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Chris Taylor is a Fellow of the IVE with over 35 years enamelling experience and is a lecturer for the IVE Basic Approach Course.

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One of the most important things I have ever had to announce is that at the Extraordinary General Meeting of the Institute held on November 4th 2010, the motion enabling the formation of the IVE - The Vitreous Enamellers Society within the structure of The Institute of Materials, Minerals and Mining (IOM3), was passed unanimously. This is the culmination of a number of years of soul searching and hard work by your council members and I would like to place on the record the thanks of the IVE membership for all of that work. The minutes of the meeting and my address to the meeting are published in this issue.

In my position as President, it is appropriate that I should write the last editorial for the “Vitreous Enameller” in its present form. The IVE has produced a journal since 1948 when the first page of Volume One Number One of what was then called “The Institute of Vitreous Enamellers Bulletin” stated:

“It has been felt by the Council for a long time that the ordinary Member of the Institute is not made sufficiently aware of the activities of the Institute. It is therefore intended to publish, periodically, a bulletin briefly reviewing the work done, and giving notice of forthcoming meetings and other matters of interest. In order to increase the interest of the bulletin, if any member would care to contribute notes suitable for incorporation, they would be appreciated.”

For your interest, here is photograph of the first two issues.
This guiding principle has been continued by the IVE for 62 years, initially as the Bulletin, which carried on in an ever improving form until 1967, when the name was changed to “The Vitreous Enameller”. It still is the only periodical journal on the subject in the English language and has been distributed to over 30 countries. That first issue contained only 8 pages, 2 of which were blank and gave details of forthcoming meetings and the minutes of the AGM. By the second issue, published later in 1948, it had grown to 28 pages and contained technical papers which had been presented to the Spring Conference held in Bournemouth. One of these is reproduced for us in this issue. The paper was an important one on Bubble Structure, which still stands up in parts to modern scrutiny. I am sure you will find it interesting. It is intended that a similar publication will form part of the portfolio of publications which are produced by IOM, thus continuing to serve our industry as a resource for information and technical knowledge.

I have been involved with the vitreous enamelling industry for 50 years and with the IVE for over 40 of those, so this change brings me some very mixed feelings. It is tinged with some sadness over the loss of so many enamelling plants in the UK. In 1960 there were getting on for 100, and now we could count them on the fingers of two hands. Also some sadness over friends and colleagues who are no longer with us, but on the other hand, one heck of a lot of good memories. I have a great feeling of pride at what we, as the IVE, have achieved over the 76 years of our existence as one of the leading (and the first in Europe) technical institutes in the field of vitreous enamel. In the final reckoning, ask yourself - have we made a difference? Well the answer most certainly is - YES!!! Long may it carry on in its new form.

So what about the future? I will actually be retiring from IVE, which probably means I might get some of those unmade model locomotive kits finally finished - well I can dream can’t I? I spent last Sunday at the National Model Railway exhibition at the NEC, inspiring myself to get started again - all I need is the time. Trouble is that it has to compete with the list of jobs that seem to plague all retired men and, of course, if you are in the same position, you will know exactly what I mean.

Also for the future, a number of us have discussed forming a reunion group. My year group from Lanchester College at Coventry, where I did metallurgy, still meet some 43 years after we finished. At the last get together in July, out
of the 15 in the final year, 12 were there, including one from Tasmania and our course tutor who had come over from Brittany! So it is possible. John Mullis and I agreed to co-ordinate an email/address list, with a target of setting up the first reunion sometime next year. We are not just talking about retired enamellers, but also some who will have left the industry and some who are still in it - it would be great to see it come to fruition. It would be very sad if the many great friendships forged over the years were to lapse. Please contact John or myself if you would like to be added to the already growing list!

What of the future for IVE - The Vitreous Enamellers Society? I would urge you all - company and personal members - to carry on supporting this society in its new form as part of IOM³. The unanimous vote at the EGM was a clear mandate for the change, so you will already be aware of just some of the benefits which you will have as part of IOM³ family - they have enormous resources, enthusiasm and vision. An interim committee has been set up to guide the “new IVE” into the future. They will be in touch with you in the near future to advise you about some exciting events which they are planning under the aegis of IOM³, giving you all some idea of what you can expect. So please, please support them. They have a tremendous amount of work to do over the next months and years and they can’t do it without your support.

I would like to thank all of you - some near and others far away who have been so supportive over those 50 years. I would not even attempt to try to list you all, but you know who you are - thank you so much and I hope to see you at one of the reunions.

Mike Collins
President - IVE

--ooOoo--
INSTITUTE NEWS

MINUTES OF EXTRAORDINARY GENERAL MEETING
OF THE INSTITUTE OF VITREOUS ENAMELLERS

HELD AT THE LONGFORD HOUSE, WATLING STREET, CANNOCK.
WS11 1SJ ON THURSDAY 4TH NOVEMBER 2010 AT 14.00HRS.

Present:

In the Chair Mr M A Collins President

Eleven Members present.
(This number comprising a quorum as required by The Articles of Association).

Also present Mrs A C Nutting Company Secretary

At the start of the meeting Mr Taylor, as the most recent past Chairman, brought the meeting to order and proposed that, in the absence of both the Chairman and Deputy Chairman, Mr Collins should Chair the meeting in his position as President. This was agreed unanimously.

Apologies for Absence

Apology had been received from Dr. S. Cook.

Special Resolution

Mr Collins informed the meeting that voting on the proposal to approve the Memorandum of Agreement would be taken as special business. He announced that the votes received by proxy would be counted. 13 proxies had been lodged with the Chairman of the meeting and 1 with Mr Ali. Members present would vote by a show of hands on approval of the special resolution as detailed:

Resolution: To approve the following Memorandum of Agreement with IOM³ and authorise the Directors to sign on behalf of the Institute of Vitreous Enamellers.
Memorandum of Agreement Between

1) The Institute of Materials, Minerals and Mining (a body incorporated by Royal Charter) whose registered address is 1 Carlton House Terrace, London SW1Y 5DB hereinafter called the Institute.

2) The Institute of Vitreous Enamellers (a company limited by guarantee without share capital and registered in England and Wales under company number 00290392) whose registered address is 39 Sweetbriar Way, Heath Hayes, Staffordshire WS12 2US hereinafter called IVE.

1. Introduction

The Institute and IVE are professional bodies/learned societies involved in the advancement of various aspects of materials science, engineering and technology.

The directors of IVE recognise the increasing difficulty in operating viably a small membership organisation. Having reviewed the options available to them, the directors consider that working with a larger and like-minded body is the best way of achieving the long term objectives of IVE.

The Institute understands the importance of vitreous enamelling and wishes to develop its involvement in the science and technology of vitreous enamel.

The Institute and IVE have agreed that in return for taking on the members and operating activities of IVE, the Institute will provide a range of services to IVE members and promote the advancement of all aspects of vitreous enamel science and technology.

The directors of IVE consider the company is solvent and will arrange for an orderly winding up of the company’s affairs within twelve months of completion. IVE will not compete with the Institute at any stage. Any surplus funds after the settlement of liabilities existing at the completion date will be applied in accordance with the IVE’s memorandum and articles of association.
2. **Name and Recognition of Vitreous Enamel**

In order to retain the recognition of the vitreous enamel community it is agreed that a new group, IVE -The Vitreous Enamellers’ Society, will be established within the Institute’s technical structure. IVE’s member journal, The Vitreous Enameller, will be published by the Institute and distributed to all members of that group. The name of the new society will enable the members see the transition of activities to the Institute and, after two years, the prefix IVE will be removed to enable the Vitreous Enamellers Society to develop as the continuing brand.

3. **Promotion and Development of the Vitreous Enamel Community**

The Institute will continue to operate and support:

- Vitreous enamelling as a profession.
- Marketing activities of that community.
- The Vitreous Enameller Journal.

The Institute values all of these activities and will use its best endeavours to protect their long term survival. This will involve a detailed review and may involve a change to working practices to improve the income/cost balance such that they become viable income sources.

4. **Representation of members of IVE in the Institute**

The governance and control of the Institute rests with the Council. Councillors are trustees for the purposes of charity law. Council delegates its responsibility for the ongoing management of strategy and performance to the managing board. The industry and technology policy board co-ordinates the activities of the Institute’s divisions. There is a division supporting each major discipline of the Institute’s members. IVE – The Vitreous Enamellers Society will form a committee of The Surface Engineering Division.
It is agreed that:

- The negotiating teams will agree the composition of the first board of IVE - The Vitreous Enamellers’ Society. Nominations for the first chairman, deputy chairman and secretary will be considered from IVE and ratified by the nominations committee for approval by Council. The chairman sits on the board of the Surface Engineering Division.

- A representative from IVE may sit on the Local Affairs Board, Younger Members Committee and Membership Committee of the Institute.

5. **Members**

- All of the Institute’s benefits will be available in 2010 to fully paid-up IVE members on merger without further payment by the members.

- Members who currently belong to both institutes will pay subscriptions at the Institute’s rates for 2010.

- Grades equivalent to all current IVE grades will be incorporated into Institute grades. IVE members will be able to retain their current designatory letters for a transitional period of 2 years and then will be replaced by new post nominals of equivalent standing.

- Differences between the subscriptions of equivalent grades will be closed in a period of up to four years.

- IVE members will be able to join and take part in other Institute divisions/societies.

6. **Transfer of Activities**

6.1 *In anticipation of or on completion at the latest, IVE will:*  

- Provide the Institute with full and sufficient details of its members to enable the Institute to provide effective and efficient services to the members.

- Pay a sum equal to the unexpired proportion of subscriptions received from members for 2010 onwards calculated on a pro rata basis to the Institute. For example, if completion takes place on 30 September 2010, IVE will pay 3/12ths of 2010 subscriptions received to the Institute and all of any subsequent subscription payments. IVE will be able to use the balance to settle liabilities.
• Transfer the ownership and copyright of the Vitreous Enameller Journal to the Institute without cost together with all records and information (both current and historical) to enable the Institute to continue its publication.

• Pay a sum equal to the value of publication subscriptions received for unpublished issues less costs incurred in preparing those publications for distribution.

• Provide full and sufficient details of all other services to be provided by the Institute including all necessary information contained on computer databases.

• Terminate current office and staffing arrangements and settle any liabilities relating to those. The position of Technical Support will be terminated on the completion date and the position of Secretary will be terminated three months after the completion date.

• Pay a sum equal to any other income received at the completion date for work to be carried out after the completion date.

• Settle all creditors for costs and expenses incurred prior to the completion date.

6.2 On completion, both parties will:

• Make arrangements to settle amounts received on behalf of the other party and amounts paid on their behalf by the other party during each month after completion within 14 days of the month-end.

The Institute will not be liable for any liabilities or obligations incurred by the company prior to completion of this agreement.

7. Non Compete Clause

The directors of IVE agree that it will not compete with any of the activities carried out by the Institute.
8. **Legal Status**

This document is intended to be legally binding on both parties save that its implementation is conditional upon:

- Approval by the directors of IVE; and
- Approval by the trustees of the Institute; and In the event that these conditions still cannot be met, this agreement shall terminate.

Mr Collins then requested members present vote on a show of hands on the resolution to approve the Memorandum of Agreement and to allow Directors to sign the resolution.

Votes on the show of hands were:

<table>
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<tr>
<th>Show of Hands</th>
<th>11</th>
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<tr>
<td>Votes against</td>
<td>0</td>
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He also announced the votes cast by proxy:

<table>
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<tr>
<th>Votes by proxy in favour</th>
<th>14</th>
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<tbody>
<tr>
<td>Votes by proxy against</td>
<td>0</td>
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He declared that the resolution was thus approved unanimously.

The Memorandum of Agreement was signed by Mr Collins as President, Mr Ali as lead of the negotiating committee and Mr Fieldhouse as Treasurer.

**President’s Address**

*Mr Collins’ address as President is quoted verbatim:*

There is no doubt that this is an historic meeting. In 1934 a group of enthusiastic enamellers got together as the result of a desire to share knowledge and to provide information about vitreous enamel and thus the Institute of Vitreous Enamellers was born. There was already an Institute in the USA, but IVE was the first in Europe. We, as the IVE, have satisfied these aims for the past 76 years and I feel that we should congratulate ourselves and those who went before us, that we have done a pretty good job.
There are no doubt those amongst you who regard this as the end of an era, but I believe that we should look at it as the start of a new chapter. In any good book, the narrative moves forward with each chapter providing a new beginning, a new challenge, a new outlook on the continuing story. We are at the start of a new chapter and I am sure that it will play some part in the survival of the process of vitreous enamelling - that process which we all regard as something a bit different, a bit better.

The IVE has left a legacy which can be taken forward as a new approach with an exciting future with a new set of minds and challenges. I would like to thank all of the many people who have contributed over those 76 years - too many to name individually but all have a special place in our heritage. I am sure that they would like me to pass on their support and good wishes to all who follow in the years to come.

As this is the last time I will address you as president of the IVE, I would like to take this opportunity to thank all my friends and colleagues for your help and support over the period of my involvement with IVE and to wish you all the very best for the future.

*The President thanked all for their attendance.*

*This concluded the business of the meeting.*

**VITREOUS ENAMELERS JOIN IOM³**

Following a series of discussions, presentations and agreements, the membership of the Institute of Vitreous Enamellers (IVE) formally voted to join IOM³ at a specially convened Extraordinary General Meeting on 4 November 2010. The IOM³ Council also agreed this arrangement at its meeting on 9 November and the formal path is now cleared for a full integration of membership and activities.

Reporting on the two meetings, IOM³ President Barry Lye confirmed how successful the development of an agreement with IVE had been and welcomed both individual and company members to IOM³. The visibility of Vitreous Enamelling is set to be developed by incorporating of this group of members within the Surface Engineering Division (SED) of the Institute, under the name
IVE: The Vitreous Enamellers’ Society. Keith Harrison, Chairman of the SED, welcomed the opportunity to showcase this important surface engineering technique in the Institute’s activities.

The transfer of member details will commence immediately and contacts will be established with IVE members to quickly provide guidance to the new arrangements. A new web microsite has been established and the governance of the new Society is under review.

Speaking on behalf of the IVE, Saqlain Ali confirmed the significant opportunity that is now available to former IVE members. ‘With this link, we have achieved a significant advance for the membership of IVE that would otherwise have not been possible. Not only will our members have more opportunity for professional development, networking and information access, but we will be in a position to see a step change in the visibility of vitreous enamelling to the product design community.’

This merging of Institute networks represents the fifth occasion in eight years when IOM$^3$ has broadened or strengthened its community base. ‘As a professional science, engineering and design-based organisation we are becoming a unique global resource for materials professionals’ said Bernie Rickinson, IOM$^3$ Chief Executive. Furthermore, the incorporation of IVE, a very small membership organisation, into IOM$^3$ is further evidence that merging of specialist interests into a large membership organisation can be accomplished with important gains for both parties.

Nuna Staniaszek
IOM$^3$

(2nd December 2010)
MEMBER’S COMMENT

As this is the last edition of the I.V.E. magazine in its present form, I felt it appropriate to put a few words together.

My father joined the I.V.E. in the 1930’s and remained a member for over 60 years. I started work in the enamel supply industry over 40 years ago. I suppose having read that you are expecting a long reminiscence from an old fogy about ‘the good old days’. Well in part yes, there were great times but there were also some dark days. There have been periods since the inception of the I.V.E. when it almost seemed if you could fabricate an article from either steel or cast iron, the immediate response was ‘let’s enamel it’.

I remember many years ago (look out there’s the old fogy) attending one of the very early basic approach courses with Mike Collins and he asked the delegates to make a list of items that could be enamelled. With Mike and the delegates input, the list was enormous, even things I had forgotten and yes, this was the same course, held in a large, very full hotel, where I managed, when giving a practical demonstration, to set off the fire alarm, resulting in the evacuation of the hotel.

Many of you will remember when the enamelling industry was spread throughout the United Kingdom, resulting in the I.V.E. having a Scottish Section, a Northern Section, Midland Section and Southern Section, all actively promoting works visits, technical meetings and for many the highlight of the year was what we used to call Dinner Dances. I will not bore you with lists but each region had a number of enamelling plants, some doing signage, some jobbing, many producing domestic appliances, others enamelling both cast iron and steel baths and sinks and also, particularly in the West Midlands, factories producing house ware (pots, pans, kettles, etc) in a wide range of colours. The whole industry was supported by a wide range of suppliers, furnace manufacturers, frit and colour manufacturers, etc. It should be noted that in the early days of enamelling in England virtually every enamelling plant smelted on site its own frits. At the same time in the United States, very few plants smelted their own frits. The Ferro Corporation in particular, after initial resistance, convinced enamellers that it was better if a specialist manufacturer supplied frit. When Ferro arrived in the United Kingdom in the 1930’s, this concept was initially resisted but the logic of their argument was
eventually accepted and specialist frit companies evolved. In the recent past I can remember at least nine companies producing vitreous enamel frit in the U.K. and today producing in the U.K. there are none. One of the dark days.

Whilst on the subject of dark days, I cannot accurately convey to you how working conditions have improved in the enamelling industry, from the guarding of moving parts on machinery to the elimination of dust and also harmful ingredients in colours and frits. Depleted uranium used to make a beautiful yellow, arsenic was a fantastic opacifier, particularly if combined with lead. As many cast iron enamels were applied by the dry dusting method with no dust extraction, the dangers from lead in these enamels was significant. There were significant cases of lead poisoning amongst workers in the sign industry. A process was used where a lead-bearing colour was sprayed, allowed to dry and then brushed from specific areas without extraction.

Another major improvement on many large-scale factories has been the elimination of the pickling process, benefiting both the interiors of factories and the outside environment. I do think cleanliness inside enamelling plants rapidly improved when white became a popular finish. After all there is a limit as to how long you can blame the frit supplier for black spots. There’s a lot to be said for black mottle!

The last few years have seen a severe reduction in large-scale domestic appliance manufacturers in the U.K. Another dark day. On a brighter note, the enamellers that remain do appear a little more optimistic and the levels of production, whilst not approaching the level of the good old days, do appear to be levelling out.

My personal feeling is that vitreous enamel is such a unique finish that it will continue long into the future and in closing let’s just spare a thought for all those stalwarts of the I.V.E., past and present, who contributed so much over all these years.

John Ball
W.G. Ball Limited
A picture from the last “Vitreous Enameller” from the early days of the IVE, believed to be the “new” enamel shop at Sidney Flavel & Company in Leamington Spa, showing the hand spray line as installed by Stewart & Gray in the mid 1930’s.

Look at the clogs and the hats!! The wording on the notice above the booths is quite readable on the original photograph “OPERATORS ARE REQUIRED TO CLEAN DOWN AT END OF SHIFT”.

Mike Collins
EVENTS CALENDAR

14 Feb 2011
Venue: New Delhi, INDIA
Contact: Tulika Sen or Anna Aleinikova
Tel: +91 11 4082 8282
Email: tulika.sen@eme-india.com or anna.aleinikova@ite-exhibitions.com
Web: http://www.mmm Expo.com/

07 Apr 2011 - Adhesives in Extreme Environments
Venue: London, UK
Contact: Ewen Kellar
Tel: +44 1223 891162
Email: ewen.kellar@twi.co.uk
Web: http://www.iom3.org/saa/

08 May 2011 - Engineering Ceramics 2011 -
12 May 2011 from Materials to Components
Venue: SLOVAK REPUBLIC
Contact: Ms. Zdena Kapi_inska
Tel: +421 2 5941 0401
Email: uachzde@savba.sk
Web: http://www.sav.sk/?lang=en

10 May 2011 - 6th China International Conference on Surface
13 May 2011 Engineering (ICSE) 2011
Venue: Xi’an, CHINA
Contact: http://www.ifhtse.org/
Email: icse2011@mail.xjtu.edu.cn
Web: www.xshy.org.cn/NewMeetShow.asp?id=43
04 Sep 2011 - 08 Sep 2011
International Conference on the Chemistry of Glasses and Glass-Forming Melts
Venue: Oxford, UK
Contact: Christine Brown
Tel: +44(0)114 263 4455
Email: Christine@glass.demon.co.uk
Web: www.sgt.org/cgi-bin/open.cgi?page=index

07 Sep 2011 - 09 Sep 2011
11th Triennial International Conference on the Science and Technology of Adhesion and Adhesives
Venue: York, UK
Contact: Paul Harris
Tel: 020 7451 7302
Email: Paul.Harris@iom3.org
Web: http://www.iom3.org/saa/

14 Sep 2011 - 16 Sep 2011
3rd International Conference on Distortion Engineering
Venue: Bremen, GERMANY
Contact: Prof Hans- Werner Zoch
Email: zoch@iwt-bremen.de
Web: http://www.ifhtse.org/
BUSINESS NEWS

UK EXPORTS STRENGTHEN

This morning’s (9 December) official UK trade data showed manufacturing-led exports – particularly to Europe – gaining much needed ground in the face of threatened reductions in home demand.

October exports rose by £0.9 billion (4.1 per cent) to £23.1 billion compared with September while exports to the EU rose by £1.4 billion (12.4 per cent) to £12.8 billion. However, total imports rose too, by £1.1 billion (3.4 per cent) to £31.6 billion, marginally widening the deficit on trade in goods by £0.1 billion to £8.5 billion, compared with a deficit of £8.4 billion in September. However, the deficit on trade in goods with EU countries narrowed by £0.3 billion to £3.5 billion, compared with a deficit of £3.8 billion in September.

Commenting on the data, Chris Williamson, chief economist at Markit, said: “October’s increase in exports builds on the encouraging upbeat manufacturing survey data in recent weeks, which have shown a renewed surge in overseas sales which gathered pace in November. UK exporters are benefitting from strong growth in major trading partners such as Germany, France and the US, as well as robust demand from many emerging markets, which is offsetting some weakness in deficit-fighting countries such as Ireland.

“This export growth needs to continue as trade will have to be a key driver of the economy in coming months. Stronger exports are needed to offset the growing likelihood of subdued domestic demand, as consumer spending in particular is squeezed by higher VAT, government spending cuts, falling real incomes and the ongoing hit to wealth generated by lower house prices.

“The surge in imports is likely to be a temporary phenomenon, and is not altogether negative as we believe it is to a large extent due to factories rebuilding their inventories. Once stocks have returned to normal, manufacturers will be on a better footing to sustain rising output and exports, helping net trade to contribute positively to economic growth.”

Source: Works Management Website (www.worksmanagement.co.uk) – 9 Dec. 2010
DROP OFF IN R&D SPEND BY UK FIRMS

R&D spend by UK companies fell by 0.6% last year, government figures have revealed. Investment on new products and services dropped to £25.3 billion according to the R&D scorecard published by the Department for Business (DBIS).

The decline was down to lower spend by firms in banking, aerospace, telecommunications and defence sectors, the report found. Sectors that boosted their R&D outlay included automobiles and parts, software and computer services and technology hardware and equipment. Despite the drop, R&D spend by UK firms was still on a par with rivals in Germany, USA and France, DBIS said. Globally, the thousand companies most active in R&D spent a total of £344bn- a 1.9% decrease against the previous year.

Universities and science minister David Willets said: “The Coalition sees technology and innovation as a key driver of growth. We have set our ambition on creating the most competitive corporate tax system in the G20 and will shortly be consulting with business on the taxation of Intellectual Property, the support that R&D Tax Credits provide for innovation and the potential for creating a Patent Box in the UK. Nearly 80% of total R&D spend occurs in the USA, Japan, Germany, France and the UK, the DBIS research found.

Source: Works Management Website (www.worksmanagement.co.uk) – 26 Nov. 2010

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NEW EUROPEAN RULES ON NOTIFYING CHEMICAL SUBSTANCES

The Health and Safety Executive (HSE) is supporting the European Chemical Agency’s (ECHA) campaign to remind companies that new rules on classification, labelling, packaging and notification of chemical substances come into force on 1 December 2010.

From December, within one-month of placing a chemical substance on the market, all companies involved in their manufacturer or import will need to notify the ECHA for their inclusion in the new Classification and Labelling Inventory.

In 2002, an international agreement established a harmonised approach to the labelling and packaging of chemicals and, through legislation, the European Union laid out how its member states would support the agreement. Phased in over a five-year period, the legislation will apply to chemical substances from December and to chemical mixtures from 1 June 2015.

Companies that carry out one or more of the following activities and place chemical substances on the market will need to notify:

• Manufacture substances subject to REACH registration;

• Import substances (e.g. dye stuffs) subject to REACH registration;

• Manufacture or import substances which are classified as hazardous, irrespective of the quantity;

• Import mixtures containing hazardous substances, irrespective of the quantity;

• Import articles containing substances which are subject to REACH registration.

ECHA has published a Practical Guide which explains the role of the Inventory, the information needed in a notification involves, and how to submit it: http://echa.europa.eu/doc/publications/practical_guides/pg_7_clp_notif_en.pdf
To ensure companies do not miss the first deadline for notification, 3 January, the ECHA recommends that notifications are submitted from now on and well before 24 December 2010.

Source: Works Management Website (www.worksmanagement.co.uk) – 1 Dec. 2010

MANUFACTURERS MISSING OUT ON SUSTAINABILITY BENEFITS

Manufacturers are not realising the commercial rewards offered by ensuring a sustainable supply chain, claims new research among 1500 legal executives at manufacturing firms.

When asked if their business viewed sustainability obligations as presenting a net opportunity, nearly half (49%) of all respondents to the survey conducted by the law firm Pinsent Masons said yes, with only 19% viewing it as a burden. However, the report goes on to reveal that despite this, a huge 54% do not include sustainability as part of their contractual relationships with suppliers.

Nearly all companies surveyed have an ethical code of conduct embracing sustainability and expected their suppliers to meet sustainability requirements but relatively few were able to confirm that those requirements were reflected in their buying terms.

The law firm’s Gordon McCreath said positive sustainability action could give businesses a competitive edge and while this was recognised by the manufacturing industry, the majority of manufacturers were not yet holding their suppliers responsible for their role in bringing this about.

The full research report – which covers the evolving legal landscape of manufacturing, looking at international and compliance issues as well as sustainability – is being distributed to the managing directors of the top 4,000 UK manufacturing companies. For more information or an electronic copy of the report, please go to:


Source: Works Management Website (www.worksmanagement.co.uk) – 30 Nov. 2010
FACTORS AFFECTING BUBBLE FORMATION IN VITREOUS ENAMELS

(MEMBER’S ZONE PAPER No.5)

The following paper by J. A. CLARKE, B.Sc., A.R.I.C. was first published in the Vitreous Enameller in 1948 and was awarded the Whittle Silver Medal by the Institute of Vitreous Enamellers.

THE fact that vitreous enamel coats have a bubble-structure has been realised for some considerable time (vide Andrews, and others), but the matter was brought back into prominence a short time ago, by a paper which Charlish and Heeley gave to the Institute of Vitreous Enamellers, and which showed that, in certain cases, this structure could cause serious defects, in that some of the bubbles extended right from the surface of the enamel coat to the metal base. The work outlined hereunder was undertaken with the primary object of deciding, if possible, whence this structure originates, and also, to attempt to throw some light on to the question of the contents of the bubbles.

Charlish and Heeley examined this structure by cutting cross-sections through enamel coats, but the method employed in this work was somewhat different. It was found, when a piece of fused ground coat enamel was examined under the microscope using oblique lighting, that the surface was covered by a large number of bubbles, and it was realised that this phenomenon would serve as a very good comparative method for evaluating the effects of various chemical and physical influences upon the “bubble-structure.” The surface of a typical piece of fused ground coat is shown in Fig. 1. Difficulty was experienced in photographing these structures, due to the fact that the non-uniformity of the bubble size caused some trouble in focussing. However, the subsequent illustrations should serve to show the varying structures produced under different conditions.
CAUSES OF BUBBLE FORMATION

One of the most obvious causes of bubble formation is the mill addition, and it was to this end that the first efforts towards elucidation were directed. The experimental procedure was as follows: the plates used were 4-in. squares of enamelling iron, and they were grease-burnt in pairs, at 850°C for 2 minutes. They were then pickled in pairs for five minutes, in 10 per cent by volume sulphuric acid at 40°C, washed in cold running water, neutralised in a cold solution containing 2 per cent of hydrated sodium carbonate and .1 per cent of borax, lightly scoured with commercial silica, and washed again in cold running water, finally being dried with a cloth. Fresh pickling solutions were used for each pair of plates. The enamel samples were wet-milled, with the appropriate mill addition, to a fineness of 9 to 10 gm. residue on a 200 mesh screen, using an initial sample of 50 ml. The pickled plates were then dipped into the enamel mixture, and dried off in an electric oven between 60 and 65°C. The dipping was controlled, so as to give a dry weight of between 41 and 42 gm. per sq. ft. on both sides. Each plate was individually weighed, before and after application of the enamel coat, so as to ensure the accuracy of the coat weight. Finally, the plates were fused singly, at 850°C for four minutes. The whole of the operations from first to last, were controlled as closely and carefully as possible in an endeavour to give each plate exactly the same treatment.

The first trial was made with ground coat enamel, milled without any addition. The plate, upon completion of the above procedure, was of a dark blue-black colour, and had the appearance of being perfectly fused and a photomicrograph of the surface of this plate is shown in Fig. 2. Though a few bubbles are apparent on the enamel surface, it is obvious that the major part of the bubble-structure is derived from the mill addition.

Upon the addition at the mill of only 1 per cent of clay, the bubble-structure is noticeably increased, as shown in Fig. 3. The clay used for this series of experiments was a white ball clay which, on ignition, had a total loss in weight of 11.36 per cent, 2.97 per cent being the loss on drying at 105°C and 8.39 per cent the loss, by difference, of organic matter and combined water.

These and subsequent illustrations are taken at x55 magnification.
For the sake of completeness, further mills were ground, containing 2 per cent, 4 per cent and 6 per cent of the same clay. Photomicrographs of the surface of these enamels, when fused, are shown in Figs. 4, 5 and 6 respectively. The white patches in Fig. 6 are conglomerates of tiny bubbles which are not individually resolved at this magnification. These illustrations show that as the clay content increases, so does the bubble-structure. As this increase occurs, the enamel layer becomes increasingly lighter in colour, and tends, finally, to have an underfused appearance. Although part of the lightening in colour can be ascribed to the white clay, the bubbles enhance this effect considerably.

During the fusion of the above plates, irregularities were observed on the biscuit surface of the enamel, before sintering and fusion occurred, due to the escape of gas through the enamel layer. This phenomenon was also apparent after the fusion process, and, consequently explains why, under the microscope, tiny areas could be observed where the metal base showed through the enamel layer. These areas cannot, unfortunately, be very easily seen on the illustrations. The number of bare areas per unit area, increases with the clay content, no doubt because the amount of gas producing material gets larger, and this, together with the greater number of bubbles per unit area, explains why, as the clay content increases, the porosity of the enamel to the high frequency spark tester also increases. Whilst the enamel with no mill addition showed a large number of faults with the spark tester, it was better than any ground coat previously tested. The enamel containing 1 per cent of clay was also comparatively good, but thereafter, the porosity increased sharply.

**COMPOSITION OF BUBBLES**

The bubbles which are derived from the clay addition contain a wide variety of compounds. The moisture is lost before any fusion occurs, since it is driven off at 105°C., and also, part of the organic matter. Some of the organic matter, however, is trapped as sintering and then fusion commences, with the formation of bubbles in the enamel layer. Plates, dipped in enamel containing clay, and previously dried, were heated in the furnace for half-hour periods at increasing
temperatures and the following results were recorded: 200°C, no change in appearance; 300°C, slight change to a brownish colour, no doubt due to charring of the organic portion; 400°C, as 300°C; 500°C, as 300°C; 600°C, sintering commences.

This tends to prove the statements made above, and also shows that decomposition of the clay is incomplete when sintering commences. This would tend to exclude air from the clay particles, and so prevent, during the fusion range, complete combustion of the organic matter. Thus, besides the normal combustion products such as carbon monoxide, carbon dioxide, water vapour, and nitrogen, other more complex reaction products are present in the bubbles which are produced from the clay content. The smallness of the majority of the bubbles also seems to confirm this view, since, if complete combustion occurred, larger bubbles than are evidenced in the illustrations would be formed.

Before leaving the effects of the clay, the question of whether any gas liberation could occur from an interaction between the inorganic portion of the clay, and the enamel, during the fusion process must be considered. A sample of clay was calcined for 45 minutes at 850°C and then a milling was carried out, using 6 per cent of this product. When this was fused, the enamel surface was found to be relatively free from bubbles (Fig. 7). Comparing this with Fig. 2, it is clear that the inorganic portion of the clay has very little, if any, effect on the “bubble-structure,” and can be discounted.

The other milling additions commonly employed in ground coats are sodium nitrite or borax. The one normally used with the primary from which the tests were taken, was sodium nitrite, and accordingly, a mill was ground, containing 0.25% of sodium nitrite only. Ordinary commercial quality was used, to simulate normal conditions. The resulting enamel surface is shown in Fig. 8, and it can be seen that this also, is a considerable source of bubble formation in enamels. Sodium nitrite is fairly stable to heat until about 650°C and then decomposition starts, according to the equation:

\[ 4\text{NaNO}_2 \rightarrow 2\text{Na}_2\text{O} + 2\text{N}_2 + 3\text{O}_2 \]
Since the enamel layer starts to sinter at about 600°C, gas liberation from the sodium nitrite only commences during the actual fusion range; very little gas is lost during the preheating stage. This undoubtedly accounts for the considerable number of fairly large bubbles produced by the addition of only 0.25% of sodium nitrite. The bubbles largely contain, therefore, nitrogen and oxygen, but there is a possibility that small amounts of some oxides of nitrogen are also present, since these have been detected from sodium nitrate in the smelting of enamels, and the conditions are sufficiently similar for this assumption to be made. The sample containing 0.25% of sodium nitrite also appeared under-fused, and this lends further support to the view that, the greater the number of bubbles, the more under-fused the plate appears. The size, and number, of gas bubbles in Fig. 8 also confirms the fact that incomplete combustion occurs in the clay samples, since 6 per cent of clay gives a content of 0.5% of organic matter plus combined water, and this could reasonably be expected, on complete combustion, to give far more gas than 0.25% of sodium nitrite, even allowing for some loss during the preheating.

Fig. 9 illustrates an enamel surface; the ground coat of which was milled with 0.25% ordinary commercial quality borax only. A few very large bubbles, and a large number of smaller ones are to be seen. According to some sources, borax, on heating, loses water to give anhydrous borax which fuses at 561°C. Other sources say, however, that anhydrous borax fuses at 875°C. It would appear probable, therefore, that at 561°C, some water may be retained, and as sintering of the enamel occurs at about 600°C, this retained water could appear in the fired enamel as the large bubbles. Some of the smaller bubbles could possibly be produced by an interaction of the borax with the enamel, forming more complex borates, with the liberation of gaseous products.

All the foregoing millings were carried out using tap water which had a Clark hardness of about 13. The calcium and magnesium salts in this water were the only possible remaining sources of bubble formation which could arise from the mill addition. A milling was therefore carried out using distilled water, and no other additions. Careful control was maintained to prevent any source of contamination, and the fused product is shown in Fig. 10. Comparing this with Fig. 2, which was an exactly similar trial, except that tap water was used, it is apparent that the effects of the water can be neglected.
For comparative purposes, a plate was enamelled using the same procedure, with a ground coat containing the normal mill addition of 6 per cent of clay plus 0.25% of sodium nitrite. This is shown in Fig.11. It was also considered desirable, at this point, to investigate for the sake of completeness, the effects of extra fusing time, and coat weight. Accordingly, samples were prepared under the same conditions as previously, except for the lengthening of the fusion time. Fig. 12 shows a plate which had six minutes fusing time and appeared perfectly fused. The plate from which Fig. 11 was obtained was somewhat underfused, but not sufficiently to cause fish-scaling. With eight minutes fusing time, the plate is somewhat over-fused, Fig. 13, while Fig. 14, with 10 minutes fusing time, tends to gross overfusion. In Fig. 14 particularly, craters can be seen where large bubbles have burst. A similar effect is produced if, instead of initial extra fusion, repeated refusion is carried out.

**EFFECT OF THIN ENAMEL COATINGS**

The same type of effect is also observed when thinner coats are applied. Fig. 15 illustrates a plate having the standard procedure, but with a coat of 27gm. per sq. ft. dry weight on both sides. In all these cases, coalescing occurs, both of adjoining bubbles, and of surface bubbles with those from lower layers. The few bubbles still evident in Fig. 10 must, however, have some origin, and the following is a list of possible sources: (a) liberation of adsorbed gases, principally hydrogen, from the base metal; (b) release of water adsorbed on to the frit particles; (c) organic impurities in the frit; (d) further progress of
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reactions not completed during the smelting operation; (e) the effects of compounds, such as aluminates and borates, taken into the mill liquor from the frit during grinding; (f) the release of gaseous products during a reaction between the metal base and the enamel layer.

These various possible effects will be considered in the order shown above. The only way to ensure that no gas liberation can occur is to heat the metal to the fusing temperature, and then apply the enamel without allowing the possibility of adsorption to recur. This entails the application of the enamel to the metal whilst the latter is actually in the furnace. With iron, the oxidation which would take place on the metal surface would entirely upset the conditions, so it was decided to try this method using platinum foil. The foil used was 0.002-in. thick, and after being allowed to reach the furnace temperature of 850°C, it was left for a further five minutes in order to expel any gases present. A dried out sample of enamel was then poured on to the platinum in the furnace, by means of a long nickel spatula. The enamel quickly fused, and after fusion, it was allowed to remain in the furnace for a further two minutes. The enamel, used was the same as that used in the preparation of Fig. 2.

Fig. 16 shows the resulting surfaces, and whilst, under the conditions employed no check could be kept on coat thickness and fusing time, to ensure exact similarity with the other trials, it is sufficient to show that gas is produced from sources other than the base metal, and that in all probability, the adsorbed gases play a minor part in the bubble-structure. These gases are apparently lost almost completely before fusing temperature is reached. As a further guide, a plate was prepared, similar to Fig. 2, but without pickling. Instead, the scale was removed from the plate by means of emery cloth. This immediately removes all possibility of hydrogen adsorption. After cleaning, the plate was washed and dried to remove abrasive particles left behind by the emery cloth. The enamel surface of this sample is illustrated in Fig. 17, and on comparison with Fig. 2, it is evident that there is no marked difference. This constitutes further evidence in support of the argument that gases adsorbed on to the base metal have little effect on the ultimate bubble-structure of the enamel.

Fig. 16: Ground coat enamel, milled without any addition, and fused on to platinum foil
In an attempt to decide whether adsorption of water, or other material, on to the surface of the frit particles caused any bubble formation, enamels were ground to different degrees of fineness, using tap water and no mill addition, on the assumption that the finer the grinding, the greater the surface, and hence the potential adsorbing area, per unit weight of frit. Fig. 18 shows an enamel ground to a fineness of 18gm. and Fig. 19 an enamel ground to a fineness of 1gm. Intermediate between these is Fig. 2, which was ground to a fineness of 10gm. If the large bubbles are discounted (the effect under consideration could hardly be expected to cause large bubbles), the smaller bubbles present do seem to show an increase with finer grinding, and it would therefore appear that adsorption on to the frit particles can make a small contribution to the bubble-structure. By a large approximation, the surface area per unit weight of frit at 1gm. fineness is roughly four times that at 18gm. fineness, and this is borne out fairly well by consideration of Figs. 18 and 19.

**ORGANIC IMPURITIES**

Organic impurities in the frit are undoubtedly the cause of some of the residual bubbles in enamel coats. Tiny particles of fuel from the smelter could be carried out by the molten enamel, and ultimately appear, and burn, in the enamel layer. Further, owing to the abrasive nature of the frit, minute amounts of material from the storage bags, either paper or cloth, are transferred to the bulk during transit and handling. Contamination from the atmosphere is still another factor which must be considered in this connection. The bubbles thus produced would be similar in type and content to those produced from the clay additions.

The technique of applying enamel to a piece of platinum in the furnace was again resorted to in an attempt to decide whether reactions were still carried on in the frit during fusing. On this occasion a piece of frit, which had previously been washed in distilled water and dried, was placed on the platinum foil in the furnace at 850°C., and allowed to remain there for four minutes. This procedure allowed for no mill addition, relatively small surface area per unit
weight, no surface contamination on the frit, and no adsorbed gases from the metal. The resulting globule of fused enamel was then examined under the microscope, and it was found to be nearly free from bubbles. Those which were present were so tiny as to show only as a point of light. In fact, it was by far the least number of bubbles ever seen on a piece of enamel. The globule was thick enough so that any gas from reaction with the metal (if any), had not had time to reach the surface. This proved fairly conclusively that no frit reaction took place during fusing. The enamel used for the plate trials was a mixed frit ground coat however, and the above test was made using one constituent only, so there does remain the very remote possibility of interaction between the two different frits. Unfortunately, owing to the shape of the globule, it was found impossible to photograph this sample.

Soluble agents taken into the mill liquor during grinding are certain to cause bubble formation. Borax, as has been shown initiates a considerable number of bubbles, and it is reasonable to assume that any borates taken into solution during milling, as undoubtedly does occur, give rise to a similar phenomenon.

Lastly, there are the effects of a reaction between the metal base, and the enamel layer. Iron, and iron oxide, the latter being formed during the preliminary stages of fusion, do definitely react with the enamel layers, since considerable amounts of iron are taken into the enamel coat. On this account, there is a distinct possibility that gaseous products could be formed when the iron reacts with the borates and silicates in the enamel, to form other more or less complex compounds. The gases so formed are problematic, but may be oxygen.

While dealing with the subject of the bubble-structure of enamels, the desirability of removing this structure from them should be considered, especially as it would seem that these bubbles confer elasticity upon the coat, and to remove them would increase the brittleness. This however requires further work, as also does the relationship between bubble-structure and reboiling troubles, since it is considered that reboiling is independent of this structure as such.

In conclusion, it only remains to be said that the bubble-structure in enamels obviously does not arise from any simple source, and that the bubble contents are very complex. The subject requires far more work for complete elucidation of the problems presented, but ultimately it may lead to a better understanding of the enamelling process as a whole.
1. ABSTRACT

The changing shape of the world’s refractory industry provides new potential sources of high quality, lower cost materials. At the same time, new developments in refractories may lead to both the elimination a long-standing glass quality problem and the possibility of transforming the process and economics of glass melting.

2. BACKGROUND

Over the last 30 years, the campaign lives of container and flat glass furnaces have continued to extend – so that the average consumption of refractories is now only ~ 5kgs per tonne of glass melted. This progress is due to several factors – one of the most important being the development and exploitation of higher performance materials – the result of successful collaboration between the glass and refractories industries. However, refractories remain the single largest contributor to furnace build and repair costs - hence, the on-going search for alternative materials and supplies. At the same time, cost pressure within the refractory manufacturing industry, exacerbated by the massive reduction in demand from European and North American steelmakers, has led to a worldwide transformation of that industry:
• Large-scale consolidation has resulted in the elimination of several well-known refractory manufacturers and their product brands.

• And refractory manufacturing, and the sourcing of many of its key raw materials, has migrated to lower cost countries. Primarily, it is the establishment of China, and to a lesser extent India, as major suppliers of refractories to the world’s high temperature industries, which has been the most significant development.

3. CHINA AS A REFRACTORY SUPPLIER

As is well-known, China is now the world’s largest manufacturer, user and exporter of refractory raw materials and finished products – reflecting that country’s primacy in both steel and cement production. Reportedly, there are almost 2,000 refractory suppliers in China – of these ~ 200 are members of the Association of Chinese Refractories Companies – a number that probably represents the largest, and probably most technically capable, manufacturers. In total, these companies produced (in 2007) ~ 35 million tonnes of refractories - almost 10 times the combined output of the USA and Japan. Of this ~ 1 million tonnes were destined for the world’s glass industry.

With multi-billion tonne deposits of high grade magnesia and bauxite, China also has a near monopoly in the supply of these critical refractory raw materials. When coupled with low labour and energy costs, the Chinese refractory industry has obvious advantages over its competitors – a position further reinforced by its government’s supportive taxation and tariff policies. As a result, China is able to offer refractories, on the world market, at prices usually much lower than other countries - as Figure 1 shows. Unsurprisingly, with ‘capital cost’ as a prime business focus, it is these potential savings that have captured the attention of glassmakers worldwide.

Also most Chinese suppliers can now be readily accessed via the Internet – creating opportunities for significant changes in buying practices. But this may also increase the risks sometimes associated with exposure to unknown, or unproven, suppliers. As always, price alone should never be the main basis for refractory selection - more important, but usually far more difficult to define, is the ‘total cost’ of a refractory (£/tonne of saleable glass produced) – allowing for its potential impact on glass quality, furnace output and campaign life.
Figure 1: Comparative price per tonne of refractories

Figure 2: Tin bath bottom blocks: Key performance indicators
4. CHINESE REFRACTORIES – ‘CAVEAT EMPTOR’

With such a large number of refractory producers, it’s not surprising that China presents the whole spectrum of manufacturing capability. Certainly, there are many ‘world class’ refractory manufacturers – several of which are the result of international joint ventures that have benefited from the input of western technology and expertise. These companies can readily demonstrate their capability to produce high quality materials – ranging from complex fusion-cast assemblies to more mundane blocks and bricks. For example, in the highly specialised supply of tin bath bottom blocks, materials that are essential to float glass production, several Chinese manufacturers now offer materials that appear equivalent to, or even better than, the established European products – as the key performance indicators shown in Figure 2 illustrate.

But, inevitably, there are also a large number of refractory suppliers where product quality and consistency can sometimes be major problems – typical of which are:

- Unacceptable variance between ‘production’ and ‘data sheet’ or ‘test sample’ properties.

- Product variability resulting from inadequate monitoring and control of raw materials. And, as China exports refractory raw materials to other countries, this can impact on products from previously reliable, established brick makers: For example, Figure 3 shows how the substitution of a sub-standard, Chinese MgO grain resulted in much inferior creep resistance in an established European manufactured magnesite brick.

- Unsatisfactory dimensional tolerances – with the inevitable furnace build and performance problems. For example, experiences of, supposedly, tight tolerance silica crown bricks actually being cut from squares are not unknown.

- Inadequate quality control – sometimes coupled with the practice, by some manufacturers, of modifying QC standards and product specifications to meet individual customer requirements – rather than being product specific.

- Problems with delivery scheduling, transport and shipping – sometimes compounded by inadequate infrastructure, in such a vast country.

- In addition, there are the usual misunderstandings that can arise from language or cultural differences.
Figure 3: Effect of sub-standard Chinese magnesite grain on high temperature brick stability

Figure 4: Alkali vapour test, 1450°C – 7 days
But, in fairness, many of these problems are not unique to China and, to their credit, the Chinese culture is one of working hard to satisfy customer needs. There can be no doubt that China offers enormous opportunities for the procurement of high quality, lower cost refractories. But, as always, the principal of ‘caveat emptor’ (‘let the buyer beware’) should apply and the same methodology, in dealing with suppliers, should be used in China as has proven effective elsewhere:

- There must be a full and realistic understanding, from both the buyer and supplier, of the other’s needs and capabilities.
- Purchase decisions should never be based solely on manufacturer’s data sheets or product price.
- When dealing with an ‘unproven’ supplier, the prospective buyer should seek support from refractory specialists. Ideally, there should be independent testing and evaluation of all critical materials.
- Appropriate quality specifications, specific to the product, must be agreed prior to purchase contract.
- An effective quality control system and, where appropriate, an independent product inspection, testing and verification regime should be established. China has several, world-class refractory research and testing facilities that can be available for this purpose.

5. INDIA AS A REFRACTORY SUPPLIER

With a large and internationally successful steel industry, India is also a major refractories producer: With a refractory production capacity of almost 2 million tonnes it is of similar size to that of the USA. But, the Indian refractories industry is highly fragmented - with over 150 manufacturers there are probably less than 20 large-scale players - some of which are owned by the major steelmakers.

Although the leading companies benefit from world-class technology, both home grown and from international collaboration, they lack China’s access to many low cost raw materials. With higher production costs, and the absence of any similar taxation and tariff policies, Indian refractories are often less price competitive than those from China. When added to intense internal competition, this forces many Indian refractory manufacturers to operate on
Figure 5: Maximum crown temperature: Melt rate (‘Clear’ float glass)

Figure 6: Relative creep resistance, 1600 °C
low margins – impacting their ability to grow, to invest and to recruit the necessary high quality personnel. Consequently, the Indian refractories industry is considered to have been generally been less successful with international joint ventures and technology transfer, than China.

Despite these difficulties, there have been some notable successes – ranging from fusion-cast to conventional brick manufacture – with several companies recognised as providing ‘world class’ products. India is a major player in the world refractory market – exporting ~ 10% of total production. Prior to the current recession, these had been increasing at an annual rate of 20 to 40% - their major export markets being Europe, the Middle East and South Africa. This is a clear reflection of that country’s capabilities and competitiveness. For example, India (like China) has now become an important source of high quality silica brick – a relatively low cost refractory that is essential to the glass industry – the value of orders for which are expected to increase by ~10%, over the coming decade.

Doubtless, the Indian refractory industry has enormous potential – its often-stated strategy is ‘to position itself between Europe and China’. This can only be to the benefit of glassmakers and furnace builders, worldwide.

6. NEW REFRACTORY MATERIALS

Additional to the drive for lower cost, the main imperatives for refractory development are for improved glass quality and for longer campaign lives. But, with some furnaces achieving campaign lives of 18 years, further life extension will be of proportionately less financial benefit. So, this article reviews some recent refractory developments and their potential impact on glass quality and furnace output:
7. CONTAINER GLASS - ‘CAT SCRATCHES’

The problem of ‘cat scratches’ has increasingly affected container manufacture. The AZS melter superstructure refractory is believed to be the prime source, and it appears that ‘end-fired’ furnaces normally suffer more than ‘cross-fired’. Bottom drains and in-canal stirring can often be beneficial – but these attack the symptom, not the prime cause, of the problem.

With the problem linked to the ‘glassy phase’ of fusion-cast AZS refractory, ‘zero exudation’ products have been developed – by modifying both the chemical composition and microstructure of these materials. Although the lab-test results are very impressive – the in-service performance of these products can sometimes be less conclusive.

All the above suggests that simple ‘exudation’ is not the main cause of this problem – more probably we are also seeing the effect of long-term alkali interaction with the glassy phase of the refractory. A potential solution is to replace the AZS materials, in the downstream superstructure, by more suitable refractories that are free of any glassy phase – these could include:

• Bonded AZS, Mullite or Mullite-zircon
• Fusion-cast alumina
• High-strength spinel

However, except for the high-strength spinel, all the other materials interact with alkali and may suffer long-term surface shelling (nepheline, _-alumina and zirconia formation) – with consequent risk to glass quality. It is only the spinel that has complete resistance to alkali attack – as Figure 4 shows. High strength spinel has now demonstrated its long-term stability in highly alkaline atmospheres - by over 10 years experience in oxy-fuel, and air-fired, furnaces. We now need to translate that success into a potential solution for ‘cat scratches’.

8. INCREASED FURNACE OUTPUT

The output of many Float (and to a lesser extent container) glass melters continue to be restricted by the temperature limitations of their silica crowns – a refractory application that has not fundamentally changed for more than 100 years. At the same time, increased melter temperatures could be the lowest
cost route to increased load – far cheaper than oxygen or electric boost (- see Fig.5.) There are now several potential refractory routes to this position – which involve replacing the conventional silica melter crowns with:

• ‘Low flux’ silica bricks: Based on a high content of cristobalite, rather than the usual tridymite, and containing ~ 99% SiO₂ – they have been developed to better withstand high alkali concentrations – both in air-fired and oxy-fuel furnaces. In addition to improved wear resistance they also have improved high temperature strength – indicating that melting temperature increases of up to 20°C may be possible. If so, this could translate into load increases of ~ 5 - 10%.

• Fusion-cast alumina: Exploiting the successful experience of several oxy-fuel float furnaces, these materials offer the potential for crown temperature of up to 1700°C – with potentially massive benefit to achievable furnace melt rates. Based on the data in Figure 5, the extra cost for such a crown would be easily recovered within 2 years.

• High-strength spinel: Although more susceptible to attack by SiO₂ than is fusion cast alumina, the high-strength spinels are totally unaffected by alkali attack. Now with excellent high temperature stability (see fig.6), this material appears highly suited as a replacement for silica furnace crowns. Already, sister products have operated, without problems, at temperatures up to 1690°C and high strength spinel is now replacing fusion-cast alumina in some recent oxy-fuel furnace builds. Potentially, it would allow an increase in melter temperature of up to 30-50°C – at pro-rata cost benefit to the fusion-cast materials.

To a greater, or lesser degree, all the above offer the potential of higher melt rates and could transform the technology and economics of glass melting.

‘May you live in interesting times’ is the old Chinese curse. I believe that we are now living in such ‘interesting times’ and that we can benefit from the challenges and opportunities that they create. The changing shape of the world’s refractory industry opens the door to sources of high quality, lower cost materials. And, new developments in refractories introduce the possibilities of both eliminating a longstanding glass quality problem and also that, by exploiting some of the newer refractory materials, we may be able to transform the process and economics of glass melting.

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