Vol. 5 • No. 2 • January - March 2012

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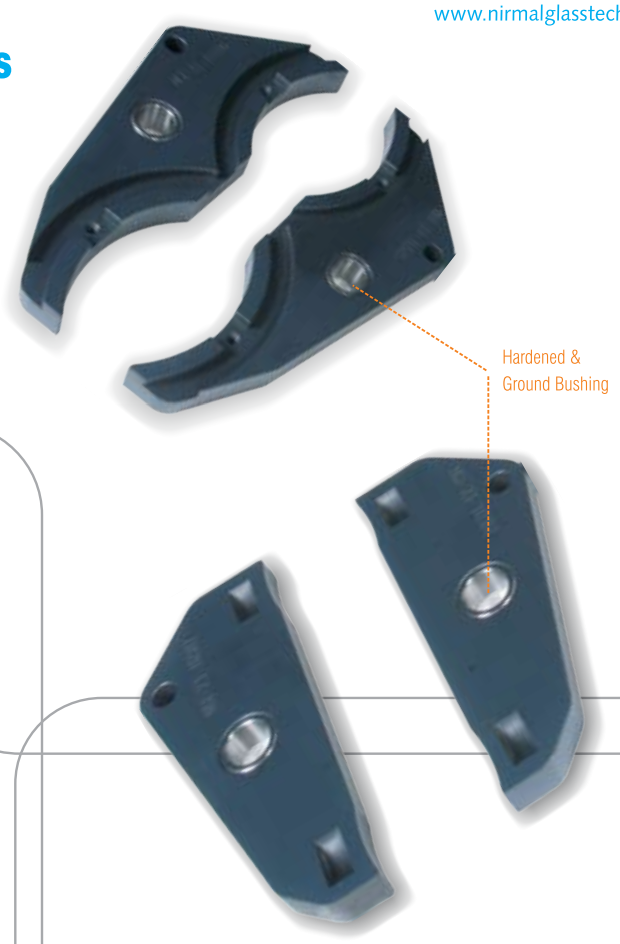

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Price (Excluding Bank Charges):
Indian Companies : Rs. 75 per Copy
Annual Subscription Rs. 300
Individuals : Rs. 25 per Copy
Annual Subscription Rs. 100
Foreign Companies : US$ 15 per Copy
Annual Subscription US$ 45

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Quarterly Journal of **THE ALL INDIA GLASS MANUFACTURERS' FEDERATION**

Vol. 5, No. 2, January-March 2012

Contents

From President's Desk

AIGMF Secretariat has been working diligently with a view to improving quality, coverage and readership of KANCH. Members would have noted the change. This is a continuous exercise and we look forward to suggestions from all readers for further improvement.

We are just about a year to go for our prestigious show Glasspex India, 20-22 March, 2013. While Messe Dusseldorf India is doing its role AIGMF members also have to put in their best to make the show a grand success. With float glass manufacturers closer participation in AIGMF activities, we expect larger participation from this segment of the industry as also of those engaged in processing of flat glass.

We have received invitation from FEVE for participation in Global Container Glass Associations meeting on 24th October 2012 in Duesseldorf, Germany. This meeting will coincide with GLASSTEC and should be a useful platform to exchange views with other associations.

Mukul Somany
President
and Vice Chairman and Managing Director
Hindustan National Glass and Industries Ltd.

March 2012

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About The All India Glass Manufacturers' Federation

The All India Glass Manufacturers' Federation was founded in 1944. The Federation is made up of five Regional Associations viz. Western India Glass Manufacturers' Associations Mumbai, Eastern India Glass Manufacturers' Association Kolkata, U.P. Glass Manufacturers' Syndicate Firozabad, Northern India Glass Manufacturers' Association Bahadur Garh (Haryana) and South India Glass Manufacturers' Association Chennai. The Federation was incorporated under the Companies Act, 1956 (No. 1 of 1956) as a Limited Company on 15-6-1970. The main aims & objects of the Federation are:-

a) To encourage, promote and develop the manufacture of glass articles of all kinds and to safeguard and protect the interests of glass industry and glassware business in India.

b) To from a common link amongst Glass Manufacture' in India and thus develop a spirit of mutual help and co-operation with one another.

c) To promote the study and research in Glass Technology.

d) To consider all matters relating to the manufacture and marketing of glass articles in India and the question of export and import thereof.

e) To devise ways and means for securing necessary supply of raw materials required for the manufacture of glass articles at comparatively lower prices and thus to decrease the cost of production and increase the national wealth.

f) To collect necessary information and data and propagate it for the benefit of Glass Industry and trade in India.

g) To make representations Whenever necessary to the Union Govt. or any unit of the Union of India for the removal of difficulties that might hamper the trade of glass articles or for grant of special facilities for the Glass Industry.

h) To draw Government or public attention to the difficulties in the way of Glass Industry and to solve other problems confronting it and to solicit their help and support through concerted action.

i) To organise a united front on behalf of all glass manufacturers and thus strive to gain all those advantages which may not be possible through individual effort.

All those engaged in the manufacture of glass and glass articles are enrolled as 'ordinary' members of the AIGMF and those associated with the Glass Industry are enrolled as 'Affiliate' members of the Federation. Almost all glass manufacturers including many in the small Scale Sector are 'ordinary' members of the Federation. Articles of Association of the AIGMF were amended in Sep. 1992 to enroll foreign companies as Affiliate Members of the Federation.

March, 2012

Manohar Lal
Secretary

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Dutch energy efficiency improvement challenge

In 2009, the Dutch Ministry of Economic Affairs, Agriculture and Innovation asked local industrialists whether the achievement of a 50% improvement in energy efficiency was possible by 2030. Léon Wijshoff discusses the origins of this programme and the Dutch glass industry's constructive and focussed response.

The origins of the Dutch Government's Long Term Agreement programme date from the late 1980s, when a stricter energy and environment policy was introduced for energy-intensive industries. It was decided that voluntary but challenging agreements were the key instrument to focus on energy efficiency in the long-term.

The (first generation) Long Term Agreements between various Ministries and industrial associations, on behalf of their member companies, were set for the period 1990-2000. The average target was a 20% energy efficiency improvement in production processes. Companies having energy consumption over 0.1 PJ were eligible to participate on a voluntary basis but not without obligations. These obligations were:

- Establish up to a four year energy efficiency plan (EEP), indicating which measures are expected to be taken to improve energy efficiency and expected energy savings.
- Participate in an annual energy consumption monitoring programme.
- Introduce and maintain an energy management system.

In this first LTA period, the focus was on energy efficiency in production processes. Approximately 1000 companies were involved, representing more than 80% of Dutch primary industrial energy consumption. By 2000, on average an energy efficiency improvement (energy savings per unit production) of more than 22% had been achieved compared to 1990 (see figure 1). Energy efficiency had become a management issue.

The Dutch glass industry achieved a 16% energy efficiency improvement for this period versus its 20% goal (figure 2). Total energy consumption increased from 11 PJ in 1989 to 13 PJ in 2000, while production increased by about 35%, showing that growth was still possible for the industry. Some of the major achievements in this period were:

- Considerable co-operative research by Dutch glass producers, conducted mainly with assistance from the TNO Glass Group in Eindhoven.
- Introduction of the first waste heat recovery unit for batch preheating in the glass container sector.
- Development of a glass handbook as a tutorial for the glass industry.
- Further development of oxygen-fired glass furnace technology, with high energy efficiency and low NO_x emissions.
- Process control software development.
- Model-based furnace control.

BENCHMARKING

The positive results generated from the LTAs and the fact that energy efficiency were still high on the political agenda was major reasons to continue the co-operative approach, although some changes were made. For energy-intensive industries, a specific Energy Efficiency Benchmarking Covenant was established.

Extensive worldwide benchmark studies have been carried out to rank individual Dutch glass factories and furnaces in terms of energy efficiency levels. The aim of the Benchmarking Covenant was to bring participating companies to the top 10% of the world's most energy efficient industrial enterprises by 2012.

The Government covered the cost of benchmarking studies (inventories) and for an independent verification body to monitor the progress and agreement. Additionally, it was agreed that the Government would not create additional regulation on energy efficiency or CO_2 emission reduction.

For medium-sized companies, a second generation of the LTA programme continued, in which the scope was enlarged to include energy efficiency improvement in the whole product chain, without quantitative targets.

A recent study by TNO Glass reported an energy efficiency improvement of 7% for the Dutch glass industry from 2000 to 2009. This study also showed that nearly 60% of energy is required for the melting process. The specific energy consumption is 8.8 GJ/ton of molten glass and 9.9 GJ/ton of sold glass.

Changes to Dutch Government policy in 2007 as well as the growing role of the European Union, eg the Emission Trading System (EU-ETS), gave rise to the establishment of the third generation of Long Term Agreements in 2008.

The LTA-3 distinguishes between EU-ETS and non-ETS companies. For all companies, the focus for energy efficiency improvement is on the complete production chain. The target for the non-ETS companies is an energy efficiency improvement of 30% in the period 2005-2020, an average of 2% per year, aiming at 20% at company level and 10% outside the company, in the product chain. The latter might include energy efficiency

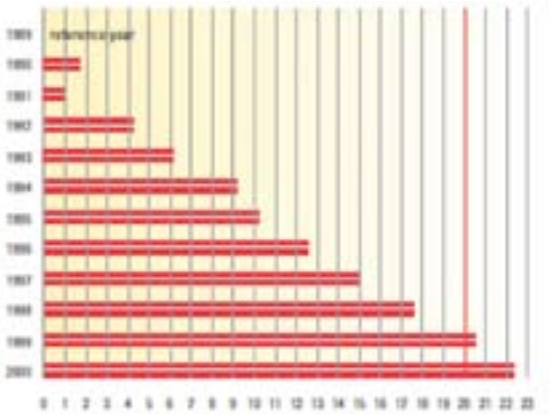

Figure 1: Development of energy efficiency improvements in Dutch industry.

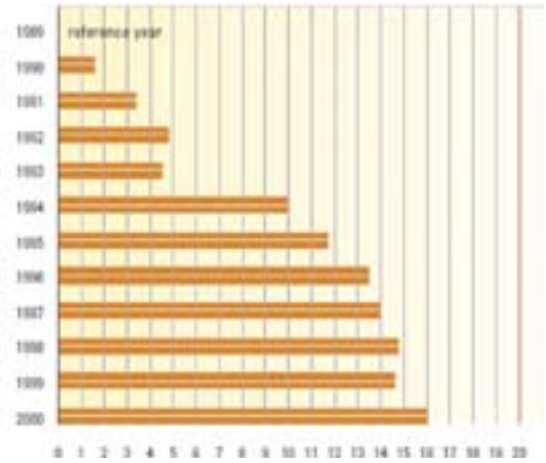

Figure 2: The Dutch glass industry achieved a 16% energy efficiency improvement.

Originally published in Glass Worldwide, preferred international journal of AIGMF

improvements in the raw materials phase, the product use phase or the recycling phase, as well as the application of renewable energy sources (see figure 3).

For the ETS companies, including all glass companies, no targets were set but the companies are expected to implement all energy saving measures with a payback period of less than five years.

In this LTA-3 covenant, one of the obligations or challenges for the companies and their sector associations is the development of a roadmap. This provides a strategic vision up to the year 2030 and indicates which technological and non-technological issues need to be tackled to enable a potential 50% energy efficiency improvement in the whole product chain. This counts for almost all glass products, including flat glass, insulation wool, glass fibre, domestic glassware and glass containers.

CHALLENGES FACED

The LTA-3 programme was launched in 2008 and the preparation of roadmaps started in 2009. Despite the fact that the economic crisis of 2008 forced many companies to focus on survival as production fell sharply, many used this period as a time to reconsider the future and identify new opportunities.

Six glass companies, with nine production facilities, participated in the ETS LTA-3 agreement. These companies also agreed to head for the 50% improvement challenge/ objective in the whole chain set by the Government.

Some major dilemmas had to be faced at the outset, notably regarding investment issues and pay-back time - even if opportunities are identified, they are dependent on international headquarters with respect to investment decisions. There are also competitive issues - because some of the companies are competitors, sharing ideas (especially in terms of product development) could be limited.

Initially, a feasibility study was carried out to identify the focus areas of improvements for the sector/subsectors, the different activities expected to achieve the 50% target and budget required and the commitment of companies to work on a constructive, focused and realistic but challenging roadmap.

This resulted in the following five interrelated focus areas:

- Optimisation of production processes, with a focus on glass melting.
- Improving product performance and applications.
- Strengthening sustainability of the product chain, with an emphasis on recycling and use of energy-extensive raw materials.
- Strengthening the position of glass (products) in society and improving education in glass technology.
- Improving innovation power.

Two of the focus areas contribute only indirectly to energy efficiency improvement.

Improving innovation power is focussed mainly on improving educational opportunities at various levels in the Netherlands, as well as having opportunities to demonstrate new technologies. The basis of innovation is creative, innovative and capable people to be educated at the highest possible level.

Here, the role of the TNO Glass Group is very important for the Dutch glass industry. TNO is active in the field of glass melting technology research and education, nationally and internationally, for example providing an updated glass technology training course, developed in close co-operation with the Dutch glass industry and Agency NL.

Improving the image of glass products and glass applications is aimed mainly at creating a more sustainable image for the Dutch glass industry and its products for consumers, government, students etc. As a product, glass should be more visible as a modern, versatile material.

The other three focus areas are more technically-oriented. Optimisation of processes includes optimisation of the glass composition, batch preparation, improving control of the melting process by means of new sensors, glass furnace designs, design optimisation and the optimal use of waste heat from flue gases and other waste streams

Strengthening sustainability of the product chain focusses on raising the level of recycling, as well as upgrading the quality of recycled material to improve the use of secondary glass or production waste (eg filter dusts) and reduce emissions and waste streams.

Improving product performance and applications focusses on society trends and future needs, given the specific opportunities for glass and glass products.

FUTURE POSSIBILITIES

It is anticipated that 20%-40% energy efficiency improvements are still possible for the Dutch glass industry.

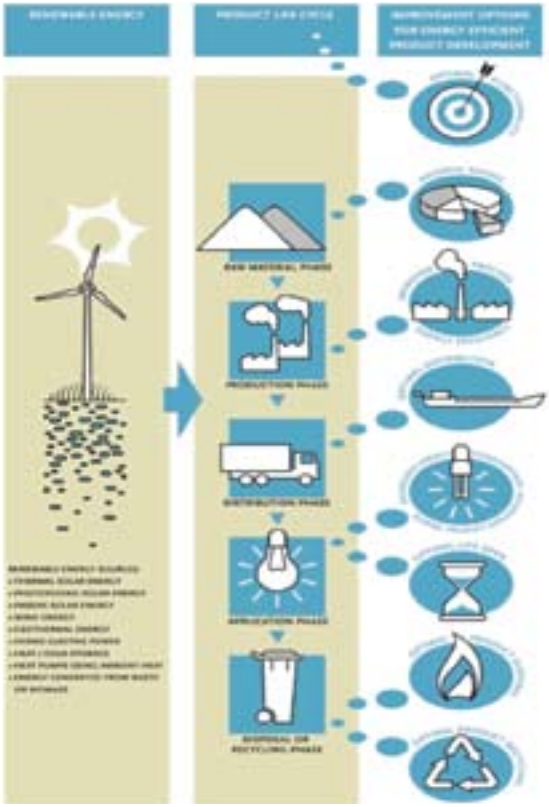

Figure 3: LTA-3 focuses on energy efficiency improvement throughout the complete production chain.

The majority of these improvements will be in the production process. Because the industry has limited experience of quantifying the impact of its efforts in the product chain, the expected contribution here is somewhat conservative.

Some major improvements are expected in the near future, via evolutionary and (in the longer term) revolutionary steps in innovation of production processes and product development. Now, the options to focus upon are the subject of evaluation. It is obvious that future steps cannot be made alone. Co-operation with suppliers of raw materials, research institutions, technology suppliers and the government is necessary to achieve the objectives.

Experiences gained need to be shared. The Dutch glass industry and Government are willing to share their experiences in ongoing and new projects and invites others to do the same. ■

CelSian Glass & Solar (formerly known as TNO Glass Group) is a technology and knowledge provider for the international glass and solar markets. Process optimisation and innovation are addressed throughout the complete glass production chain, from raw materials to final product, providing industrial solutions, applied contract research, software tools, on-line operation support systems, training and consultancy.

ABOUT THE AUTHOR:
Léon Wijshoff works for NL Agency, the implementing agency for the Dutch Government relating to sustainability, innovation and international co-operation.

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AIGMF Executive Committee Meet

AIGMF Executive Committee Meet was held on March 19, 2012 in AIGMF office in New Delhi.

Apart from normal Agenda, the Committee decided to constitute Architectural Glass Planning Panel within the aegis of the AIGMF. The panel will work to encourage, promote and develop the Architectural Glass Industry.

Mr. Sanjay Labroo, CEO & MD, Asahi India Glass will be Chairman of the Panel.

Chairman asked the members to supply requisite information for inclusion in the Directory, if not already done so. The Committee decided that names of companies (with logo) may be given in Extra Bold letters and in a different colour scheme on payment.

Membership of AIGMF

Membership

Members of the federation are classified into two categories; manufacturers of Primary Glass articles are enrolled as **Ordinary Members** of the Federation and suppliers to glass industry viz., suppliers of machinery, raw materials.

Consultants and others connected with glass industry are enrolled as **Affiliate members**.

Foreign Companies supplying machinery etc., to glass industry are also enrolled as Affiliate members.

The membership forms can be downloaded from http://www.aigmf.com/membership.php Members of the Federation are enrolled on the recommendation of Zonal Associations viz.:

- Western India Glass Manufacturers' Association
- Eastern India Glass Manufacturers' Association
- U.P. Glass Manufacturers' Syndicate
- Northern India Glass Manufacturers' Association and
- South India Glass Manufacturers' Association

Admission Fee / Annual Subscription Affiliate Members:

The admission fee and annual subscription is Rs. 2,000/- and Rs. 5,400/- respectively.

Applicants for enrollment for a period of five years may pay a consolidated amount of Rs. 27,000/- (including admission fee).

Affiliate members from Countries other than India

i. The admission fee and annual subscription is US $ 100/- and US $ 200/- respectively.

ii. Applicants for enrollment for a period of five years may pay a consolidated amount of US $ 1000/- (including admission fee).

Ordinary Members:

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ii. More than one Unit: Rs. 50,000/-

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USE OF INDIAN BLAST FURNACE SLAG AS ADDITIVE FOR ACCELERATION OF MELTING AND REFINING OF GLASS

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ABSTRACT

Blast furnace (BF) slag, a by product of iron extraction from iron ore and produced in large quantities are partly used for making ballast in making of slag coment, in making of glass wool, glass ceramics, as additive for glass melting etc. However a processed blast furnace slag is being used for the last four decades for acceleration of glass melting and fining. Operation for processed blast furnace slag has been started in several countries under the trade name of calumite. Indian BF slag can also be used as such additive. In this paper an introduction is given on the BF slag produced in India and will be followed in the second part information about its use in glass melting

INTRODUCTION

During the carbon reduction of iron ore in a blast furnace (BF) the siliceous and clayey materials in the ore are separated out by the addition of limestone, in the form of a molten mixture of calcium silicate called the slag. The slag being lighter than the metal rises atop metal bath and is tapped out through the slag notch at regular intervals. Sufficient time has to be given so that separation takes place and the impurities are well partitioned between the metal and the slag. The amount of slag produced varies from 250 to 500 kg per tonne of steel produced. This depends on the quality of the ore and the limestone and coke charge. The slag should have an appropriate viscosity for tapping out of the blast furnace and the composition should be such that impurities like sulphur, alkalies MnO, TiO_2 etc. find their way into the slag and to a lesser extent into the molten iron. After tapping, the slag is collected in large ladles which are sent to dumping grounds or to the granulation plant. In earlier days, BF slag was used chiefly as ballast for construction of roads or for similar jobs and its disposal was a big problem. One is familiar with the usual sight of hills of slag around iron and steel mills. However, work on utilisation of BF slag revealed that finely ground blast furnace slag could be mixed with Portland cement clinker to an extent of 30 to 60 per cent and the resultant product had almost the same properties as Portland cement except that it took longer time to harden. Blast furnace slag mixed with lime also produced cement which was very suitable for under sea and underground construction.

A small amount of slag is used for the production of slag wool by a process similar to that used for the production of glass wool for the purpose of thermal insulation. A few such plants have already been set up near the steel plants.

In USSR, glasses having a large percentage of BF slag are crystallized in a controlled manner to produce abrasion resistant and hard glass- ceramic products called slag Sital. These are used as floor tiles and for other components of buildings as well as for abrasion resistant lining for chutes, pipes, etc.

Since 1925, the use of BF slag in glass melting has been reported from various countries. In some cases slag was used to introduce all the alumina required in the glass composition as it was more easily digested than feldspar or hydrated alumina. However, it was later found that small amounts of slag properly used in glass batch could both accelerate the melting and the refining of glass. An US patent was granted to J. R. Monks in 1964 for use of slag for this purpose [1]. Since the work of J. R. Monks, a product called Calumite has been marketed in USA and later in UK and now in few other countries. It has been widely used in many countries with good success. The net advantage of the use of this material in glass melting is higher draw for the same fuel input and almost complete absence of any seed problem. At CGCRI, the details of the nature of the process as well as how the Indian blast furnace slag could be used for this purpose was studied and a brief report was issued.

Composition of BF slag:

TABLE I shows ranges and typical values for the oxide composition and temperature of BF slag. The slag temperature values are estimates based on the assumption that this type of slag is approximately 100°C hotter inside the furnace than the tapped metal temperature. These values listed here can vary greatly between plants due to variances in the feed material

TABLE I - Ranges and typical values of component mass percentages and temperatures of BF slag

Property	Range (mass%, or °C)	Typical Value (mass %, or °C)
CaO	30.0 – 45.0%	40.0%
MgO	3.0 – 18.0%	8.0%
Al_2O_3	8.0 – 17.0%	12.0%
SiO_2	30.0 – 47.0%	36.0%
S	0.2 – 2.5%	1.0%
K_2O	0.2 – 1.9%	0.6%
Na_2O	0.1 – 0.6%	0.4%
TiO_2	0.4 – 2.5%	0.7%
FeO	0.1 – 0.6%	0.3%
MnO	0.1 – 1.8%	0.3%
(CaO+MgO) / (Al_2O_3+SiO_2)	0.7 – 1.2	1.0
Slag Temperature	1520 – 1640°C	1590°C

Relevant properties of Blast furnace slag:

Primarily, the slag consists of calcium, magnesium, and aluminium silicates in various combinations. The cooling process of

slag is responsible for generating different types of slag required for various end-use consumers. Although the chemical composition of the slag may remain unchanged, physical properties vary widely with the changing process of cooling. The degree of vitreous phase in slag depends on the degree of cooling e.g. quenched granulated slag may be made mostly of vitreous phase. The mineral composition of the BF slag may be best understood from the phase diagram of the system $CaO-MgO-Al_2O_3 - SiO_2$. The other constituents like Fe_2O_3, MnO etc also play a role in the formation of the compounds in cooled blast furnace slag. The four component phase diagram was the subject of study in the fifties of the last century to understand the optimum properties of the slag so far as lowest temperature, desulphurization characteristics, low iron content and viscosity of the slag was concerned. The diagram has been studied at different levels of Al_2O_3 or MgO content. Similarly, the viscosities of the slag at different temperatures have been reported.

According to these diagrams, the following phases are expected at the given conditions:

The major minerals appearing in a slowly cooled slag is mainly:

- ☑ Akermanite, $Ca_2Mg(Si_2O_7)$ Ghelenite $Ca_2Al_2SiO_7$ and their solid solution
- ☑ Melilite, $(Ca)2[Mg,Fe_2+,Fe_3+,Al]\{Fe_3+,Al,Si\}_2O_7$
- ☑ Pyroxene, $Al_2Ca.SiO_6$
- ☑ Merwinite, Ca_3MgSi_2O8
- ☑ Dicalcium Silicate, $(Mg, Mn, Fe, Ca)_2SiO_4$
- ☑ Periclase, MgO
- ☑ Monticellite, $CaOMgOSiO_2$
- ☑ Pseudowollastonite, $CaSiO_3$
- ☑ Rankinite, $Ca_3Si_2O_7$
- ☑ Spinel, $MgAl_2O_4$
- ☑ Wollastonite, $-CaSiO_3$
- ☑ Forsterite, Mg_2SiO_4
- ☑ Sulphur which goes in the slag appears as Oldhamite (CaS).

The part of the phase diagram limited by the composition of the slag is of interest to Blast furnace operator. The number of mineral constituents will therefore be limited to the area bound by the slag composition.

The physico- chemical properties of the slag is important in optimization of the BF operation and profitability. Slag viscosity also determines the slag–metal separation efficiency, and subsequently the metal yield and impurity removal capacity. In operation, the slag viscosity is indicative of the ease with which slag could be tapped from the furnace, and therefore relates to the energy requirement and profitability of the process.

There is an optimum composition of slag in respect of:

- ☑ Best removal of Sulphur and other impurities
- ☑ Minimum slag volume
- ☑ Minimum cost
- ☑ Low liquidus temperature so that it does not solidify too easily during tapping
- ☑ Low viscosity for a tappable slag. The lower the viscosity the better is slag metal separation.

The ratio of $CaO + MgO/ SiO_2 + Al_2O_3$ in the slag called the basicity of the slag is important in dictating some properties like viscosity, desulphurization and dephosphorization of the slag as well as the amount of Fe_2O_3 it may contain

Nature of Indian BF slag:

Indian slag has evolved during the last fifty years. The slag produced in the fifties were high in alumina that varied from 25 to 30% because of the nature of the ore. In mid seventies the alumina content varied from 21 to 24% and the CaO+MgO was below 40%. Presently, the alumina content is around 20% and the CaO and MgO totaling over 40% A typical composition of slag which is a world average (Table I) shows an alumina content of around 12% A high alumina slag makes it viscuous and less efficient in removing sulphur

Microstructure of Indian slag:

Microstructure of Indian BF slag produced in the fifties of last century have been reported [2]. Air cooled slag from Bhilai, TISCO, Durgapur and IIsco were studied. Microstructures of some of the slags have been reproduced below. Major phases are mellilite and diapside. Oldhamite appears in fine cluster. This can be detected as well by X-Ray. However the granulated slag examined by the author did not show the presence of CaS. It appears that the CaS does not get time to precipitate from the glassy phase.

This optimum composition has been shown on the

phase diagram at 25% Al_2O_3 level. This is high in CaO and the total of CaO and MgO amounts to over 50%. The basicity of the optimum slag lies between 1.27 to 1.57. However using more of CaO introduces more Alumina and needs more coke that introduces ash producing large volume of slag. There fore most blast furnaces operate at lower percentage of CaO + MgO of around 40% or higher. The optimum composition of the slag is given in so far as desulphurization, low melting point and viscosity are concerned for slag at 25% alumina level lies around 56% CaO and 8% MgO which however is not attained during BF operation

If the typical world average is taken the section of the diagram at 12.5% alumina has to be considered. The liquidus temperature of this section has been shown in Fig. 26 and he iso-viscosity lines in Fig. 7.[4]

Types of BF slag - Two types of BF slag are produced in India. The naturally or slowly cooled variety, and the granulated slag. In the former the slag is air cooled and crystallization of the slag takes place this slag is very hard and contains different percentage of the glassy phase. One may expect to find the minerals mentioned above. The other variety is presently used by the cement plants for the production of slag cement. The slag is brought in ladles to a large reservoir where the hot slag is disintegrated by a strong jet of water. The slag is friable and mainly glassy. Presently a method where the hot slag is converted into granules by a rotating perforated cup is being developed to make the suitable for cement production. It is also mainly glassy.

Almost all steel plants in India have granulation facilities. The granulation plants are associated

Fig. 1: Microstructure of Lath shaped Well developed mellilite in a Matirix of ferrousoferric diapside

Fig. 2: Microstructure of Oldhamite (Tisco)

Fig. 3: Fine crystals of mellilite in a rapidly Cooled slag. (IIsco)

Fig. 4: Mellilite and diapside (Bhilai)

TABLE II - Chemical analysis of BF slag produced at different steel plants in India as in 2007
(Source: Indian bureau of Mines)

Plant	SiO_2	Al_2O_3	CaO	MgO	MnO	FeO	S	Basicity CaO + MgO/ SiO_2 + Al_2O_3
Bhilai	34.66	19.27	31.74	11.25	0.32	0.54	0.74	0.8
Bokaro	32.90	19.90	32.74	10.60	0.68	0.50	0.68	0.81
Tata	33.50	19.50	36.30	6.50	—	0.45	—	0.8
Durgapur	33.02	21.75	32.36	9.08	—	0.43		0.8
Visakhapatnam	33.64	19.24	35.39	9.13	0.22	0.48	—	0.84

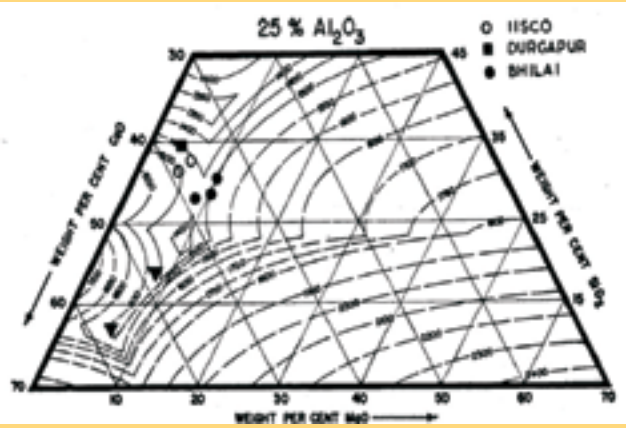

Fig. 5: The isotherms in degree Fahrenheit at 25% alumina level.[3] The solid triangle is the optimum composition. The circles are actual slag composition of the decade of 1950

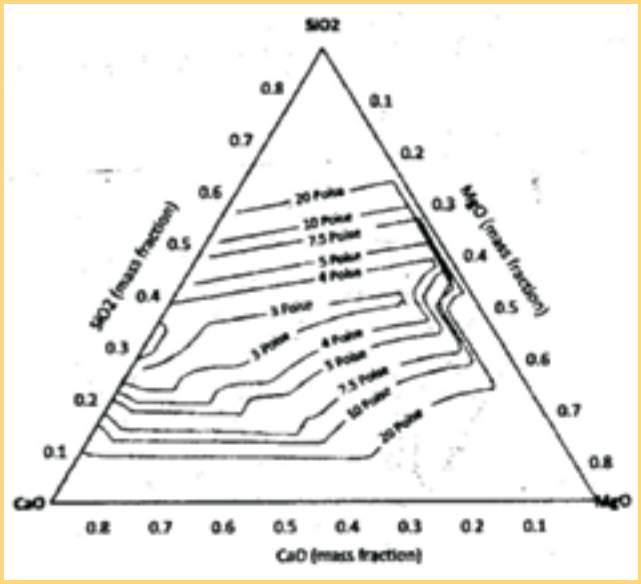

Fig. 7: Isoviscosity lines in the above diagram

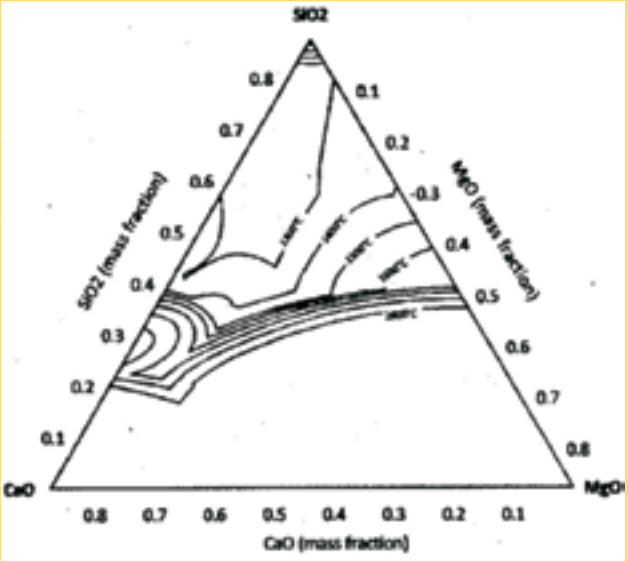

Fig. 6: Isotherms of the section at 12.5% alumina

with a cement company e.g. Durgapur sells its slag for granulation to Durgapur cement.

Another form of BF slag is a foamed slag similar to foam glass produced by controlled cooling of glass in conjunction with compressed air or steam. This is a porous light weight material that is used as aggregate for concrete. There is no information that such product is made in India

Production of granulated slag in India:

The annual production of BF and granulated slag is given in table II. Granulated slag is the product of interest in glass industry as the air cooled slag is very hard and is difficult to grind. The grinding operation introduces ferrous metal that may be difficult to separate.

TABLE II - **Plant Capacity of production of BF and Granulated slag**
(Source: Indian Bureau of Mines)

Plant	Capacity of Granulation ('000 tpy)	Production of Slag (in '000 tonnes) BF Granulated 2007-2008
Bhilai	2675	2148 1602
JSW Steel Bellary		1403 1026
Tata	1400	1360 1360
Rourkela	600	700 260 (2005-2006)

Conclusion: BF slag produced in India is high in alumina because of the ore. The composition of the slag has changed over the years and now the alumina content is around 20% while the world average is around 12.5%. Granulated BF slag is produced in most steel plants and the plants are associated with a cement company. This slag is friable and is suitable for use in the in glass industry.

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INFLUENCE OF ELECTRODE CONFIGURATIONS IN ALL-ELECTRIC FURNACE ON DISTRIBUTION OF POWER DENSITY IN GLASS MELT

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Keywords: glass, all-electric furnace, modelling, electrode, power density, temperature

ABSTRACT

The power density in glass melts has been studied at different arrangements of electrodes in all-electric melting furnace. Bottom, top and plate electrodes have been arranged into the model furnace in form of hexahedron about the edge 1m. The results of mathematical modelling showed that there has been very narrow relationship between the distribution of power density in glass melt and the temperature field and therefore by means of suitable arrangement of electrodes it is possible to influence the intensity of convective currents of the glass melt. From evaluated dependencies of power density distribution near the tips of electrodes follows that in case of rod electrodes, the power density decreases with increasing length of the electrodes. Opposite behaviour happens at plate electrodes because the power density distribution in the centre of the basin between electrodes increases with increasing distance of the electrodes from the bottom of the furnace. By means of mathematical modelling also have been evaluated the volumes of glass melt in surroundings of electrodes where are the power densities superior to pmean (60000 W.m-3). The volumes are very small with regard on the total volume of furnace and do not exceed the value 22%. From mentioned follows that mathematical modelling of glass melting furnaces by means of CFD programme Fluent gives to acceptable computational subservience to study of power density distribution in all-electric melting furnaces.

INTRODUCTION

The possibility to predict the operation characteristics of all-electric glass melting furnaces is of pivotal importance when the electric energy is used for glass melting. The determination of the most convenient electrode configuration represents one of the most important steps in the design of the glass melting tank furnace and, specifically, of its melting compartment because this configuration influences the following two factors of great importance for the furnace operation. These factors are:

a) Technological conditions – consisting in the setting of the required temperature field in the glass melt that, in its turn, results in the creation of a suitable flow pattern in the tank.
b) Electrical conditions – consisting in a uniform loading of all installed electrodes and all phases of the supply source as well as in adequate values of voltages and resistances between the electrodes.

The first factor is very important because – as obvious from the principle of the electric melting of glass – the electric power is transformed into the thermal energy directly in the glass melt that functions as an ohmic resistance generating the Joule heat. In this way, a local convection flow can be developed in the glass melt by arranging conveniently the electrodes; the convection flow exerts a favourable effect on the rate of the glass melting process as well as on the final glass quality because the glass is homogenized more thoroughly.

The distribution of the power density released by the electric current in the glass melt, i.e. the distribution of the power density within the glass bath must be known for each proposed configuration of heating electrodes if the temperature distribution in the tank is to be determined. The intensity of the convection flow of molten glass is then assessed on the basis of the temperature distribution.

The above problems were investigated by a variety of workers in the past because it is important to know the distribution and magnitude of the power density in the glass melt at different electrode arrangements in the tank when all-electric furnaces are designed. The work carried out by Stanêk [1] and Curran [2, 3] can be regarded as fundamental in this field. By using a method of physical modeling Stanêk studied the amount of energy released in the glass and the glass temperature distribution for four basic configurations of electrodes. The data obtained permitted to visualize the amount of the released energy and the temperature in a model liquid in the tank cross-section of a physical model and to formulate a statement according to which the amount of the released energy corresponds to the temperature distribution. Curran investigated the distribution of energy released in the glass melt by using a 2-D mathematical model under isothermal conditions when the following equation is valid because of the validity of the Joule's law governing the generation of heat released by the electric current passing through a conductive medium (glass melt) and the Ohm's law for the 3-D conductor:

$$p = \frac{\vec{E}^2}{\rho_{\acute{e}}} = \frac{(grad\ \varphi)^2}{\rho_{\acute{e}}} \qquad (1)$$

The data published by Stank and Curran, i.e. the distribution of the power density as well as the temperature field, are in a good agreement.

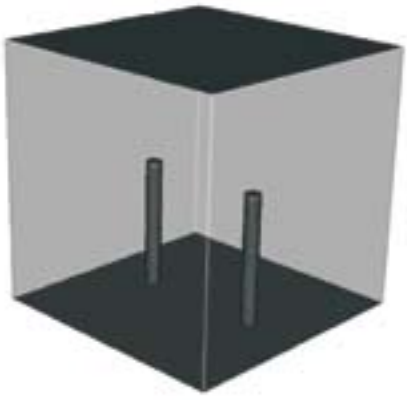

Fig.1: Bottom electrodes

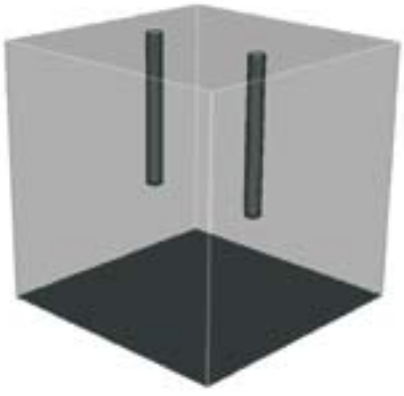

Fig. 2: Top electrodes

Fig. 3: Plate electrodes

Modelling

At present, both hardware and, particularly, software, e.g. CFD FLUENT (V6.3.26) expanded by a MHD module [4, 5] are available. The above-mentioned software gives the possibility to find solutions for 3-D mathematical models yielding the distributions of physical fields in molten glass melted by the Joule heat under non-isothermal conditions. The present contribution focuses on calculations yielding the distributions of temperature and power density fields in a furnace of a simple shape at various configurations of three types of electrodes under the following conditions:

a) Configuration of the 3D mathematical model

The investigation into the effect of the heating electrode configuration on the amount and distribution of the electric power was carried out by using a furnace having the shape of a cube with an edge 1 m long. Two rod electrodes of various lengths were inserted into the tank through the tank bottom (the so-called "bottom electrodes") or through the tank crown ("top electrodes"). The 3rd type of the furnace was equipped with two plate electrodes and the distance between the lower edge of the electrodes and the tank bottom was changed in a step-by-step manner. The furnace operation was investigated at zero pull and a constant power input was supplied to all electrode pairs. The configurations of the investigated furnaces equipped with the bottom, top and plate electrodes are shown in Fig. 1, 2 and 3.

b) Arrangement and parameters of heating electrodes

Furnace with bottom and top electrodes

Type of electrodes: rod

Electrode diameter: 0.06 m

Electrode length: 0.2 – 0.8 m

Furnace with plate electrodes

Type of electrode: plate-shaped

Electrode dimensions: 0.8 x 0.2 x 0.01 m (length x height x width)

c) Glass and its properties

Glass type: TV glass (faceplate)

Viscosity: log (log (η)) = 7.0922 – 2.348 log T [dPa.s; K]

Density: ρ = 2790 – 0.2378 T [kg.m-3 ; K]

Electric resistivity: log ρ_{el} = - 1.5235 + 3874.5/T [Ohm.cm; K]

Effective thermal conductivity: λ_{eff} = 2.0 + 1.5 e–8 T3 [W.m-1.K-1; K]

Heat capacity: c_p = 1200 J. kg-1.K-1

Coefficient of the thermal volume expansion: β = 1.005 e-4 K-1

Reference temperature: T_r = 1623 K

d) Selected boundary conditions

Sidewalls and bottom: zero heat losses

Glass surface: heat transfer by convection, α = 42.553 W. m-2.K-1; Ta = 313.15 K

Electrode input: 60 kW

Results

The mathematical model of the investigated furnace

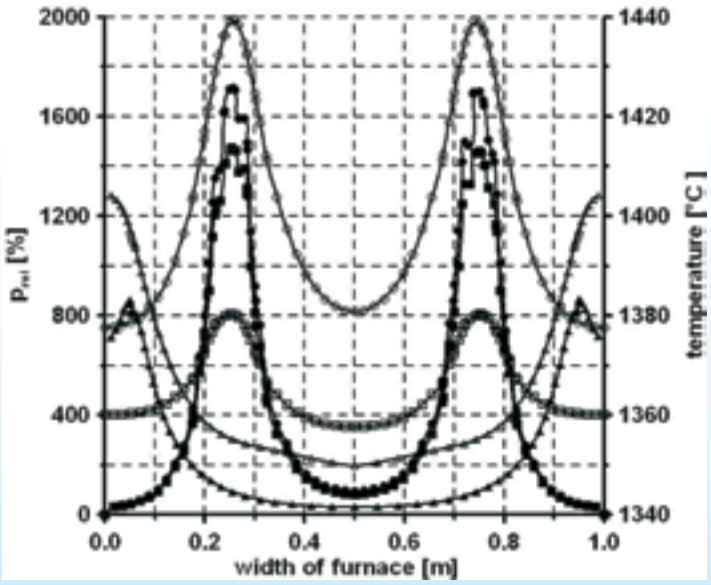

Fig. 4: Power density and temperature distribution in horizontal gradients (points-bottom electrodes, squares-top electrodes, triangles-plate eletrodes, full symbols-power density, empty symbols-temperature)

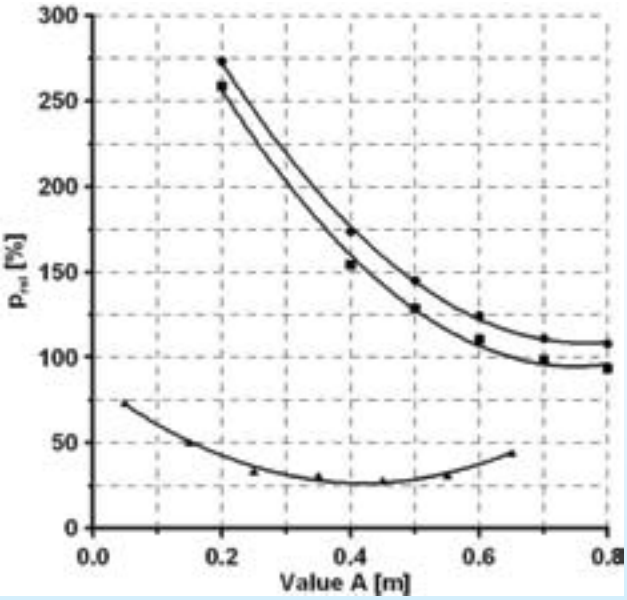

Fig. 5: Power density distribution in the central vertical gradient Value A means the length of bottom and top electrodes or the distance of plate electrodes from the tank bottom (points-bottom electrodes, squares-top electrodes, triangles-plate electrodes)

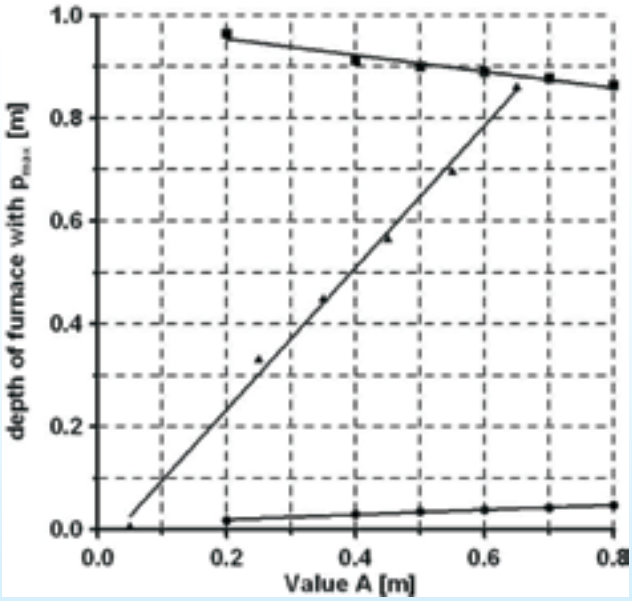

Fig. 6: Dependence of the depth in the central vertical gradient with the maximum power density on the electrode length or the distance of plate electrodes from the tank bottom

provided sets of data containing the distributions of the temperature and power density in the whole volume of the furnace. The numerical values of temperatures and power densities in selected gradients as well as other parameters (for instance, the volume of the glass melt with a power density superior to the mean power density in the furnace) have been calculated. The results are mentioned below:

a) Distribution of the power density and temperature in the horizontal gradients at the following levels: (see Fig. 4)
   - 0.05 m above the electrode tips – for the bottom electrodes
   - 0.05 m below the electrode tips – for the top electrodes
   - 0.05 m above the top edge of the electrode – for the plate electrodes
b) Power density distribution in the central vertical gradients at the electrode tip level of bottom and top electrodes or at the top-edge level of plate electrodes in dependence on the length of bottom and top electrodes and the distance of plate electrodes from the tank bottom (see Fig. 5)
c) Dependence of the depth in the central vertical gradient with the maximum power density on the electrode length or the distance of plate electrodes from the tank bottom (see Fig. 6)
d) Volume of the glass melt with the power density superior to pmean (60,000 W.m-3)

The values of the volume of the glass melt with the power density superior to pmean (60,000 W.m-3) are given in Table 1.

TABLE 1

	bottom electrodes	top electrodes		plate electrodes
l_{el} [m]	V [m3]	V [m3]	h_{dhe} [m]	V [m3]
0.2	0.111	0.112	0.05	0.217
0.4	0.152	0.152	0.15	0.191
0.5	0.166	0.167	0.25	0.192
0.6	0.178	0.180	0.35	0.197
0.7	0.189	0.191	0.45	0.193
0.8	0.199	0.201	0.55	0.192
			0.65	0.198

Discussion of results

The results yielded by the 3-D non-isothermal mathematical model set up with the aid of CFD program modules of the Fluent software corroborated the conclusions of investigations carried out with the aid of isothermal models in previous years. Nevertheless, the 3-D mathematical model applied within the framework of the present investigation represents a very extensive

mathematical apparatus yielding a considerable wealth of data that offer completely new perspectives as regards the solution of the given problem.

First, the distribution of the power density and temperatures in horizontal gradients at levels close above the electrodes have been evaluated on the basis of the acquired data. The calculated and plotted data reveal a very intimate relationship between the power density distribution and the temperature field in the glass melt. Both dependences exhibit pronounced peaks in the electrode zones for all examined alternatives; therefore, it can be declared that the intensity of the glass convection flow can be influence by a convenient arrangement of electrodes in the tank.

The next step focused on the evaluation of the power density distribution in the central vertical gradient at the level of cylindrical electrode tips as well as at the top-edge level of plate electrodes. As regards the rod electrodes, the power density in the central gradient drops with the increasing length of electrodes. This phenomenon is due to the fact that the glass volume in the close vicinity of electrodes where the maximum amount of the electric energy may be released also increases with the increasing electrode length. A quite opposite situation occurs in the case of plate electrodes: the amount of the energy released in the centre of the tank grows with the increasing distance between the electrodes and the tank bottom. The results showing the dependence of the depth in the central vertical gradient with the maximum power density on the electrode length are in a perfect agreement with the above findings.

Attention has also been paid to the calculation of the glass volume in which the released energy is superior to the mean power density. It is evident from the data in Table 1 that a predominant part of energy is released in the glass melt in the close vicinity of electrodes because the power density superior to the mean value calculated for the whole tank could be detected in the glass melt whose volume ranges from 10 to 20% of the total tank content. This statement is valid for both the bottom and top electrodes. As regards the plate electrodes, the glass volume with $p > p_{mean}$ does not vary in dependence of the electrode position in the tank; it amounts to about 20%.

Conclusions

The following conclusions can be drawn on the basis of above findings;

1. The power density distribution in the glass melt shows typical local characteristics (temperature, power density).
2. The above characteristics can be influenced substantially by electrode arrangement in the furnace as well as by the type and dimensions of the electrodes.
3. Local characteristics also influence fundamentally the glass flow pattern in the tank.
4. The above characteristics must be identified if efficient and high-performance all-electric tank furnaces are to be designed.
5. The application of the method of mathematical modeling to the identification of the above characteristics is extremely useful, for instance, CFD FLUENT software expanded by suitable user's functions targeted at the solution of magneto-hydrodynamic phenomena in a conductive medium.
6. The necessity to pay attention to the transfer of released energy in the direction from the heating electrodes to the surrounding glass melt remains one of very important tasks of furnace designers.

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Acknowledgement

This work was a part of the project No 2A-1TP1/063, „New glasses and ceramic materials and advanced concepts of their preparation and manufacturing", realized under financial support of the Ministry of Industry and Trade and also a part of the research programme MSM 6046137302 "Preparation and research of functional materials and material technologies using micro and nanoscopic methods" realized under financial support of the Ministry of Education, Youth and Sports.

Glasstech Asia 2012 to help jump-start Thai national economy

Glasstech Asia 2012, one of the world's renowned glass exhibitions, will be held in Thailand from 18 to 20 July 2011 at Bangkok International Trade & Exhibition Centre (BITEC). The show will boast the latest technologies, trends, and developments of the local glass industry.

"Glasstech Asia 2012 comes at a time when the Thai government is establishing a US$1.6 billion insurance fund as part of a five-pronged, US$85 billion program to jump-start the national economy after it has been hit by floods. With Glasstech Asia 2011 having the record of generatingUS$117,100,00.00 in sales and potential sales over the next 12 months, I am expecting Glasstech Asia 2012 to give a good boost to the Thai economy. We hope to help boost the Thai economy to grow to around 4 per cent in 2012 with factories returning to full capacity, as rebuilding efforts and the policy stimulus get underway," said Mr. Gan Chee Siong, Chairman of the Singapore Glass Association.

It is also timely that the show should return to Bangkok in 2012, since the last time it was in Bangkok was way back in 2007.

4,500 trade professionals are expected to visit the three-day event, which will bring together the best from over the world for a specialized glass event that truly benefits the locals, the glass industry, as well as, foreign investors.

Some 380 companies from 45 countries are also expected to take part in the 8,000 sqm gross area show.

Apart from showcasing the latest products and technologies of the glass industry, other highlights of Glasstech Asia 2012 will include a series of seminars, business match-making, networking reception and an awards presentation. This makes Glasstech Asia 2012 an ideal platform for industry players to expand their network and discover new business opportunities. Glasstech Asia has seen continual success in generating positive business returns in the industry through its targeted business match-making programmes.

The latest industry developments will be presented by leading experts in the field, led by:

- Glass Machinery Manufacturers
- Glass Manufacturers
- Glass Processors
- Hollow Glass Machinery Manufacturers
- Glass Accessories Manufacturers

"This is the long-awaited event for glass industry practitioners and we look forward to have more exhibitors and visitors at Glasstech Asia 2012. I am sure the future of the glass industry will be very bright although there may be obstacles along the way," said Mr. Edward Liu, Group Managing Director of Conference & Exhibition Management Services (CEMS) Pte Ltd, who is on the organizing committee of Glasstech Asia 2012.

With the support of glass associations from Malaysia, Vietnam, the Philippines,

the United Kingdom, USA and Italy, Glasstech Asia 2012 is jointly organized by Conference & Exhibition Management Services (CEMS) Pte. Ltd. Singapore and the Singapore Glass Association. Glasstech Asia 2012 is hosted by the Thai Glass Dealer Association (TGDA).

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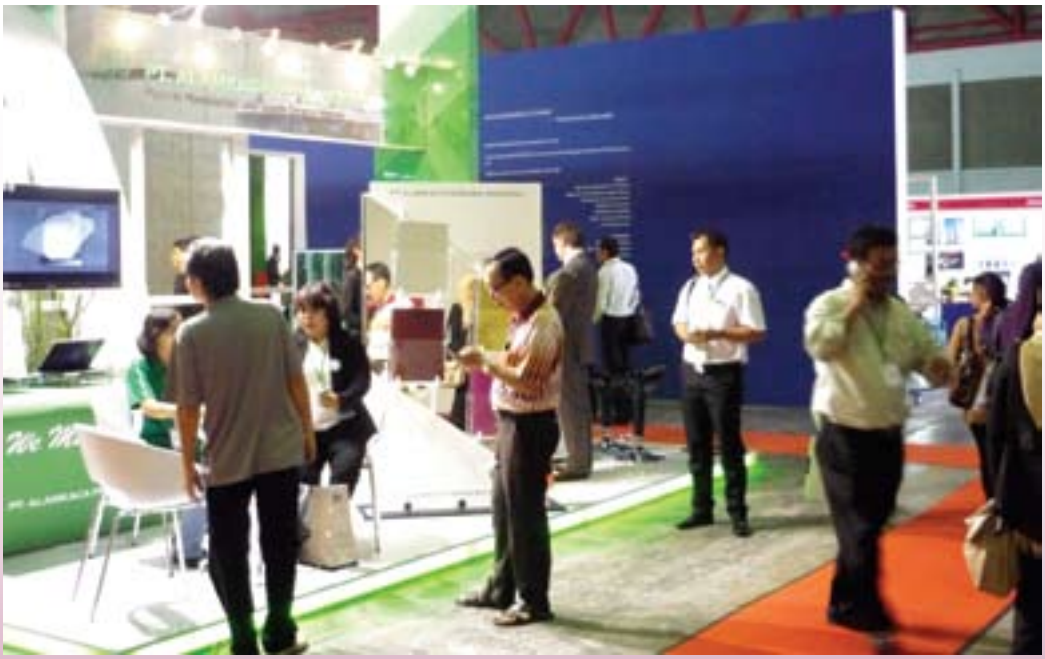

Glasstech 2012 brings the right buyers to the doorstep".

ANALYSES OF ANCIENT INDIAN GLASS FROM HISTORY OF INDIAN GLASS

M.G. Dikshit*

*The data have been taken from the appendix I of History of Indian Glass by M.G. Dikshit published by the University of Bombay in 1969. This is a Pandit Bhagawanlal Indraji endowment lecture delivered in 1967

ABSTRACT

History of Indian Glass by M.G. Dikshit traces the Indian history of glass from 1100 B.C to the early part of the last century. The source is essentially the samples excavated at different regions of India. Many of the glass samples were chemically and spectrographically analysed and reported in various archaeological and history journals. In the West they took interest on the ancient Indian glass samples and analysed in their laboratory. The analyses of ancient Indian glasses have been presented in two parts. These results give interesting view of the composition of glass, the colouring agents used and the type of raw materials. It is interesting to see that many of the glasses were high in silica ranging from 60 to 70 percent and it was melted and shaped.

INTRODUCTION

The importance of the analyses of Indian glass cannot be over-emphasized. Recent advance in scientific studies and accuracy in analytical methods have brought this feature into great prominence. Technologists of the present day arc not content in knowing the principal constituent compounds in glass but by studying the trace elements in different glasses they wish to establish, by matching several examples, if these could be traced to a common source of their fabrication. Culture contacts between widely separated places can thus be established. Spectrography and Atomic bombardment of even the minutest samples have greatly furthered these studies, particularly in the United States. Some definite groups of glasses in different countries at different periods now seem to have been fairly well established. A clear picture in broad outline is thus before the student of ancient glass from several countries.

Unfortunately, Indian glass has not been subjected to such a critical treatment as the **Roman** and the Chinese or the Persian glass has received. Though many specimens appear to have been analysed in the past, the impression one carries about Indian Glass through different epochs in its history is still a very hazy one because very few reliably dated specimens have come to light and secondly the subject has not attracted the attention of the scientist in India as much as it should have. The data available are collected here and is given below arranged in chronological order.

1100 - 800 B.C.

Hastinapura: Two specimens of glass bangles from Hastinapura, belonging to Period II 1100-800 B.C. were analysed by Dr. B. B. Lal. His findings appear in ***Ancient India,*** Nos. 10-11, p. 13.

One of the bangles (Hst 1-1446) was of brownish glass with a hardness between 5 and 6. The sp. gr. was **2.55**. The glass belonged to the ordinary soda-lime-silicate variety, containing a small amount of iron, which accounts for its brownish colour. It had a very low percentage of aluminium and. silica. Its softness was suitable for the making of the bangle.

Tile second specimen (Hst 1-1459) was black in colour, with a conchoidal fracture typical of glass. The hardness was about 6, the specific gravity being 2.56. This glass also has a low percentage of aluminium and silica. Cobalt; was absent.. The dark colour of tile glass was due to the presence of. Iron. There were traces of phosphates and sodium in large quantities. The specimen therefore belonged to a soft soda-lime glass.

600 - 200 B.C.

Rajghat - The ancient site of Rajghat, near the Kashi Railway Station was excavated by S.K. Krishna Dava of the Archaeological Survey of India in Oct-Nov. 1940; and by Dr. A. K. Narain and his colleagues since I959. The excavations have brought to light enough material to show that glass was being used there from ***circa*** 600 B.C. onwards (Period I). About 24 beads of glass of Period I were recorded, of which six were of black glass, five of various shades of blue, five of green and the rest were of opaque red glass of sealing wax colour. Analyses of five selected beads by H C. Bharadwaj have recently been published (Table I). These are

1.	Translucent Black glass bead	600 B.C.-200	B.C. Sp. Gr. 2.31
2.	Translucent Blue-green glass bead	do.	Sp. Gr. 2.39
3.	Transparent Olive-green glass bead	600 B.C.-400 B.C.	Sp. Gr. 2.36-
4.	Translucent Pale blue glass bead	do.	Sp Gr. 2.37
5.	Opaque Reddish brown glass bead	do.	Sp. Gr. 2.44

TABLE I Glass Beads From Rajghat

	SiO_2	Fe_2O_3	Al_2O_3	CuO	Cu_2O	NiO	CaO	MgO	Na_2O	K_2O
1.	64.68	4.2	7.89	-	-	-	5.45	0.86	17.54	0.30
2	70.09	1.26	3.34	1.13	-	-	6.90	1.10	5.20	9.74
3	67.07	2.58	9.95	-	-	-	6.35	0.44	13.81	0.36
4	68.08	1.84	2.76	2.40	-	-	8.04	0.98	16.03	0.62
5	65.01	9.67	2.28	-	5.27	0.15	4.08	0.40	13.06 by difference	

H. C. BISARADWAJ, "A note on the chemical composition of some Glass Beads from Ragliat.Varanasi,''Puratatva (Bulletin of the "Indian Archaeological Society" Varanasi, 1907-OH), No. 1,

It has been observed that Nos. 1, 3 and 4 are Soda-lime silicates, whereas No. 2 is a Potash-cum-soda lime silica glass. The Silica contents re quite high in these specimens. Soda was the most popular alkali but Potash (probably in the form of wood ash) was also used in conjunction with soda. High content of alumina in No. 1 and 3 suggest the use of Feldspar. Lead is absent in these. Copper compounds seem to be the main colouring agents.

The reddish brown opaque beads are important as the process of their manufacture has a chequered history. The colour is mainly due to Cuprous Oxide crystals held by the batch. There is a high percentage of iron oxide (9.67%) which seems to be responsible for the opaque red colour. The nickel contents are probably due to impurities associated with copper-ore.

Early Century of Christian Era:

Arikamedu: The site of Arikamedu on the eastern coast of India is well known to be an emporium in the early centuries of the Christian era. Importance of this site was first recognized by Joveau Dubreuil who sent some specimens of glass beads to the Madras Museum. In 1950, Subramaniam of the Madras Museum published in ***Current Science,*** Vol. 19 (1950), pp 1)-20. Analyses of some blue glass beads, almost opaque, having a esp. of 2.55 These appeared to have some small seeds, which were responsible for the ***opacity*** of the glass. There blue colour was due to the presence of iron compounds. Copper and cobalt were absent. The lime contents appeared to be very low but iron was present in considerable quantity. The analysis is given in Table 1(a). The high content of potash in the glass at Arikamedu is again confirmed by the analyses published by Dr. B.B. Lal ***Ancient India***, No. 8, pp. **25-26.** His specimens consisted of a deep violet g1ass, (No. 1) which was coloured with manganese; and a bluish violet specimen (No. 2) which was similarly rich in manganese. The latter however had a number of greenish particles in the batch. Both these potash glasses have a very low percentage of alumina and lime. These glasses are sturdy and durable, probably made by using wood-ash (potash) for their fusion. Mr. Lal's analyses are given here in Table 1(b). Glass specimens from Arikainedu were further examined by Dr. M. Tornati of the Stazione Spcrimentale dcl Vetro di Murano, in 1960. One of the specimens of Indian red glass (No. **1)** examined by her showed a similar high content of potash, but the alumina and the lime contents were slightly higher than tile previous specimens. The Indian red colour was due to oxides of copper. She also examined a green glass bead a common soda-lime silicate glass. Her analysis is given here in Table 1(c).

200 B.C. to 200 A.D.

Kausambi : The only analyses of glass from Kausambi is available from the specimens lent by Dr. W. G. N. van. der Sleen to Dr. M. Tornati of Murano. The latter has published her analyses in ***Vetro,*** Vol. IV 1969, P. 29. The specimens comprised of a green glass bead (No. 1), a cylinder circular bead of blue glass (No. 2) and another of the same variety in opaque terracotta-red. Specimen No. 2 was very rich in alkali, mostly potash, and indicated

TABLE I a - Glass from Arikamedu (a) Dull Blue opaque beads

Source: Subramaniam- Current Science, *Vol. 19* (1950), pp. *19-20.*

SiO_2	Al_2O_3	Fc_2O_3	MnO	CaO	MgO	NaO	K_2O	FeO	Total
73.6	1-9	1-1	0-4	8.9	1.421	2.1	13-4	2.0	89-8

TABLE I b - Sturdy and durable Potash glass as analysed by Lal

SiO_2	PbO	Al_2O_3	Fe_2O_3	MnO	CaO	MgO	Na_2O	K_2O	Total
78.02	0.07	1.88	8.84	MnO	1.94	0.30	1.30	12.78	100.25
72.49	0.07	1.12	6.50	1.90	2.94	0.68	0.20	14.14	100/18

TABLE I c - Green soda lime glass as analysed by M. Tornati

SiO_2	SnO_2	Al_2O_3	Fe_2O_3	CaO	MgO	CuO	Cu_2O	Na_2O	K_2O	TiO_2	P_2O_5	SO_3
64.81	0.89	8.41	1.20	4.81	2.35	0.72	1.33	11.35	4.32	0.31	5.00	0.1
75.90	0.68	2.88	2.58	1.84	1.81	1.50		4.27	3.96	0.17	4.81	0.2

TABLE II - Glass from Kausambi

Source: Tornati in Vetro IV (1960), p. 23, Table V.

SiO_2	SO_3	P_2O_5	SnO_2	Al_2O_3	Fc_2O_3	MnO	CaO	CuO	Na_2O	K_2O	TiO_2	Cu_2O
65.08	0.23	5.16	1.54	4.02	1.12	—	2.23	1.00	1.80	13.57	2.92	0.29
76.42	0.10	—	2.38	1.18	1.42	3.14	0.55	0.28	4.11	10.12	0.10	57.34
—	1.95	—	4.70	4.48	0.39	3.30	2.18	7.50	0.89	0.33	-	10.0

TABLE III - Glass from Kohlapur

SiO_2	CuO	Fe_2O_3	Al_2O_3	CaO	MgO	Alkali by difference
45.45	1.81	2.14	2.40	9.00	3.37	35.74

that probably wood-ash was used in its fabrication. The colouring matter was mostly due to the oxides of copper in the first two specimens and oxides of iron in No. 3. These are dated between 200 b.c.—200 A.D. The analyses are reproduced in Table II below.

Kolhapur: A number of polychromic bangles of the Bahmani period from Kolhapur were examined by B. B. LAL in 1951. His analyses showed that the various coloured glasses were superimposed one over the other and the line of the demarcation was clearly seen in the enlarged cross-section... He analysed one fragment of a light blue coloured transparent glass bangle, which belonged to the Satavahana Period ***(circa*** 100 B.C.-200 A.D.) The results shown in Table V are from Lal's paper published in the ***Bulletin of the*** Deccan ***College Research Institute,*** Poona, Vol. **XIV,** No. 1**,** p 51**.** The bangle was moulded with a diamond shaped design, its colouring agent was known to be copper.

Conclusion: The description and analyses of ancient Indian glasses from 1100 B.C to 200 A.D have been given in this section. The source of these glasses is the excavation products and samples are kept in various museums of India. Often the numbers quoted are that of the numbers given in the museum. It is interesting to see that people were able to melt glasses containing over 70 percent silica (Arikamedu) and as expected these glasses were hard and durable.

IMPROVEMENT A KEY FOR SUCCESS

Part III*

Sanjay Ganjoo

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*Part II published in Vol. 5, No. 1, October-December, 2011

Till now we have tried to understand how to improve our workplace but sustainability of same is more challenging. The next part of '5S' is about maintaining achieved conditions which we term 'SEIKETSU'.

The definition of Seiketsu means that workplace is maintained in a condition of cleanliness and neatness. In other words, it describes a situation or a result and not phenomena or operations. We have Seiso (the act) and Seiketsu (the result), the two are inseparable. Going one step further, we can say the Seiketsu is none other than the maintenance of good Seiri, Seiton and Seiso.

The basic elements of "Seiketsu" maintenance systems

It is used in direct and indirect relation to production and is not temporary, but means a condition in which things are always maintained and production is accomplished on time without trouble. Production however is process in which things get dirty for which a method is necessary for temporary cleaning. It is necessary to have a structure which can grasp indications of trouble at every step of Seiri, Seiton and Seiso. Let me list some of the important elements in brief.

1. Select objects of Seiketsu which can be same that of Seiso.
2. Seiketsu methods, steps and points: The methods and points of emphasis for keeping each object of Seiketsu from getting dirty. If they get dirty, the methods are same as used in Seiso.
3. Seiketsu Standards: Define Seiketsu Level, check points for Seiketsu level and operation time when nothing is dirty.
4. Seiketsu Equipments: Equipments used to prevent things from getting dirty. Same equipments can be used to clean things as used in Seiso.
5. Seiketsu Workers: On duty workers for Seiketsu, workers in-charge of Seiketsu.
6. Objects for Inspection: Each system, basic elements and results of Seiri, Seiton and Seiso.
7. Objects for Inspection… Each System, all basic elements, and results of Seiri, Seiton and Seiso.
8. Method of inspection… Methods as decided for Seiri, Seiton and Seiso.
9. Inspection Standards…. Definition and degree of each disorder for inspection objects.
10. Inspection Equipments… inspection tools, equipment and check lists.
11. Purpose of inspection…. Setting themes fro improvements and making improvements for disorder.

Along with the systems and basic elements, in order to make "Seiketsu" maintenance systems improvements, it is necessary to categorize the types of maintenance by degree of dirt and the period in which it occurs and then to systematize.

One type of maintenance system is the daily Seiketsu. This is a structure which is used to get rid of dirt, trash or any unwanted element generated during production operations. The point of emphasis for this improvement system is to remove dirt and trash in quick time and as effectively as possible, to keep necessary tools close at hand and train Seiketsu workers to be able to keep disorder to minimum.

The other system is emergency maintenance system. This structure is get rid of dirt, trash or dust which get generated suddenly and in great quantities to affect the production operations. The emphasis of this improvement system is to pursue the source of dirt, trash and dust, get hold of factors, create and study a plan for dealing with problem, discover and improve disorder which cause defects, breakdowns, frequent stoppages and productivity reduction.

There are analytical methods and principles for Seiketsu Improvements. Analysis of reliability and maintenance in order to get rid of breakdowns and frequent stoppages.

A breakdown is a situation in which stress reaches its maximum in intensity. The intensity level drops with time and machine stops sometimes. Finally it stops due to sporadic breakdown. This becomes a frequent stoppage. Stress and time are the immediate cause of breakdown.

There are two reasons generally for frequent breakdowns:

1. The operations department is indifferent about daily preventive maintenance
2. Breakdown measures are left to the discretion of maintenance department.

The two systems and their improvement steps are summarised in below table:

S. No.	Improvement steps category	Improvements Objects " Seiketsu" maintenance systems (Improvement Theme)	
		Main Theme	Sub Theme
1.	Improvement steps for daily "Seiketsu" maintenance system.	Daily "Seiketsu" steps (for each Seiketsu Object group)	"Seiketsu" method for each Object. Inspection steps and methods for disorder. Individual improvements for disorders Individual "Seiketsu" improvements and equipment for each Object.
2.	Improvement steps for Emergency "Seiketsu" maintenance system.	Emergency "Seiketsu" steps (for each Seiketsu Object place and group)	1."Seiketsu" method for each Object. 2.Inspection steps and methods for disorder. 3. Individual "Seiketsu" improvements and equipment for each Object. 4. Creation of inspection standards for disorders

Improvement steps and points for Daily "Seiketsu" Maintenance Systems

Steps	Points and Methods
Gather Equipments ⇩	Equipments for morning, evening and during work will be different because dirt situations will be different
Do cleaning with emphasis on dirt ⇩	Only spots that stand out are cleaned in the morning, only spots that get dirty are cleaned during work, everything is cleaned in the eveing.
Inspection of cleanliness ⇩	Inspection to see if there is a uniform level of cleanliness
Inspection of disorder ⇩	Inspect disorder and places which are hard to clean, add them into plans for improvments
Minor Servicing ⇩	Do small repairs and servicing which can be done right away in the workshop. Procure equipments.
Put away equipment	Put equipment in order and store.

Improvement steps and points for Emergency "Seiketsu" Maintenance Systems:

Steps	Points and Methods
Gather large Equipments ⇩	Prepare cleaning equipment which is appropriate to the place in question and the amount of dirt, trash,or dust etc which is being generated.
Do general cleaning ⇩	Do general cleaning of the object in question. Clean very dirt places especially well.
Inspection level of Seiketsu ⇩	Confirm uniform level of standards of Seiketsu
Inspection of disorder ⇩	Make ssure of places where the cause of the large amount of dirt, trash,oil etc.
Make prompt communication and reports ⇩	Discover major damages and disorders, notify superiors and maintenance department and request repair and improvement
Do improvements of minor disorders ⇩	Immediately do repairs, servicing and improvements.
Put away equipment	Repair,lubricate, service and clean equipments as soon as the claening is finished and put back in its designated place.

Unless the operation department and maintenance department cooperate, breakdown phenomena cannot be grasped accurately, pursuit of cause becomes lax, almost all potential defects are overlooked and five mistakes are repeated. These five mistakes are:

i. Mistake of not making preparations for basic conditions which means there is no Seiso.
ii. Mistake of not considering good conditions for enhancing the correct functions of mechanical facilities and structural parts.
iii. Mistakes of making partial improvements and not dealing with degradation.
iv. Mistake of taking measures without sufficient analysis of breakdown phenomena.
v. Being only concerned with machines, tools, materials, etc and forgetting how human behavior ought to be.

The final "S" of "5S" is SHITSUKE. It is generally referred to in terms of manner and attitude. It is different form other 4S, however, it is an abstract phenomena because it has to do with individual feelings. It is something born out of other 4S.

Normally the meaning of Shitsuke is learning manner, having manners, dressing neatly or instilling the customs necessary for a member in work place or society.

Looking deeper into the meaning of Shitsuke, we see that work of other 4S is maintained, the attitude of the people be firm. In this case it plays an indispensable role. Shitsuke appears in a concrete fashion when rules such as wearing helmets and safety shoes, keeping hair short, wearing name plate etc. In other words it means:

1. Complying with workplace rules and methods.
2. Complying with these rules and methods must become a habit. Even outside the workplace, the attitude should naturally make itself evident in everyday actions.

In following chart five measures are mentioned against breakdown:

Maintain basic conditions	Do through Seiso	
Fllow proper operating procedures	maintain good conditions and operate correctly	Extraction and processing of potential defects.
Rehabilitate deterioration.	Make early discovery of indications of abnormalities.Restore deteriorations. Never do partial improvments	
Improve weak points in design	Get a good understanding of breakdown phenomena. Improve the real weakpointsin design.	
Improve proficiency	Improve opereation proficiency. Self maintenance proficiency	Improve Inspetion proficiency Improve proficiency in minor servicing and repairs

3. This attitude, which is the "knitting thread" which works to maintain the other 4S, is very important.

The basics of Shitsuke begin with obeying with company customs, company rights, company concepts and proceed onto obeying the rules for maintaining a pleasant and orderly workplace conducive to cooperative living. In order to have "Shitsuke" behavior or in order to have rules obeyed, it is necessary to learn or to be trained. Next, the "knitting threads"---- systems, equipments, methods and standard operations which have been found to be effective are necessary. Last of all, methods of motivation, self-management system, 5S enactment certificates, acknowledge certificates, poster promotion, 5S examinations, 5S patrols etc will be necessary. It does not mean only following rules but also improving disorder.

When improving a system for exploiting a "Shitsuke" constitution, being aware of basic elements and the type of structures makes it easy to create a structure and fewer mistakes are made.

One of type of system is the autonomous "Shitsuke" enforcement system. This system is one which each workshop makes its own plans for the 4 S and puts them into action and improves disorder.

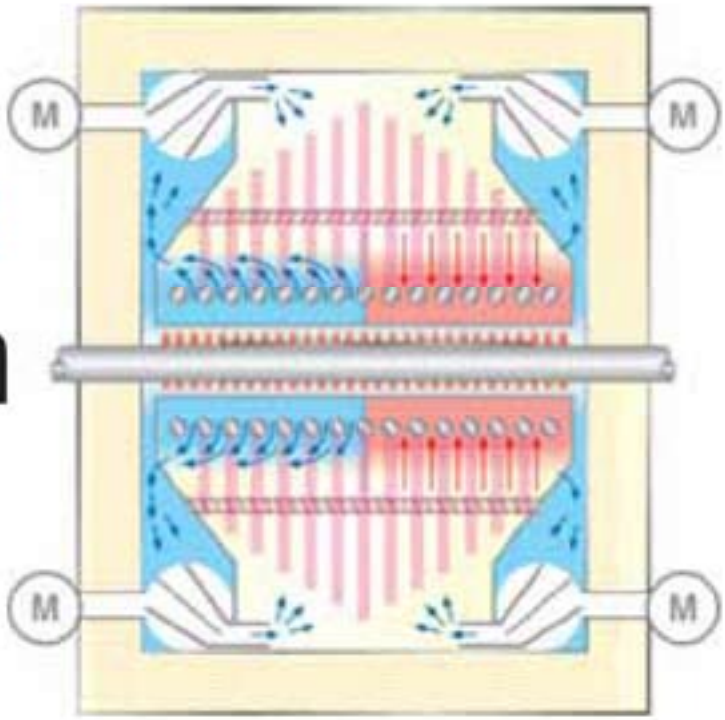
The second system is one which recognizes workshop having successfully implemented 4 S and good results are achieved.

The third is a structure for giving simulative encouragement for enacting the 4S. The system is used where 4S has been introduced without decisive progress being made. This system indicates 4S enactment theme, and themes for improving disorders, puts them into an order of priority and assists enacting the improvements.

To be concluded...

Glass in particular, can be recycled an infinite number of times without any loss of quality

Feracitas: convection in its best and most affordable form



Risto Nikander
FERACITAS OY

The technology used for the heating of glass in furnaces has developed rapidly over the years. The cause for this is also due to the complex forms of glass used, especially with regards to low-E. In this article, Finnish company Feracitas gives us an idea of the history behind the developments, also comparing the different types of furnaces from some of the main players of the glass machinery industry.

History and status

Convection has been known throughout the history of mankind. Maybe more in cold countries like Finland, where cold and wind keep people well aware of its effects. In Finland there is even saying, "wind freezes the house, but frost does the same for the poor barn". However, in glass tempering radiation heating was dominating until low emissivity and coated glasses became common.

In order to fully understand essential development it is good to remember something of the past. The introduction of roller hearth furnaces revolutionized glass tempering by replacing vertical furnaces. Both of them used radiation heating. *Glasstech Inc.* of the United States was the pioneer in the change from vertical to horizontal furnaces. However, *Tamglass* followed quickly, also making interesting developments.

Roller hearth furnaces brought great advantages, but also a problem, into the tempering process. Radiation heating did not keep the roller temperature stable, and the rollers were sometimes too hot or too cold depending on loading conditions. Hot rollers caused two main problems:

- the glasses were 'smiling' when entering the furnace due to the hot rollers, resulting in white haze on the glass surface; and

Feracitas: convection in its best and most affordable form

- the glasses sometimes even broke due to the too hot rollers

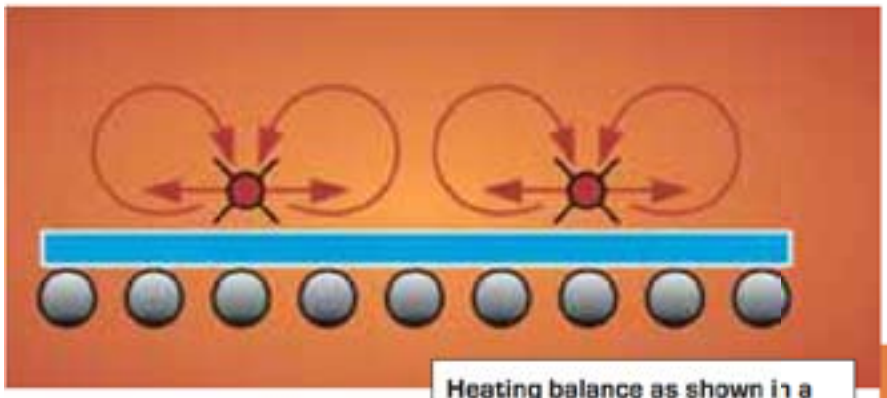
On the other hand, with continuous full loadings, the roller temperatures dropped and caused glass breakage in tempering and poor glass straightness or instability of the glass panes. That could be partly corrected by leaving 'empty loadings', which needed increased operator skills and caused a reduction in capacity.

Glamec double chamber furnace

Heating balance

To eliminate problems due to hot rollers, Pauli Reunamäki, Product Development Director of Tamglass, invented a very good and interesting solution: 'heating balance'. As its name says, what this really meant was 'balanced heating speed on the upper and lower sides of the glass'. 'This was achieved by air turbulence, which was slight convection by compressed air on the glass surface. With this method, it was possible to eliminate both the 'smiling' and white haze.

Over 30 years have passed since this invention and, today, 'heating balance' is standard in all radiation heating furnaces.



Heating balance as shown in a Tamglass patent
Note: direction of air jets are horizontal

Heat focusing

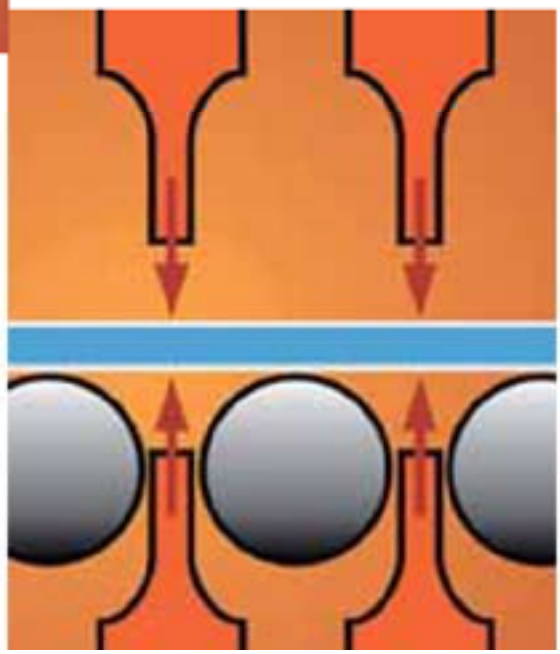
Another important development in Tamglass furnaces was accurate heat focusing. 'Closely spaced and individually controlled heaters (radiators), were close to the glass and enabled heating to respond accurately with different loading conditions, for both small and large glass sizes. Heating balance and heat focusing created the famous HTF tempering furnace series.

The downside of compressed air convection is heat loss. When heating balance was used for low-E glasses, the air quantities had to be increased. Many improvements were tried to avoid problems and increase the effect of heating balance. Examples include heat exchanger for outcoming air, (Tamglass ProConvection); and increase in air volume by means of compressed air by ejector effect, (Erdman Jetstream).

Turbo convection (*Uniglass*, Tamglass *Sonic*) was something in between blower and compressed air, which circulated air inside of the furnace and avoided heat losses. However, already at the end of 1980s, Reunamäki, who worked and was a shareholder in *Glamec*, made another interesting development: a double chamber furnace. The first chamber was a blower operated convection heating chamber at about 450°C, while the second chamber used quite normal radiation heating. The machine design did not fulfill the good convection principles as we know them today. Low temperature in the first heating chamber obviously made it at least as good a furnace as HTF. Glamec furnace capacity was also much higher than HFT.

Full convection

In the mid 1990s, real efforts for the development of 'full convection furnaces' started. This involved large air volumes by means of hot air blowers, internal circulation and furnace temperature around 700°C. The first furnaces obviously had high heating speed but the processes were poor. Now it is easy to explain why. The convection air had no 'heating profile' and rollers were without any proper heating. See picture below.



Cattin and WSP patent principles

SHANGHAI REFINE MACHINERY

Shanghai Refine Machinery Company owner and key staff originated from the world's biggest glass tempering machine manufacturer Luoyang North Glass. The company has good know how in tempering machines. It has been in operation for about three years and has sold over 60 machines to China.
Shanghai Refine Machinery has worldwide rights for Feracitas convection patents and technology.


Figure A


Figure B


Figure C

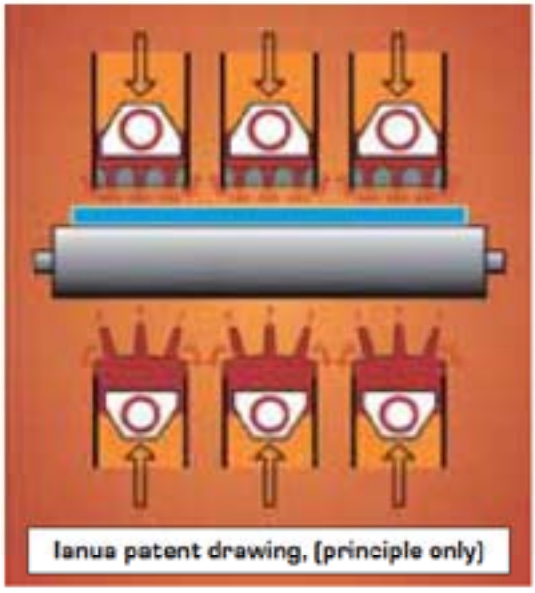
Fig. A - Owner of Shanghai Refine, Mr. James Tang (left) and his client Mr. Wang Bishang

Fig. B - Tempering machine max. flat glass 3,300mm x 13,000mm feeding from this direction. Cylindrical bending, feeding from the opposite direction

Fig. C - Shanghai Refine Machinery Co.,Ltd. workshop and machines under construction

Tamglass acquired *Cattin* and added three radiation heating elements between the nozzle blocks. A longer one was placed in the middle of the furnace and two shorter ones at the sides. The idea was to create a 'heating profile'. This obviously did not have sufficient effect as the return air cooled down the radiation heaters and radiation would not adsorb into low-E glasses anyway.

It therefore becomes easy to understand why *Ianua*'s *Convair* was immediately – in 1996 – a great process success. Convair applied the heating principles of radiation furnaces to the convection air, additionally stabilizing roller temperature.


Ianua patent drawing, (principle only)

It seems from many subsequent developments, that if these main principles are not followed, the process does not work well any more. Deviation from them needed to be corrected at cost or the process characteristics suffered.

The most common problems in some other types of full convection heating furnaces are:
- The return airflow has been arranged to flow to two sides of the furnace, which causes two major problems:
  - operation becomes indefinite and difficult because heat focusing, (temperature profile) is lost. That happens due to the fact, that even though convection air has been given correct heat focusing, it is lost because the return airflow hampers convection air jets;
  - capacity loss is great, about 30 per cent com-

Feracitas: convection in its best and most affordable form

HIGH QUALITY CONVECTION DEVELOPMENT AND COMPARISON

The first convection heating furnaces were almost disasters due to the facts that:

- They were blowing uniform temperature air onto the glass. They did not follow the heating principle of radiation heating furnaces. Heating profile is a must also for convection air.
- They did not stabilize the temperature of the rollers. In convection heating furnaces this is even more important than in radiation heating furnaces due to the higher heating speed of convection.

Ianua made the first perfect convection heating furnace (see below), but the question is: who makes it affordably?

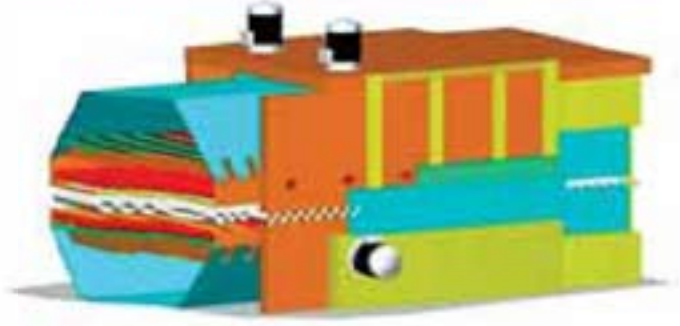
Furnace	Top convection	Iridescence	Bottom convection	Notes
Ianua Convair in 1996. Design based on HFT technology, with flat radiation plates to enable machining of convection nozzles.	Nozzles machined in radiation plates, well directed convection air jet impingement. Normal furnace size includes six blowers.	Not any iridescence thanks to method of making nozzles as explained on the left. Even air return between nozzle boxes, (C-C ~20mm), does not cause any problems.	Rollers heated mainly by convection. Stable roller temperature. Normal furnace includes six blowers.	Process was immediately perfect when machine was started. Design is very expensive.
Feracitas, Finnish patent granted in 2003 but due to strong competitor opposition, final acceptance only in 2008.	Nozzles punched or laser cut into convection chamber all the way from one side to other side, (no discontinuities).	No iridescense since *air returns from glass to the direction of glass movement, (not sideways) and see comment left	Heating mostly as per radiation heating furnaces, but required balance by forced convection. Patent pending.	Best process features but simpler and less components: *less heat and power loss and *less maintenance *cheaper to make
Glassrobots RoboTemp development started in 2003.	Radiation plates replaced by sheet metal. Direction of convection air jets not accurate. Normally six blowers.	Iridescence problems were eliminated only by adding special, costly nozzles in nozzle boxes.	Practically similar to IANUA. Excessive convection, ducting, nozzles, blowers, drives, electrical and control equipment . Normal furnace has six blowers.	After eliminating iridescence problems cost advantage small if any.
Glaston FC 500 in 2010. Longitudinal nozzle blocks as in Ianua and Glassrobots.However, with two heaters in each nozzle block.	Return air flows sideways reducing impingement of air jets and heat transfer coefficient as well as heat focus accuracy.	Iridescence problems obviously eliminated by special nozzle arrangements. Different solution from Glassrobots.	No bottom convection. Radiation heating only applied for glass bottom.	Glaston design many years after other high quality convection furnaces. Design includes features to avoid patent infringements and reduce costs.

Note: There are some Chinese designs imitating Glassrobots. Invariably they have inferior process characteristics.

pared to good, direct convection. This results from heat transfer coefficient reduction because convection air jets hit return air flow instead of impinging straight on glass.

- elimination of bottom convection also leads to two problems:

- top convection increases heating speed. That is why roller temperature stabilization



is even more difficult than in radiation heating furnaces;
- capacity reduction also seems to be significant.

THE BEST AND MOST AFFORDABLE PROCESS

After Ianua Convair process was proven to be ideal, the question was: Who makes the best and most affordable process?

Logically one needs to think about the tempering section. Its heat transfer coefficient has to be very high with thin glasses. This has led to the known technologies for ducting, pressure boxes, nozzle boxes, nozzle design and air evacuation. The same is also applicable in convection heating. However, air temperature and density, maximum heating speed (without breaking the glass) and blowing distance, etc. lead to convection heating operating parameters which are quite far from tempering of thin glass.

Moreover, convection air must include principles of radiation heating as earlier explained.

Feracitas' convection

Feracitas' convection patent combines tempering and heating technologies in an optimum way, which avoid problems of best known convection furnaces, save on operation costs and manufacturing. These characteristics are applied into the furnace conditions as follows:

Glass oscillates in the heating section in the direction of the furnace. Nozzle boxes are crosswise to the glass movement. There is no inter-

THE WORLD'S BEST CONVECTION HEATING FURNACE HAS BEEN AVAILABLE SINCE 1996. NOW IT IS EVEN BETTER AND MORE AFFORDABLE

Ianua in Italy made top quality convection process by utilizing old and proven Tamglass technology and by adding high intensity convection for the machine. Right from the beginning the process was a success. Ianua's patent claims were, however, poorly formulated. They did not protect features, which made process excellent, (method of heating convection air and roller temperature stabilization). This has permitted the use of Ianua's Convair process principles. Glassrobots RoboTemp is a well made example of this.

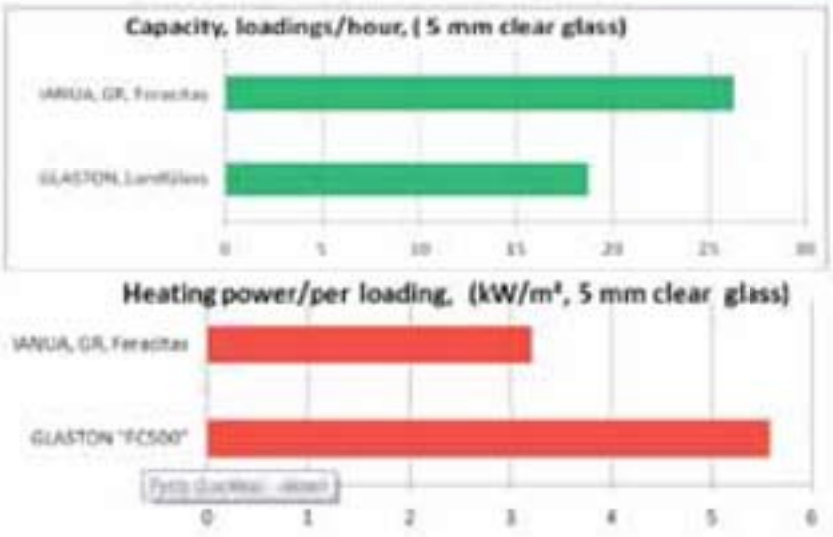
Ianua's Convair and Glassrobots RoboTemp are expensive to make and they have some excessive features like strong bottom side convection. As bottom convection is less important than top convection, several manufacturers make machines without bottom convection. Its elimination, however, reduces capacity and makes process more unstable, more difficult to operate. Feracitas patents and application improve certain features of the Ianua and Glassrobots process but do not deteriorate any their properties. The patents reduce operating, maintenance and manufacturing costs. When Feracitas process based machine is manufactured in China, it is very competitive in price. Business partner of Feracitas is Shanghai Refine Machinery Co. Ltd., (See Box Shanghai Refine Machinery).

COMPARISON TO OTHER KNOWN PROCESSES

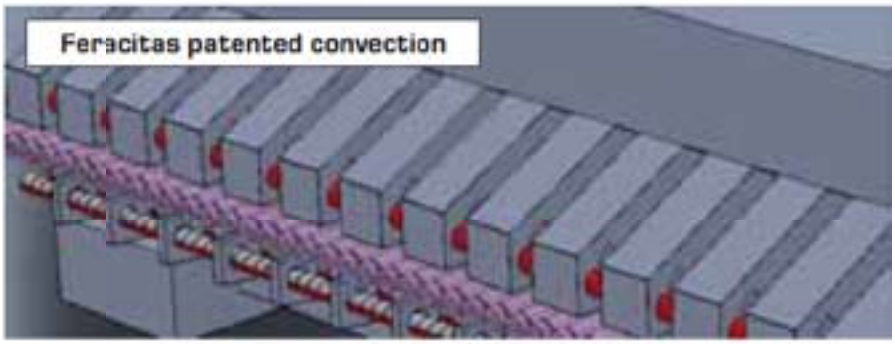
Technical data of Ianua and Glassrobots is taken from their catalogues. They are naturally almost exactly the same. They have the same chief designer and practically the same process and design.

Technical data of LandGlass and Glaston is taken from their catalogues. They show the same capacity figures. However, heating power installed on Glaston furnaces is about 1.5 times higher than that of LandGlass.

Reliable power consumption data may not be available. Manufacturers tend to report the same numbers irrespective of their particular situation. That is why the best comparison may be to compare the average connected heating power to the average loading area of different machine sizes. This comparison should naturally take loading rate (capacity) into consideration. Loading rates and installed heating power of known technologies are compared in graphic form on the left. However, LandGlass brochures are not clear with regards to heating power and, therefore, it has not been included for heating power/m² loading rate comparison.



Feracitas: convection in its best and most affordable form



ruption in rows of nozzles so every point of glass gets uniform convection.

After impinging the glass surface, the air returns a short distance in the longitudinal direction of the furnace. Thus harmful airflow across the furnace width can be avoided. The main heaters, however, are longitudinal to the furnace so heating pattern follows good and well-known radiation heating and the best convection heating furnaces.

In radiation heating furnaces, glass bottom heating is inexpensive, but it has certain small defects as explained earlier. Experiences of glass bottom heating in convection heating furnaces now cover all good and bad features. One excuse not to have bottom convection is the possible breakage of glass inside the furnace, in which case nozzles between the rollers could cause additional damage. The second excuse is that convection is not as important on non-coated glass surfaces. Convection is also expensive to make and increases furnace price by quite a reasonable sum.

Feracitas principle

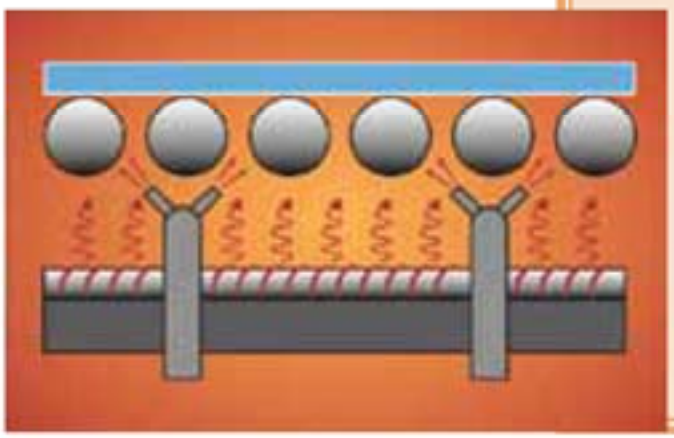
Feracitas principle is to utilize everything good in radiation heating furnaces, free of cost heat transfer by radiation. This, however, needs assistance. The furnace below the glass is covered about 75 per cent by rollers. Therefore glass bottom heating takes places mainly through the rollers. Sensible possibilities for any other heating method are nonexistent in roller hearth furnaces. It is therefore logical to increase the heat transfer through the rollers.

Feracitas patents

Feracitas patents and patent application are designed to reduce the number of components, such as hot air blowers. Simpler design also reduces operating costs by reducing heat losses, electricity to run the blowers and service costs. Expensive hot resistance ducting and connections inside the furnace are minimized. These factors reduce operating, maintenance and manufacturing costs. On the other hand, other operating parameters are maintained on the level which ensures high capacity and maintains or even improves all process features.

Cooperation agreement

Shanghai Refine Manufacturing Co., Ltd. and Feracitas have signed a cooperation agreement covering all convection aspects of furnaces ranging from technical collaboration, marketing and selling, manufacturing and services. This cooperation combines the best western technology with professional and price competitive Chinese furnace business and manufacturing. ■



Feracitas bottom heating principle, patent pending

HIGHLIGHTS

INDIAN UNION BUDGET 2012-13

- For Indian economy, recovery was interrupted this year due to intensification of debt crises in Euro zone, political turmoil in Middle East, rise in crude oil price and earthquake in Japan
- GDP is estimated to grow by 6.9 per cent in 2011-12, after having grown at 8.4 per cent in preceding two years
- India however remains front runner in economic growth in any cross-country comparison
- For 2012-13, Rs.30,000 crore to be raised through disinvestment. At least 51 per cent ownership and management control to remain with Government.
- Twelfth Five Year Plan to be launched with the aim of "faster, sustainable and more inclusive growth"
- Efforts to arrive at a broadbased consensus in consultation with the State Governments in respect of decision to allow FDI in multi-brand retail up to 51 per cent
- National Manufacturing Policy announced with the objective of raising, within a decade, the share of manufacturing in GDP to 25 per cent and creating of 10 crore jobs
- Proposal to continue to allow repatriation of dividends from foreign subsidiaries of Indian companies at a lower tax rate of 15 per cent up to 31.3.2013
- Exemption from Capital Gains tax on sale of residential property, if sale consideration is used for subscription in equity of a manufacturing SME for purchase of new plant and machinery
- Turnover limit for compulsory tax audit of account and presumptive taxation of SMEs to be raised from Rs.60 lakh to Rs.1 crore
- Proposal to provide weighted deduction at 150 per cent of expenditure incurred on skill development in manufacturing sector
- Tax proposals for 2012-13 mark progress in the direction of movement towards DTC and GST
- Service tax confronts challenges of its share being below its potential, complexity in tax law, and need to bring it closer to Central Excise Law for eventual transition to GST
- To maintain a healthy fiscal situation proposal to raise service tax rate from 10 per cent to 12 per cent, with corresponding changes in rates for individual services
- Standard rate of excise duty to be raised from 10 per cent to 12 per cent, merit rate from 5 per cent to 6 per cent and the lower merit rate from 1 per cent to 2 per cent with few exemptions
- Concessions and exemptions proposed for encouraging the consumption of energy-saving devices, plant and equipment needed for solar thermal projects

काँच की संरचना संघटन व संघटन गणना

प्रो. देवेन्द्र कुमार एवं प्रो. ओम प्रकाश

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काशी हिन्दू विश्व विद्यालय, वाराणसी-221005
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'काँच' पत्रिका के अक्टूबर-दिसम्बर 2011 के 5:1 अंक में हमने 'काँच उद्योग के विकास के लिये काँच के गुणों व उपादेयता के वैज्ञानिक अध्ययन के महत्व' का वर्णन करने का प्रयास किया था। इसी लेख की अगली कड़ी के रूप में 'काँच की संरचना, संघटन व संघटन गणना' विषयक लेख प्रस्तुत है।

काँच दो अवस्थाओं, द्रव व ठोस अवस्था में पाया जाता है। काँच की द्रव अवस्था के गुणों का अध्ययन व ज्ञान काँच बनाने की प्रक्रियाओं को समझने, नवीन प्रक्रियाओं की खोज में तथा प्रक्रियाओं के सुचारू रूप से संचालन में सहायक होता हैं। काँच की ठोस अवस्था के गुणों का अध्ययन व ज्ञान, काँच को विभिन्न उपयोगों के अनुरूप ढ़ालने में सहायक होता है। इन्हीं गुणों का अध्ययन व ज्ञान, काँच के विभिन्न नवीन उपयोगों की खोज, व उनके व्यापार में भी सहायक होता है।

काँच की द्रव अवस्था अथवा ठोस अवस्था के गुणधर्म, विभिन्न प्रकार के काँचों की संरचना व उनके संघटन पर निर्भर करती है। काँच की आणविक संरचना भी काँच के घटक पदार्थो के संघटन पर निर्भर करती है। इस प्रकार काँच के घटक पदार्थों के संघटन से काँच की आणविक संरचना प्रभावित होती है तथा काँच की आणविक संरचना के प्रभावित होने से, काँच के द्रव अथवा ठोस अवस्था के गुण धर्म प्रभावित होते हैं। इसके अतिरिक्त विभिन्न गुण धर्मो के काँच के उपयोगी उत्पादों के लिये काँच के संघटक व उनकी मात्रा निर्धारित की जाती है।

आक्साइड काँचों के अतिरिक्त, घात्विक तथा पालीमरिक काँचों की भी खोज हुई है, लेकिन इन काँचीय पदार्थो का उपयोग सीमित है इस लेख में हम आक्साइड काँचों की संरचना व संघटन का अध्ययन सरल रूप से करेगे। आक्साइड काँचों का प्रमुख घटक पदार्थ सिलिका (SiO_2) है। सिलिका का रासायनिक सूत्र SiO_2 है, लेकिन ठोस पदार्थों, केलासीय अथवा काँच में यह $(SiO_4)^{4-}$, टेट्राहैड्रल आणविक इकाई के रूप में रहता है। इसी प्रकार अन्य आक्साइड विभिन्न प्रकार की आणविक इकाई के रूप में उपस्थित रहते हैं। इन आणविक इकाईयों के केन्द्र में धनात्मक आयन जैसे Si^{4+}, Al^{3+}, B^{3+}, P^{5+} इत्यादि आयन रहते है तथा इन धनात्मक आयनों को ऋणात्मक O^{2-} आयन घेरे रहता है। O^{2-} आयन दो या उससे अधिक आणविक इकाइयों का हिस्सा हो सकते है। जब O^{2-} आयन दो आणविक इकाईयों का हिस्सा होते हैं तब वे

दोनों आणविक इकाईयाँ इस सेतु O^{2-} आयन के माध्यम से जुड़ी रहती है तथा इस O^{2-} आयन को सेतु O^{2-} आयन कहा जाता है। सिलिका काँच में एक $(SiO_2)^{4-}$ आणविक इकाई अपने चार सेतु O^{2-} आयन की सहायता से अन्य चार $(SiO_4)^{4-}$ आणविक इकाइयों से जुड़ी रहती है। इस प्रकार प्रत्येक आणविक इकाई क्रमशः एक से दूसरे, दूसरे से तीसरे, तीसरे से चौथी आणविक इकाईयों से जुड़कर एक नैटवर्क की संरचना करती है। दो आणविक इकाईयों के सेतु बिन्दु पर कुछ लचीलापन रहता है। यह लचीला पन ही इन पदार्थो को ठोस अवस्था में अकेलासीय या काँच का रूप प्रदान करने में सहायक होता है। जिन तत्वों के आक्साइड आणविक इकाईयों सिलिका (SiO_2) के प्रकार की नैटवर्क संरचना बनाने में सक्षम होती है, उनको नैटवर्क बनाने वाले या काँच बनाने वाले आक्साइड कहा जाता है। उदाहरण के लिये SiO_2, B_2O_3, P_2O_5 इत्यादि नैटवर्क या काँच बनाने वाले आक्साइड है। अतः यह कहा जा सकता है कि काँच की संरचना को Randam नैटवर्क के रूप में जुड़ी विभिन्न आणविक आक्साइड इकाईयों के रूप में प्रदर्शित किया जा सकता है।

कुछ तत्वों के आक्साइड जो स्वतः या अकेले काँच बनाने मे सक्षम नहीं है, लेकिन काँच बनाने वाले आक्साइडों के साथ काफी मात्रा में मिलकर काँच बनाते है। इनमें प्रथम वर्ग में एलकली व एलकलाइन अर्थ आक्साइड जैसे (Na_2O, K_2O, Li_2O, CaO इत्यादि) जो काँच की संरचना में नैटवर्क का हिस्सा नहीं बनते है, वरन् नैटवर्क को उनके सन्धिस्थान से तोड़कर नैटवर्क का रूपांन्तरण करते है। इनको नैटवर्क रूपान्तरकारी (Modifier) कहा जाता है। तीसरे वर्ग में Al_2O_3 इत्यादि जैसे आक्साइड आते है जो सिलिका नैटवर्क में सिलिकान परमाणु के स्थान पर जाकर नैटवर्क का हिस्सा भी बन सकते है या Na_2O इत्यादि की तरह नैटवर्क का रूपान्तरण भी कर सकते है। इनको उभय गुणी आक्साइड कहा जा सकता है।

नैटवर्क रूपान्तरकारी आक्साइड के उपयोग से $(SiO_4)^{4-}$ का O^{2-} आयन सेतु बिन्दु टूट जाता है तथा उन बिन्दुओं पर अलग-अलग O^{2-} आयन अलग-अलग $(SiO_4)^{4-}$ आणविक इकाईयों के हिस्से बन जाते है। इन O^{2-} आयनों को (अ-सेतु) (Non-bridging) O^{2-} आयन कहा जाता है। इन आक्साइड के उपयोग से व नैटवर्क टूटने से काँच का गलनांक कम होता है तथा काँचीय द्रव की श्यानता (Viscosity) भी कम होती है। अतः ये आक्साइड काँच बनाने की प्रक्रियाओं को सुगम बनाने में सहायता करते है। इन आक्साइड की सहायता से काँच के भौतिक तथा रासायनिक गुणों का परिवर्तन भी किया जाता है।

काँच बनाने की प्रक्रिया में द्रव काँच में बुलबुले बने रह जाते हैं जो द्रव काँच की अधिक श्यानता के कारण उसमें से बाहर आसानी से नहीं निकल पाते है। द्रव काँच में उपस्थित इन बुलबुलो को सरलता से निकालने के लिय As_2O_3, Sb_2O_3, एलकली नाइट्रेट या सल्फेट को कुछ मात्रा में मिलाया जाता है। इनको काँच का रिफाइनिग एजेन्ट कहा जाता है। कुछ ट्राँन्जीशन व रेयरअर्थ आक्साइड पदार्थो को काँच के अपवर्तनाँक (Refractive Index) के परिवर्तन व आकर्षक रंग प्रदान करने के लिये किया जाता है।

इस प्रकार यह देखा जा सकता है कि व्यवसायिक रूप से उपयोगी काँच की संरचना में विभिन्न गुण धर्म वाले अनेक प्रकार के आक्साइड हिस्सा लेते हैं। लेकिन कुछ आक्साइड जैसे SiO_2, Al_2O_3 इत्यादि को छोड़कर अन्य आक्साइडों का मूल रूप में काँच का बैच बनाने में उपयोग नहीं होता है। ये आक्साइड कार्बोनेट, नाइट्रेट, सल्फेट या अन्य प्राकृतिक योगिकों के उपयोग से प्राप्त होते हैं।

काँच बनाने के लिए जिन मूल पदार्थो का उपयोग उसके बैच में किया जाता है, उनमें से कुछ इस प्रकार है।

1. सिलिका सैंड (रेत)	2. सोडा ऐश
3. फेल्सपार	4. बोरेक्स
5. डोलोमाइट	6. लाइम स्टोन
7. नेफेलीन	8. काइनाइट

इनके अतिरिक्त काँच बैच को सुगमता पूर्वक द्रवीभूत करने के लिये काफी मात्रा में कलेट (Cullet पुनः

संग्रहीत काँच) का भी उपयोग होता है। शोध कार्यो के लिये, सामान्यत: शुद्ध, लेवारेटरी ग्रेड के रसायनिको, जो आक्साइड, कार्बोनेट, नाइट्रेट इत्यादि होते हैं, का उपयोग काँच का बैच बनाने के लिये किया जाता है। ये रसायनिक पदार्थ महगें होते है। सामान्य व्यवसायिक काँच पदार्थो के बैच के लिये सामान्यत: उपर्युक्त प्राकृतिक पदार्थो का उपयोग किया जाता है।

इस प्रकार प्रथम प्रकार के शोध कार्यो में उपयोगी काँचों के लिये बैच (संघटन) गणना आसान होती है। सामान्य काँच के बैच की गणना जटिल होती है। जहाँ प्राकृतिक रसायनिकों का उपयोग होता है, जहाँ एक प्रकार का आक्साइड विभिन्न मूल पदार्थो से प्राप्त होता है। जैसे फेल्सपार से SiO_2, Na_2O, K_2O, Al_2O_3 प्राप्त होता है। बोरेक्स से Na_2O व B_2O_3 प्राप्त होता है तथा डोलोमाइट से MgO तथा CaO प्राप्त होता है।

काँच की संघटना प्राय: घटकों के मोलर अनुपात में या भारिक अनुपात में प्रदर्शित की जाती है, लेकिन काँच के बैच बनाने के लिये विभिन्न पदार्थो का भारिक अनुपात में तौल कर सम्मिश्रित किया जाता है अत: काँच के घटक आक्साइड पदार्थो के मोलर या भारिक अनुपात को, बैच घटक पदार्थो के भारिक अनुपात में परिवर्तन करना आवश्यक होता है। इनको निम्न उदाहरणों के रूप में समझा जा सकता है।

माना कि शुद्ध मूल पदार्थो के द्वारा एक बोरो सिलीकेट काँच बनाना है, जिसका रसायनिक संघटन इस प्रकार है।

$74\ SiO_2,\ 2Al_2O_3,\ 16\ B_2O_3,\ 6\ Na_2O\ 2K_2O$ (मोल%)

इन रसानिक घटकों के लिये SiO_2 व Al_2O_3 को मूल रूप मे, B_2O_3 के लिये H_3BO_3, Na_2O के लिये Na_2CO_3 तथा K_2O के लिये K_2CO_3 का उपयोग किया जाता है तथा बैच एक बैच घटक के लिये एक ही मूल पदार्थ का उपयोग किया जाता है। इस काँच के बैच के लिये संघटनीय गणना सारणी (1) के रूप में किया जा सकता है। सारणी में कॉलम 7 में मूल पदार्थो के भार % गणना के लिये, कॉलम 6 के विभिन्न मूल पदार्थो के भार में सभी पदार्थो के कुल भार से भाग देकर 100 का गुणा किया जाता है।

व्यवसायिक काँच बनाने के लिये सस्ते अधिक मात्रा में उपलब्ध प्राकृतिक पदार्थो का उपयोग किया जाता है। इन पदार्थो की शुद्धता कम होती है तथा एक मूल पदार्थ काँच के लिये एक से अधिक घटक पदार्थ विभिन्न मोलर अनुपात में प्रदान करता है:

सारणी 2 में प्राकृतिक योगिकों के एक मोल से प्राप्त होने वाले विभिन्न प्रकार के काँच के घटक पदार्थों को दर्शाया गया है। इस प्रकार व्यवसायिक रूप से काँच उत्पादन के लिये बैच संघटन की गणना कठिन व जटिल हो जाती है। इसकी गणना सामान्य रूप से करना कठिन हो जाता है।

काँच की बैच गणना के लिये सारणी

घटक	घटक का मोल%	मूल पदार्थ	मूल पदार्थ के मोल	मूल पदार्थ आणविक भार	मूल पदार्थ के आणविक भार * मोल	मूल पदार्थो का भार%
SiO_2	74	SiO_2	74	60.08	4445.92	58.958
Al_2O_3	2	Al_2O_3	2	101.96	203.92	2.704
B_2O_3	16	H_2BO_3	32	61.83	1978.56	26.238
Na_2O	6	Na_2CO_3	6	105.99	635.94	8.433
K_2O	2	K_2CO_3	3	138.21	276.42	3.665

*B_2O_3 के एक मोल के लिये के 2 मोल लेने चाहिए

1. फेल्सपार–

   (अ) एलवाइट (Albite)

   (1 मोल Na_2O 1 मोल Al_2O_3 6 मोल SiO_2)

   (ब) आर्थोक्लेज (Orthoclase)

   (1 मोल K_2O 1 मोल Al_2O_3 6 मोल SiO_2)

2. वोरेक्स (Borox) $Na_2B_4O_7.10H_2O$

   (1 मोल Na_2O 2 मोल B_2O_3)

3. डोलेमाइट (Dolormite) $MgCa(CO_3)$

   (1 मोल MgO 2 मोल CaO)

इसके अतिरिक्त एक ही घटक के लिये अलग-अलग तरह के मूल पदार्थो का उपयोग किया जाता है तो बैच को गलाते समय होने वाली प्रक्रियाओं में अन्तर आ जाता है।

अत: बैच संघटन गणना के लिये कई प्रकार की जटिल गणितीय प्रणालियों तथा कम्प्यूटर प्रोग्रामिंग माध्यम का उपयोग किया जाता है। यह कार्य एक तरह से Optimization tehnique से गणना करने का है और गणना करने में यह ध्यान रखा जाता है कि काँच के बैच का मूल्य कम से कम हो, काँच को द्रवीभूत करने की प्रक्रिया सरल हो, तथा कम ऊर्जा लागत वाली हो तथा काँच उत्पाद की गुणवत्ता में कोई कमी न आने पाये।

Contact Details of AIGMF Members

It has been observed that contact information of some of the members is not updated in AIGMF records. Certain circulars / information do not reach them on time.

To serve you better, we request Members to kindly supply their updated details in the following format at info@aigmf.com

	1	2
Category- Please specify (Glass Mfr/Supplier/Consultant/Others)		
Company's Name		
Contact Person		
Department / Designation		
Address 1		
Address 2		
City		
PIN		
Telephone		
Mobile		
Fax		
Email		
Website		
Remarks (if any)		

SMS facility: Last year, AIGMF has introduced SMS facility to disseminate critical information directly to select members on their mobile phone. In order to avail this facility one or two alternate mobile phone nos. may be provided.

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+91 9219668446
+91 5612280841
Email: zulfiqar_ali_fzd@yahoo.com

RIICO awards for outstanding contribution of Industries

"RIICO (Rajasthan State Industrial Development & Investment Corporation) felicitated Industries for their outstanding contribution on its foundation day celebration on 28th March in Birla Auditorium Jaipur. Honorable Minister of Industries, Rajasthan, Mr. Rajendra Pareek was the chief guest along with the Chairman RIICO Mr. Sunil Arora and MD RIICO Shri Rajendra Bhanawat.

Eminent personalities from Jaipur, representatives of different industries associations and members from industries operating in different RIICO industrial areas in Rajasthan attended the program.

HNG Neemrana received two awards – First Runner-up in the category of Corporate Social Responsibility and Commendable Performance in the category of Efficient Water Use, "Green" Unit & Innovative Practices.

Mr. Bharat Somany received these awards (Trophy and Certificates) from Mr. Rajendra Pareek, Industries Minister of Rajasthan. Mr. RL Khandelia, President and Mr. KK Sharma, Vice President/Plant Head HNG Neemrana also attended the ceremony."

Gujarat goes green with solar panels on Narmada Canal

The small Indian state in the west side of India sharing its borders with Pakistan, Gujarat is promisingly developing and its Chief Minister, Mr. Narendra Modi is doing a very commendable job. The Janmarg BRTS and the GSRTC Volvo Wifi buses already being hit projects, now joins one more in the line – The state now generates electricity from solar panels laid atop the Narmada Canal.

The solar panels are being laid atop the Narmada branch canal near Chandrasan village of Mehsana's Kadi taluka, around 75 km from Ahmedabad. The Gujarat State Electricity Corporation Limited (GSECL) will install these solar panels for about 1 km over the Narmada Canal for generating 1 MW of solar power. The engineering, procurement and construction contract for the project has been awarded to Sun Edison at a cost of Rs 17.71 crore. In traditional solar energy plants, the solar panels are laid on the land and in this unique method, the solar panels will be covering the canal. This project is believed to have the following advantages:

1. The electricity is generated from renewable solar energy and hence it is clean and environment friendly
2. Since the canals are covered with solar panels, there will be no explicit need to acquire land to install the solar project
3. The water evaporating from the canal will be reduced as the canal will be covered.
4. The power generated will be supplied to villages alongside the canal, which will lead to lower transmission losses

Bulk of India's future energy to come from renewables

By 2050, nearly 69 per cent of the electricity produced in India will come from renewables like solar energy, suggests a recent market insight on the "BIPV (Building-integrated photovoltaics) Market – Emerging Opportunities through Sustainable Resources" by Frost & Sullivan. India's strategic geographical location enables it to tap the vast potential for solar power generation, with about 300 clear sunny days in a year, the Frost & Sullivan report says.

Significantly, India, at present, is facing a severe electricity deficit, amounting to 67.148 billion KWH during 2010-11. The overall consumption of electricity in India in 2010 was 601 billion KWH with industrial, residential, commercial, and other

sectors contributing 35 per cent, 28 per cent, 9 per cent, and 28 per cent respectively. This is likely to surpass 1,000 billion KWH annually by 2020.

Therefore BIPV projects are the only viable solution for every individual/corporate to be aware of and be self-dependent to generate power on their own and also to contribute to overcome the energy deficit in the country, the report says.

BIPV are photovoltaic materials used to replace conventional building materials (such as glass facades/panels, or aluminium cladding/structural glazing, and so on) in parts of the building envelope. The concept of BIPV is new and at a very nascent stage in India. In developed countries, the BIPV system is interfaced with the available utility grid, but BIPV may also be used in standalone, off-grid systems, and is cost-effective.

"The costs of BIPV building envelope materials are more than the conventional building envelope materials that are commonly used in building construction. However, by replacing and avoiding the cost of the conventional materials and power generator, the incremental cost of the BIPV is reduced and their lifecycle cost is improved. That is, the cost of BIPV systems often has lower overall costs than PV systems that require separate dedicated mounting systems," Frost & Sullivan mentions.

Interestingly, India, at present, does not have any infrastructure for raw material production for solar panels (polysilicon) and is entirely dependent on imports.

Tie-up between LUBITECH and IHARA FURNACE CO.

LUBITECH ENTERPRISES has signed an agreement with Japan's leading glass plant and services providers IHARA FURNACE CO. LTD., JAPAN to offer their services in India. List of equipment and services provided by IHARA FURNACE CO. LTD., are

1. Glass Plant and Glass Auxiliary Equipment
   a) Glass Plant and Glass Furnace
   b) Combustion Equipment
      I. Melting end combustion equipment
      II. Working end and forehearth combustion equipment
   c) Reversing Valve and Flue Damper
   d) Batch Charger
   e) Furnace Cooling Equipment
   f) Metallic Recuperator
   g) Electric Boosting System
   h) Furnace inside Monitoring Equipment
   i) Instrumentation Equipment
      I. Central monitoring & Control equipment
      II. Combustion control system
      III. Glass level control system
   j) Annealing Lehr
   k) Batch Plant
   l) Exhaust Gas Treatment System
   m) Chimney

Mr. Kazuhisa Arai, Ihara Furnace Co. Ltd and Mr. Jayant Shroff, Lubitech Enterprises shaking hands at tie-up ceremony in Mumbai on March 12, 2012

2. Construction, Maintenance, and Other Services
   a) Plant Construction
   b) Furnace Construction
   c) Furnace Repair Service, Maintenance Service, and Diagnosis Service
   d) Heating Up and Drying Out Service
   e) Furnace Energy Saving Diagnosis

3. Other Technology and Services
   a) All Electric Melting Furnace
   b) Pot Furnace and Small Sized Tank Furnace
   c) Cullet Preheater

K S Shetty to head CII Puducherry

K S Shetty, Vice President, Hindusthan National Glass and Industries Ltd, Puducherry was elected as Chairman of Confederation of Indian Industry (CII), Puducherry State Council for 2012-13.

K S Shetty holds a B Tech (Mech) degree from Regional Engineering College, Surathkal, and has a vast industrial experience of around 30 years in the Glass Industry. He was the vice Chairman of CII Puducherry for the year 2011-12. He was the Convenor of Membership Panel of CII Puducherry for last year and actively participated in various activities of the CII.

"Quality Brands 2012-14" awarded to Empire Industries Ltd., Vitrum Glass

"National Education & Human Resource Development Organisation" awarded "Quality Brands 2012-14" to Empire Industries Ltd., Vitrum Glass, Mumbai at its national level seminar on "Individual Achievements, Intellectual Excellence & National Development" in Mumbai on January 31, 2012.

Prominent National leaders, Economists, Industrialist and Eminent people from Television and Film Industry were present on the occasion. Quality Brands awards were presented to micro, small & medium scale Industries selected from all over the country. Selected individuals were also honoured with "Rashtriya Udhyog Ratna Award" for the exemplary services rendered by them in their respective fields.

Piramal Glass invests Rs 115 crore on Vadodara plant expansion

Glass packaging company Piramal Glass has invested Rs 115 crore for capacity expansion at its Jambusar unit.

Piramal Glass Managing Director Vijay Shah told that "We want to focus on high margin cosmetic and perfumery (C&P) segment. Hence, we decided to increase our production in the segment."

Mr. S.S. Parmar, Director, Vitrum Glass was awarded "Rashtriya Udhyog Ratna Award" on the occasion of *National Economic Growth through Individual Contribution*

About operations in Sri Lanka and USA, Shah said in both these countries their units have been doing well.

"We are clocking double-digit growth in Sri Lanka while relining of one furnace is over in US which will further improve its performance," said Shah.

Talking about the company's third quarter results, he said net profit for the October-December period stood at Rs 22.9 crore on a consolidated basis.

Consolidated net sales stood at Rs. 340.1 crore, up from Rs 310.6 crore in the same period last year.

The Piramal Group firm is one of the top global manufacturer of specialty glass containers for cosmetics & perfumery (C&P), specialty foods & beverages (SF&B) and pharma segments. In Q3 FY12, the C&P segment grew by 7 per cent and contributed 47 per cent of the total sales, Shah said.

SF&B division grew by 31 per cent on account of higher sales in Sri Lanka thereby, contributing 27 per cent to the sales, the Managing Director said.

Consolidated sales for the nine-month period ended on December 31, 2011 grew by 10.2 per cent to Rs. 980.3 crore as against Rs 889.6 crore in the corresponding period. Profit after tax (PAT) stood at Rs 81.9 crore.

Interactive Session with SINGAPORE SAFETY GLASS PTE LTD

Mr. Seng Choon, Singapore Safety Glass Pte Ltd (SSG) met Manufacturers/exporters of Architectural Safety Glass in India regarding Strategic Partnership with Glass Manufacturers.

Chemical and Allied Products Export Promotion Council of India (CAPEXIL) along with The All India Glass Manufacturers' Federation (AIGMF) organised an interactive meet of Manufacturers/Exporters of Architectural Safety Glass in India with SINGAPORE SAFETY GLASS PTE LTD on Jan 17, 2012 at CAPEXIL New Delhi office.

(*Glass News Source: World Wide Web*)

The use of recycled glass in new containers helps save energy. It helps in brick and ceramic manufacture, and it conserves raw materials, reduces energy consumption, and reduces the volume of waste sent to landfill

Every metric ton (one long ton or 1,000 kg) of waste glass recycled into new items saves 315 kilograms of carbon dioxide from being released into the atmosphere during the creation of new glass

UP GLASS MANUFACTURERS' SYNDICATE (UPGMS) Programs

Workshop on Sourcing Overseas Buyers

A workshop on sourcing Overseas Buyers and Terms of Payment was organized by Federation of Indian Export Organizations (FIEO), New Delhi at Hotel Monark, Firozabad on March 14, 2012. Around 30 members of U.P. Glass Manufacturers Syndicate and members of Exporters Association, Firozabad participated in the workshop.

Awareness Programme on Intellectual Property Rights (IPR)

As part of the Intellectual Property Rights (IPR) component of the National Manufacturing Competitiveness Programme (NMCP) of the Ministry of MSME, the Federation of Indian Micro and Small & Medium Enterprises (FISME) organized an awareness programme on Intellectual Property Rights (IPR) in association with U.P. Glass Manufacturers Syndicate (UPGMS) for the MSMEs of Firozabad Glass Industry on February 25, 2012.

Mr. Mohan Lal Aggarwal, President, UPGMS and Mr. Hanuman Prasad Garg, Director, The Glass Industrial Syndicate inaugurated the programme which was attended by the entrepreneurs from the glass units in and around Firozabad.

The programme was intended to sensitize the industry members on the importance of acquiring IP rights of their work through trademark, copyrights and patents for gaining an edge over competitors. During the event participants were informed about the role of the Intellectual Property Facilitation Centre (IPFC) for MSMEs and the services to be provided by this centre. IP experts participating in the programme focused on the importance of protecting Industrial designs so that the Glass Industry of Firozabad can get recognition for the creativity of their intellectual work.

Firozabad glassware has a long history going back to King Akbar and the industry started with manufacture of bangles, small bottles and other glass articles. These products such as decorative lights, candle stands, flower vases are unique as they do not have joints.

Officials of FISMA's IPR Facilitation Centre explained to the participants the content and scope of Geographical Indications applications as an intellectual property right with examples related to the local glass industry and how the term 'Firozabad Glass' can be protected from a GI perspective and how other such GI rights such as Kannauj Perfume, Kanpur Saddlery, Moradabad Metal Craft, etc. can be created and protected through artisans forming communities to register and control the use of their GIs. Such GIs could then be used for the development and overall benefit of the Glass Industry in Firozabad.

Millars

HIGH SPEED PAN MIXER

For Glass Industries

TECHNICAL DATA

Technical Data	THZ 375	THZ 750	THZ 1125	THZ 1875	THZ 2250
Capacity maximum Input in Ltrs.	375	750	1125	1875	2250
Capacity maximum dry Input in Kgs.	375	750	1200	2000	2500

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Glass Recyling Figures Steady in 2010

Using waste as a raw material feeds the circular economy

According to the latest glass recycling estimates [1] – published by the European Container Glass Federation (FEVE) and one year ahead of Eurostat's official data – the average glass recycling rate in the European Union remains stable at 68%. That means about 25 billion glass bottles and jars were collected throughout the European Union in 2010.

While industry makes use of all the glass that is collected; not all types of recycling carry the same environmental benefit. The product closed loop is at the top because it replaces the need for virgin materials within the same product life cycle: 80% of collected glass bottles and jars are recycled in a bottle-to-bottle closed loop recycling system. By recycling glass, in 2010 in the EU[2] :

- More than 12 million tons of raw materials (sand, soda ash, limestone) were saved: that's two Egyptian Pyramids worth of sand and other raw materials saved[3] .
- More than 7 million tons of CO2 was avoided equal to taking 4 million cars off the road.

Because glass is 100% infinitely recyclable in a closed loop system, each time a bottle or jar is properly collected and recycled and made into new containers, energy and raw materials are saved and less CO_2 is emitted. These characteristics make glass a clear example to follow in the ambitious strategy of the European Commission to make the European Union a 'resource efficient'

economy where recycling is the key factor to waste reduction and where waste is considered as a valuable resource[4].

"Glass collection and recycling is the perfect component of a circular economy," says Niall Wall, President of FEVE. "As there is still 32% of glass that is not yet collected our goal is to get this precious resource back in the bottle-to-bottle loop. With the help of national and EU authorities, collectors and processors we want to increase the quantities of good quality glass collected so that we can recycle more in our plants."

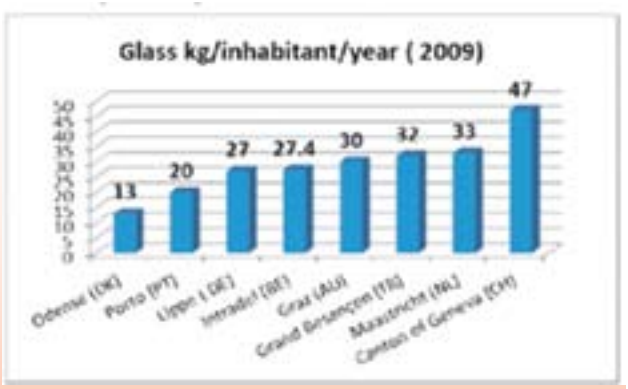
FEVE has recently worked with ACR+ the Association of Cities and Regions for Recycling and Sustainable Resource Management to promote good practices in glass recycling in Europe. The report[5] says separated waste collection schemes should be widely supported if we are to build a circular economy for glass packaging. In May 2012 the EU Commission is due to announce a new legal status for post consumer glass (cullet) – giving cullet a status of non-waste, a measure that is likely to help further increase glass recycling rates.

1) Published on www.feve.org. The number of units has been calculated on a standard average EU weight of 450g. Currently, glass lightweight bottle can weigh 285g. Where data 2010 were not available from FEVE sources, 2009 Eurostat data were used.
2) Based on calculations backed by COREVE and FEVE. See www.feve.org
3) It is estimated that 5.5 million tons of limestone, 8,000 tons of granite and 500,000 tons of mortar were used in the construction of the Great Pyramid. http://en.wikipedia.org/wiki/Great_Pyramid_of_Giza
4) http://ec.europa.eu/resource-efficient-europe
5) http://www.acrplus.org/glass_recycling_report

ACR+ and FEVE report shows good practices in glass recycling

A report published by the Association of Cities and Regions for Recycling and Sustainable Resource Management (ACR+) for the European Container Glass Federation (FEVE) says: Separated waste collection schemes should be widely supported if we are to build a circular economy for glass packaging. It stated that Europe needs to use its resources much more sparingly by recycling more, meaning we need higher collection rates and higher quality of collected glass. The report concludes that only glass bottles and jars collected separately will result in both a higher quantity and quality of post-consumer glass (cullet) availability that can save resources to make new packaging.

Glass stands out as one of the best examples of the closed loop production model because it is one of the most effectively recycled materials in Europe (67 percent on average). This is not only because of its natural characteristics - it is 100 percent and infinitely recyclable -, but also because of well-established separate collection schemes. More can be done however and the study highlights some good practices. More recycled glass brings major benefits for the environment because when recycled glass is used, fewer raw materials are extracted, less waste is generated, less energy is used and less CO_2 is emitted.



25bn bottles and jars collected

"Last year, more than 25bn bottles and jars were collected in Europe, while almost 100 percent of the glass collected is used, the vast majority of it well over 80 percent is actually recycled in a bottle-to-bottle production system supporting a circular economy", observes Adeline Farrelly, FEVE Secretary General. "The better the quality of the glass collected the more we can recycle in a bottle to bottle system. This type of glass recycling is not only a local industry but also brings major economic and environmental benefits. We strongly support the findings of this timely study which underpins the importance given to recycling in the EU's waste hierarchy."

Based on a comprehensive assessment of European municipalities' collection schemes, the ACR+ study identifies eight schemes including bottle banks with colour separation, as key drivers to glass recycling growth.

Separate collection system is better

In separate collection systems the processed material is of better quality to meet the specifications necessary for the bottle-to-bottle production and is cost competitive in relation to the use of virgin raw materials. Other systems, like co-mingled collections can be either too costly or provide glass only suitable for low-grade applications (e.g. as aggregate). These applications are literally a waste – because the material is lost forever from the circular economy.

"We need a more integrated approach with all the stakeholders along the chain, including citizens, and make more sustainable waste collection decisions in the future", states Olivier De Clercq, Secretary General of ACR +. "We think it's important for local authorities and collection organizations to know more about what happens to materials once they are collected. Clear technical guidelines and ad hoc support for proper glass collection would make recycling easier and even better performing."

Clearer communication recommended

The study also recommends more and clearer communication to citizens about the benefits of glass collection and recycling in a bottle-to-bottle system, and the role they can play. Municipalities can work on this aspect too, as can industry. The European container glass manufacturers - through FEVE - support "Friends of Glass", a self-fed European consumer community of more than 30,000 people promoting the consumer right to choose food and drinks in glass packaging. A number of tools are available on www.friendsofglass.com to increase consumer awareness about glass recycling and the environment.

The study "Good practices in collection and closed-loop glass recycling in Europe" and its synopsis is available on www.feve.org

UAE brings forward ban on disposable plastics

The United Arab Emirates (UAE) has brought forward its ban on all disposable plastic products, except on those made from oxo-biodegradable plastic, by one year.

The ministry of environment and water issued a decree banning the use of non-biodegradable plastic bags by the end of 2012.

Originally, the ban was proposed to be made

effective on 1 January 2013 but concerns about plastic products accumulating in the deserts and the sea, and the effect on the local wildlife, have led the ministry to rethink.

Plastic packaging

The ban covers all packaging and disposable articles made from plastic polymers derived from fossil-fuels, except those made from oxo-biodegradable plastic, according to the Ministry.

The banned products include flexible shopping bags and semi-rigid plastic packaging for food, magazines, consumer-durables, garbage bags, bin-liners for household use, shrink wrap, pallet wrap and cling film.

It also covers other articles normally used over short periods and subsequently discarded.

The official notice stated that all plastic products from now on will require ECAS Registration Certificate issued by Emirates Authority for Standardisation & Metrology (ESMA) only for products made from oxo-bio plastic.

The products should comply with UAE Standard 5009 of 2009 and must be made with pro-degradant additive from suppliers who have been audited by ESMA.

ESMA will inspect plastic bags and other plastic products at port-of-entry and also conduct factory inspections to ensure full compliance of products being manufactured within the UAE.

About the ban on disposable plastics, PAFA chief executive Barry Turner said: "The focus has to be on educating the consumer to use packaging responsibly and to reuse and recycle it.

"We have to reuse and recycle to conserve resources and not destroy resources.

"There is no escaping this and to think there is a silver bullet is misleading. In fact there is a real danger that consumers think they can discard used bags just because they will degrade so far from addressing the route causes this measure can and will make things worse."

'Opportunity'

Oxo-biodegradable plastic firm Symphony Environmental said the ban presents the company with an opportunity to supply a market estimated at 500,000t and where it is an authorised supplier.

Symphony is also making its d2detector, a portable device which can tell instantly whether a plastic product is oxo-biodegradable, available in the UAE.

Oxo-biodegradable plastic has a controlled lifespan and ability to biodegrade completely either on land or water and has proved popular across the Middle East and particularly in the UAE.

Recycling one glass bottle saves enough energy to power a 60-watt bulb for four hours, a computer for 30 minutes or a television for 20 minutes

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'Europe's most advanced' glass recycling site planned

Viridor's glass recycling site at Bonnyrigg, Midlothian, is set to become home to 'Europe's most advanced glass recycling infrastructure' following a £6 million investment by the waste management firm.

The company is installing technology to sort mixed glass according to colour, allowing it to be returned to its original streams for re-melt, whilst any contaminated material will be rejected.

Viridor has already installed similar glass sorting technology at its Sheffield facility

The facility will use the latest generation 'electronic eye and air jet' separation technology. It is understood this is being provided by German-based manufacturer Mogensen, however a contract has yet to be signed.

Viridor's Bonnyrigg site already features a £3 million glass recycling facility which handles up to 100,000 tonnes of container and plate glass every year, from both material recycling facilities (MRFs) and source separated collections. The facility handles glass from 18 local authorities, which, once processed, is supplied to Scottish container remanufacture, insulation and aggregate sectors.

The new technology will increase the facility's capacity to 140,000 tonnes-a-year.

Commenting on the investment, Richard Lochhead, Scotland's Cabinet Secretary for Rural Affairs and the Environment, said: "Zero waste isn't simply about high rates of recycling, it's about extracting the most value we can from items that can be recycled. Closed loop recycling – glass going back to glass – reduces our consumption of raw materials and helps reduce carbon emission.

"This £6million technology Viridor is investing in will mean that glass can potentially be recycled an infinite number of times, a win-win for our planet and our economy."

The facility is expected to be operational in September 2012.

Emirates Glass looks to build on Dh160m facility

Dubai Emirates Glass, a leading processor of architectural flat glass in the Middle East, said it will invest in glass companies in Qatar, India and Iraq.

The company has opened a Dh160 million post-temperable coating line that aims to boost production capacity to over 3.5 million square meters, a statement said.

UAE Minister of Economy Sultan Bin Saeed Al Mansouri inaugurated the coating line at Emirates Glass, a subsidiary of Glass LLC and wholly owned by Dubai Investments.

Speaking on the occasion, Khalid Bin Kalban, Managing Director and Chief Executive Officer of Dubai Investments, noted: "Reinstating Emirates Glass' position as a pioneer in adopting technological innovations, the new coating line will enable the company to capitalise more effectively on the burgeoning demand for energy-efficient architectural glass."

Dubai Investments has invested Dh1.5 billion in four glass factories and plans to invest an additional Dh800 million in 2013-2014.

The expansion will include upgrading of the Emirates Float Glass factory in Abu Dhabi. Furthermore, Dubai Investments will also invest in glass companies in Qatar, India and Iraq.

glasstec 2012 offers opportunities for young, innovative companies

German Ministry of Economics and Technology grants subsidies of up to EUR 7,500

The German Ministry of Economics and Technology sponsors young and innovative companies wanting to exhibit at glasstec 2012 (23-26 October 2012), the most important international trade fair in the glass industry. The aim is to provide the best possible support for the marketing of innovative products in other countries. With 57 per cent international visitors, glasstec offers an ideal platform.

The sponsorship scheme of the German Ministry reimburses up to 80 per cent of costs for stand rental, stand construction, electric power and waste disposal expenses, with an upper limit of EUR 7,500. To qualify for funding under this programme, a firm must be a small or medium-sized company and must operate and be based in Germany. It must also be less than 10 years old, have an annual turnover of no more than EUR 10 million and employ a workforce of less than 50. Moreover, it must exhibit newly developed products or processes at the trade fair.

Messe Düsseldorf will have a joint stand with the German Ministry of Economics and Technology at glasstec 2012, presenting all the companies that have been admitted to the sponsorship programme. Registrations are now accepted by Messe Düsseldorf via www.glasstec.de. At the same time a sponsorship application must be submitted to the Federal Office of Economics and Export Control (BAFA). Registration becomes effective as soon as sponsorship has been confirmed.

US firm wins deal for $300m Saudi soda ash plant

Jubail has grown into one of Saudi Arabia's largest industrial centres

Jacobs Engineering Group has been awarded a contract to provide engineering and project management services for the construction of a $300m soda ash and calcium chloride production facility in Saudi Arabia.

The contract for the facility was awarded by IDEA Soda Ash and Calcium Chloride Company (ISACC) and will be built in Jubail's Second Industrial City.

The commissioning production run is scheduled to start by end of 2014 and commercial operations are expected to follow in the first quarter of 2015.

Officials did not disclose the contract value, but added in a statement that the facility is the first of its kind in the kingdom and the GCC to produce soda ash (sodium carbonate) and calcium chloride.

These products, currently being imported, are used in oil and gas drilling operations, as well as in the manufacture of glass and detergents.

Following award of the engineering, procurement and construction contract, Jacobs said it is also providing the project management services up to the plant start-up.

Abdulaziz A-Muaiyyad, ISACC Managing Director & CEO, said: "The project will make a significant contribution to the development of Saudi Arabia's non-oil economy with all basic materials secured from mines within Saudi Arabia."

Jacobs Group Vice President, Bob Irvin, added: "It (the project) is the first of its kind in the kingdom and we fully recognize the importance of increasing the participation of the chemical industries sector in the national economy."

Work is currently in progress to secure all the other necessary utilities to run the project.

ISACC said it is setting up a new entity — Jubail Inorganic Chemicals Industries Company — to run the new facility.

New Sales Director for Heye International

Heye International announces the appointment of Dr. Rainer Hauk as Director Sales and Marketing from January 1, 2012. He succeeds Peter Kiewall, who is retiring in March 2012 after more than 45 years in the glass industry. Peter Kiewall was formerly holding positions as project manager and head of engineering at Heye International, knowing many key players in the container glass business around the world.

Dr. Rainer Hauk has gained extensive experience in the glass industry, e.g. in the batch plant and cullet treatment sector, on a global level. He will continue Peter Kiewall's work on the implementation of Heye International's growth strategy.

Peter Kiewall Dr. Rainer Hauk

(*Glass News Source: World Wide Web*)

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A step closer to 'green' glass melting

Brazil's AmBev Vidros Rio is employing biogas to melt glass in a furnace designed and commissioned by Horn Glass Industries. Matthias Kunz explains.

In 2007, German furnace manufacturer, Horn Glass Industries AG installed its first furnace for AmBev Vidros Rio in Brazil. The customer is part of the AB-Inbev Group, Brazil's largest consumer goods enterprise and the world's largest brewery.

As reported in *Horn News* August 2009, the furnace is operated with an energy consumption of less than 800 kcal/kg (780 kcal/kg on average) and was heated with natural gas. Recently, Horn installed additional heating equipment to heat the furnace with biogas, which develops as a by-product, for example, in the agricultural, food and beverage industries.

BIOGAS PRODUCTION

Biogas is a combustible gas which is produced by fermentation of, for example, the grain mash from the brewing process. The microbial decomposition of organic materials under anoxic conditions produces methane (CH_4) and carbon dioxide (CO_2). There are also traces of nitrogen (N_2), oxygen (O_2), sulphurated hydrogen (H_2S), hydrogen (H_2) and ammonia.

The composition of raw biogas varies, the values being on average as those shown in table 1.

In order to utilise the raw biogas for further energy generation, it is adapted to the quality of natural gas by various conditioning steps. Sulphurated hydrogen and ammonia in particular are unwanted in the raw biogas. These are removed during conditioning before combustion to prevent corrosion in downstream components (among others the gas supply stations).

The following purification steps are required:

- Desulphurisation to avoid corrosion of components.
- Drying to avoid the formation of considerable quantities of condensed water if temperatures fall below the dew point.
- Separation of CO_2 for accumulation of methane (CH_4) and thus increase the calorific value.

After conditioning, the gas can be utilised to generate electrical energy, to operate vehicles or it can be supplied into a gas supply system.

CONSTITUENT	PROPORTION
Methane	60%
Carbon dioxide	35%
Water vapour	3.1%
Nitrogen	1 %
Oxygen	0.3 %
Hydrogen	< 1%
Ammonia	0.7 mg/m³
Sulphurated hydrogen	500 mg/m³

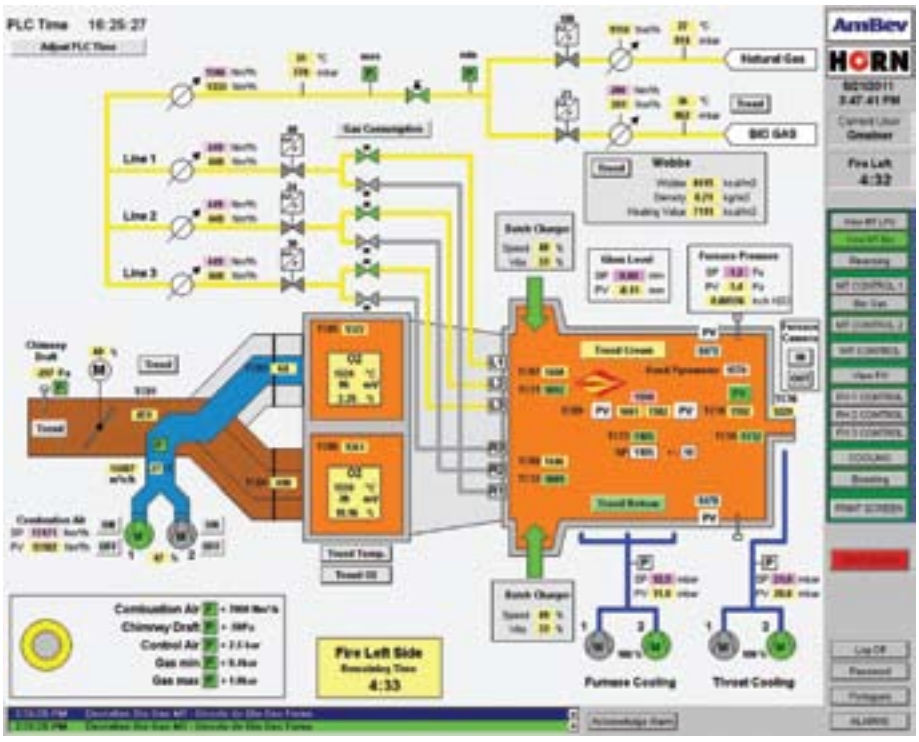
Table 1: Composition of biogas.

BIOGAS USE IN GLASS MELTING

Horn Glass Industries AG supplied additional gas stations to AmBev to supply the biogas into the existing natural gas supply system. A separate pressure control and filter station were installed for this purpose, as well as a gas measuring and control station. Wobbe measurement is also provided, to determine the exact calorific value of the biogas. This value can also be keyed in manually, if required.

Supply of biogas is provided for a quantity of 500 Nm³/h minimum up to 1100 Nm³/h maximum. However, the overall gas consumption of the furnace is higher and therefore, the biogas is mixed with natural gas and then supplied to the furnace. The main problem with such a mixture is the different and variable calorific values of the biogas and natural gas. Energy supply to the furnace would vary constantly if the gas quantity were controlled exclusively according to the volume flow in Nm³/h. This would lead to temperature variations and thus to a reduced operating life for the furnace.

To avoid this scenario, gas quantity control was



Screen shot of the control system.

Originally published in Glass Worldwide, preferred international journal of AIGMF

Gas stations for supplying biogas into a glass melting furnace.

converted into mcal/h according to the energy input. For this purpose, the exact calorific value of the biogas is required, which is calculated by separate Wobbe measurement in the supply stations. In the case of fluctuations in the calorific value, the volume flow of the respective gas is automatically readjusted to maintain constant energy input to the furnace.

Horn executed installation of the plant, as well as commissioning during production. Therefore, no temporary production stoppage was necessary. Moreover, the low energy consumption of the furnace was maintained at a constant level. Consequently, the biogas has no impact on energy consumption. Furthermore, there were no fluctuations in the process parameters of the furnace or in glass quality.

Wobbe measurement of biogas.

ENVIRONMENTAL IMPACT

Biogas has the advantage of being acquired at reasonable prices, since it develops as a by-product. However, the biggest advantage is the carbon-neutral emission of CO_2. The CO_2 quantities arising from combustion are absorbed from the air by the biomass beforehand. This may be advantageous for companies that may not exceed a certain annual CO_2 quantity. These companies can increase their production capacity with constant CO_2 emissions by means of biogas.

Thereby, AmBev actively contributes to environmental protection with an energy saving glass furnace and the utilisation of biogas in glass production. ■

ABOUT THE AUTHOR:
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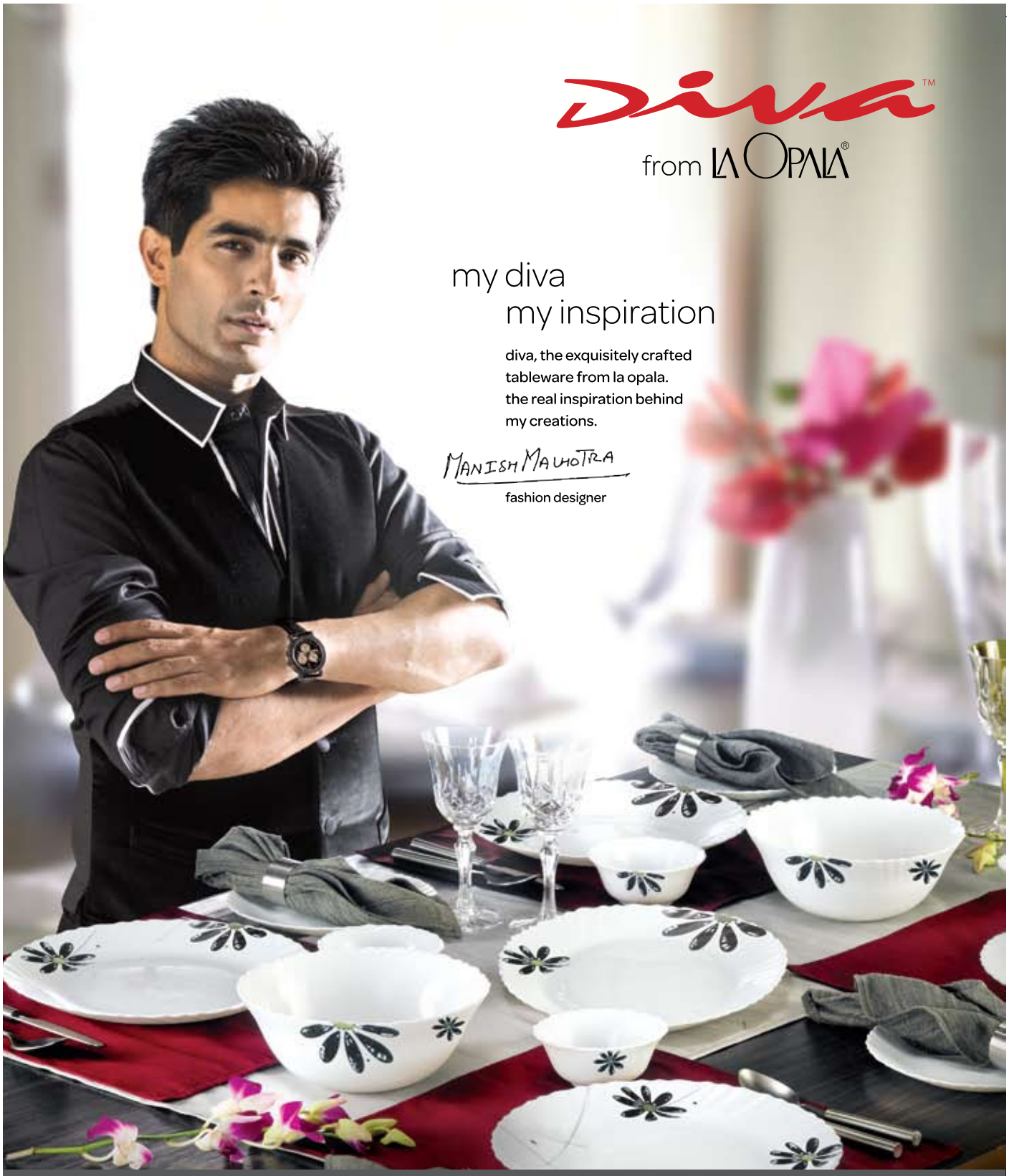

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