procedure (but there is no harm in giving as much information as possible provided it is relevant), the methods were well described. The application of these tests to practical assessment was also competently discussed. A triangular test is normally sufficient for new-make grain spirit, and either test could be appropriate for new-make malt according to circumstances. The complexity of mature whisky makes a descriptive test almost essential, but some candidates noted that a triangular test may be appropriate for checking trueness-to-type of a blended whisky. Eight candidates answered this question; 7 passed.

DIPLOMA IN DISTILLING EXAMINATION 2005

Module 3 – Process Technology

Wednesday 8th June 0930–1230 hrs

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. In calculations, show detailed working: you will not score full marks for the correct final answer alone.)

Fourteen candidates sat this module and 13 (93%) passed, 1 at grade B, 7 at C and 5 at D. Although that is a good result, there was substantial variation in the marks achieved in different questions, and every candidate failed in at least one question of his/her paper. Questions 4, 5 and 6 involved calculation, and in many of the answers the working was very difficult to follow. Future candidates, please set out calculations in an organised way, identifying the purpose of each step, so that I can give credit for steps that are correct (or done in the correct way) even if the final answer is wrong. Perhaps the apparntly disorganised layout of many of the poorer answers contributed to the candidates' own difficulty with the calculations.

Question 1

Draw a graph of the theoretical liquid/vapour equilibria of alcohol/water mixtures showing the relationship between temperature and alcohol concentration at atmospheric pressure. Accurate boiling points of the purest ethanol (78°C) and pure water are expected, otherwise a reasonable approximation to true values is sufficient. [8]

Explain, with reference to the graph (and with any necessary annotation of the graph):

> **why the ethanol concentration in the distillate is greater than in wash or low wines. [4]**
>
> **why the energy input to pot stills has to be increased throughout distillation. [4]**
>
> **the maximum possible alcohol strength from distillation at atmospheric pressure. [4]**

The first part of question 1 required candidates to reproduce from memory the graph of vapour/liquid equilibria of distillation alcohol/water mixtures, but provided temperature and concentration were plotted accurately for pure water and the 97% abv azeotrope, a reasonable approximation to the correct shape of the graph was sufficient for 8 marks. For the written parts, it was sufficient to explain with reference to the graph (a) that evaporated liquid condensed at a higher % abv, (b) that the temperature of distillation increased with falling % abv and therefore energy input must be increased throughout the distillation and (c) the convergence of the dew point and bubble point lines at 97% abv and therefore the impossibility of concentrating further at atmospheric pressure. Other acceptable explanations for (b) were that since the percentage of water in the pot increased throughout distillation, the boiling point increased, or a greater input of energy was required as latent heat of evaporation. Thirteen of the candidates answered this question, most scoring high marks. But I was surprised that some candidates referred to an increase of % abv throughout distillation, ultimately reaching the azeotrope. Surely they must have noticed that the alcohol concentration falls during a malt whisky distillation.

Question 2

Why is the basic single-column continuous still with a partial reboiler and total top condenser unsuitable for distillation of grain whisky spirit? Explain with the aid of simple diagrams of both the basic still and a Coffey still (or other design of whisky still) how only the latter meets the necessary requirements. [20]

The intention of question 2 was an explanation why the basic single-column still, intended for a simple alcohol/water mixture, is impracticable for distilling the complex mixture of solids and flavour congeners in wash. A description of the construction and operation of the two types of still did not answer the question; an explanation of the disadvantages of the single-column still was necessary: problems such as the large number of plates, fouling of the reboiler and excessive recycling of volatiles from the top condenser. These were recognised in some of the 14 answers; although none was outstanding, 12 achieved at least a pass mark.

Question 3

Give a description, including simple diagrams, of *two* types of centrifuge which could be used for separation of grains-in spent wash of a grain distillery into spent grains and a supernatant stream for subsequent evaporation. Discuss the advantages and disadvantages of each type. [20]

This question on centrifugation, was attempted by 13 candidates. The application of the question being separation of solids from spent wash, all chose to describe a horizontal helical (decanter) centrifuge, with a disk (bowl) centrifuge as alternative. Although all drawings showed the solid – liquid separation in the rotors clearly enough, the routes of the separate outlet streams were not always obvious. In most papers the advantages and disadvantages of each type were adequately described, particularly those confirming that the decanter is best suited for the specified heavy duty.

Question 4

Describe the basic principles of co-current and counter-current plate heat exchangers and the temperature profiles within each type, using diagrams to supplement the explanation. Also explain the choice of counter-current for wort cooling duty in a malt whisky distillery. [10]

In a malt whisky distillery a plate heat exchanger is used to cool first wort of density 1080 kg m^{-3} from 60°C to 20°C at a rate of 150 litres min^{-1}. Cooling water at 8°C is supplied at 220 litres min^{-1}. What is the outlet temperature of the coolant? [5]

How many heat exchanger plates of area 0.6 m^2 are required?

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

Density of coolant water = 1000 kg m^{-3}

Heat transfer coefficient = 800 W m^{-2} K^{-1} [5]

Although there are few applications where a co-current heat exchanger is preferable to counter-current, candidates are expected to understand the principles of both, or at least the implications for temperature profiles as featured in question 4. The construction of both is essentially the same, but counter-current has the advantage of greater temperature difference between the wort and coolant over the length of the unit, one result being more rapid cooling. Some candidates made the calculation difficult for themselves by using unnecessarily large numbers, e.g. working in W rather than kW, and getting lost somewhere in the calculation. Other mistakes occurred through wrong combinations of temperatures for LMTD. Therefore few candidates were able to determine the minimum number of heat-exchanger plates (58, by my calculation based on 37.3°C as outlet temperature of coolant, although close numbers were also accepted on the basis of slightly different data). However, the combination of descriptive and arithmetical halves of the question allowed all but two of the 13 answers to score at least a pass mark. Incidentally, 2 candidates forgot that heat exchangers need a whole number of plates.

Question 5

(a) Calculate the energy required to heat a wash charge of 11,000 litres, of 8.0% alcohol by volume, to distillation temperature in a still of empty weight 2.5 t. Assume an average distillation temperature 96°C. Ignore heat losses by radiation during the 40 min heating program.

Initial temperature of wash = 32°C

Density of 8% alcohol by volume (6.4% alcohol by weight) = 986 kg m^{-3}

Specific heats
water = 4.2 kJ kg^{-1} K^{-1}
alcohol = 2.4 kJ kg^{-1} K^{-1}
copper = 0.4 kJ kg^{-1} K^{-1}

Surface area of the wash still = 50.0 m^2

Film heat transfer coefficient of copper surface = 10 W m^{-2} K. [6]

(b) If the distillation, producing low wines of 21% abv, takes 3 h 20 min from the first appearance of distillate, calculate the average weight of steam required per hour for the distillation stage, allowing for heat losses by both convection and radiation. Assume that steam is supplied at constant pressure 0.5 bar g (112°C) throughout the distillation.

Ambient temperature of the still-house = 16.0°C

Latent heat of evaporation of water at 96°C (average distillation temp) = 2261 kJ kg^{-1};

Latent heat of condensation of steam at 112°C = 2227 kJ kg^{-1},

Latent heat of evaporation of alcohol at 96°C = 837 kJ kg^{-1},

Density of 21% abv (17.0% alcohol by weight) = 972 kg m^{-3}.

Equation of radiated heat loss: $q_R = A\varepsilon\sigma\ (T_1^4 - T_2^4)$

Where

q_R = amount of heat transferred by radiation,

A = heat transfer area,

T_1 = absolute temperature of the radiating surface,

T_2 = absolute temperature of the receiving medium,

σ = Stefan-Boltzmann constant = 5.67 × 10–8 W m^{-2} K^{-4},

ε = emissivity (ε of polished copper = 0.07 W m^{-2}). [14]

Question 5 was chosen by only 6 candidates, none of whom gained a pass mark. As in question 4, some calculations generated enormous numbers; working in MJ would have been easier. The question stated the alcohol concentration of the wash in both % by volume and % by weight; the latter must be used to calculate energy requirement: the weight of wash is 10846 kg of which alcohol is 6.4% and water 93.6%. However the % abv value had to be used for calculating the volume of low wines: 7.9% abv (since 0.1% remains in the pot ale) was concentrated to 21% abv. My comment in the introductory paragraph on the disorganised layout of calculations is particularly relevant to this question, which is a succession of simple calculations but you have to keep track of what you are doing. For those attempting the calculation for practice, the energy required to heat the still and contents to average distillation temperature is 3063 MJ and for the duration of the actual distillation, steam is required at an average amount 1.1 tonnes per hour, based on energy released both by condensation and cooling to 96°C.

Question 6

Discuss briefly the typical distillery applications and the design features of each of the following pumps: open impellor centrifugal pump, mono pump, and diaphragm positive displacement pump. [6]

For a centrifugal pump sketch a characteristic curve, showing the effect of using impellors of different diameters. Indicate on the diagram the dead end head, the open discharge flow rate and a line of constant efficiency. [4]

Calculate the head developed by a pump and its power requirement in kW to move wash of specific gravity 0.998 through a 75 mm diameter pipe to the top of a still charger at 2 m s^{-1}. The pump is 10 m below the liquid surface in the washback and the entry point at the top of the wash charger is 20 m above the pump. Both vessels are at atmospheric pressure, pump efficiency is 50%. Ignore friction losses. [10]

This question was even less popular, with only 3 answers, and only one attempted the calculation. Since that accounted for 10 marks, it is scarcely surprising that there was only one pass. Descriptions, usually including drawings, of the three named types of pump were adequate, but to answer the question it was important to specify their duties in a distillery. In the second part, I was surprised that the characteristics of a centrifugal pump were presented without calibrated axes to two candidates' graphs.

Question 7

Discuss, with the aid of diagrams, the instrumentation and control requirements for an automatic cleaning-in-place system for stainless-steel washbacks and associated pipework, using a caustic detergent/sterilant preparation. Use either a partial recovery or a full recovery system as your example (specify which in your answer). [20]

After the disappointing answers to questions 5 and 6 it was reassuring to read some excellent accounts of CIP in question 7. But however good the description of the layout may have been, the question was concerned with the instrumentation and control systems. Three of the 7 answers omitted that essential information and received low marks, but the 4 which passed included some outstanding answers covering all possible aspects of operating and monitoring the plant.

Question 8

Draw a steam-heated wash still and its associated shell-and-tube condenser, showing the safety devices to prevent damage by accidental pressure changes. Give a brief description of their operation, and the likely causes of such pressure variations. [8]

Also indicate on that diagram the sites most liable to corrosion, and explain why these areas are the most

susceptible. What corrosion differences are likely to occur between stills heated by a) steam coils or pans and b) direct-firing by gas, and why? [6]

Discuss the advantages and disadvantages of constructing continuous stills of stainless steel rather than copper. [6]

The final question, combining safety devices and corrosion, was answered by 13 candidates, of whom 10 passed. In some drawings the appearance of the still suggested it had already suffered the sort of damage that pressure and vacuum relief valves are intended to prevent, but there were also some excellent sketches and written answers.

MASTER BREWER EXAMINATION 2005

Module 1 – Materials and Wort Production

Tuesday 7th June 0930–1230 hrs

Answer any FIVE questions

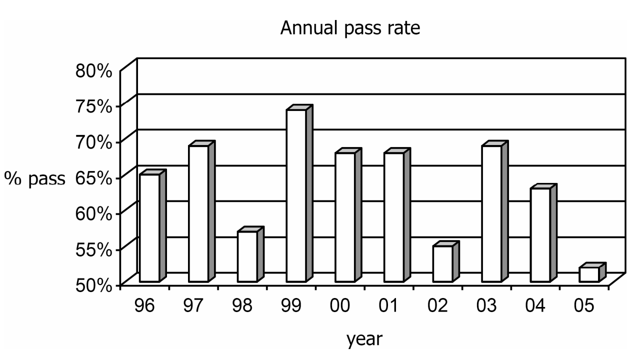
There were 39 candidates registered for this examination, although only 31 papers were returned; this is an increase on the previous two years. 16 (52%) candidates achieved a pass mark. This success rate should be compared with previous years' results, as shown in the chart below.

The general standard of papers this year was very disappointing and is the lowest recorded since the examination was introduced in modular format.

There were a few good papers but far too many candidates failed or were just above the pass mark. One of the candidates was re-sitting the exam having failed several times over in the last few years. It was quite apparent this year that too many candidates neglected to do anything like the necessary amount of preparation. Mentors should be encouraging their pupils to get as wide a range of practical brewing experience as is feasible in their individual situations and to read as widely as possible from textbooks, journals as well as electronic media. Mentors also have a responsibility to ensure that candidates under their tutelage are properly prepared for the examinations.

Question 1

Draw up a design brief for barley intake, drying and storage facilities for a 60,000 tonnes of malt per year maltings. Describe the quality assurance procedures required for this area.



This question was attempted by 14 (45%) of candidates with only 4 (29%) achieving a pass. The standard of answers for this question was quite poor with many candidates demonstrating that they are not well acquainted with the design requirements of a modern maltings. Candidates should have calculated throughputs and vessel and batch sizes and should have taken into account the degree of 'maltings loss'. Several candidates did not discuss the quality assurance procedures required in such a plant.

Question 2

Discuss the importance of the control of moisture content during the malting process and explain how correct moisture levels are achieved at each stage.

Describe practical ways in which water usage and effluent production in a maltings can be reduced.

This question was attempted by 23 (74%) of candidates, with 17 (74%) achieving a pass mark. In general this question was answered well. A good answer explained how conditions may be set to achieve the correct water levels during steeping, germination and kilning, the ideal level that should be achieved at these stages to accomplish the correct malt specification and implications of getting the water content incorrect. Some candidates lost marks by ignoring the second part of the question about reducing water usage and effluent production. Simple procedures like water re-use and unsophisticated treatment plants were sometimes not discussed.

Question 3

Specify the plant required to treat water obtained from a borehole that has this composition: calcium 220 mg/l, magnesium 30 mg/l, sodium, 50 mg/l, carbonate 150 mg/l, sulphate 350 mg/l, chloride 30 mg/l, nitrate 50 mg/l and silicate not determined. This water will be used for brewing a pale lager type beer, in cleaning-in-place (CIP) systems and as boiler-feed water.

This question was attempted by 18 (58%) of candidates with 8 (44%) achieving a pass mark. This question was answered with little competence. Quite often the reasons for selecting a particular water treatment plant were very superficial and failed to explain the advantages and disadvantages of the plant described; the water composition was specified in the question but other aspects of the brewery situation were left to the candidates' discretion. The various treatments to achieve water suitable for the duties described were often hardly touched on. Some answers included diagrams but in general these were poorly executed and failed to elucidate adequately the systems being described.

Question 4

Explain the reasons for recent changes in the global hop market.

Discuss the ways hops and hop pellets may be stored highlighting techniques that may be used to enhance their storage life.

This question was attempted by 13 (42%) of candidates with 5 (38%) achieving a pass mark. The answer to the first part of this question can not be found in a text-book. Candidates must extend their range of reading matter to the various brewing journals where the current state of the world hop market is often given an airing; the internet is another excellent source of facts and figures and mentors should be helping with introductions to growers and merchants. The second part of the question was much more ably answered, though many failed to describe the processes employed in the manufacture of hop products in anything like sufficient detail.

Question 5

Describe the manufacturing process for one particular liquid brewing adjunct and propose a specification for the chosen finished product.

Discuss the technological and economic factors that need to be considered for its use in the brewhouse.

This question was attempted by 10 (32%) of candidates with 8 (80%) achieving a pass mark. The general standard of answers was good. Most answers included a detailed and accurate description of the process flow from raw material to finished syrup. A few candidates failed to identify some of the basic technological and economic factors that must be considered before adjuncts are used. These may include raw material as opposed to adjunct cost, brewhouse capacity, wort nitrogen dilution and alpha amino acid dilution. Candidates who were able to explain why these last two factors have to be assessed picked up extra marks. Also beer style and beer flavour must be considered.

Question 6

Describe three commercially available systems for heating and boiling wort and discuss the advantages and disadvantages of each.

This question was attempted by 27 (87%) of candidates attempting it and 11 (41%) gaining a pass mark. As with the hop question this question was best answered by those who have kept up to date with brewing journals and manufacturers' technical handouts, again most of which are available on the internet. A well drawn and labelled diagram often enhanced an answer and provided a rich source of marks, on the contrary some diagrams were no better than rough sketches with little or no explanatory labelling. When a question asks for advantages and disadvantages of the various systems being described candidates would do well to list out at least some of them.

Question 7

Describe the various devices available for separating spent hop material and other particulate matter from wort at the end of the boil. Include the advantages and disadvantages of each. Why is this process important and how would the cold wort quality be monitored to ensure that it has been carried out successfully?

This was the most popular question of this year's exam. 28 (90%) of candidates with 19 (68%) obtaining a pass mark. On the whole answers were presented in a workman-like way. This question like others, invites several well drawn diagrams; though time is of the essence in the examination room, with the minimum use of a ruler or coloured pens and pencils, but with well thought out labelling, marks could be garnered easily. For some candidates though time appeared to have run out since the importance of the process and how it could be monitored were hardly touched upon.

Question 8

Describe the procedures that must be employed to introduce and maintain safe working practices in a brewhouse.

This question was attempted by 21 (68%) of candidates with 11 (52%) gaining a pass mark. A very similar question was asked last year and it is clear that many candidates did not absorb the suggestions for dealing with this type of question given in last year's examination report. Issues of safety must be dealt with by adopting structured procedures for identifying and assessing hazards and risks then taking action and writing procedures, with responsibilities agreed, which reduce or eliminate risk. Implicit in this approach is the need to document at each stage and to re-visit and review on a regular basis. In a good answer all these elements were illustrated by examples from the candidate's practical knowledge. In a poor answer, in place of the structured procedures and the pertinent examples, there was a disparate catalogue of safety issues which candidates thought should be taken care of.

MASTER BREWER EXAMINATION 2005

Module 2 – Fermentation and Beer Processing

Tuesday 7th June 1400–1700 hrs

Answer any FIVE questions

Twenty nine candidates submitted scripts for the paper and 19 gained pass grades, a pass rate of 66%, which is a poorer performance than last year. However it is pleasing to report that 4 candidates achieved passes at grade B. Other grades were 4 papers at grade C, 11 papers at grade D, 8 papers at grade E and 2 papers at grade F.

There were some areas of examination technique that let candidates down. As usual candidates were asked to attempt five questions. Several of the questions consisted of two parts, however in some instances candidates did not attempt to cover both. One candidate only attempted four questions and another answered six. In the latter case the sixth answer was not marked.

Similar to last year, several candidates failed to gain good marks by using terms such as "check" or "audit" without stating what to look for, the expected condition or the action that should be taken. This is worth noting as the examiner sometimes had the impression that a candidate may well have known the required detail but just failed to write it down!

Several questions were ideally answered by including a well presented labelled diagram or graph. This is a simple way of presenting large amounts of information without taking too much time. Diagrams ranged from very good to very poor. The best used at least half a side of paper, were drawn with a ruler and were neatly annotated with appropriate labels. The worst were very small, untidy and without adequate labelling. The examiner recommends that future candidates should practice drawing diagrams of all of the main plant items (vessels, filters etc.) as part of their preparation.

Question 1

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

18 candidates attempted this question with only 4 passing (22%). There were no good answers.

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

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

Few candidates got near the full scope of the question. Many mentioned various in process targets such as original gravity, attenuation limit or yeast viability. Although important, such factors are not normally considered to be KPIs.

Question 2

Discuss the factors that determine the process capacity of a beer fermentation tank farm.

Due to volume demand a brewery is forecast to exceed its current fermentation capacity by 30% over the next three years. Choose examples that would be sufficient to extend the process capacity of the existing fermentation tank farm, without resorting to significant capital expenditure or additional fermentation vessels.

12 candidates attempted this question with 4 passing (33%).

The first part of the question worth 60% of the marks required a discussion of factors such as high gravity brewing, vessel filling rate (% headspace). fermentation speed, overall process time, use of external chillers and centrifuges, downtime per vessel turn and working patterns.

The second part invited candidates to provide an illustration of how one or more of these factors could be optimized to achieve a phased capacity expansion over a designated timescale.

Most candidates discussed one or more of the relevant factors involved, but there were only limited attempts to illustrate the effects in terms of numbers, whether by providing typical original gravities, expected filling rates or process time hours. The second part of the question was especially poorly answered with no candidate providing a detailed practical proposition for an integrated capacity expansion plan.

Question 3

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

17 candidates attempted this question with 7 passing (41%).

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

Answers to this question ranged from very good to very poor. The best answers were based on quality diagrams of each type of filter, showing the design configuration in terms of plates, frames, filter sheets, candles, leaves and membranes etc, and also the flow patterns of beer through the filter. Good answers then went on to discuss the advantages and disadvantages in terms of comparative facts and figures. The weakest answers failed to describe the filters adequately and gave only vague descriptions of the advantages and disadvantages e.g. cheaper cost, easy to turn round.

Question 4

Microbiological analysis of green beer samples at the end of fermentation has indicated a significant level of infection over recent weeks. Describe the steps that could be taken to eliminate this problem.

Describe microbiological analyses suitable for detecting unwanted micro-organisms in beer at the end of fermentation.

20 candidates attempted this question with 16 passing (80%).

The first part of the question worth 60% of the marks required a description of a systematic process to determine the type and source of infection starting from cold wort to the end of fermentation. Processes to consider included wort aeration, sterilization and CIP, yeast handling, process additions and fermentation performance.

The second part of the question should have been addressed by discussing appropriate microbiological techniques such as microscopic examination, forcings and plate counts. In each case the type of media should have been described, together with the purpose of the test and the conditions (temperature and time) of incubation.

The best answers to this question approached the topic in a practical way just as such an investigation would be carried out in the brewery. Possible infection routes were identified, along with the checks that should be carried out and corrective action that would be appropriate. e.g. If infection has been identified in cold wort, then the source might be wort aeration and the corrective action might be to change the air filter and ensure routine steaming out between brews. One candidate started by suggesting that the laboratory results should be queried as the first activity. This wasted time as the question stated that a significant level of infection existed.

The second part was generally more challenging for most candidates. Many answers listed beer spoilage microorganisms and then went onto list various media. However there was often confusion about which media is appropriate for detecting which microorganism and also what the appropriate incubation conditions should be.

Question 5

Discuss the range of controls and monitoring procedures that should be in place in the fermentation and beer processing areas of a brewery in order to ensure product safety.

12 candidates attempted this question with 6 passing (50%). Most were borderlines and there were no particularly good answers.

The answer to this question required a description of HACCP processes together with a detailed description of the materials or processes at risk and the preventative measures that can be taken in each case. Materials to be mentioned could have included priming sugars, hop preparations, oxygen, carbon dioxide, antifoam, enzymes, kieselguhr etc. Appropriate preventative measures might have included the use of product specifications, supplier quality assurance, clear labelling and storage etc. Processes such as wort aeration, cooling and CIP should have been discussed along with the importance of sterile filters, product and coolant pressures in heat exchangers and CIP interlocks. Other basic measures such as housekeeping routines, equipment maintenance and product traceability could also have been described.

The strongest answers described the steps of a HACCP analysis and employed useful flow diagrams to illustrate the process flow from cold wort to bright beer tank and to demonstrate the critical control points present. They then went on to discuss practical steps to minimize or eliminate the particular hazard. The weakest answers briefly alluded to HACCP and only mentioned a few of the hazards.

Question 6

Describe a typical fermentation and conditioning profile for *either* a lager *or* an ale. Include all of the key parameters that will influence the final quality of the beer.

28 candidates attempted this question with 21 passing (75%). This was the most popular question on the paper and most of the passes were achieved with comfortable scores.

The first part of the question worth 50% of the marks was most effectively answered by the use of an annotated graph illustrating a typical lager or ale fermentation and conditioning profile. Parameters to be shown included wort original gravity, wort dissolved oxygen, attenuation vs time, temperature, yeast cell count, pH and diacetyl. In each case appropriate values and units should have been stated.

The second part of the answer should have gone on to describe the typical types of slow fermentation such as extended lag phase, slow rate of attenuation or tailing off. The possible causes should have been stated such as aspects of wort composition, wort aeration, yeast quality and pitching, temperature control and pressure. In each case appropriate corrective action should have been recommended.

Good answers used a graph to plot the essential parameters of the fermentation profile and used supporting text to discuss and quantify other essential parameters such as wort dissolved oxygen, pitching rate and time and temperature of conditioning. They then went on to describe the factors that can lead to slow fermentations such as low pitching rate, poor yeast viability and premature cooling and suggested practical measures to overcome each problem. The weakest answers only described the most basic parameters such as attenuation profile and then suggested a few causes of slow fermentation such as wort temperature too low, but without suggesting why this might be.

Question 7

Describe the steps that can be taken to minimise the amount of effluent produced in the fermentation and beer processing areas of a brewery.

Review the options available for the handling of surplus fermentation vessel yeast crops and tank bottoms.

11 candidates attempted this question with 4 passing (36%). This was the least popular question. There was only one good answer.

The first part of the answer worth 50% of the marks should have described the principle effluent streams such as green beer loss, yeast, filter aid, CIP solutions and water, along with practical suggestions on how to minimize each. Points to mention could have included the use of recovery CIP systems, vessel design, minimizing spillages, waste yeast handing, beer recovery, interface control, maintenance of valves and pumps etc.

The second part of the answer required a basic description of equipment such as yeast presses, centrifuges and cross flow filters as applied to surplus yeast handling, along with the advantages and disadvantages of each.

The best answer covered most of the above points comprehensively. The weakest answers only discussed CIP cycle times and recovering cleaning solutions, or limited handling of surplus yeast to selling it or mixing it with trub.

Question 8

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

What routine checks should be carried out to ensure the equipment is operating effectively?

26 candidates attempted this question with 24 passing (92%). Most were comfortable passes and there were some very good answers.

The first part of the question worth 70% of the marks was best addressed by means of a diagram illustrating the typical features of a recovery or single use CIP system. Dependent on the type of system selected, design features to show included concentrated and dilute detergent and sterilent tanks, water and rinse water tanks, spray heads, mains, valves, pumps, heat exchangers, along with temperature and conductivity probes. The operation part of the question was looking for a brief description of the plant to be cleaned and typical cleaning cycles including rinses, detergent and sterilent washes with details of appropriate times, temperatures and concentrations.

Routine checks should have considered periodic inspection of vessels and sprayballs, detergent and sterilent analyses, microbiological checks, calibration and audit of cleaning cycles.

Most candidates based the first part of their answer on a brief description of the equipment to be cleaned and a detailed diagram describing all of the features of a recovery or single use CIP set. They then went onto describe a typical CIP cycle of rinses, detergent washing and sterilization, together with appropriate times, detergents, concentrations and temperatures. Appropriate checks were then described as above. The weakest answer only mentioned the availability of recovery and single use systems without describing the design of either.

MASTER BREWER EXAMINATION 2005

Module 3 – Packaging and Beer Dispense

Wednesday 8th June 0930–1230 hrs

Answer any FIVE questions

In 2005, 25 candidates sat the examination of whom 14 (56%) achieved the pass standard. This represents a significant improvement on last year's percentage.

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

It is pleasing to note that the overall standard improved significantly this year not only in the quantity of passes, but also in the quality. There were some excellent answers submitted for some of the questions.

The best answers included the basic answer to the question, enhancements with process and quantitative detail and a demonstration of close acquaintance with the issues involved in the subject area.

Examination technique was also improved this year with most candidates able to apportion their time correctly to provide reasonably full answers to the required five questions.

Those failing to meet the required standard were either, only able to write convincingly in one or two areas, or only had a superficial knowledge across the whole paper.

Question 1

Design a canning line to produce the following volume:

> **250 000 hl of 330 ml cans and 800 000 hl of 500 ml cans.**

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

Which indicators would be used to assess overall line performance in post-installation acceptance trials?

This was the third most popular question with 20 (80%) of candidates answering though it was relatively poorly answered with only 8 (40%) reaching the pass standard. There were, however, a couple of very comprehensive answers which scored well.

Despite the first part of this question being a fairly standard request for a small pack line design it was still not answered well by many candidates. Good answers could clearly identify the required plant and size it suitably for the required output with sensible assumptions of operating time and machine efficiencies. Poorer answers included wrong calculations or started with a shift pattern to drive the sizing which became unrealistic. Non-feasible plant capabilities were not recognised in poor answers. The acceptance trials part of the question lead to a range of answers. Again poorer answers were superficial, some avoided this part of the question altogether whilst others dealt only with one aspect such as oxygen control. A good answer should include a range of parameters including for example speeds, efficiencies, beer quality and pack quality.

Question 2

Describe the process of preparing and conducting a technical audit of a bottling operation.

In the areas of:

> **Packaging material storage**
> **Primary packaging process**
> **Secondary packaging process**
> **Finished goods warehouse**

list and justify quality standards to be examined, highlighting potential corrective actions in the case of nonconformance.

This was a moderately popular question with 17 (68%) candidates answering. It was the question which had the best rate of candidates achieving the pass standard with 14 (82%) passes.

Good answers to this question included appropriate detail on the practicalities of auditing and then were able to apply this to the bottling operation. Good examples were given of the types of non-conformance which can occur and sensible corrective actions were proposed. Poorer answers were lacking in detail. It is insufficient to say 'audit against the procedure', knowledge of the contents of the procedures needs to be demonstrated. Poorer answers also either failed to mention corrective actions or suggested inappropriate actions.

Question 3

Explain in which situations minimum stock holding (just in time) systems are favoured. What risks are associated with such systems?

For a bottling plant *or* a canning plant, producing product in tray and shrink and in solid board multi-packs, describe the range of factors which would influence stock holding level. Include all materials.

This was the second least popular question with 8 (32%) candidates answering. It was poorly answered with only 1 (13%) candidate achieving the pass standard.

As with last year's question in this area, there was insufficient demonstration of depth of knowledge or understanding of the issues involved here. Answers which only addressed the first part of the question which deals with the general principles scored poorly. In order to gain fuller marks it is necessary to deal with the materials in detail and show understanding of how the general principles apply to each material.

Question 4

List the utilities needed to operate either a canning plant *or* a bottling plant.

What methods can be employed to measure the use of each utility?

For each utility, give one example of how the consumption data can be used in an automated process control system to assure product quality.

This was a moderately popular question with 15 (60%) of candidates answering and was also moderately well answered with 7 (47%) reaching the pass standard.

As with other questions good answers dealt with the whole question asked. Poorer answers focussed entirely on listing utilities and detailing the plant items where these utilities would be used. Better answers went into measurement possibilities. Top answers were able to relate measurement to control systems and give credible examples of where automated process control would be of use. Examples might include gases on the filler, steam in a pasteuriser or air on a inspector rejector system.

Question 5

For either a keg filling *or* a cask filling operation:

Explain how poor performance for each key plant item can adversely affect costs. Describe suitable remedial actions. Where these actions incur cost identify which revenue or capital budgets would be affected.

This was another moderately popular question which was attempted by 16 (64%) candidates. This was the second most poorly answered question with 7 (44%) candidates achieving a pass, though one excellent pass was submitted.

Good answers to this question included all key plant items and were able to identify how poor performance in terms of speed efficiency or quality could affect costs, appropriate remedial actions were proposed which could include replacement, maintenance or working practices and cost centres allocated. Poorer answers again only dealt with superficial issues without detail and gave a stock answer on cost control.

Question 6

List the parameters that should be controlled in-glass for a draught beer (keg or cask) in a retail outlet.

Explain how the design of the dispense system impacts on the attainment of the listed parameters.

This was the second most popular question with 21 (84%) of candidates attempting the question of whom 15 (71%) achieved the pass standard, including 2 excellent submissions, making it the second best answered question.

Poorer answers to this question just presented facts relating to cellar design and did not deal with the question asked. Good answers were able to list relevant parameters such as temperature, clarity, foam and say why they are important. Dispense system detail was well presented in good answers including different ways to achieve the same effect. Finally, good answers made it clear how the design linked to in-glass performance.

Question 7

For either kegs and extractor tubes (spears) *or* casks, shives and keystones:

Identify a material of construction for each component and state why this material is suitable for this use.

For your chosen components write a technical specification against which the component could be purchased.

Explain the relevance of the parameters specified.

This was the least popular question with only 3 (12%) candidates answering. It was well answered by those attempting and the 2 (67%) who achieved the pass mark did so comfortably.

This was a question exploring an area of the syllabus not examined extensively recently which probably explains the lack of popularity. Well prepared candidates were able to give good answers which gave significant detail of a technical specification for these containers and fittings. Appreciation of physical (e.g. dimension, pressure) and quality (e.g. taint, permeability) specifications as well as cost considerations all added to a good response to the question.

Question 8

For either a keg filling *or* an aseptic bottle filling operation:

Describe suitable controls (both measurements and actions) to assure that product microbiological quality is assured.

This was the most popular question with all 25 (100%) of the candidates answering of whom 15 (60%) achieved a pass.

Poorer answers to this question only gave a few plating measurements and stated that equipment should be cleaned. Better answers included action standards and process control measures. Top answers (of which there were a number) were able to relate a range of process controls to microbiological quality assurance and demonstrate a practical knowledge of operating an aseptic filling operation.

MASTER BREWER EXAMINATION 2005

Module 4 – Central Functions

Wednesday 8th June 1400–1700 hrs

Answer any FIVE questions

Overall, 22 papers were marked and 16 were passed (72.73%), a significantly higher result than in 2004. Health and Safety was the best answered question and although most candidates attempted the laboratory organisation question, the answers were variable. There was a good understanding of steam demand, effluent streams and project management but a lack of knowledge or interest in costing and the financial considerations of brewery operation. The maintenance question showed most candidates lack of real involvement and was further demonstrated by not featuring as an option in the question on line efficiency.

Question 1

Why is it necessary to chemically treat boiler feed water? Give two examples of problems and the treatment required.

Describe with the aid of a simple diagram the major types of steam demand in a brewery in terms of quantity and duration.

How would the brewery ensure it has sufficient steam raising capacity to meet the demand and regulatory downtime requirements?

Attempted by 18 candidates, 13 passed (72%)

Overall the main elements of steam demand and water treatment were understood but lacked detail.

Most candidates identified, scale and corrosion as reasons for feed water treatment, some mentioned the effect of oxygen and pH. There were some good explanations of appropriate treatments but most answers were sketchy.

Most candidates produced a diagram of the main steam uses and the better candidates showed some expected flow rates. Some candidates identified the phasing between departments but none provided a complete answer.

Nearly all candidates proposed a standby boiler to meet peak demand and allow for regulatory downtime and the better answers referred to careful original design and management of demand between departments.

Question 2

Describe the various stages of a capital plant project from identification of need to successful commissioning. Use a recent large or small project as an example.

Identify the key personnel involved and describe their roles and responsibilities.

Suggest ways of ensuring the project is successful in terms of cost control and fitness for purpose.

Attempted by 17 candidates, 12 passed (71%)

Several candidates had clearly experienced a significant project at first hand and were able to describe the various stages. There was a general lack of emphasis on handover and training to the user department and some candidates failed to specify the need to correctly define the scope at the outset.

The section on key personnel was answered variably and the better answers included the change in responsibilities as the project progressed. Some answers failed to identify the key Project Manager role and the responsibility for managing contractors on site.

Success criteria was mostly defined in financial terms and the better candidates included the initial planning and setting performance targets. Review meetings were referred to and attention to clearing snagging (butt) lists.

Question 3

In a single site brewery, describe the structures and procedures that should be put in place to ensure effective management of Health and Safety. Include the responsibilities of the operators, managers and Health & Safety professionals.

If the accident rate on a packaging line is considered too high, how could an investigation into possible causes be organised and improvements implemented?

Attempted by 15 candidates, 13 passed (87%)

It was good to see a high pass rate and most candidates expressed the view that Health & Safety was everyone's responsibility and senior management had the additional responsibility to ensure procedures were observed. Structures to ensure good Health & Safety management were not consistently well defined but the better candidates referred to regular review meetings, audits, training and risk assessments.

The investigation into a high packaging line accident rate was generally well answered and included an analysis of accidents, a re-appraisal of risk assessments and appropriate modifications to the plant, training and procedures. The better candidates referred to incorporating the findings in an overall improvement plan.

Question 4

Identify the main streams of brewery effluent and their typical strengths and quantities.

What procedures should be put in place to ensure compliance with the local discharge consents or regulations?

If the pH of a brewery's effluent stream suddenly rose, what could be the potential causes?

What techniques are available to ensure pH remains below the upper limit?

Attempted by 18 candidates, 14 passed (78%)

Main brewery streams were identified but generally lacked quantities and values other than COD. There was little detail on ensuring compliance and several candidates only offered a treatment plant as the solution. The better candidates included inter departmental communication and management of CIP, regular monitoring and sampling.

Most candidates correctly identified a rise in pH in the effluent would be the result of excess caustic and the better candidates suggested several causes. There were some good answers on treatment using balance tanks, acid dosing and CO_2 injection.

Question 5

Following a successful product launch, demand for the brewery's latest bottled beer is exceeding the current packaging capacity although brewing and process capacities are sufficient.

Packaging efficiencies are slightly below industry standards and the line runs on two shifts of eight hours per day and five days per week.

Discuss the options available to increase capacity, identifying the risks and cost implications of each suggestion.

Attempted by 12 candidates, passed by 9 (75%)

Although most candidates passed, the marks achieved were low. The required option of increased efficiency, reduced rejects and changes to shift patterns were often correctly identified but the risks associated with each were poorly discussed. The better candidates identified that efficiency improvement would take time and action would be required in the short term to protect the recent product launch. Ways of achieving improved efficiencies were limited but some candidates did refer to a TPM programme and operator training. A variety of shift patterns and overtime plans were proposed and some candidates included the wider possibilities of contracting out or installing an additional line.

Question 6

A brewery produces 500,000 hl of a single brand of beer, packed 70% in 50 litre kegs and 30% in 330 ml returnable bottles.

Identify the key direct and indirect costs of production and state whether they should be considered as fixed or variable.

Draw up a table showing the standard product cost items for each packaging type.

If the brewery were to introduce a 500 ml non-returnable bottle version giving an additional 50,000 hl, what alterations should be made to standard product costs?

Attempted by 2 candidates, not passed by either.

This was the least popular question by a large margin and was sketchily answered. The difference between fixed, variable, direct and indirect costs were correctly defined but examples were limited and the table of costs to make up the packaged products were poor. The final part of the question, looking for changes as a result of a new package type, was not answered well and no mention was made of re-allocating costs to the additional product.

Question 7

For a keg, can or bottling line, identify on a diagram the main components and propose a suitable maintenance strategy for each plant area. Give reasons for the recommendations.

To support the maintenance strategy, how would the appropriate stock levels in the Engineers stores be assessed?

Discuss the merits and implications for the line of both annual overhauls and maintenance on a continuous rolling programme.

Attempted by 10 candidates, passed by 4 (40%)

In general this question was not well answered and showed a lack of practical involvement in plant maintenance. Several theoretical strategies were mentioned but discussion was limited although some candidates offered varying strategies to suit the different plant areas.

The section on stores stock holding lacked detail but the better candidates offered some good analysis of spares usage and lead times.

The discussion comparing annual overhauls with continuous maintenance was poorly answered although the better candidates showed a good analysis of the advantages and disadvantages.

Question 8

A brewery has a central laboratory whose technicians carry out all the QC checks. It has been agreed to devolve some of the checks to the process and packaging operators to improve ownership and involvement.

Describe the type of tests which could be suitable for this approach and which should remain as a central function.

If these changes were implemented, what would be the potential cost implications for the production departments and central laboratory?

Attempted by 18 candidates, passed by 12 (67%)

Most candidates provided a comprehensive list of tasks that could be performed on-line and retained the longer term micro testing in the central laboratory. There were variations in detail and explanations but most candidates could show some experience.

The second part on cost implications was poorly answered and limited to the cost of satellite equipment and potential staff cuts in the central laboratory. The better candidates identified some of the less quantifiable issues such as time pressures on-line, adequacy of training and ensuring remote calibrations were kept up to date.

MASTER BREWER EXAMINATION 2005

Brewing Module 5 – Case Study

Thursday 9th June 0930–1230 hrs

Answer only ONE question

This year 17 candidates sat the paper and 8 passed (47%), rather less than as last year. Seven candidates chose question one and 6 of those achieved a pass, 10 candidates chose question two and 2 of them achieved a pass.

This year showed a wide range of scripts with at least one exemplary answer and several who appeared not to have taken the benefit of the 15 minute reading time.

Question 1

Government legislation regarding waste and emissions has been introduced to a region in which your company operates a brewery of 1 million hectolitre output

per year producing ales and lagers in draught, bottle and can. This legislation will require the brewery to declare known levels for registration and taxation.

Detail and quantify the likely waste and emission streams from this brewery, how they may be minimised and how they could be handled to reduce any negative environmental impact. When analysing the outputs, state if your answer refers to cask or keg packaging for draught and returnable packaging for bottles. Highlight any actions or investments you would recommend to minimise the potential for accidental discharges.

This question was generally well answered, good answers described the site and process in the form of a flow diagram identifying waste emissions and quantities at key points. These points were then expanded in the script to indicate their potential impact on the environment and methods for their handling and reduction.

In the introduction and assumptions the candidate should have set the scene for the brewery's location, the ground condition around it, existing contamination from previous use, proximity of rivers and water courses, wild life and other points of interest or historical significance within a radius of influence from the brewery. In the introduction there should also have been reference to local rules and legislation, housing and neighbouring developments.

The question also looked for comments on capital investment, procedures and work instructions, training and liaison with local government and authorities.

Better answers would include description of more innovative schemes in areas such as effluent handling, use of drainage systems to capture liquid emissions as well as bunding. These answers also clearly identified emissions effecting both local and wider environments for liquid, gaseous and noise emissions.

In order to score good marks a candidate needed to show knowledge of how spillage and leakage could be reduced rather than just to identify where it may occur and that it should be minimised. Marks were given if the candidate highlighted potential capital investment projects, how much they would be likely to cost and how they would be evaluated, justified and implemented.

Question 2

Your company has signed a deal with a major customer to supply a range of beers in bottle and can. Most of the products to be supplied already exist as part of the brand portfolio but to complete the range a low cost 5% Alcohol by Volume (ABV) lager is required. Stating assumptions describe how such a beer would be designed, the type of materials and recipe which would be used, its brewing process and package format. The answer should include reference to marginal costing and standard product costing principles.

Many candidates would have benefited from taking the 15 minutes reading time, using it to read and understand the question then think of an answer plan before rushing in to answering a question which was not asked.

This question was not well answered with too many candidates wanting to write about design and sizing of a brewery along with its operational principles rather than to focus on the question which looked for design and costing of a product not the plant to produce it. The answer should have highlighted opportunities in recipe, material selection and the brewing process to minimise cost of production not how to brew in general.

In the accounting section the question asked for principles and not just a list of expected costs so to gain good marks a candidate needed to illustrate an understanding of how standard product costing is applied in business and the influence of overheads in marginal costing and overall profitability. Key to this was to highlight any under utilised capacity in the brewery during the introduction and assumptions.

Packaging evaluation was particularly poorly covered with most candidates wasting time calculating recipe quantities which were irrelevant as the question was looking for recipe and raw material evaluation from a cost point of view.

Good candidates reviewed the range of raw materials available and considered the use of more radical and cost effective methods of obtaining both fermentable extract and hop character and bitterness.

Beer analysis needed to be explained and consideration of options such as high gravity brewing and super attenuation needed to be included for good marks.

Energy conservation with minimisation of boil time and evaporation, evaluation of collection temperatures and yeast viability to ensure as rapid a fermentation as possible, use of transfer cooling rather than in vessel needed to be discussed.

Good scripts gave consideration to flavour showing that low cost did not want to be cheap and nasty and above all to get higher marks a candidate needed to mention the relationship of fixed and variable overheads to the cost of the product so that the accountancy part of the question was covered.