

# ELEMENT

Your Guide to Foundries in Pakistan

SPECIAL EDITION 2018



**PAKISTAN**  
FOUNDRY ASSOCIATION  
PFA for Development of Foundry Industry

Industrializing Pakistan

دنیا ہماری منڈی

## 7<sup>th</sup> INTERNATIONAL FOUNDRY CONGRESS & EXHIBITION (IFCE-2018)

14th-15th November 2018, Pearl Continental Hotel, Lahore





# PAK THERM

The Fastest Heating Solution



Mr. Misbah-Ud-Din

**MANUFACTURER OF  
INDUCTION MELTING FURNACES  
CAPACITY 50 KG TO 25 TON**



## CORE FEATURES

- Lowest power consumption.  
50-60KWH/Ton steel electricity saving.
- More production with less MDI
- Flash Track Model
- More lining heats
- Fastest after sale service.



POWER SUPPLY SYSTEM



MELTING CRUCIBLE



TRANSFORMER



11KM Sharakpur Road Sagian Moti fouji Road Near Al-Mugni Trust Nain Sukh Lahore.

Tel : +92 42 37934233, Fax : +92 42 37934236 Mob : +92 321 4473308

Email : Paktherm@gmail.com Website: www.paktherm.com.pk



## Measuring Beyond Expectations



Ajay Syscon Private Limited

A joint venture with Syscon International Inc. U.S.A.

147/1&2, Shembekar Industrial Compound, Chinchwad, Pune - 411 019, India

Tel. Office: +91 20 2543 9582. Factory: +91 20 2744 0462

Email: [info@ajaysyscon.com](mailto:info@ajaysyscon.com)

[www.ajaysyscon.com](http://www.ajaysyscon.com)

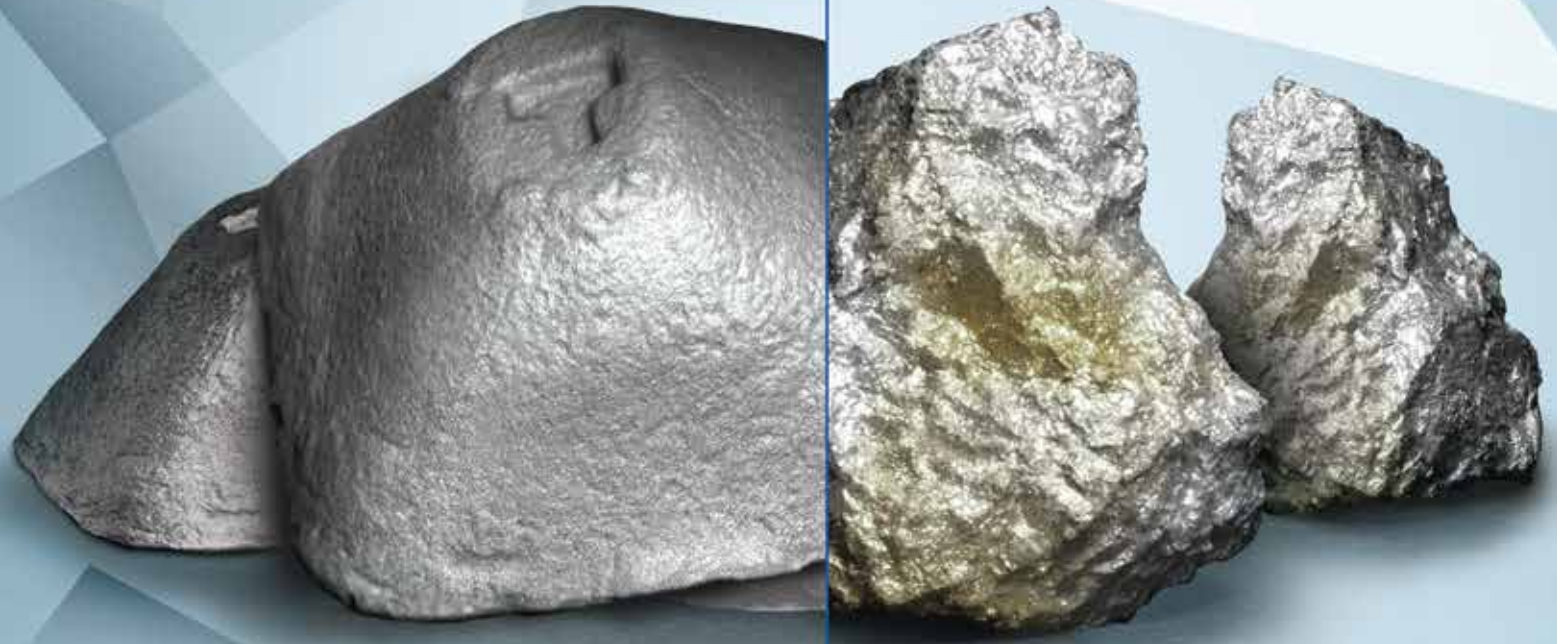


Branches: • Ahmedabad • Agra • Bangalore • Belgaum • Chandigarh • Chennai • Coimbatore • Delhi • Hyderabad • Jalandhar • Jamshedpur • Kolhapur • Kolkatta • Ludhiana • Nagpur • Rajkot • Vapi





www.aveks.com



## Your GLOBAL STORE.

Broad spectrum of suppliers  
Wide range of products  
Cost effective and creative solutions ...



- Pig Iron
- Recarburizers
- Chromite Sand
- Ferro Alloys
- Inoculants
- Abrasives

# PRESIDENT MESSAGE

2018

Element Special Edition IFCE

1

Pakistan Foundry Association (PFA) will organize 7th International Foundry Congress & Exhibition (IFCE-2018) on 13th-15th November, 2018 at Pearl Continental Hotel, Lahore. I feel pleasure to invite all PFA members, casting producers, machinery manufacturers, foundry material suppliers, service providers and global foundry technologist from various countries.



Mr. Abdul Razzak Dawood, Advisor to Prime Minister on Commerce, textile, and industry will Inaugurate IFCE-2018, with the objective to prepare local foundries for export markets. The purpose of the event is technological up-gradation and skills development.

The International foundry consultants and speakers are invited from Europe, China, India, UK, Turkey and Germany, representatives from European & Asian foundry association. They will be available to meet casting producers and users to address their issues in casting, in cast source meetings. The exhibition will provide an opportunity to investors, machinery manufacturers, foundry material suppliers

and service providers to showcase their products and services. IFCE will have exhibition and foundry technology Workshops and Seminars for two days. They will be conducted by International foundry experts/ consultants and speakers. All foundrymen, engineers and their technical staff from various industrial sectors are invited.

Around 25 Technical sessions of one to two hours each, have been planned during two days. Length of session depends on importance of the subject. Translators in local language will be available in each session to ensure maximum understanding of the subject. Pakistan Foundry Association team has proposed these topics for the technical session, but the experts may choice presentation according to the need of the audience.

*I pray to almighty Allah for the great success of IFCE-2018 to make it a memorable event.*

**Sikandar Mustafa Khan**  
President-PFA

## Table of Contents

02

State of the U.S. Cupola Industry

08

Marketing and Exports of Quality Castings and Modern Technology

19

Heat Treatment

26

Concept of Neutral Refractory lining in Coreless Induction Furnace

### Chief Editor

**Mr. Fahad Iqbal**

Joint Secretary  
Pakistan Foundry Association



### Editor / Publisher

**Mr. Abdul Rashid**

Secretary  
Pakistan Foundry Association  
Foundry Service Center,  
University of Engineering & Technology,  
(Opposite Gate # 5, U.E.T) G.T Road, Lahore, Pakistan  
Ph:+92-42-36851559, Cell: +92-322-8487873 /  
+92-300-8673873  
E-mail: pakistanfoundryassociation@gmail.com/  
info@pfa.org.pk, Web: www.pfa.org.pk



# State of the U.S. Cupola Industry

Cupola melting systems in the U.S. produce a majority of iron castings, and advancements in the melting technology has made their use sustainable into the future.  
 david kasun, p.e., kuttner llc (port washington, wisconsin)

Since the advent of time, cupola furnaces have melted the vast majority of cast iron worldwide and in the U.S. While the number of operating cupolas in the U.S. has decreased from about 200 to 42 cupolas since the turn of the century, advances in cupola technologies, increases in cupola efficiency and the metallurgical and cost benefits of cupolas have ensured they remain as a significant, and leading technology for iron production. The 42 cupola foundries in the U.S. produce approximately 53% of all domestic cast iron. Nearly 62% (3.75 million tons per year) of all gray iron production and nearly 38% (2.3 million tons per year) of all ductile iron production is produced by cupola melting.

Projections from AFS Metalcasting Forecast & Trends show that total annual shipments for iron castings is 6.74 million tons per year. By applying typical yield rates for the various SIC codes (ductile pipe, municipal, agricultural, automotive, etc.), estimates show that total tons melted for all iron types totals about 11.45 million tons per year. By applying knowledge-based estimates of the cupola industry, it is estimated that of the total iron melted, about 6.07 million tons per year are melted by 23 companies using cupolas.

There are SIC sectors, such as ductile iron pipe and high production automotive/industrial/municipal foundries, where cupolas are the mainstay. In other SIC sectors, demand for a wide variety of metallurgical grades have made the cupola less attractive. Cupolas have, however, remained highly competitive,

due to their flexibility, giving them a competitive advantage over electric melting methods. While cupolas are a big part of the iron melting picture in the U.S., the landscape of the cupola has changed. Stricter environmental regulations in the last three decades, combined with the changing metallurgical demands in foundries, have led many to believe that cupolas are going away. While it is true that there are fewer cupolas, it can be said with certainty they are not going away anytime soon. Cupolas continue to have some advantages, compared to electric melting, but there are six primary myths about cupolas that should be dispelled.

## Myth 1: Cupolas are going away.

Many old, inefficient, obsolete cupolas have mostly gone away. While some cupolas are challenged by operation at low production rates, the remaining cupolas mostly have increased thermal efficiencies and many have incredibly high efficiency rates. Some technical advances can be made with minimal capital expenditure. The post combustion heat recovery systems are better, and cupola shops are pursuing methods to reclaim waste heat and increase hot blast temperatures (up to 1,150F) to decrease coke rates while many have found ways to beneficially reuse slag. Alternative carbon and fuel sources have been established and chemistry transition practices have been modernized. The bottom line is cupolas now are more efficient with higher productivity per unit. Many cupola shops continue to invest in technical improvements in furnace efficiency and heat recovery systems as part of their long term strategy for sustainability.

## Myth 2: Cupolas are economically infeasible.

Continuous production rates and flexibility in scrap input gives cupolas an economic advantage. Production rates are steady and predictable. A wide range of scrap input can be handled, such as dirt, high zinc, shredder contaminants, bundles, iron briquettes, high oxide content and self-reducing briquettes. In stream desulfurization for ductile or compacted graphite base iron allows for the melting of low-cost high sulfur scrap. Cupolas can accommodate up to seven iron chemistry changes per day, supplemented with in-spout alloy additions. Cupolas are well known to have lower labor cost per unit of iron, especially for high production cupolas, say above 20-25 tons per hour.

Cupolas continue to have some advantages, but six primary myths about cupolas should be dispelled.

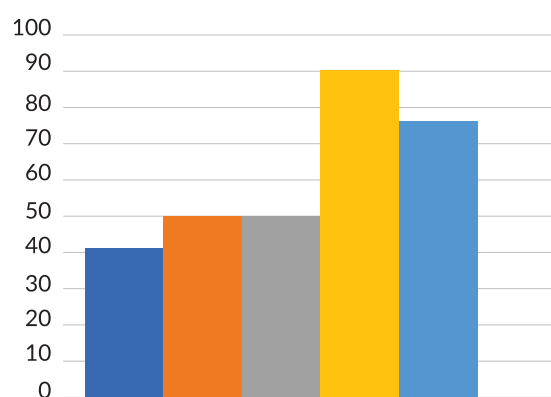
## Myth 3: It is impossible to obtain permits for cupolas.

While regionally designated environmental areas can make permitting difficult for any new foundry, new cupolas can be permitted and meet the strictest requirements. New gas combustion and dust collection technologies can meet MACT particulate matter and hazardous air pollutant and volatile organic compound standards. Gas concentrations like SO<sub>x</sub> and NO<sub>x</sub> are generally not of great concern, even in some EPA designated ozone non-attainment areas. State of the art pollution controls for cupolas have been in place in Europe for two decades, where regulations are more strict than in the U.S., proving that properly designed air pollution control systems make cupolas viable. In fact, properly designed control systems provide ultra low maintenance costs, with extended

filter life (bag changes) on the order of 8-10 years.

## Myth 4: Cupolas are energy intensive and inefficient.

Cupolas are inefficient only if they are following "old" methods and designs. The high efficiency cupola plants of today produce iron that is 15% less energy intensive than iron produced from coalproduced electricity (medium frequency). When methods for waste heat reclamation are installed (cupola flue gases), cupolas are 40-60% more energy effective than electric melting. As electricity prices and natural gas prices increase in the future, the benefits of cupola melting, using coke as a the heat source, will become more attractive. We



■ Ductile Iron ■ Gray Iron ■ Malleable Iron  
■ Ductile Iron Pipe ■ Gray Iron Pipe & Fittings

By applying typical yields to attain tons melted (corrected by SIC code sectors), it was determined that while 6.74 million tons of iron castings are shipped per year, the actual tonnage melted per year is more than 11 million tons.

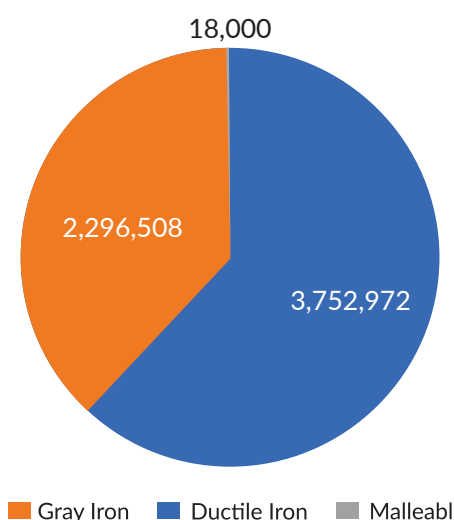
should remember that only about 85% of the coke charged into a cupola is burned for heat, and that about 15% of the coke is dissolved into the cast iron as metallurgical alloy, a very effective means of carburizing iron, especially for high steel charge mixes. Technology advances extend beyond the furnace, to further to reduce the energy intensity of the entire cupola plant. Approximately 20 U.S. states have now defined industrial process



waste heat as a renewable resource, making it, in some cases, not only recognized as a resource for harvest, but also making the capital investment eligible for funding and/or tax credits. The best, most efficient cupola shops have already installed, or are actively pursuing the installation of waste heat capture systems that can harvest and re-use the heat for a variety of processes. These include:

- Plant and office makeup air heating.
- Cupola blast air dehumidification.
- Core oven heating.
- Electric power generation.
- Domestic water heating.
- Other process heating.

Investment in these technologies will significantly reduce the electric and/or natural gas consumption of the foundry and reduce the overall energy intensity of the final product, iron castings.



Shown is the breakdown of cupola production as a percent of total melted domestic tons.

### Myth 5: Coke is too expensive.

It is true that coke is somewhat costly, but prices have significantly dropped and stabilized in the last five to eight years. Electricity prices, meanwhile, have increased

and been somewhat unpredictable. It appears that high quality European coke and formed coke suppliers have been placing pressure on domestic coke pricing.

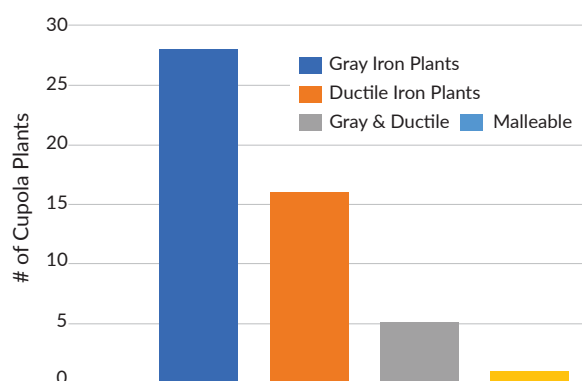
### Myth 6: Coke is not going to be available in the future.

According to David C. Ailor, president, American Coke and Coal Chemicals Institute (ACCCI), the present foundry coke demand is only 38.2% of the four domestic merchant member coke-producers' capacity. Like cupolas, domestic producers are fewer, but they are strategically suited for the long-term supply of the foundry industry. The merchant coke production capacity is 1.78 million tons, while the current domestic demand is about 0.8 million tons. The four merchant members producing foundry coke have taken several steps to continue as sustainable partners for U.S. metalcasters by:

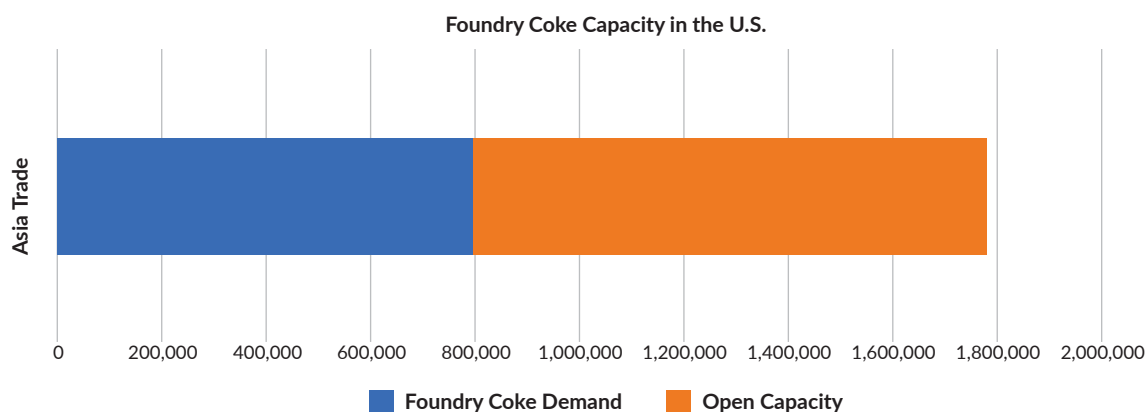
- Tailoring operations to meet the coke requirements/needs.
- Organizing to engage regulatory agencies as the need arises.
- Using many different coal blends.
- Tailoring transportation/delivery infrastructure to meet customer needs.
- Maintaining batteries to ensure long-term, reliable battery operation, performance and environmental compliance.

### U.S. CUPOLA LANDSCAPE

Forty-two cupola plants operate in the U.S., represented by 23 companies. The top 10 cupola foundries melt a combined 4,181,800 tons per year, which is 63.2% of total cupola production and 36.5% of total cast iron production in the U.S. The chart here shows the breakdown of cupola plants by metal melted.







The U.S. coke plants producing foundry coke have enough open capacity to handle double the current domestic demand. The majority of foundry coke is supplied by four merchant producers of metallurgical coke.

## What does the future hold?

Cupolas continue to produce the majority of iron in the U.S., especially gray iron. The benefits of modern cupola melting systems include:

- The ability for in-stream desulfurization for ductile and compacted graphite iron.
- Flexibility in alloying (charge or in-stream).
- Improvements in heat reclamation and heat recovery.
- Low labor cost.
- Low scrap cost.
- Flexibility in scrap material selection.

It is clear that “old” cupola technology will not work in the foreseeable future, especially as the U.S. sees continued competition globally. Many U.S. foundries still use methods and equipment that has been surpassed by competitors in Europe, Asia and - South America. Without the necessary investment, U.S. cupola foundries could fall behind. But it is also clear, that those foundries who continually advance their cupola technologies and improve energy efficiency, will realize a strong, competitive and sustainable means of cupola melting, well into the future.

This article is adapted from AFS Melting Methods & Material Division panel (18-122) with presentations by David Kasun and David Ailor, at the 2018 AFS Metalcasting Congress.



**PAKISTAN**  
FOUNDRY ASSOCIATION  
PFA for Development of Foundry Industry

# ELEMENT

Your Guide to Foundries in Pakistan

To enhance the corporate image of your company and to grow your business

## ADVERTISE IN

**Rate for Local Companies**

**Rs:20,000/- (A4 size)**

**Rate for Foreign Companies**

**\$ 400/- (A4 size)**

## CONTACT

**Mr. Abdul Rashid**

Secretary

Pakistan Foundry Association

Foundry Service Center,

University of Engineering & Technology,

(Opposite Gate # 5, U.E.T) G.T Road, Lahore,

Pakistan

Ph:+92-42-36851559,

Cell: +92-322-8487873 / +92-300-8673873

E-mail: [pakistanfoundryassociation@gmail.com](mailto:pakistanfoundryassociation@gmail.com)/

[info@pfa.org.pk](mailto:info@pfa.org.pk), Web: [www.pfa.org.pk](http://www.pfa.org.pk)



# **QADRI GROUP COMPANIES**

experience of a 100 years



Manufacturers & Exporters of Heavy Plant & Equipment  
for Industrial Sectors including Sugar, Cement, Steel, Chemical, Power



- Qadri Brothers (Pvt.) Ltd.
- Qadcast (Pvt.) Ltd.
- Qadri Foundry (Pvt.) Ltd.
- Qadbros Engineering (Pvt.) Ltd.
- Qadri Engineering (Pvt.) Ltd.
- Qadri Forge (Pvt.) Ltd.
- Qadri Sons (Pvt.) Ltd.
- Kashif Trading (Pvt.) Ltd.

#### **CORPORATE OFFICE**

Sharif Centre, 72-A Izmir Town, P.E.C.H.S, Canal Bank, via Thokar Niaz Baig, Lahore-53800, Pakistan

Tel: + 92-42-3 596 1761~65 Fax : + 92 42 3 596 17 66 Email: [info@qadbros.com](mailto:info@qadbros.com)

**[www.qadrigroup.pk](http://www.qadrigroup.pk)**

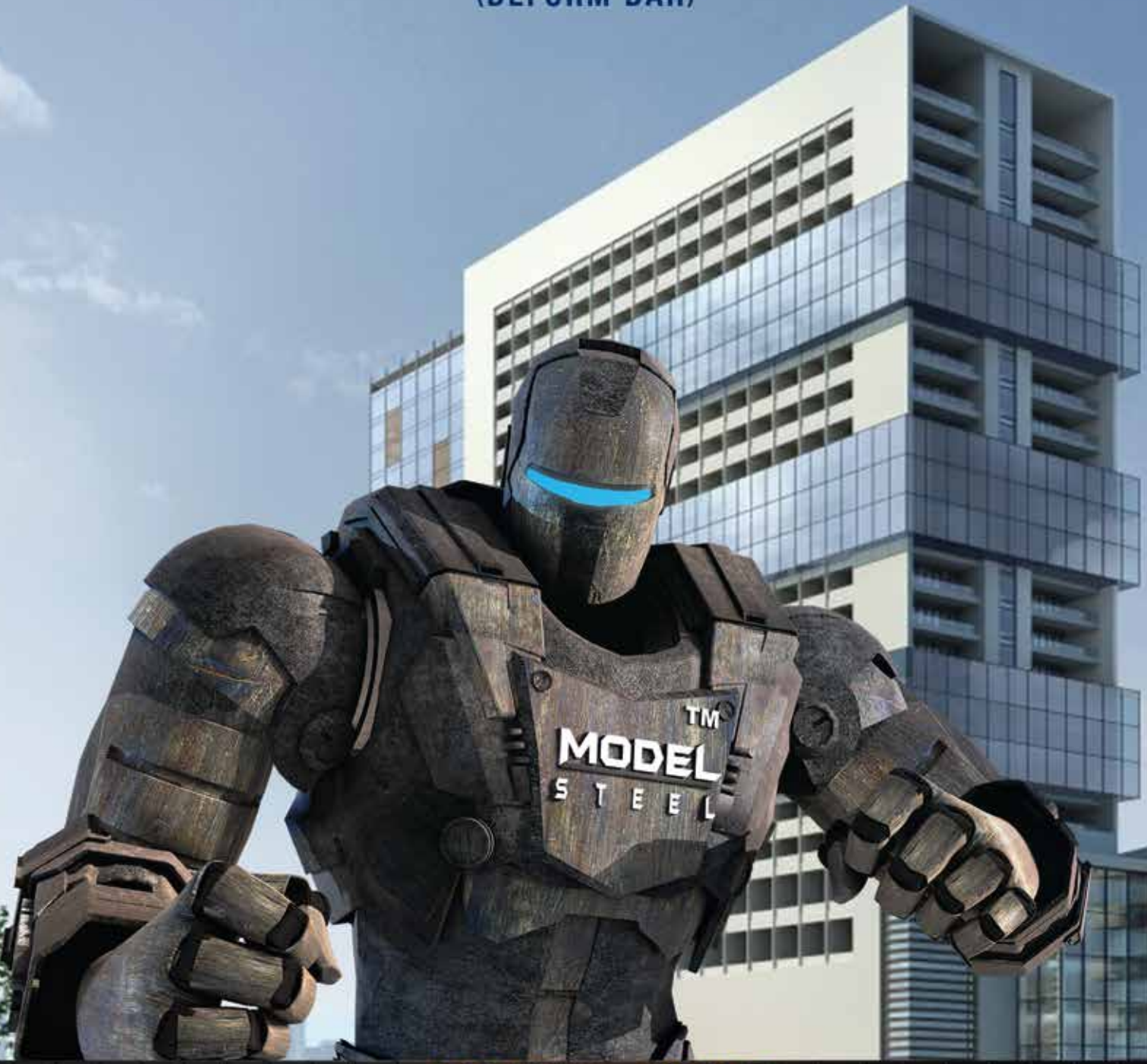




Model of Strength

# M-FORCE G60

(DEFORM BAR)



info@modelsteel.com

Σ Ω Δ Ε Λ Γ Ο Ο





# Marketing and Exports of Quality Castings and Modern Technology

S K Paknikar  
Metallurgical & Foundry Consultant, Pune India  
E-mail: [skpaknikar@gmail.com](mailto:skpaknikar@gmail.com)

## Introduction

Marketing strategy is a long-term, forward-looking approach to planning with the fundamental goal achieving and a sustainable competitive advantage. Strategic planning involves an analysis of the company's strategic initial situation prior to the formulation, evaluation and selection of market-oriented competitive position that contributes to the company's goals and marketing objectives. Marketing strategy highlights the role of marketing as a link between the organisation and its customers. At its most basic level, strategic marketing addresses three deceptively simple questions:

- (1) Where are we now?
- (2) Where are we going?
- (3) How are we going to get there?

In attempting to answer these questions, strategic planners require sophisticated skills in both research and analysis of global market for all types of quality castings.

Definitions of marketing strategy- Scholars continue to debate the precise meaning of marketing strategy. Consequently, the literature offers many different definitions. On close examination, however, these definitions appear to centre on the notion that strategy refers to a broad statement of what is to be achieved.

## Marketing management versus marketing strategy

The distinction between "strategic" and "managerial" marketing is used to distinguish "two phases having different goals and based on different conceptual tools. Strategic marketing concerns the choice of policies aiming at improving the competitive position of the firm, taking account of challenges and opportunities proposed by the competitive environment. On the other hand, managerial marketing is focused on the implementation of specific targets.

## CDI and BDI

CDI means Category Development Index while BDI denotes Brand Development Index. The category/brand development index is a method used to assess the sales potential of a region or market and identify market segments that can be developed (i.e. high CDI and high BDI). In addition, it may be used to identify markets where the category or brand is under-performing and may signal underlying marketing problems such as poor distribution (i.e. high CDI and low BDI).

### BDI and CDI are calculated as follows:

$$\text{BDI} = (\text{Brand Sales (\% in Market A / Population (\% in Market A))} \times 100$$

$$\text{CDI} = (\text{Category Sales (\% in Market / Population (\% in Market A))} \times 100$$

## Brief Description of PEST Analysis

PEST analysis: variables that may be considered in the environmental scan



Fig 1: PEST Analysis

Strategic planning typically begins with a scan of the business environment, both internal and external, this includes understanding strategic constraints. An understanding of the external operating environment, including political, economic, social and technological which includes demographic and cultural aspects, is necessary for the identification of business opportunities and threats. The main elements of the PEST analysis are:

- ▶ **Political:** political interventions with the potential to disrupt or enhance trading conditions e.g. government statutes, policies, funding or subsidies, support for specific industries, trade agreements, tax rates and fiscal policy.
- ▶ **Economic:** economic factors with the potential to affect profitability and the prices that can be charged, such as, economic trends, inflation, exchange rates, seasonality and economic cycles, consumer confidence, consumer purchasing power and discretionary incomes.
- ▶ **Social:** social factors that affect demand for products and services, consumer attitudes, tastes and preferences like demographics, social influencers, role models, shopping habits.

**Technological:** Innovation, technological developments or breakthroughs that create opportunities for new products, improved production processes or new ways of transacting business e.g. new materials, new ingredients, new machinery, new packaging solutions, new software and new intermediaries.

## Relationship between marketing strategy and marketing policy

The generic, competitive strategy provides overall structure and guidance for day-to-day operational planning and decision-making. The 4P's are very important which can be considered as under –

- Price
- Product
- Place and
- Promotion

This is also known as the marketing mix or marketing programme representing the tools that marketers can use in day-to-day operational planning. This marketing programme enables marketers a means for turning the long-term vision into every day practice. Similarly SWOT analysis is also significant in marketing of castings.

In addition to the PEST analysis, firms carry out a Strengths, Weakness, Opportunities and Threats (SWOT) analysis. A SWOT analysis identifies:

- ▶ **Strengths:** distinctive capabilities, competencies, skills or assets that provide a business or project with an advantage over potential rivals; internal factors that are favourable to achieving company objectives
- ▶ **Weaknesses:** internal deficiencies that place the business or project at a disadvantage relative to rivals; or deficiencies that prevent an entity from moving in a new direction or acting on opportunities. internal factors that are unfavourable to achieving company objectives

► **Opportunities:** elements in the environment that the business or project could exploit to its advantage

► **Threats:** elements in the environment that could erode the firm's market position; external factors that prevent or hinder an entity from moving in a desired direction or achieving its goals.

Typically the firm will attempt to leverage those opportunities that can be matched with internal strengths; that is to say the firm has a capability in any area where strengths are matched with external opportunities. It may need to build capability if it wishes to leverage opportunities in areas of weakness. An area of weakness that is matched with an external threat represents a vulnerability, and the firm may need to develop contingency plans.

#### Market-based resources include:

- Organisational culture e.g. market orientation, research orientation, culture of innovation, etc.
- Assets e.g. brands, Mktg IS, databases, etc.
- Capabilities (or competencies) e.g. market sensing, marketing research, relationships, know-how, tacit knowledge, etc
- Some marketing Managers suggest the following classification of competitive positions:
  - Price positioning
  - Quality positioning
  - Innovation positioning
  - Service positioning
  - Benefit positioning
  - Tailored positioning (one-to-one marketing)

Four Squares of Time management is also very significant for marketing of castings (Fig 2).

Time management matrix



Fig 2:Time Management matrix

Till now the important parameters of good marketing strategies have been considered. Many foundrymen from India from time to time attend international exhibitions and Congresses/conferences in foreign countries like GIFA, Hannover Fare, Metal China, World Foundry Congress, World Technical Fourm etc and exposed to new innovative and advanced technologies. They should apply these production techniques in their foundries to ensure that they can produce quality castings of ferrous or non-ferrous castings for export.

#### Export of Indian castings to global market

However, the Indian aluminium Gravity and High Pressure Die castings have good global market particularly for space craft internationally. These castings are produced particularly by Investment Casting Process (Fig 3).

India is in number two just after China in world ranking of casting production. China is producing castings in large volume however, the quality of Indian castings is far better than that of China.



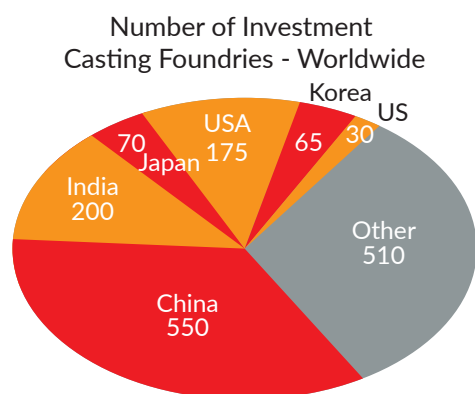


Fig 3: Number of Investment Casting foundries worldwide

This means Indian foundries cannot produce large number of castings per month for exporting just because the foundries have

limitation due to the capacity of production as the limited machines available in all sections of foundries. Therefore, they cannot compete with their Chinese counterparts.

### Market Prospects

HPDC Casting are mainly consumed all over the world by

1. Automobile Industry
2. Electrical & Electronic Industry
3. Communication Industry (Mobile Phones, Laptop Bodies , etc)

Market prospects of HPDC processed castings

## Export of Indian castings of all types of ferrous metals

Table-1: Production castings and energy consumption

Type of casting Produced	Melting Technology	Specific Energy Consumption (MJ/KG)		
		Min	Average	Max
Cast Iron	Induction furnace	3.57	3.78	4.05
	Cupola	3.05	3.79	4.86
SG Iron	Induction Furnace	4.50	4.91	5.32
Steel	Induction Furnace	4.50	4.74	5.22
Cast Iron and SG Iron (hybird units)	Induction Furnace	-	3.66	-

The above table shows all types of cast iron castings are exported globally.

So, what innovative technology is for Indian foundries. For example, there is no foundry producing compacted graphite cast iron (CGI). This is a patented process by Sintercast Pvt Ltd, UK and Dr Steve Dawson is the President & CEO of this company. He is very helpful to Indian Foundries however, many foundries consider that the cost of producing CGI in this process very expensive so they are less interested in going for this technology. There are a number of foundry clusters which are producing ferrous and non-ferrous castings as per international standards and exporting castings to various destinations across the globe (Fig 4).



Fig 4: Foundry Clusters in India

In the latter part of this article quality aspect of castings with relation to marketing and export of the same at competitive cost has been discussed. New concepts of production technology are coming in from countries like Japan, Germany etc. "Nodularity" in aluminium-silicon alloys and substitution of steel castings by Ductile Iron may be mentioned in this respect. Some problems faced by some overseas foundries and solutions thereto have been covered in the following case studies.

These are (1) "IDAS" in aluminium alloys (2) "Nodularity" in aluminium alloys (3) "WHN" Hardness Testing and (4) "Replacing Steel Casting" by ferritic ductile iron.

## Case Study - 1

### IDAS in Aluminium alloys microstructure measurement

Measurement of Inter Dendritic Spacing (IDAS):

The most commonly casting alloys are of hypoeutectic type. It contains dendrites of alpha in a matrix of eutectic which is in inter dendritic space. The measurement of this Inter Dendritic Arm Spacing (IDAS) has effect on the properties of castings. There was a difference in difference of opinion between German and Indian experts in respect of the methods of measurement of IDAS in microstructure.

Microstructure of hypo-eutectic Al-Si alloy:

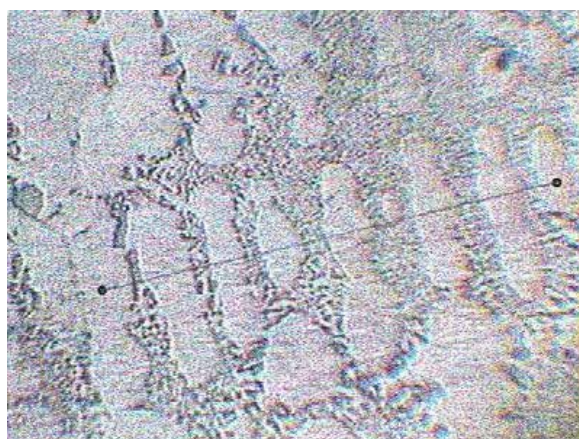


Fig 5: German Method of measuring IDAS

German Method - They draw a line through the dendrites and measure the length of the line in microns and divide the total number of alpha dendrites to get SDAS in microns at 200X magnification.

Total length of line 473 microns/7 dendrite = 67.50 microns

Indian method of measuring IDAS:

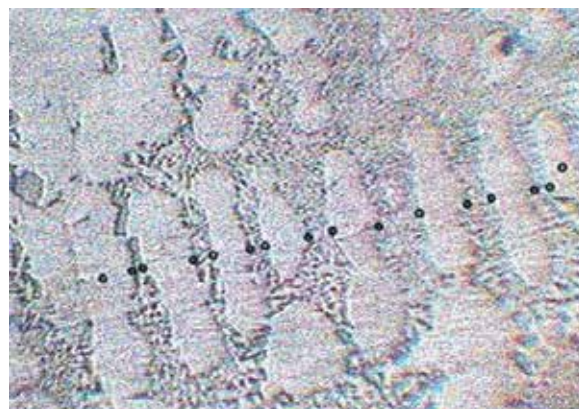


Fig 6: Indian method of IDAS measurement

Same Number of dendrites was selected and measurement of width of eutectic spacing was carried out. Average of that was reported which was between 13.3 to 20.0 microns as compared to German method which was 67.50 microns. It was demonstrated on different specimens.

(A) Readings of IDAS were 11, 20, 16, 25, 43, 25, 16 and average of 20 microns at 200 X magnification.

(B) Readings of IDAS were 20, 15, 12, 09, 13, 15, 13 =  $97/7 = 13.38$  microns at 200 X magnification.

## Case Study - 2

### Concept of nodularity in aluminium-silicon alloys

The term “nodularity” in ductile iron is well known. Now Japanese specifications for aluminium-silicon alloys include concept of “nodularity” of the alloys. It is sometimes confusing but they have clarified that the “nodularity” of alloys indicates the efficiency of modification treatment given to liquid metals. It is simple that modification treatment is given to convert the silicon phase in eutectic shows to spherical form just like nodules in ductile iron. This can be accurately measured under microscope. Higher the nodularity better is the ductility of the alloy.

Nodularity of any grade of ductile iron for different components is quite common. That entirely depends on controlled by the composition of the molten metal during melting. It also depends on the magnesium treatment to be given in treatment ladle. The pouring techniques are also have effect on the nodule count and the properties of castings. Thus the new concepts can be solved by proper study of Metallurgical of that alloy during melting and metal treatment. In addition, the complete solidification of that alloy casting in moulding must be understood.

### Modern Techniques of Metallography

Histogram showing even distribution of eutectic nodules (Fig 7 & 8).

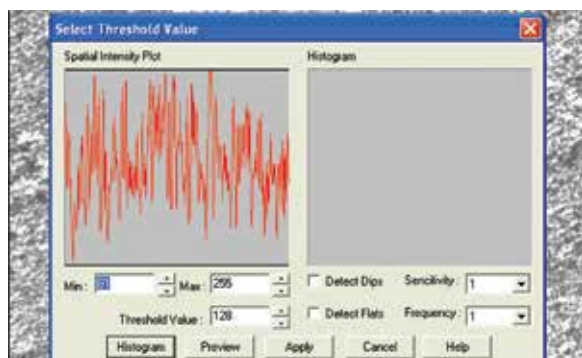


Fig 7: Histogram showing distribution of eutectic nodules

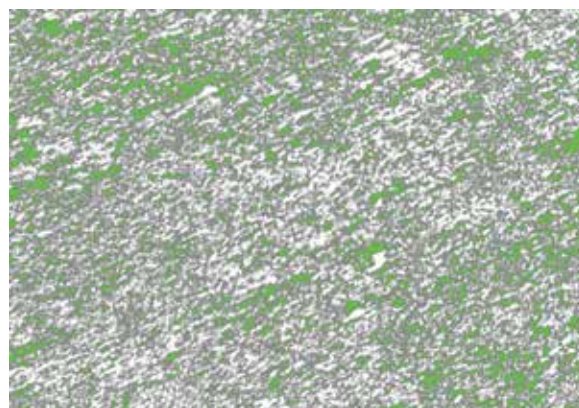


Fig 8: Eutectic nodules coloured in black small nodules

### Observations and conclusions

From indepth metallurgical examination and the new techniques used for microstructure observations it is clear from the Histogram that the eutectic structure is well-modified throughout and nodularity of eutectic shows that the modification treatment given was very perfect and useful to improve the mechanical properties of the alloy. Nodules of eutectic will improve toughness of the aluminium-silicon alloy.

## Case Study - 3

### WHN Measured on Normal Hardness Testing Machine

The term ‘WHN’ is used to measure hardness of very hard castings that are wear resistant. The BHN hardness testing machine can be used for WHN but the diameter of ball used is 10 mm. Load is also 3000 lbs. However, the ball used must be made of Tungsten Carbide. Tungsten is denoted by W, so it is called WHN.

Normally, WHN is related to hardness Rockwell Rc and not BHN.

Normally BHN is used for soft metals while Rockwell harnesses are used as Rockwell Ra, Rb and Rc are used for slightly higher harnesses but for more hardness only Rockwell Rc is used. In all these, the indenter is different such as Ra and Rb; the indenter used is of hardened steel. It is sometimes



called “Brale” indenter. Rockwell Rc is used for very hard metals. The indenter used is a square based cone. The indentation of this test is square shaped. The average of two diagonals is taken for calculation of area of indentation. One more test criteria as compared with BHN is that initially 10 lbs. Load is applied so that there will not be some recovery as found in BHN.

## Case Study No 4

### Replacement of Steel Casting with Ferritic Ductile Iron DIN GGG 40 by German Company

A case study of M/S Vulcan Technologies Pvt Ltd, Pune

Vulcan Technologies Pvt Ltd produces a variety of castings of couplings of different types. They had a typical practical working problem during working of L - shape ring and Hub steel castings when a rubber ring was fitted on the exterior outer circular surface of casting (as shown in the picture) of “L - shape ring casting of steel” (Fig 9).



Fig 9: Shape of ring castings of steel

## Problem

The problem was of adherence of rubber with the surface of steel casting during working. It was thought that it could be solved if the cast material (steel) was replaced by some other material.

## Solution

The points considered for the replacement of steel by SG iron for better adherence of rubber with surface of the casting were as under.

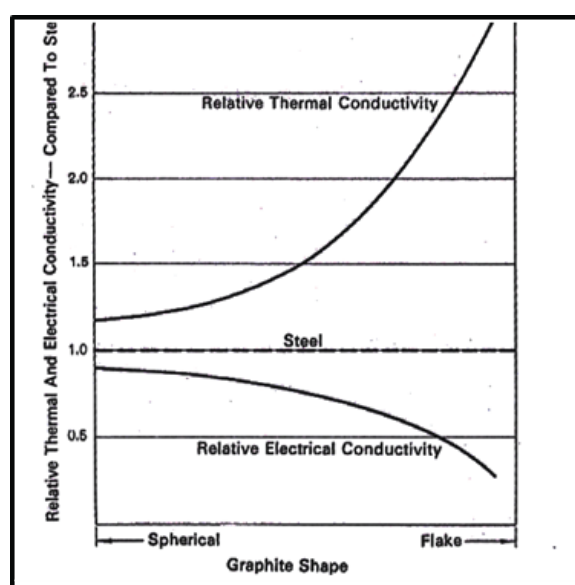


Fig 10: Effect of Graphite shape on the relative thermal and electrical conductivity of grey and SG iron as compared to steel

## Thermal conductivity of steel and cast iron

The thermal conductivity of steel or cast iron is influenced by the microstructure of steel or cast iron in discussion. The thermal conductivity of grey iron at room temperature is approximately same as other ferrous materials ranging from 0.110 to 0.137 Cal/sq cm/sec/cm/ C depending upon microstructure of the grey or SG iron.

The following table indicates the effect of micro-constituents on thermal and electrical conductivity in relation with temperature.

Micro-constituent	Thermal Conductivity at different Temperatures		
	0 – 100oC	500oC	1000oC
Graphite	0.7 – 1.0	0.2 – 0.3	0.1 – 0.15
Ferrite	0.17 – 0.19	0.1	---
Pearlite	0.12	0.1	---
Cementite	0.017	---	---

From the above values it was clear that Ferritic SG iron (GGG40) has superior thermal conductivity as shown in the graph. The graph actually shows higher thermal conductivity of flake graphite than nodular or SG iron however, due to its lower torsion fatigue it is not recommended for our application.

- **Specific gravity:** The specific gravity of steel is 7.7 gm/cm<sup>3</sup> while that of SG iron is 7.1 gm./cm<sup>3</sup>. So, there would be less weight of the castings and so less cost.

- **Shrinkage tendency:** Steel has higher shrinkage during solidification of casting hence higher risering is required to compensate the volumetric shrinkage in casting. In this case, due to higher yield of casting more fettling work is required increasing cost of production.

- **Bonding factor with natural rubber:** Normally, bonding of rubber on metallic surface of SG iron is higher due to presence of graphite nodules which act as an interface between metallic matrix and rubber. This is also because of better thermal conductivity of SG Iron compared to steel.

- **Machinability of SG iron:** Machinability of SG iron is better than that of steel due to presence of graphite nodules which break the continuity of metallic matrix. The chip formation during machining is segmental while in steel it is continuous ring formation that also affects the surface finish of casting after machining.

So, in conclusion it can be said that modern technologies are urgently required to be adopted for production of quality casting

complying with customer specifications and exporting them to the international markets.

## References

1. Study of marketing strategy of our foundries by visiting foundries in India.
2. Study of marketing research available in Wikipedia free in Google.
3. Case studies brought to the author by his students working in various foundries and he could give them the solution. Nodularity in aluminium-silicon alloys was brought by Noblecast Pvt Ltd, Pune.
4. Case study of replacing steel casting given by Vulcan Technologies Pvt Ltd Pune who have been exporting castings to German companies also.

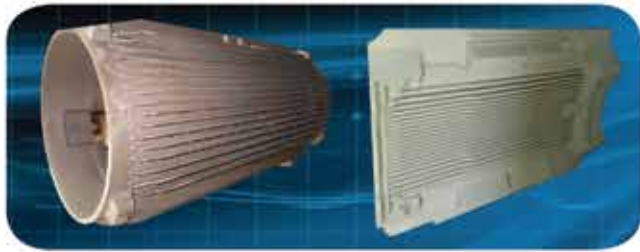
consistent quality  
increased productivity  
wide accessibility  
prompt technical backup



**forace Industries**



**forace polymers™**



## Providing Customized Solutions

Forace Group is a name synonymous with reliability. As the largest producer of Foundry Consumables in India, we offer a wide range of solutions to our ever increasing clients across the globe. Backed by robust infrastructure, a state-of-the-art fully automated manufacturing unit, R & D and Quality control centres, Forace Polymers delivers customized solutions for Binders, Coatings, Foundry Consumables, Phenolic-Liquid and Powder Resins.

### Binders

Shell resin system (solid / liquid / regular / NF)  
Two part no bake ester set system (steel, SG, NF)  
Phenolic urethane self setting system (steel, Iron, NF)  
Phenolic urethane gassing cold box  
Hot box system for ferrous & non ferrous  
Furan no bake (steel, SG, CI, NF)  
CO<sub>2</sub> cured phenolic  
Inorganic no bake system

### Coatings

Zircon spirit/water based  
Graphite spirit/water based  
Alumino-silicate mix refractory spirit/water based  
Magnesite spirit based  
Graphite water base for metallic trough  
Bismuth base coating  
Coating for lost foam process  
Tellurium base coating  
Sulphur blocking coating

### Other Foundry Consumables

Thinners  
Pattern cleaning agents  
Release agents  
- Release agent for green sand mould  
- Release agent for alkaline phenolic no bake system  
- Release agent for cold box  
- Parting agent for shell (water / solvent based)  
- Aluminium based release for no bake system

### Core joining paste

- Hot to hot  
- Cold to cold  
- Cold to cold (ultra fast)  
Collapsible agent for silicate  
Mould sealing rope

Sealing compound for mould and core  
Silicon carbide, zirconia foam filters  
Ceramic sand  
Chromite sand  
Slag coagulant (perlite ore)  
Sand Additives (Sphereox) of Chesapeake Specialty Products, USA  
Furnace & refractory cleansing fluxes of ASI International, USA  
- Redux EF40L briquettes  
- Redux EF40 bricks  
Additive for thermal reclamation of alkaline phenolic no bake resin  
Anti Veining solution from John Winter & Co., UK

### Non Ferrous Foundry Consumables

#### Forace die coatings

- Graphite based die coatings
- Silicate based die coatings
- Aluminium based die coatings
- High pressure die coatings
- Zircon water base dressing
- Graphite based lubricant (plunger lubricant)

#### Forace degasser

- Forace degasser N2 (nitrogen based)
- Forace degasser CF (chlorine free)

Forace grain refiner (powder & tablet)

Forace cover fluxes

Forace modifier

Forace mastic

Forbrail

Forbruss

Ceramic alumina foam filter

Master alloys

Others for refractory industry

#### Shell Resin Coated Sand

Forsand AC (for anti cracking grade)

Forsand LN (for steel casting with low nitrogen)

Forsand GP (for heavy section iron casting)

Forsand NF/AL (for non ferrous casting)

Exclusive Distributor for Foam Filters of Drache, Germany  
Exclusive Distributor of John Winter & Co. Ltd., of UK  
Exclusive Distributor of Chesapeake Specialty Products, USA

### forace Industries pvt. ltd.

E-29 Industrial Area, Haridwar – 249401, Uttarakhand, India  
Phone: +91 1334 334000, 325988, 325989, 9219417552 | Fax: +91 1334 334043  
Email : mktg@foraceindustries.com, contact@foraceindustries.com  
Web: www.foracepolymers.net

### forace polymers™ (p) ltd.

10th K.M. Stone, Haridwar-Delhi Road, Haridwar – 249402, Uttarakhand, India  
Phone: +91 1334 334000, 325988, 325989, 9219417550 | Fax: +91 1334 334043  
Email : contact@foracepolymers.in, mktg@foracepolymers.in  
Web: www.foracepolymers.net





**H.B.**  
Engineering (Pvt) Ltd.

Differential Sub Assembly



Axcel Set



Propeller Shaft



Front Wheel Hub



Die-Casted Wheel Hub



Brake Caliper Set



2 Pieces Disc-Brake Drum



Double Disc-Brake



Singel Disc-Brake



“Manufacturers & Assemblers of  
**AUTO PARTS**”



+92 42 3760 5626  
+92 321 446 1714  
info@hbengineering.com.pk  
www.hbengineering.com.pk  
Samanzar Colony, Near Hajvery  
Mosque Shad Bagh, Lahore.







# QADIR ENGINEERING

**Provides Best Quality Products**

**Manufactures and Assemblers of  
Aluminum High Pressure Die-Casting  
& Sheet Metal Parts**



**[www.qadirengineering.com](http://www.qadirengineering.com)**

## Company Profile

"Qadir Engineering" is Lahore based company has a covered area of over 252000sq.ft. as unit in glamour adda near Sundar Industrial Estate Lahore. Qadir Engineering was found in 1995. Qadir Engineering is an ISO 9001-2008 certified company.

Qadir Engineering is famous for high pressure aluminium die-casting. Qadir Engineering specializes in the manufacturing of motor-cycle auto parts like clutch cover, crank cases, front and rare wheel hub, front and rare brake panel plate, brake shoe and different kind of service line material for Sui Northern Gas Pipelines Limited Lahore and Sui Southern Gas Company Limited Karachi.



**Head Office:** B-2, Faisal Park, Main Road, China Scheme, Lahore-Pakistan. Tel: +92-42-37604970  
**E-mail:** qadirengineering@yahoo.com **Web:** www.qadirengineering.com  
**Factory:** 6Km, Raiwind-Manga Road, Near Adda Glamour, Lahore-Pakistan. Tel: +92-42-35395052



ArchiView  
0333-4538892

# Heat Treatment

Ir G Henderieckx Gietech BV

Heat treatment is called every, by purpose, temperature change and returning back to room temperature.

The purpose is to achieve, in castings or other parts, a target condition (mostly about residual stress), microstructure and mechanical and or physical properties.

A heat treatment is extra cost and should be avoided if possible.

This possibility is present for grey, ductile and compacted iron, although sometimes heat treating is done for correcting microstructure and carbide presence.

Materials that solidify dendritic (all steel and white solidifying iron) always need a heat treatment for getting a homogeneous structure and grain size.

There are 4 important temperatures: Ac3, Ac1, Ms and Mf (all depending on the chemistry of the material).

Ac1 is the temperature above which the austenite structure is formed.

Ac3 is the temperature above which only austenite (exception delta-ferrite) can be present.

Formula (all in °C) according Andrews:

$$\text{Ac3} = 910 - 203 \times (\%C)^{1/2} - 15,2 \times (\%Ni) + 44,7 \times (\%Si) + 104 \times (\%V) + 31,5 \times (\%Mo) + 13,1 \times (\%W)$$

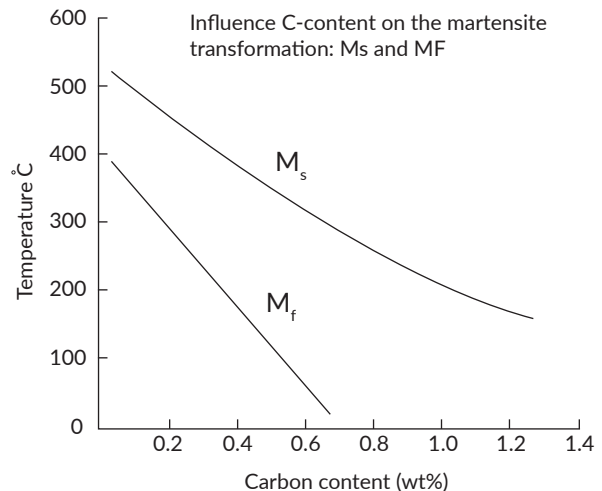
$$\text{Ac1} = 723 - 10,7 \times (\%Mn) - 16,9 \times (\%Ni) + 29,1 \times (\%Si) + 16,9 \times (\%Cr) + 290 \times (\%As) + 6,3 \times (\%W)$$

Ms is the temperature below which austenite starts transforming to martensite.

Mf is the temperature below which no austenite can be present anymore.

Formula (all in °C) according Andrews:

$$\begin{aligned} \text{Ms} = & 539 - 423 \times (\%C) - 30,5 \times (\%Mn) \\ & - 17,7 \times (\%Ni) - 12,5 \times (\%Cr) \\ & - 71,5 \times (\%C) \times (\%Mn) - 67,5 \times (\%C) \times (\%Cr) \end{aligned}$$



The heat treatment exist of 3 steps: first changing the temperature; second staying at the temperature for equalizing the temperature throughout the material section and possibly have a transformation (or stress relieve); third returning to room temperature.

**The heating temperature rate** (except for cryogenic treatment) is important for not creating too high thermal stress that can lead to cracks (especially for complex shaped castings). The transformation will happen above Ac1-temperature and be finished above Ac3-temperature.

**The dwelling time** (time on temperature) has the function to equalize the temperature throughout the material section and to assure that the target transformation (getting complete austenite structure, dissolving carbides...) is finished.

This process is ruled by the temperature (difference between the temperature and the Ac3-temperature) and time on temperature. The old rule of 1 hour plus 1 hour per 25 mm is obsolete and sometimes negative. Mostly

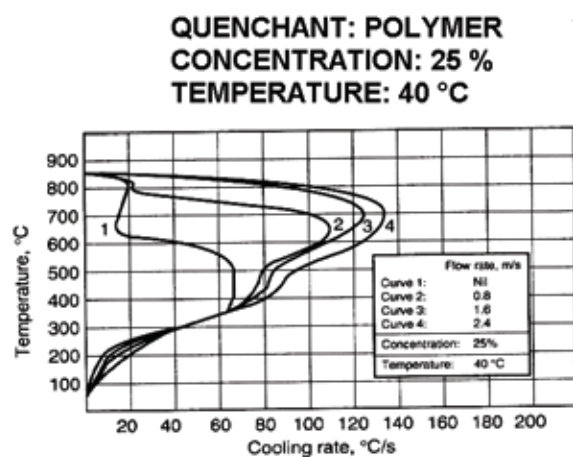
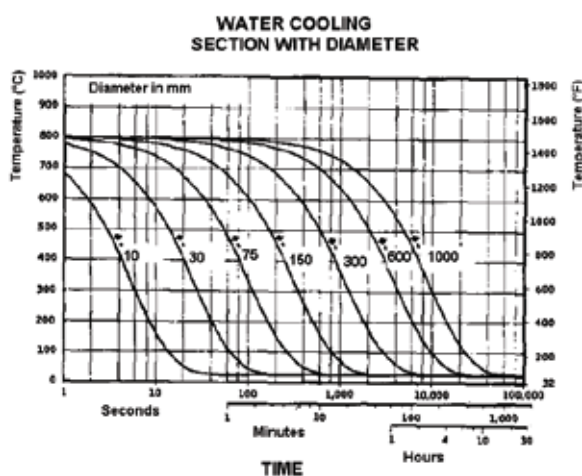


0,5 hour plus 0,5 hour per 25 mm is proven to be sufficient.

Once the austenite is formed, during all the dwelling time, the grain size will increase. This is mostly not preferred because large grains decrease the yield strength and mostly increase the brittleness.

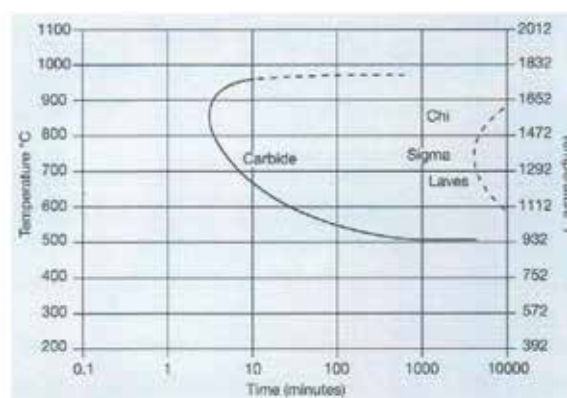
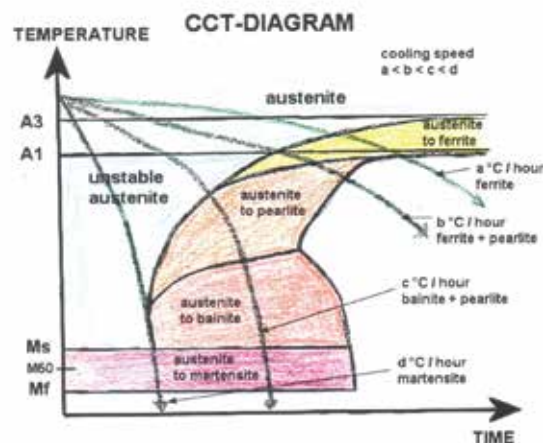
**The cooling** (except for cryogenic treatment) is the phase where the new microstructure is set and the carbides are appearing or not. It is the most important step of the heat treatment. It is also important for the stress in the treated casting. The stress that will be the combination of the physical stress (difference in shrinking), the transformation stress (especially for martensite) and the thermal stress (due to temperature difference in casting sections).

The cooling can be in calm or forced air, oil, water, gas or copolymers, all of them having a particular cooling rate.

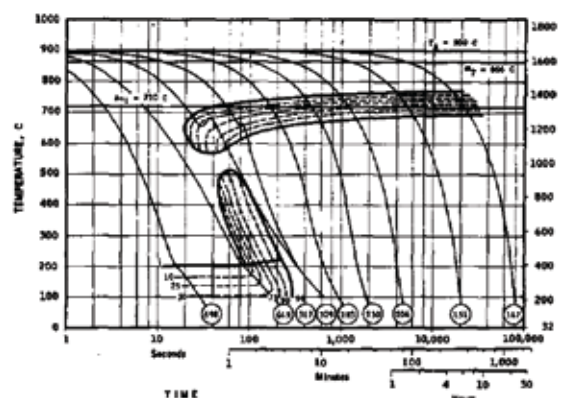


Agitation    Curve 1 Nil    Curve 2 0,8 m/s  
                  Curve 3 1,6    Curve 4 2,4 m/s

The CCT diagrams will predict the microstructure, presence of carbides (especially for austenitic material) and the hardness. Next figures are giving the principle, example for steel, austenitic steel and ductile iron.



Carbide & secondary phases formation  
Stainless steel 316



UNALLOYED DUCTILE IRON No 1

## Remarks:

1. No heat treatment will change the free graphite!
2. The maximum hardness of quenched material is depending on the C-content. The alloying elements have an influence on the hardenability (difference in hardness between the surface and core of the material section).

## Common Types of Heat Treatment

### 1. Normalizing

Heating the material above  $A_{c3}$ -temperature (austenite zone) and cooling in calm air. Homogenizing the microstructure (removing dendritic structure) and grain size. All steels (except austenitic steels) will have this treatment after cooling from pouring.

### 2. Annealing

Heating the material above  $A_{c3}$ -temperature (austenite zone) and cooling in a way to get the lowest hardness.

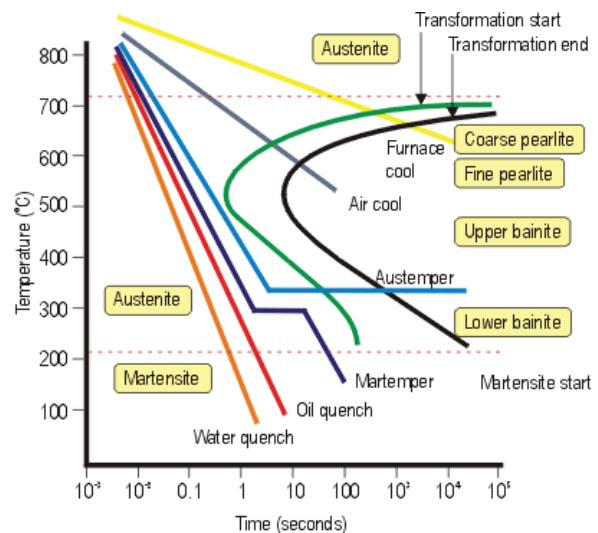
Heating the material just below the  $A_{c1}$ -temperature (austenite zone) and cooling in a way to get the lowest hardness.

Homogenizing the microstructure (removing dendritic structure) and grain size as well as removing the carbides in order to get a low hardness.

Applied for steel and iron castings.

### 3. Quench & Tempering

Heating the material above  $A_{c3}$ -temperature (austenite zone) and cooling in a way to get the required microstructure and hardness. There is always a tempering treatment of which the temperature depends on the as quenched hardness and the target hardness. The tempering will restore the ductility, especially in case of martensitic structure.



**CCT DIAGRAM**

Homogenizing the microstructure (removing dendritic structure) and grain size as well as getting a high strength and hardness, combined with a fairly ductility.

Applied for alloyed steels and sometimes alloyed iron material.

In case of austenitic iron and steel, to avoid the formation of carbides.

Special hardening effect after quenching are present if the  $M_f$ -temperature is below room temperature:

1. heating till bainite zone for transforming the residual austenite to bainite
2. cooling to a temperature below the  $M_f$ -temperature for transforming the residual austenite to martensite.

It is preferred, in both cases, to do a second tempering treatment.

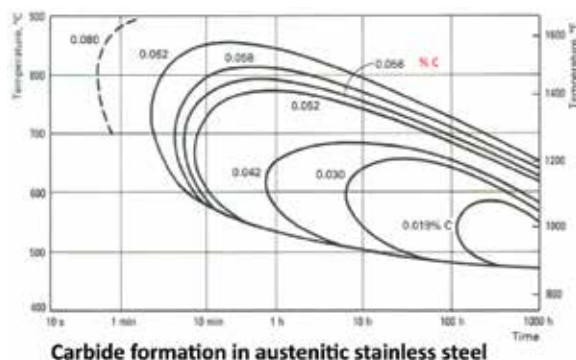
### 4. Stress Relieving

Heat treatment for removing the stress introduced during the cooling of the casting (after pouring or sometimes heat treatment). This treatment has never a microstructure change and will not influence the mechanical properties.

The stress is the sum of the thermal stress and the transformation stress.

Stress relieving is also done after welding, intensive fettling and or machining, especially for parts that must have a close dimensional tolerance

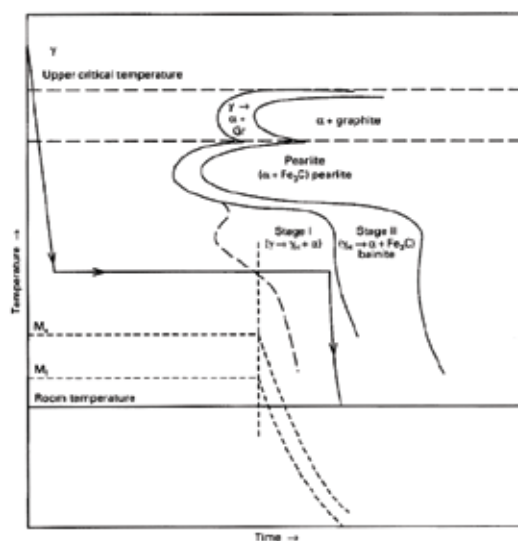
Stress relieving of austenitic material is very difficult because at temperatures above 550 °C will give way to carbide formation.



## 5. Austempering

Heating the material above the Ac3-temperature, transformation to austenite completed, then quick cooling to a temperature at which bainite is formed, holding that temperature until the austenite is completely transformed to bainite, after that cooling to room temperature.

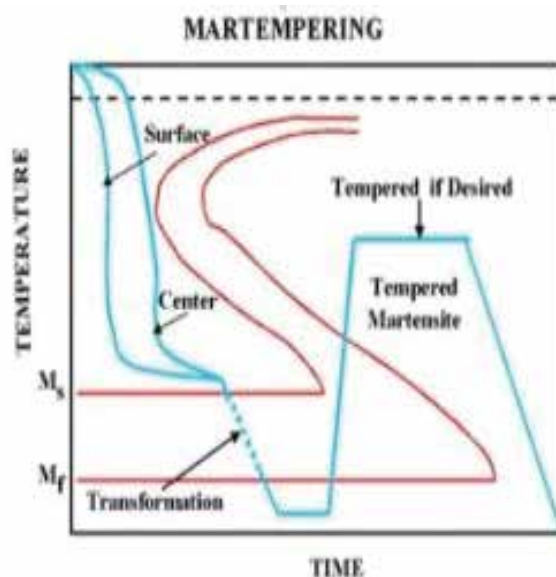
The bainite structure is a high strength (medium hardness) structure with a high ductility. The necessity for a tempering is very low.



## 6. Martempering

Heating the material above the Ac3-temperature, transformation to austenite completed, then quick cooling to a temperature at just above the Ms-temperature, holding that temperature until the complete material section is at the same temperature (and bainite not yet formed), after that cooling to room temperature. During this cooling the martensite is formed.

This treatment leads to a low stress level and lower risk for cracking and deformation. The necessity for a tempering is low.





# ENGINEERING FOR LIFE!

Millat Tractors Limited has played a pivotal role in Pakistan's Agricultural and Industrial sector for over five decades. Our eight dependable tractor models excel in quality and cater to the farming needs and buying power of Pakistani farmers. To the Industrial sector, we offer quality Forklift Trucks and Power Generator Sets as reliable, low-cost solutions for better performance and peace of mind.

For Millat, engineering is not a profession, it's our passion!



**ACCORDING TO EVERY FARMER'S NEED & PURCHASING POWER**

**TO GET YOUR MILLAT TRACTOR IMMEDIATELY, CONTACT OUR DEALERS OR BELOW MENTIONED OFFICES TODAY**

  
**MILLAT TRACTORS LIMITED**  
 8.5-km, Sheikhupura Road, Shahdara, Lahore-Pakistan  
[www.millat.com.pk](http://www.millat.com.pk)  
[info@millat.com.pk](mailto:info@millat.com.pk)

	LAHORE	KARACHI	ISLAMABAD	MULTAN	SUKKUR
<b>Phone</b> ➤	042-37911021-25	021-34553752	051-2271470	061-6537371	071-5815041
<b>UAN</b> ➤	111-200-786	111-200-786	111-200-786		
<b>FAX</b> ➤	042-37925835	021-34556321	051-2270693	061-6539271	071-5815042



# We Pour Quality Into Castings

## THE ART OF CASTINGS AT...

Being a modern and well equipped foundry, holding a major market share of Tractors and Automotive castings, **Bolan Castings Limited** can rightly claim to be the leading foundry of its kind in Pakistan.



**Bolan  
Castings  
Limited**

A Millat Group Company



- Casting unit produces Grey and Ductile Iron castings like, Cylinder Block, Center Housing, Axle Housing, Transmission Case, Hubs, Brake Drums, etc.
- State of the art inspection and testing facilities; including Spectrometer, Chemical Lab, Metallography lab, Physical Lab & Sand Lab.
- BCL is the first ISO certified foundry in Pakistan (since April, 1999). Currently, the company has achieved ISO 9001:2015 version of Quality Management System.

Main R.C.D Highway, Hub Chowki, District Lasbella, Balochistan.

Phone # +92-853-363295, 363296, 364033, 364036

Fax # +92-853-363292

E-mail: [bclho@bclpk.com](mailto:bclho@bclpk.com)

[www.bolancastings.com](http://www.bolancastings.com)



# Do you have the most energy efficient furnace in the World ?

## "BUY DiFOC®, BE EFFICIENT"

- More than 200 efficient customers across the world have already adopted this latest technological innovation for their steelmaking plants
- Most of the reputed steel makers globally have extended warm welcome to DiFOC® not only for new plants but even for replacing their existing furnaces of other make with DiFOC® based DTi® model
- Make your melt shop GO DiFOC® WAY...
- Benchmark the efficiency ... Better than ever with...

# DiFOC®

**Latest State-of-the-art Digital Inverter technology through Fibre Optic Communication (DiFOC) systems in power supply units up to 36,000 KW**





# Concept of Neutral Refractory lining in Coreless Induction Furnace

Jaydip Goswami\*, Bismit Ghosh, Sandip Samaddar, Vidosh Sarup, Virinder Khosla  
Saint – Gobain, Grindwell Norton Limited, Performance Ceramic Refractories, India

## Abstract

A coreless induction furnace consists of a nonconductive refractory crucible, surrounded by a coil of copper tubes. Running a powerful alternating current through the coil creates a magnetic field that induces electric currents inside the metal and quickly melts the charge inside the furnace. Proper and well –maintained refractory linings are important for a safe operation of the induction furnace.

Choosing the right refractory material for a given melting or holding application is important. Neutral Ramming Mass (NRM) has superior performance, longer life etc over conventional Silica or magnesite ramming mass.

## Introduction

Important parameters for designing a NRM are selection of raw materials & Binders, Granulometry, Density, Thermal expansion, Fired Strength, Refractoriness, vitrification temperature and resistance to chemical attack. Refractoriness must be sufficiently high so that the mass will not melt at high temperature.

There is a situ spinel formation ( $\text{MgO} \cdot \text{Al}_2\text{O}_3$ )

at steel melting temperature for NRM refractory.

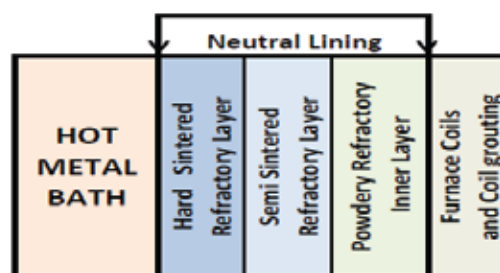


Fig 1: Schematic diagram of multi-layer concept of NRM.

## CDI and BDI

NRM is the main working lining and designed in the concept of in situ Spinelisation which associated with :

- Volume expansion and provide rigid structure.
- Hard sintered refractory surface layer resistance to metal bath and erosion.
- The inner refractory layer will be in powdery form.
- As soon as the top layer eroded, the next inner layer exposed to the metal bath and become sinter by in situ spinel formation.

## Discussion

Sintered layer is in direct contact with Hot Metal and Slag. This layer actually undergoes interactions between Slag and the Refractory lining at working Temp. This Black sintered layer actually prevents slag penetration. Black sintered layer thickness should be hard & thin. This is a critical parameter as a resistance to slag attack and longer life. Higher the black sintered thickness, indicates more erosion in lining due to Slag – Refractory reaction and furnace life will be lower. Refractory used should be very pure and withstand the severe slag attack at working temp.

Semi-Sintered layer is the next inner layer. This is not in direct contact with hot metal & slag and remained unaffected by direct Slag attack. This is softer than sintered layer and white in color. During operation, when sintered layer gradually eroded, next inner semi-sintered layer becomes harder and forms sintered layer. Temperature profile will be lower at the back of the lining. Semi-Sintered layer actually interfaces between Sintered and Powder layer and protects the lining from damage by sharp objects like heavy scrap etc. If Semi-sintered layer is not there, then in case of any damage of sintered layer, Powder starts to fall and lining may collapse. Generally, thickness of White colored Semi-sintered layer is higher than Black Sintered layer.

Powder layer is available at extreme back up i.e. near to coil coat and required for multiple Patching cycle.

The thickness of Sintered – Semi-sintered – Powder layer thickness varies at different zones of the same furnace depending on the working temp and metal contact time. Generally at Furnace Top portion, total remaining lining thickness is higher (due to less erosion and less metal contact) and the thickness will be lower at furnace center and bottom, due to more exposure to working Temp / higher metal & aggressive slag contact. Again, this pattern varies from furnace to furnace and also depends on charge mix, operation parameter. Depending on the various applications, a design has to be done

to have the optimum lining thickness to get the best performance.



Fig 2: Metal contact sintered layer of NRM

Saint-Gobain has specially designed NRM (VA1248LG) for bigger induction furnaces. This is a fused alumina based dry vibrating refractory. Due to the presence of Fused grains, compact grain size distribution and spinel bond, it is highly resistant to slag attack. It is a high purity system, using very high purity raw materials in aggregate and matrix, i.e. very low content of impurity and fluxing material. This restricts the formation of low melting liquid phases during operation and the dense hot face is highly resistant to erosion. The bigger grains present provide excellent resistance to hot metal abrasion, erosion, stress and thermal shock during operation and increase the direct life. Selective use of binders & additives provides, less sintered layer thickness supported by more back up powder layer.

The sintered layer can be easily chipped out before patching and back up powder layer can be utilized for next patching cycle. Due to its excellent resistance to slag attack & erosion

Resistance, the metal contact sintered black layer thickness will be less. This indicates a very dense hot face with no saturation at all and good semi-sintered & non-sintered back up.

A proper installation is as important to the safe furnace operation as the selection of the right refractory material. If the refractory material is inadequately compacted, voids or low density areas may create weak spots easily attacked by the molten metal.

The sintering procedure provided by the refractory manufacturer must be followed and never hurried. If the refractory material is not given enough time for proper bond development, the lining will be prone to attack by molten metal and slag. The sintering schedule must be completed once it has started. Chemical erosion depends on porosity level, slag chemistry and presence of high oxidation potential constituents like FeO, SiO<sub>2</sub>, MnO, Cr<sub>2</sub>O<sub>3</sub>, too high slag fluidity, unsaturated slag in MgO, long operating time at high temperature. Because of the above parameters, infiltrated slag weakens the refractory matrix bond and causes erosion. Different stresses associated during furnace operation like Mechanical stress, Thermal shock, Hot Metal Abrasion, Hot metal erosion. Particularly in Bigger Furnace, all the stresses are very high and lining eroded fast as a cumulative effect of all stresses.

One of the main weaknesses of conventional silica refractory is the formation of low-temperature melting corrosion products, causing severe and rapid erosion. The high-alumina refractories have high refractoriness, no low temperature liquid formation with slag, and better corrosion resistance.

## Case – Study

This is a comparative cost sheet and case study in 12 MT Induction Furnace (Silica vs Neutral lining) in Pakistan Rs.

Cost saving for conversion of Silica to Neutral Lining				
Cost Parameter	Silica Lining	Silica side/Patch	Neutral Lining	Neutral patching
Remaining material consumption per lining @ furnace size 12 ton	3400	3600	3240	12500
No. of patching	9	3	5	5
Avg. Lining life	9	27	81	279
Furnace output in Tons	12	12	12	12.9
Avg. Production (in tons) (Life x furnace output)	108	324	792	3407.5
Remaining material landed cost —Rs/ton	8800	8800	306000	306000
Shipping material landed cost —Rs/ton				
Remaining material cost —in Rs (consumption x cost)	29920	79200	1117500	2542500
Labour cost per lining (patching) —in Rs	1600	4800	1600	8000
Former cost			12000	60000
Total cost —in Rs	31520	84000	1141100	2607500
Cost/ton —Rs/ton (Cost/Production)	292	259	1436	769
Cost/ton —Rs/ton (Cost/Production)				
Cost/ton —Rs/ton	267.81		808.37	
Saving in Neutral Lining				
Production in one campaign of 220 hours —in tons	2640.00		4152.00	
Saving of fixed expenses on extra production @ Rs 2500/ton			286750.00	
Cost saving in neutral lining due to extra production (Rs/ton)			69.34	
Average Power in kWh	649.00		639.00	
Power (12 units/ton) @Rs 24/Unit in Neutral Lining			288	
Power Consumption			352	
Power Saving @ 3.7 Agh/ton. Power cost Rs 210/kWh in Neutral Lining				
Total Cost/ton	267.81		188.36	
Total Saving in Neutral Lining —Rs/ton	23.87			
Extra Benefits with NEUTRAL RAMMING MASS				
Possibilities of Keeping Hot Metal and then by saving in power consumption and Productivity improvements.				
Less maintenance —longer life of furnace with proper refractory.				
Less space requirement —compact for huge silica ramming mass storage requirement.				
Less usage of electrical and mechanical equipment (Crew / Fork Lift / Pallet Loader) (Approx saving 5-Ton/ton).				
Less Downtime —better house keeping —more safety.				
And Above All —Very High Industrial Safety to Man and Machine				

## Conclusions

The selection of refractory lining is a key for coreless induction furnace to reach the longest possible life with optimum cost, in current hard competition and tight market conditions. Although the initial cost of Neutral Ramming Mass is higher than silica, it is still overall profitable if we consider the costs of former and mica, labor, energy, production loss, higher metal output, etc.

Neutral Ramming Mass has 3 Phase structure – Sintered / Semi-Sintered/ Powder layer during operation, combine effect of 3 – Phase results Slag/Metal resistance, longer life. At the end of lining life, patching can be done with Neutral Ramming Mass by keeping the virgin powdery backup, so overall campaign life can be increased with Neutral.

## References

- [1] Inductotherm Corp, "Induction Heating & Melting Safety Fundamentals Guide". Page No. 4, 20 to 23 copyright @2006, Inductotherm Corp..
- [2] William D Callister Jr., "Material Science & Engineering an introduction", Page 407.
- [3] Jaydip Goswami, Bismil Ghosh, Olivier Francy, Frederic Roulet, Sandip Samaddar, Vignesh Babu, Amit Sinha, Vidosh Sarup "New Generation Refractory Lining For Coreless Induction Furnace".
- [4] Ozan Uylas<sup>1,2</sup>, Muharrem Timuçin<sup>3</sup>, Ender Suvaci<sup>1</sup>, Muammer, Bilgiç<sup>5</sup>, Beyhan Özdemir<sup>4</sup>, Oktay Uysal<sup>2</sup>, Uğur Cengiz<sup>5</sup>, Özkan, Kurukavak<sup>4</sup>, Hasan Erdoğan<sup>4</sup>, Yakup "Post Mortem Study on Al<sub>2</sub>O<sub>3</sub>-MgO Induction Furnace Linings".





# PAKISTAN SANDS

**Washed & Graded  
Silica Sand**

*Quality, Variety & Services*



**SILICA**



**MOULDING**



**QUARTZ**



**TILE BOND**

H/Office A-64/4, Lane# 02, Lala Rukh Wah Cantt, Rawalpindi

Works: Near Railway station Kamar Mushani, Mianwali

Phone: + 92 300 6099644 - + 92 320 6099644 | Email: [pakistan\\_sands@yahoo.com](mailto:pakistan_sands@yahoo.com)

Whatsapp: + 92 300 0227374





# INFINITY

## SCHOOL OF ENGINEERING

Shaping Lives for Skillful Living

ISO  
29990:2010  
Certified

Backed by  
Group of  
Companies

Outcome  
Based  
Education  
(OBE)

Well  
Equipped  
Labs

Free  
Certification

## Introduction

Infinity School of Engineering (ISE) was established back in 2016 with a vision to provide education and training in engineering and management disciplines that pursue **knowledge**, **skills** and **attitude**, providing synergy between youth and industries for national development.

Being the only institute backed by a Group of Engineering Industries, ISE is providing quality trainings in a number of industrial demand driven courses, hence bridging the gap between youth and industries.

ISE is the pioneer institute in the country that is **certified on ISO 29990:2010**, to meet the quality of technical training and management according to international standards.

## Agreements Signed Under CPEC

Students Exchange  
Programs

Faculty Exchange  
Programs

Technology Exchange  
Programs

Curriculum Exchange  
Programs



Shandong Vocational  
College of Industry,  
China



Hunan Chemical  
Vocational Technology  
College, China



Shaanxi Institute of  
Technology, China



China Foundry  
Association



Tianjin Ixinsheng  
Advanced Casting  
Co. Ltd. of China

+92-334-4228634/+92-301-5644724/ +92-42-37970011/12 [www.infinity.edu.pk](http://www.infinity.edu.pk)

[trainings@infinityengg.com](mailto:trainings@infinityengg.com) [www.facebook.com/infinityschoolofengineering](https://www.facebook.com/infinityschoolofengineering)

18-KM Shekhupura Road, Lahore, Punjab, Pakistan



## Grind Wheel (Pak) Ltd

### *Manufacturer of Grinding Wheels for Foundries since 1948*

*Grind Wheel Pak Ltd* was established in **1948** in Karachi and has become one of the most successful Company in Pakistan. This **seven decades** experience has enabled us to develop many products according to customer's required **size and specification**.

*In this time span* our **high standard of quality**, expertise in **development** and an exceptionally quick response, dedications to our **customer's needs** and philosophy of **providing solutions** to them has earned us to build a strong customer base of **many satisfied customers**.

*We are proud* because we know, we are a company that keeps its words to its customers and **guarantee** after sales service.

### *Our Products for foundries*

We are manufacturer of perfect **Grinding wheels**, **Cup wheels**, **Flaring cups**, **Grinding & cutting discs** for all Grinding & Cutting applications in **Fettling shops** with greater efficiency for both **Manual fettling** & for **Machining of Castings**.

Our Products are available in **Aluminum Oxide & Silicon carbide abrasives grains** and are available in **vitrified bond & Bakelite bonded wheels** which can operate between **30 to 45 m/sec machines**.



**"GWP"** Grinding wheels give you the perfect snagging high performance, high- tech wheels are specifically engineered to remove unwanted material and flaws on ductile and Grey iron castings in foundries, welding and fabrication shops.



We will be thankful to your patronage to give us an opportunity to be of service to you.

### *Sales and Marketing Division*

Grind Wheel (Pak) Ltd , F-30, S.I.T.E., Karachi.

Contact: 03453330060, 03353191931

Email: [grindwheelabrasives@gmail.com](mailto:grindwheelabrasives@gmail.com), [sales@grindwheelabrasive.com](mailto:sales@grindwheelabrasive.com)





OMEGA SINTO FOUNDRY MACHINERY

New Harmony >> New Solutions™

www.ofml.net

1994  
SPARTAN I



1984  
OMEGA 2



1978  
OMEGA 1 HIGH  
SPEED MIXER



1998  
SPARTAN II



2005  
SPARTAN III



2018  
SPARTAN IV



**40 YEARS OF TECHNOLOGICAL  
DEVELOPMENT**

**Omega Mixers – Setting the pace in foundry sand mixing**



**MOSH INTERNATIONAL**  
44-C, 11th Jami Commercial Street, D. H. A. Phase - VII  
Karachi - 75500, Pakistan.  
T: 021 3531 1014 & 5 M: 0300 287 5262 F: 021 3531 1016  
E: shamshadali@engineer.com W: www.moshpakistan.com



**OMEGA SINTO FOUNDRY MACHINERY LTD**  
Morley Way, Peterborough, Cambridgeshire,  
PE2 7BW, United Kingdom.  
T: +44 (0)1733 232231 F: +44 (0)1733 237012  
E: sales@ofml.net W: www.ofml.net

# EXCEL GROUP OF COMPANIES



Engineering Pvt. Ltd



Hussein Engineering Works  
Pvt. Ltd.

📍 lahore

📍 karachi

## Manufacturer of Machined Castings

### OUR VALUABLE CLIENTS



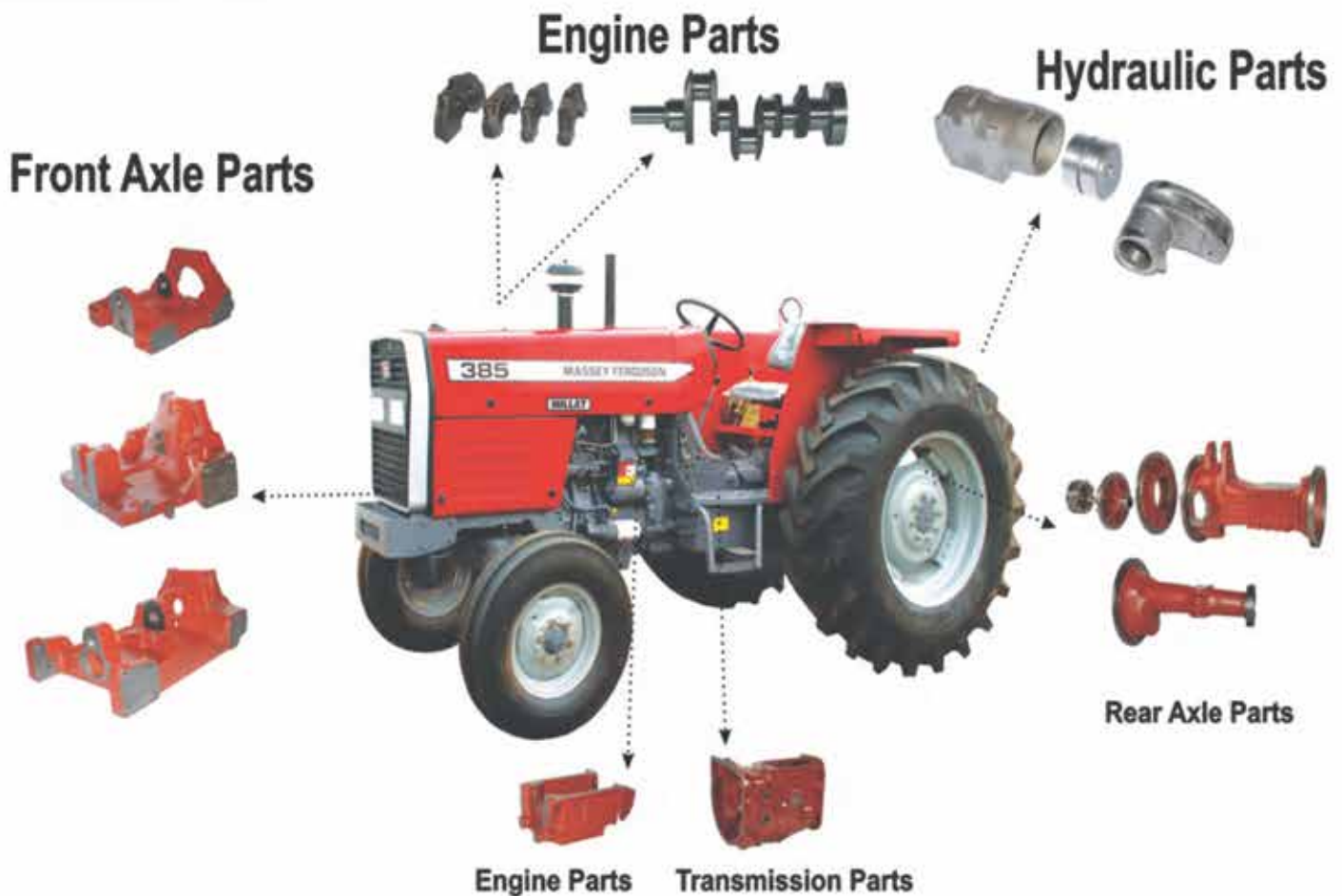
Office: 131/4, Quaid-e-Azam Industrial Estate, Lahore - Pakistan. Tel: (92-42) 35155667-8  
Email: [excel@excelengg.com](mailto:excel@excelengg.com) [info@husseinengineering.com.pk](mailto:info@husseinengineering.com.pk)

[www.excelengg.com](http://www.excelengg.com) [www.husseinengineering.com.pk](http://www.husseinengineering.com.pk)





# **CHENAB ENGINEERING WORKS & FOUNDRIES (PVT) LTD**



**Jhumra Road Nishatabad, Faisalabad, Pakistan**

**Tel : 0092 41 8751048**

**0092 41 8751424**

**0092 41 8751423**

**Fax : 0092 41 8752482**

**E-mail : [info@chenabfoundries.com](mailto:info@chenabfoundries.com)**

**web : [www.chenabfoundries.com](http://www.chenabfoundries.com)**



# ELECTRO HEAT

**For total melting solutions**

**Manufacturers of Medium Frequency Induction Melting Furnaces**

**Custom made foundry solutions**

**Flexible design to match your foundry requirements**

**Motor Generator upgrade solutions to Solid State Furnace**



**Made In Pakistan**  
**Based on latest technology**

**Melting Capacity**

Steel Frame Crucible: 10MT to 50MT

Yokeless Aluminum Crucible: 50kg to 10MT

**Power Pack**

Series Inverter: 50 kW to 900 kW

Parallel Inverter: 50 kW to 14000 kW

**Address:**

10km, Gujranwala-Lahore G.T Road, Attawa, Gujranwala Pakistan

Mobile: +92 300 8442057

Phone: +92 55 34000505

Fax: +92 55 3264490

Email: [electroheat@gmail.com](mailto:electroheat@gmail.com) | [mnubeg@gmail.com](mailto:mnubeg@gmail.com)

Website: [www.electroheat.com.pk](http://www.electroheat.com.pk)

**Among our prestigious customers:**

Bolan Castings Ltd, Karachi

Chenab Engineering Works and Foundries (Pvt) Ltd, Faisalabad

Friends Foundry (Pvt) Ltd, Islamabad

Qadri Brother (Pvt) Ltd, Lahore





## Chemical Tools for Foundry Engineering **SINCE 1974**

### WHO WE ARE ABOUT US

Çukurova Kimya Inc. was established back in 1974 which is located in an industrial zone in Manisa / Turkey. Cukurova Kimya who provides high quality products to ensure customer pleasure from date of foundation, has a lead position in Turkish market with regard to sales of foundry products. Çukurova Kimya offers you more than 40 years of experience, extensive know-how and engineering expertise.

### WHAT WE PRODUCE?

Foundry Resins

Feeding Systems

Insulation Materials

Refractory Coatings

Industrial Resins