Innovation: The Journey of Tata eFee™

It all started in October, 2008. After an intensive feedback from over 100 customers across India, Tata Metaliks Limited (TML) realized that it had to take some quick steps towards reduction of energy consumption in pig iron foundries of India. Being world's largest producer of foundry grade pig iron, the foundries looked up to TML for solving one of their biggest challenges in recent times; energy consumption. TML decided to take up this challenge and thus started the journey of Tata eFee™, world's first branded pig iron.

Why is energy consumption, a big challenge for Indian foundries?

There are predominantly two types of furnaces in Indian Foundry Industry; cupola furnace and induction furnace, with majority of furnaces being cupola furnace. Induction furnaces are relatively new in India but are technologically more advanced than cupola furnace, while also being more expensive. There is capacity limitation in induction furnaces, hence large foundries still prefer cupola furnace over induction furnace.

The sources of energy vary from a cupola furnace to an induction furnace. While coking coal is the source of energy for melting in cupola furnace, electricity is used for the melting in induction furnace. Over last few years, the prices of both coking coal and electricity have risen thereby leading to a sharp rise in the power bill of the foundries. This cost is significant as energy costs are the second largest cost after raw material costs in foundry operations, accounting for 12%-15% of the total cost.

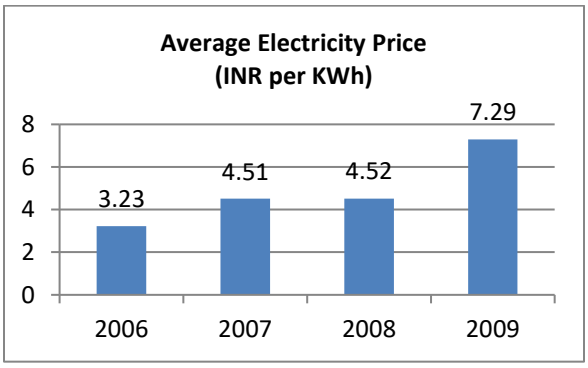


Figure 1: Rising energy costs in Induction Furnace

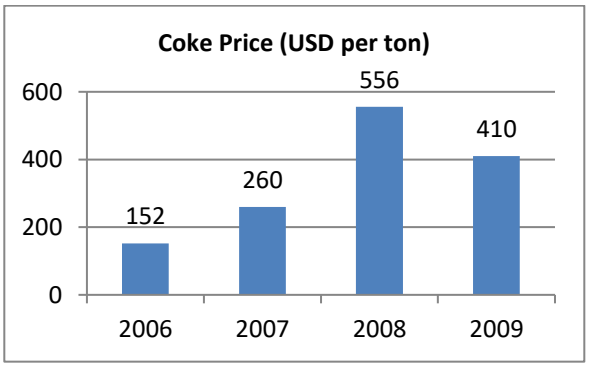


Figure 2: Rising energy costs in Cupola Furnace

Energy Consumption is not only a concern for Indian foundries but has long been recognized as a global challenge. According to American Foundry Society, “The profitability of the foundries will be at risk if the energy consumption is not controlled”. As per Foundry Management and Technology Journal, “Addressing rising energy costs is essential for economic survival of foundries”.

However, Indian foundries still have a long way to go to match international standards in energy consumption. The following charts depict a comparison between average energy consumption in both cupola and induction furnaces in India and internationally.

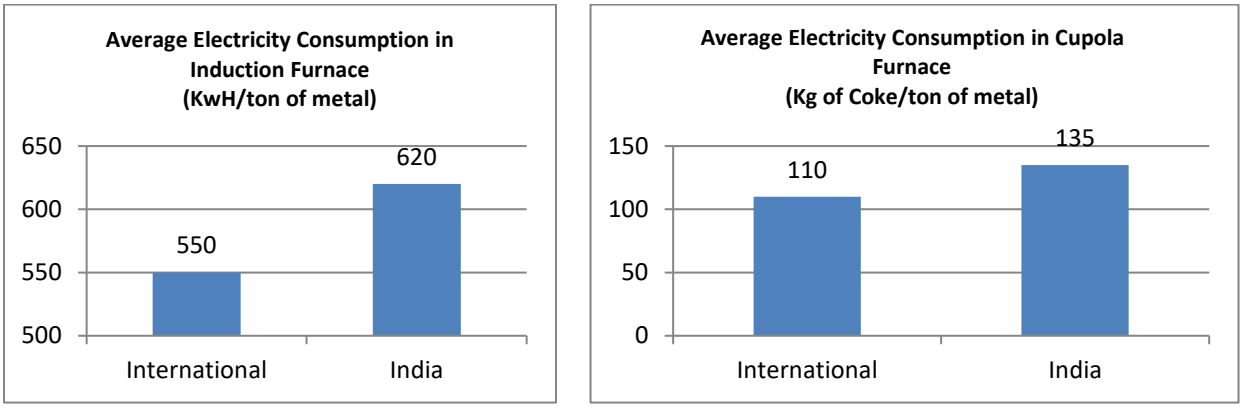
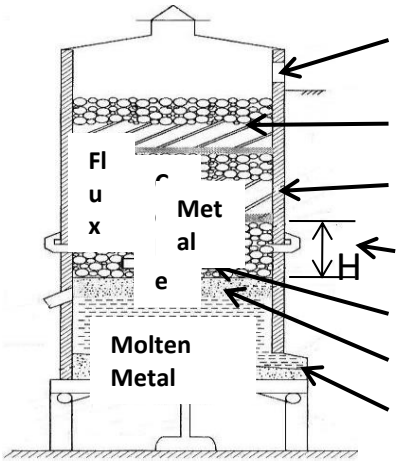


Figure 3: India falling behind global standards of energy consumption in Cupola and Induction Furnaces

Why is it a challenge to control energy consumption?

The melting processes in cupola and induction furnaces are completely different. While melting takes place due to convection in cupola furnace, radiation is used for the same in induction furnace. This makes any research very difficult as the need is to find a solution which will work in both these melting processes.

Being a raw material supplier to foundries, TML has its own limitations as there are many other variables apart from raw material that influence the energy consumption in furnaces as shown in figures below, be it cupola or induction furnace. Some of these factors being charge mix, chemical composition of inputs and end product, quality of raw materials, sequencing of charging, foundry etc. The presence of advanced control mechanisms and energy management programs in foundries is essential to measure and control these factors. However, 80% of the foundries in India are still in small to medium category without the presence of these advanced control mechanisms, thereby making it difficult to monitor and control energy consumption.



Method of Charging

Charge mix composition, Quality of materials

Heat Conduction, Heat accumulation by lining walls

Coke bed height

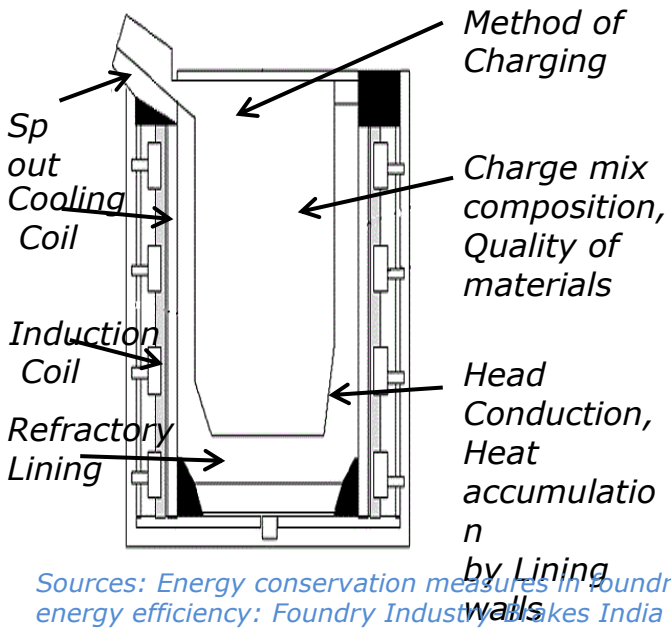
Air flow rate, Temperature of Blast

Deslagging and tapping Temperature

Other factors:

- End product
- Level of Automation
- Operational factors like
  - ✓ Mould making
  - ✓ Pouring time
  - ✓ Tapping time
  - ✓ Void distribution in furnace
- Utilities like bulbs, compressor, etc

Figure 4: Energy Consumption in Cupola Furnace is a multi-variate problem



Other factors:

- End product
- Level of Automation
- Operational factors
  - ✓ Mould making
  - ✓ Volume of 'Heel'
  - ✓ Pouring time in mould
  - ✓ Tapping time
  - ✓ Packing Density in furnace
- Utilities like bulbs, compressor, etc

Sources: Energy conservation measures in Foundry Industry, SIDBI, DFID, Latest trends in energy efficiency: Foundry Industry Cases India

Figure 5: Energy Consumption in Induction Furnace is a multi-variate problem

Apart from multiple variables influencing energy consumption, another significant difficulty in controlling energy consumptions in Indian foundries is also the existence of traditional foundry practices and minimal mechanization. Global advancements in technology and processes still seem to be far away from majority of Indian foundries. This makes it difficult to measure and control the energy consumption; thereby any effort to reduce the same may not even be acknowledged by the foundries in short to medium term. Any such efforts in research and development will bear fruits only in long term.

The first step: Identifying the right partners

For any journey to be successful, one needs good partners to work with. Even in this journey, TML partnered with multiple organizations which brought technical and market know-how to the table.

One of the first partners was Tata Steel's Research & Development and Automation team at Jamshedpur, which included Dr. Sandip Kr. Saha, Dr. Sumitesh Das, Ms. N Gurulaxmi Srikakulapu, Mr Jacob Joshi, and Mr P K Tiwari.

Another important partner in R&D was Sponsored Research Industrial Consultancy (SRIC) cell of Indian Institute of Technology (IIT) Kharagpur. Further research guidance was sought from Prof. G.L. Datta from the same institute, who is also Editorial Board Member of Indian Foundry Journal.

From the marketing side, TML partnered with Nueve Consultancy. Nueve specializes in providing Market Entry Strategy & Implementation support to B2B companies in India. The fact that it was started by a Tata Administrative Services (TAS) officer was a big comfort as Nueve imbibed the same values and business ethics that Tata Group stands for. Nueve's Advisory Board included Dr. Sharad Sarin, Professor of Marketing at XLRI Jamshedpur, and the author of "Strategic Brand Management for B2B Markets". He is widely respected as an expert in the area of B2B marketing and his guidance was readily available through TML's association with Nueve.

The approach towards the challenge

Deeper study of the energy consumption in furnaces revealed that 70% of the energy consumption takes place during the melting process in the furnaces. Hence, TML team decided that if it could work on a new product that could significantly melt faster than the existing pig iron, it would be able to considerably bring down the energy consumption in the furnaces, thereby helping foundries resolve the energy consumption challenge to a great extent.

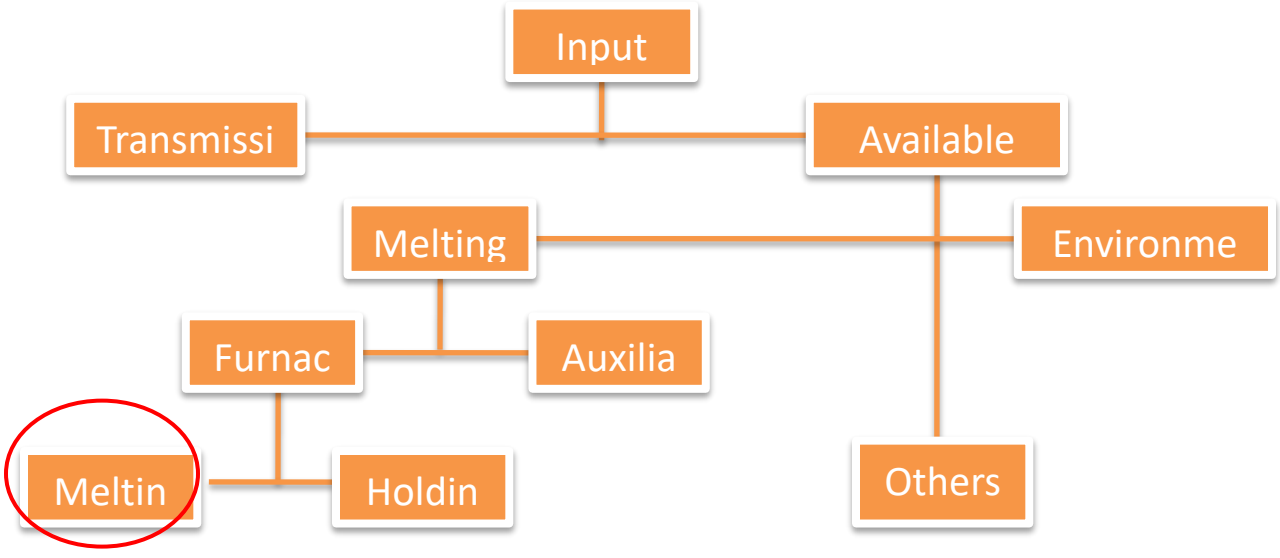
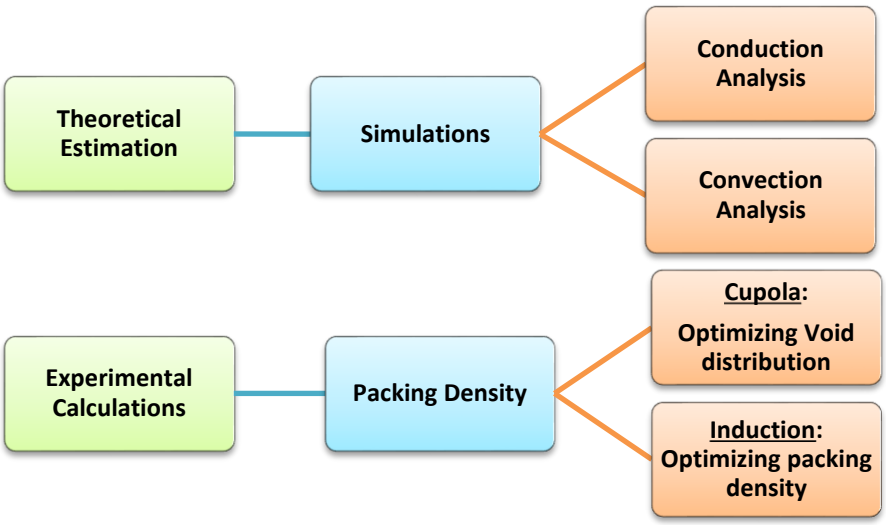


Figure 6: Melting consumes maximum energy in a furnace

It was also decided that improvements in the physical parameters of the product should be the starting point of the research as that increased the chances of success and would help in faster entry to market.

Simultaneously, research on product improvement through changes in chemical composition should be carried out to bring the next generation products to the foundries.

Research & Development Methodology



Two-pronged research methodology was chosen for carrying out the research by the research team from IIT Kharagpur and Tata Steel; theoretical estimations followed by experimental calculations. Some salient features of theoretical estimation are given below:

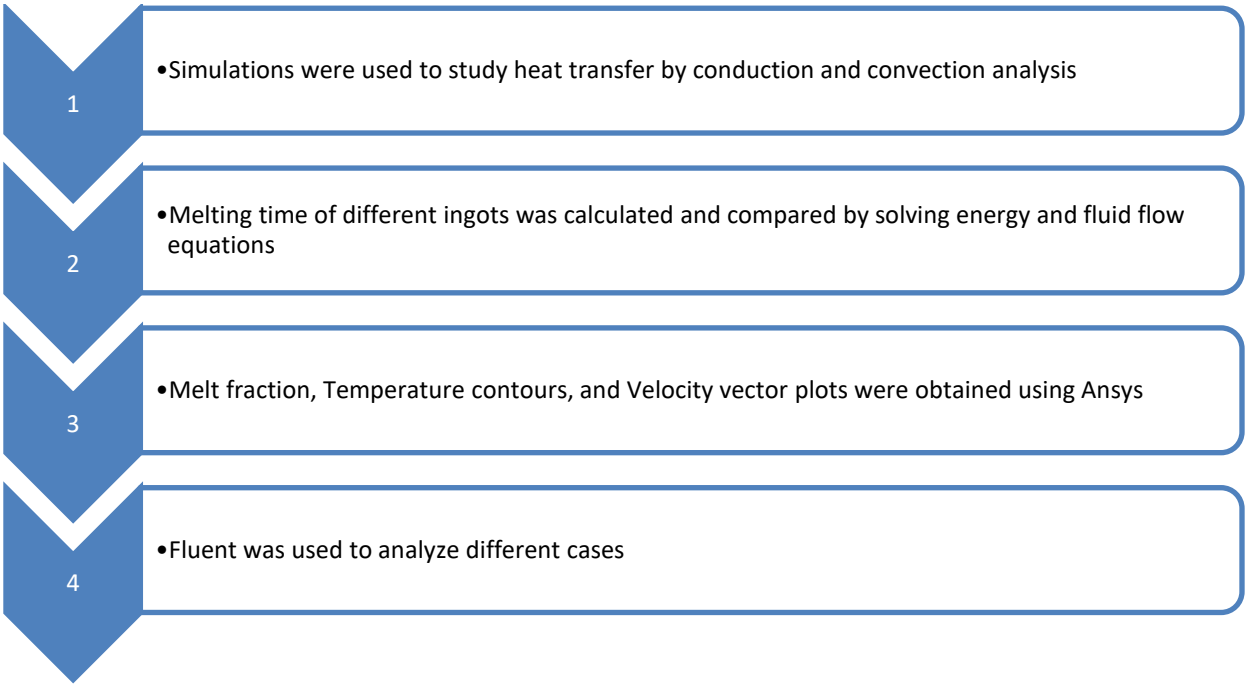


Figure 7: Theoretical Estimations Methodology

Packing density is a measure of degree with which ingots are packed inside the furnace; remaining unfilled space is void. This means that the higher the void distribution, the lower the packing density. Hence the

key is to arrive at an optimum design which would optimize both void distribution in cupola furnace and packing density in induction furnace.

While doing experimental calculations, scaled down models of cupola furnace and ingots were used to calculate the void distribution and packing density. Void distribution was obtained at different heights of model cupola furnace by taking images and processing them. Voids at a plane, 10 cm from bottom of furnace, were measured for 2 different ingots.

Cold model of furnace

Ingot

Furnace packed with ingots

Random packing

Figure 8 : Rubber Models of Cupola Furnace & Ingots used for Simulations

Packing density for different ingots calculated experimentally using scaled down model and using theoretical correlations. Correlations developed by 'Yu and Standish' and 'Brown et al.' used to calculate packing density theoretically.

For cupola,

- Flow of air blast in furnace (porosity) is essential for faster melting
- Uniform void distribution leads to central air blast flow in furnace
- Voids between metal surfaces initiate early melting in such surfaces

For Induction,

- Melt rate is directly proportional to packing density
- Packing density is estimated using theoretical research, further validated by experimental research
- Void Distribution = 1 – Packing Density

Results of the research

Improving melt rate of ingots was found to be the key to reduce energy consumption in foundries and uniform void distribution & packing density were identified as important parameters to improve melt rate. Optimum void distribution and packing density were arrived at for highest melt rate.

An optimum ingot design was arrived at, which would offer optimum void distribution in cupola furnace and optimum packing density in induction furnace.

Introducing Tata eFee™

After the research was complete and an optimum ingot design was arrived at, the key challenge was to test its effectiveness and benefits with regards to the melt rate improvement in furnaces, both cupola and induction furnace.

It was decided to conduct the trials in both laboratory and actual furnaces in various foundries to generate data on the benefits of this new design. Many trials were conducted in various sizes of cupola and induction furnaces at foundries located all across India like Howrah, Kolhapur, Belgaum, Hyderabad, Coimbatore, and Nagpur.

The trials were conducted in collaboration with TML's technical service team and Nueve Consultancy which supervised all the trials to maintain consistency in trial conditions, material handling, sequence of material feeding, data collection format, etc.

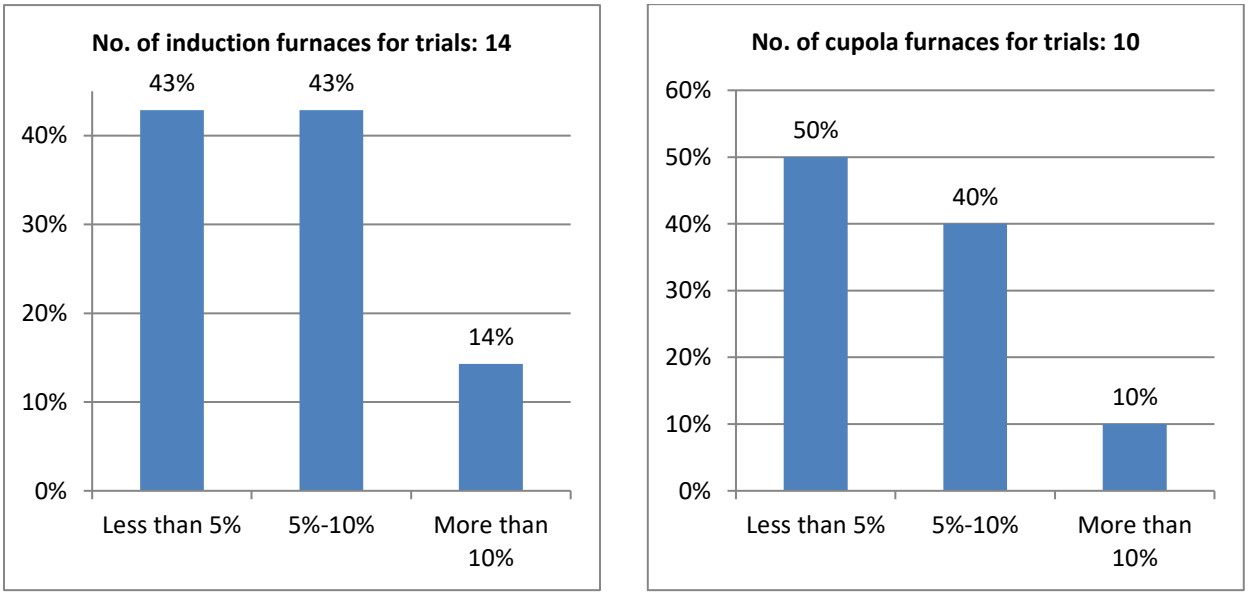


Figure 9 : Melt Rate Improvement due to new product design in both Cupola & Induction Furnace

Brand Building

After convincing itself of the benefits of the new product design, TML faced another daunting task; that of introducing a brand in a highly commoditized market of pig iron. Price is typically the key differentiator

in any commodity market and there are very few differentiators that the suppliers offer to their customers.

With the help of Nueve Consultancy and under able guidance of Dr. Sharad Sarin, TML prepared a brand strategy which will work with Indian foundries. All the elements of the brand building, starting from brand identity to final launch of the brand was jointly conceptualized and implemented by TML and Nueve team.

The name for this brand was kept as Tata eFee, where "Fe" is the chemical symbol of Iron and "e"s at the beginning and the end of "eFee" denote energy efficiency and environment friendliness. Typically, all the foundry owners are aware of "Fe" irrespective of their literacy level, owing to the test certificates provided by pig iron suppliers, which denotes the "Fe" content of the pig iron.

The strategy was simple. Initially, the foundries were offered Tata eFee on a trial basis to let them realize the benefits of the products themselves. This was coupled by aggressive customer communication through one to one meetings, location wise customer meetings, and participation in IFEX 2011 (International Foundry Exhibition).

The pricing of the product was another important decision to be taken. Since Tata eFee was offering clear cost reduction to foundries and was also positioned as a premium product, it was decided to charge minimal premium on each ton of Tata eFee. A very high premium would have been extremely risky, owing to the fact that this was the first brand to be introduced in the pig iron market ever.

The Road Ahead

After successful launch of Tata eFee™ in South & West India, TML intends to launch the product across India over next few months. Efforts are on to standardize the product quality and volume of production. Regular customer feedback and interaction has been identified as the key to the success of Tata eFee™. Sales & Marketing teams have been trained on the elements of brand building and have been equipped with all necessary marketing collaterals.

TML also understands that every brand has a shelf life and has already started the next phase of research which will fuel the introduction of brand extensions of Tata eFee™.

As per TML's vision, it wants to lead the market by "*Reaching Tomorrow First*".