FABRICATION OF FOUNDRY CUM FORGING FURNACE

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Abstract - The paper deals with the fabrication of a coal-fired crucible furnace using locally sourced materials. For reducing the cost of energy, recycle and productively reuse the abundant scrap metals in the industries, workshops, production plants etc. For a more efficient working of our foundry industries led to this paper. This work focuses on the design, and construction, of a coal or charcoal-fired crucible furnace. In order to increase the efficiency of the furnace proper attention was given to the installation of tuyere and oxygen enrichment was also introduced. The components of coal-fired crucible furnace were furnace casing, crucible, furnace cover, burner housing, furnace cover stand, base stand and burner, air blower. Construction drawings were made and mild steel sheet was used for the fabrication of the furnace, while the other components needed for the design were selected based on functionality, durability, cost and local availability nature of the furnace**.** the most advantage of the coal crucible furnace is that the process can be done also in absence of huge electrical energy that issue in case of any other electrical based furnace. Very less electricity is required just run the air blower which is the plus point of coal crucible furnace.

Keywords - Crucible furnace, fabrication, heating process, melting process, coal combustion.

1. INTRODUCTION

The furnace is the most important instrument used in the foundry industries. It is a mechanical device in which metal is heated at a high temperature to get the desired product. Almost all industries rely on casting and forging product whose production is impossible without a furnace. In furnace heat is supplied can be a chemical type like coal, gas etc.

Foundry deals with the melting of metals to their molten state, and eventually pouring the molten metal into a prepared mold to form a casting and forging also deal with the rise the temperature of the respective metal to give the desired shape the size by applying external force on it after heat. A crucible furnace is a instrument used in the foundry industry for melting metals for casting metallic wares such as; machines, machine parts, and other related engineering materials. A coal fired cast iron crucible furnaces are therefore one meant for melting and casting of the cast–iron products. Generally, furnaces are also employed in the heat treatment of metals in order to influence their mechanical and physical properties.

The furnace is the very important equipment used in the foundry industry, which is an industry that uses logical methods for shaping metals. Examples of industries that rely on foundry industry are Automobile, Machine tools, Aerospace, Electrical, Plumbing, etc. [1]

The importance of the cast iron crucible furnace to the foundry industry as it impacts the industrial and technological development of any nation cannot be overemphasized since many machine components are made of cast iron.

The purpose and focus of this work are to enunciate steps leading to the designing, modifying, and updating the crucible coal furnace located in Engineering Workshop.

The high cost of transportation of foreign furnaces, raw materials etc. which had resulted to low production output, loss of human hours, the high cost of production, and in most cases, loss of jobs occasioned by the closure of most of the industries.

It also provides employment in the manufacturing sector in the country. The furnace is an efficient and reliable cast iron crucible furnace with an operating temperature range of approx. (11000c to 13000c). It is simple easily designed to be

constructed with locally available materials and to be fired with coal fuel in order to deal with the dual problems of the poor electrical power supply which has made it almost impossible for the foundry industry to success. This design has a lot of absolute economic implications such as availability, maintainability, functionality etc. thus leading to comparable cost advantage over the imported ones. [2]

2. MATERIALS AND METHODS

The common materials utilized for the fabrication of the coal-fired furnace were 4mm thick mild steel, stainless steel rod, fire brick, cartable refractory (Durax) and sodium silicate. And as energy source coal is generally used for the combustion to provide the heat to the crucible. [4]

Basically, Coal can be removed from the earth either by surface mining or underground mining. Once the coal has been pulled, it can be used directly (for heating and industrial processes) or to fuel power plants for electricity. If coal's less than 61 meters (200 feet) underground, it can be extracted through surface mining. This is an amorphous form of carbon. [4]

Charcoal is usually produced by slow pyrolysis (the heating wood or other substances in the absence of oxygen). The resulting soft, brittle, lightweight, black, fine material resembles coal. By comparison, burns at an intense temperature of up to 2700 as opposed to the melting point of cast iron of approximately 1200 to 1550. It is also an admirable reducing fuel for the production of cast iron and has been used in that way since Roman times. It has high calorific/energy/heating value (HCV) greater than coke.[3]

The work done include use(selection) of a more durable and suitable lining using refractory bricks, incorporation of a drop bottom, charging door, spark arrester, oxygen enrichment to increase the efficiency of the furnace.

2.1. Components of the furnace

The coal-fired crucible furnace consists of the following parts: furnace casing, crucible, furnace cover, burner housing, furnace cover stand, base stand, burner, mold, and strainer and holdings tools.

2.2. Component of Fabrication

2.2.1. Furnace casing: The mild steel sheet was selected for the fabrication of the furnace casing because of its relative light weight, good strength, excellent formability, weld ability, availability and low purchase cost. The furnace casing houses all the parts of the furnace including fire bricks and lining, the burner and the crucible. [8]

2.2.2. Welding Process: In this process the casing of the furnace by folding or rolling the cut sheet metal in sheet metal mill to produce a cylindrical or square housing for the furnace frame. The rolled sheet metal was then welded to the needed shape and the burner part is also welded to the furnace casing. Stainless steel of diameter 50mm was cut to a length of 305mm and was arranged with the burner housing hole. This was welded together to form the burner housing completely [7]

2.2.3. The setting of bricks: Proper brick installation with horizontal and vertical joints between the bricks or tiles is filled with mortar. This will assure a strong wall impervious to penetration by molten metal. It is approved that all be bricks be laid with the thinnest possible joint. Bricks should be dipped in the mortar and placed with a thin brick-to-brick joint. The wall was also muffled with sodium silicate before the surface is plastered with the mixture of the refractory cement and sodium silicate.

2.2.4. Flooring. This was done by first forming the surface of the base of the furnace wet with a mixture of water and sodium silicate before pouring a very thin layer (2mm thick) of the refractory mixture before sorting fire bricks into the base of the furnace.

2.2.5. Proper air supply: During the fabrication of the furnace, a stainless steel pipe of diameter 55mm was used for the air pipe to enable the introduction of large volume of air from the blower to the combustion zone from the blower for a higher air-fuel ratio that enters the furnace which will lead to an improved combustion rate.

2.2.6. Furnace cover and stand: The fabrication of the cover was based on the internal diameter or cross-section of the furnace and cover made with a same respective cross section from steel rim using totally the same mixture of Durax and sodium silicate with a hole in the rim which serves as the exhaust. Outer standee fabricated by mild steel with having proper strength and also is being designed (shaped) so that it can easily carry or hold the complete assembly. [8]

3. MATERIAL SELECTION

The choice of materials for the building of the furnace was based on the following engineering requirements:

(a) Weldability: This is the capability of the material to be welded

(b) Toughness: This is the ability of the material to resist shock and absorb energy due to impact.

(c) Fatigue: This is the capability of the material to resist cyclic stresses.

(d) Ductility: This is the capability for the material to be drawn into wire.

(e) Durability: The ability to unaffected by wear, pressure, or damage.

(f) Availability: The materials are easily available.[10]

The mild steel plate used for fabricating most components of the furnace is ductile, thus making it possible for it to be rolled, folded and bent without cracks or fractures. [9]

The under listed materials were specified for the design of the coal-fired crucible furnace.

- Mild steel plate (5mm)
- Flat bar (5mm mild steel)
- L-Type bar (mild steel rod)
- Plane bearing (cast iron)
- Holding tools
- Forced tools [2]

4. WORKING PRINCIPLE OF THE CRUCIBLE FURNACE

The furnace is first and leading preheated before firing it by igniting combustible materials such as coal in the combustible chamber. Air blow through the air blower nozzle an under pressure. The air is blown over the burning coal as well as it oxidizes for combustion. As this continues over time, the temperature rises gradually within and around the crucible, thereby When the crucible content is fully melted and is ready for pouring, the crucible is lifted out by means of a lifting tong, which is handled by two persons and then poured into the prepared mold cavity while at the time of forging the respective metal is lay on the combustion area of coal but the temperature is much lower than as the melting process. when the metal substance become hot red taken out from the burning coal and the further process is done on the red-hot metal by using forced tools like anvil hammer etc. to get the desired shape. After getting the desired temperature according to the requirement the air blower is switched off i.e. the supply of air is stop which leads to decrease the furnace temperature or to stop the combustion. Melting its content. The furnace temperature can be read directly from an optical pyrometer and by installing the thermostat inside the furnace combustion chamber wall. [7]

5. EFFICIENCY OF THE FURNACE

The efficiency of the furnace is the rate of the heat input to useful output. To calculate the furnace efficiency, we divide the theoretical amount of heat essential by the actual amount of heat used to melt a specific amount of metal.

Efficiency = (Heat output/Heat input) × 100 %

The efficiency of crucible furnaces range from a low 3.5% to a high 28%, the follows: common commercial average being around 15%. [2]

6. CONCLUSION

We have studied that the fabrication of forging cum furnace is very useful for the various foundry purpose. One of the main the coal furnace it can be run without electricity. The fabrication of this furnace can be easily achieved by using the local raw materials like refractory material, metal sheet, coal, different tools etc. Coal furnace will produce capable of producing small quantities of molten metal for various purpose .The furnaces can, therefore, be used at various small-scale workshops. This furnace plays an important role in the workshop. Its comparable cost advantage when compared with imported ones gives it additional credit. Also improvement and cost reduction in iron melting processes.

7. ACKNOWLEDGMENTS

Wish to thank Mr.Ram Jatan Yadav, Mr. Chandra Shekhar Singh (department of mechanical engineering) for their support to us during the course of this research work.

REFERENCES

[1] J.OOsarenmwind Department of Production Engineering, University of Benin, P.M.B 1154, Benin City, Nigeria

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[6] G. N. MAKAROV ET AL 3,667,746

FURNACE FOR CONTINUOUS HEAT PROCESSING OF VARIOUS MATERIALS, June 6, 1972

Filed Jan. 29, 1970

[7] B.S Raghuwanshi a course in workshop technology vol.1 (2015)

DHANPAT RAI & Co.

[8]Khurmi R.S. and Gupta J.K. (2005): A Textbook of Machine Design. Printed in India by RajendraRavindra Printers (Pvt) Ltd. 7361, Ram Nagar, and published by Eurasia Publishing House (P) Ltd. Ram Nagar.

[9] R.BalasubramaniamCallister's Materials Science and engineering.

[10] Jain R.K (2009): Production Technology (Manufacturing Process, Technology, and Automation). Published by Ramesh Chander Khanna for KHANNA PUBLISHERS 2-B, Nath Market.