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ENERGY CONSERVATION IN INDUCTION FURNACE: A REVIEW

Imam Hussain [1] Anula Khare[2]

[1]M.Tech Scholar, Department of Electrical and Electronics Engineering, Technocrats Institute ofTechnology, Bhopal, India

[2]. Professor, Department of Electrical and Electronics Engineering, Technocrats Institute ofTechnology, Bhopal, India

ABSTRACT

The iron and steel industry presents one of the most energy intensive sectors within the Indian economy and is therefore of particular interest in the context of both local and global environmental discussions. It is a part of people's everyday life, in both the developed and developing world. A historical examination of productivity growth in India's industries embedded into a broader analysis of structural composition and policy changes will help identify potential future development strategies that lead towards a more sustainable development path. Now-a-days demand of steel is increasing due to increase in infrastructure and globalization. And to meet this demand we are looking for such foundry process which will produce high quality steel with minimum time. The aim of this paper is to study the overall performance of induction furnace and to suggest the method to improve melt rate with optimum use of electricity. This paper mainly put attention on induction furnace as these are main consumer of electricity in foundry. In case of induction furnace efficiency is sensitive to many controllable features lie in operational practices, coil height; charge mix, furnace utilization etc. So with the help of recommendation, it is easy to find out the ways to lower the specific energy consumption in this furnaces. So, in this paper we are trying to develop certain relationship between input and output parameters to improve the Whole process.

Keywords: Coil height, Controllable, Energy, Optimum, Utilization.

I. INTRODUCTION

The iron and steel industry presents one of the most energy intensive sectors within the Indian economy and is therefore of particular interest in the context of both local and global environmental discussions. Increases in productivity through the adoption of more efficient and cleaner technologies in the manufacturing sector will be effective in merging economic, environmental, and social development objectives.

But now a day's the demand of steel is increasing because of increase in infrastructure and globalization .That's why steel industries are looking for such a furnace which can produce good quality steel with high production rate, and controlling quality, composition, physical and chemical properties. This can be achieved by using

"INDUCTION FURNACE" and hence it comes into picture. So, in this paper, we are trying to develop certain relationship between input and output parameters to improve the Whole process.

The energy efficiency of any foundry largely rides on the efficiency of the melting process a multi-step operation where the metal is heated, treated, alloyed, and transported into die or mould cavities to form a casting. The melting process is not only responsible for the energy consumption and cost-effectiveness of producing the castings (Exhibit 3), but it is also critical to the control of quality, composition, and the physical and chemical properties of the final product.

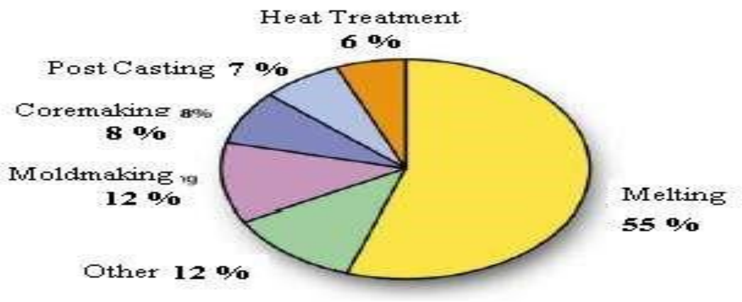

Figure 1: Report Source: 2020 Metal Casting Annual

The industry spent $1.2 billion in fuels and electricity purchases alone in 1998. The concern over the energy efficiency of processes has been growing with the recent rising costs of energy. Factors like increasing energy demands, compounded by spikes in energy costs from world events will continue the upward trend in energy costs, pressing the need for developing energy-efficient solutions for the melting process.

Figure 2: Source 2021 Metal Casting Annual Report

Although the energy consumption in the melting process has been a significant concerning foundry operation. Studies have shown that by Implementing best practice technologies, iron and aluminum melting can save approximately1.2 and 3 million per ton respectively. In summary, striving to reduce energy consumption in melting ferrous and non-ferrous metals shows a promising path to lowering operating costs in foundries and in turn cutting down the production costs for the entire U.S. manufacturing sector.

II. METHODOLOGY STUDY OF INDUCTION FURNACE- A REVIEW

2.1 Induction Furnace

Induction furnaces are widely used in the foundry industry. Out, of the two types of induction furnaces coreless and channel - the careless induction furnace finds application in melting cum holding operations. The scope of this Project is restricted to coreless furnaces only.

Coreless furnaces were traditionally designed to operate at mains frequency of 50 Hz with a molten metal heel. Medium frequency furnaces operating between 150 Hz and 1000 Hz, are posing a serious chal1enge to the mains frequency furnaces because of their ability to operate without molten heels and their smaller size.

2.2 Principle of Induction Furnaces

The working of induction furnaces is based on the principle of electromagnetic induction and basic concept is same as that of a transformer but with a concept is same as that of a transformer but with, a single turn short circuited secondary winding. The charge to be heated and melted forms the secondary while the hollow water cooled copper coils excited by the A. C. supply from the primary.

In the core type furnaces, in order to maintain the electric path there must always be a sufficient molten metal in the furnace. This is called the molten heel.

In the coreless induction furnaces, the primary coils surround a refractory crucible in which the charge to be melted is put. The eddy currents induced by the primary winding generate heat in the charge. Since there is no core, a large current is required to overcome the reluctance between the coils and the charge and results in a very low pf.

The coil is surrounded by a laminated magnetic yoke to provide a return path for the flux to prevent stray losses and improve the pf. The whole furnace is contaminated in a mechanically rigid structure and mounted so that it can be tilted for pouring.

III. REVIEW OF LITERATURE

The literature review reveals that a great deal of work has been carried out in the field of process improvement in the industries using Induction furnace for steel melting, It is observed that there is lot of work has been done on the parameters which are responsible to reduce the energy consumption and reducing the production cost of steel.

J. Powell has analyzed in his paper presented at the institute of British foundries that in case of coreless furnaces, full power should be applied to the furnace for the maximum possible time to ensure maximum output and minimum energy consumption, and holding periods should be kept to a minimum .The use of medium frequency furnaces started from cold and emptied completely immediately after each melt can have better energy consumption figures, since there are few if any holding periods. In addition, the increased power densities available with such furnaces and their increased melting rate capability further reduce energy consumption.

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The type of refractory construction employed in channel furnaces can also affect energy consumption and lining wear has an adverse effect. With all furnaces, it is important to minimize heat losses by proper attention to linings and the use of lids and covers.

W. A. Parsons has shown that Electric Furnaces which are operated with a molten heel practices are vulnerable in a reduced output situation since the holding component to the total electrical energy consumption tends to increase. The adverse effects of this type of operation may be overcome in mains frequency coreless furnace melting where it is possible to produce the lower output by working at optimum furnace melting rate and decreasing the number of working days.

Apart from the liquid metal quantity, variation in charging practice also affects the heat time. It has been found that similar liquid metal quantity has taken with variation in heat time. This has adverse impact on the energy consumption. Also due to erosion of lining, the tap quantity increase along with lining life number, which has reduced specific energy consumption.

Investigation by **S. K. Dutta** shows that main problems faced by steelmakers are short supply, fluctuating prices together with extremely heterogeneous nature and presence of tramp elements of steel scrap. Use of direct reduced iron (DRI) as a partial replacement to scrap, to some extent does help in overcoming this hurdle. However, unlike scrap and even pig iron, DRI is characterized by high porosity, low thermal and electrical conductivities which, in turn, pose problems in its melting.

Attempts were made to study melting of DRI in a laboratory size induction furnace using molten steel bath as hot heel. The induction stirring accelerates the transfer of heat and promotes the melting of DRI. The effect of partial replacement of scrap by DRI on various melting parameters has been studied. Also kinetic studies were made to evaluate net melting rate. It was revealed that since melting and refining are taking place simultaneously, the increasing proportion of DRI in the input charge increases net melting rate and metallic yield. It was concluded that higher proportion of DRI, as a replacement to scrap, contributes to improve mechanical properties with no segregation of carbon content and the decrease in sulphur and tramp elements in the product that improves steel quality.

L. Smith has concluded that it is essential that consideration be given to energy costs both at the purchase stage and throughout a furnaces useful life. It is through awareness of salient factors such as charge materials, charging practices, linings, temperature measurement and keeping that minimum energy costs can be attained. These costs should not be divorced from other factors such as recovery, flexibility and environment. The environmental impact is very difficult to quantify in terms of energy efficiency, although for a large number of operations the absence of fume offers additional energy savings by virtue of elimination of extraction facilities. Seminar report by **The Energy conservation Center, Japan** focused on energy saving opportunity in induction furnace few of them are, Rated power is supplied to the furnace only when thickness of furnace refractory remains normal. Furnace power may be lowered when its inner diameter changes due to erosion of furnace wall or slag attached to the wall. Furnace wall damaged by erosion should be repaired to maintain the standard diameter in respect to thermal efficiency of the furnace.

Before charging the material it is necessary to remove sand, rust and other foreign matters causing slag formation. Quantity of heat required for cast iron melting process up to its melting point (about 1150°C) accounts for 65%

of the total heat consumed for heating cold material of room temperature (20°C) to tapping temperature (1500°C). Induction furnace consumes 87% of the total power consumption required for melt down. Remarkable power saving may be realized if raw material is preheated up to 500 -600°C by any method more effective than induction heating.

The advancement of any nation technologically has been influenced and elevated by the extent to which it can usefully harness and convert its mineral resources. The productions of metal in foundries and in all human lives have also become a general practice. Different melting techniques are in practice with different energy sources. The cleanliness and availability of electrical energy sources in Nigeria is of paramount importance to its use in foundries, hence the need for this design. This paper deals principally with the mechanical and electrical requirements for induction furnace production. The mechanical aspect gives consideration to the geometrical components, cooling system, and the tilting mechanism. The electrical aspect deals with the furnace power requirement to make it functional. The design was achieved through consideration of relevant theories and their practical application.

Study by R. L. ROD shows that during the past 30 years, the melting methods and associated molten metal handling systems used by the U.S. foundry industry have changed significantly. During the same period, while ductile iron production has experienced continued growth, the quality of metallic scrap and other iron unit feed stocks has steadily deteriorated. The result: slag related melting problems have become widespread issues in recent years. Yet, a search of the foundry technical literature from the past 30 years about slag control and buildup will result in only a handful of articles. A new flux, Redux EF40L, has been developed that controls and minimizes buildup in pouring ladles, melting furnaces, pressure pour furnaces and magnesium treatment vessels with minimal to no adverse effects on refractory linings.

IV. CONCLUSION

So, in this paper, we are focusing on improving the efficiency of steel melting processes. **After actually w**atching all the steel melting process, we came to know that what are the various losses and where heat is lost. Hence for improving its efficiency and for reducing the losses we have made recommendation, if this comes in regular practice obviously it helps to increase its efficiency. The heat loss in the furnace is major due to open mouth of furnace, due to transmission of molten metal through transfer media, and mostly we are concentrated in this paper to avoid such loss, so that maximum power is saved.

Material and energy losses during these process steps represent inefficiencies that waste energy and increase the costs of melting operations. It is, therefore, important to examine the impact of all proposed modifications over the entire melting process to ensure that energy improvement in one step is not translating to energy burden in another step.

Although these technologies require little or no capital for deployment, engineering assistance is needed for the facility to reap its maximum benefits. The study concludes that to achieve energy reduction goals, renewed R&D efforts must target the current technical barriers in the melting technologies and pursue multiple paths as recommended (Result & Discussion). Advances from such efforts will not only save substantial energy in the overall melting process, but also provide high-quality molten metal that will reduce the cost of the casting process and enhance the quality of the final casting product.

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