JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

"EXPERIMENTAL INVESTIGATION OF DIFFERENT SHAPE REFRACTORY FIRE CLAY BRICKS."

A Review

Vaibhav C. Pimple[1], Avinash R. Mankar [2], Satish S. Markad[3]

1(Currently pursuing masters' degree program in Heat Power Engineering in Guru Nanak Institute of Technology
Kalmeshwar Road, Dahegaon, Nagpur, Maharashtra, India- 441501)

(Asst. Professor, Mechanical Engineering Department in Guru Nanak Institute Of Technology
Kalmeshwar Road, Dahegaon, Nagpur, Maharashtra, India- 441501)
Contact No. 09975497994

(Asst. Professor, Mechanical Engineering Department in Guru Nanak Institute Of Technology
Kalmeshwar Road, Dahegaon, Nagpur, Maharashtra, India- 441501)

Abstract:-

world move towards the advance technology because of that demand of energy is increased but source are limited after some year it's big issue for world due in this project we are trying to analysis various combustion furnace and bricks to improve the working condition of the furnace by using different types shape of bricks and material to hold the maximum thermal heat generated by furnace and increasing heat holding capacity of the furnace and compare with present system. the used the different shape hollow bricks, the manufacturing cost very less light in weight and heat holding capacity is little less but compare with all thinks the hollow shape bricks are 12-13% efficient than existing one and life of the fire clay refractories hollow bricks is similar to solid brick.

Key word: - Bricks, heat transfer, fire clay refractories, thermal

1. Introduction:-

It is becoming increasingly evident to consumers and producers of refractories that specialization, which is the outstanding feature of our age, must also be applied to this type of product. One grade of this material can no longer be expected to meet the requirements of every type of installation and, with the rapid advance which is being made in the economical combustion of fuel and the general speeding up of manufacturing processes, the demands of the industry are becoming more and more urgent for the very best refractories which can be made with the materials provided by nature. The ceramic literature is replete with papers and discussions on the subject of fire-clay refractories, but a search of the same will show that those papers which are devoted to a presentation of results of investigative workcover grades of material which have long been known as number one, number two, and number three refractories.

The principal purpose of this past work has been to determine physical and chemical properties characterizing these various grades and usually without considering a particular industrial application.

2.LITERATURE SURVEY:-

Number of incident happen in processing industries like cement, steel making, petrochemicals any many others where shutdown are taken due to failure of refractory material. There are various cause of refractory failures.one of them could be due to metallic anchor failure. Lot of research had been done in failure of refractory because of metallic anchor embedded in it with different reason like improper welding of metallic anchor, improper installation of refractory, material quality of metallic anchor, improper selection of steel grade of metallic anchor and refractory materials etc.

Aeslina Abdul Kadir

Several trillion cigarettetes produced worldwide annually lead to many thousands of kilograms of toxic waste. Cigarette butts (CBs) accumulate in the environment due to the poor biodegradability of the cellulose acetate filters. This paper presents some of the results from a continuing study on recycling CBs into fired clay bricks. Physico mechanical properties of fired clay bricks manufactured with different percentages of CBs are reported and discussed. The results show that the density of fired bricks was reduced by up to 30 %, depending on the percentage of CBs incorporated into the raw materials. Similarly, the compressive strength of bricks tested decreased according to the percentage of CBs included in the mix. The thermal conductivity performance of bricks was improved by 51 and 58 % for 5 and 10 % CBs content respectively. Leaching tests were carried out to investigate the levels of possible leachates of heavy metals from the manufactured clay-CB bricks. The results revealed trace amounts of heavy metals.

DaviFagundesLeala

This paper aims to analyze the thermal behavior and residual mechanical properties of concrete hollow-blocks structural masonry and its component materials in fire situation using experimental investigation. Compression tests were carried out on blocks, prisms and small walls at room temperature and after being exposed for 70 minutes to the ISO 834 Standard Fire. The test at high temperatures was run using a furnace powered by natural gas and instrumented with thermocouples to measure temperatures in the specimens. The influence of the initial concrete strength on masonry behavior was evaluated considering the use of blocks with different strengths at

room temperature. In addition, exposure to fire was also investigated considering masonry elements with no coverings and submitted to two different fire exposure conditions: one or both sides. The results indicate a substantial loss in the masonry load capacity at high temperatures, especially in cases of fire exposure on both sides, where the residual compressive strength resulted, on average, between 20% and 27% for the blocks and approximately 14% for prisms and small walls. Its performance with fire heating up on only one face is much higher, with an average residual masonry strength equal to 46% compared to its strength at room temperature. The obtained results are also useful for evaluating masonry regarding the integrity and thermal insulation criteria, the latter achieved with little over 60 minutes of testing.

Eugenia ObiageliObidiegwu

Manufacturing and processing industries usually consume large quantities of materials and energy in the course of their operations. The energy supplied for high-temperature processes are used partially for the actual technical process and between 30 to 40% of the energy escapes through the walls of the reactor into the atmosphere, leading to a high degree of thermal inefficiency and fuel consumption. This paper studies the thermal behaviour of insulating refractory bricks produced from a blend of fireclay and agroforestry wastes. The fireclays used were obtained from Ukpor deposit in Anambra State (Latitude 5.95°N, Longitude 6.92°E), Osiele deposit in Abeokuta, Ogun State (Latitude 7.18°N, Longitude 3.45°E) and Kankara Katsina State (Latitude 11.93°N, Longitude 7.41°E), all of which are in Nigeria. Samples were prepared with various weight percentages (60–100 wt.%) clays and (0–40 wt.%) of agroforestry waste, with grain sizes between 212 and 600 µm. Raw materials and the developed refractory bricks were characterised using appropriate standard techniques. The chemical, mineralogical constituents and phases present in the microstructurewere examined. Physical and thermo-mechanical properties were investigated. The insulating refractory bricks developed have porosity of 78.83% , cold crushing strength (CCS) 3.144 kN/m2 and thermal conductivity 0.04–0.046 W/(m·K) that compare favourably with imported bricks 75–85%, 2.756 kN/m2 and 0.049 W/(m·K) in both physical, mechanical and thermal properties respectively. The reason is that the agroforestry waste used (coconut shell), served to create the pores that improve insulation after burning. Also the ash that remains serves as reinforcement to improve the mechanical properties. The thermal behaviour of the bricks was studied using Finite Element Method and shows a strong correlation with the experimental findings. This indicates that the produced insulating bricks have the thermal properties required for insulation of furnaces. Production of insulating fire bricks from mixture of two different clays (kaolin and plastic clay) with sawdust addition is investigated. Suitability of kaolin with different weight percentages of plastic clay (20 to 40%) and sawdust (17 to 27%) have been added into the insulating firebricks, wet milled, spray dried, shaped and fired at different temperatures (900 – 1200°C). The properties of the resultant material then determined, water absorption, porosity, therma conductivity, modulus of rupture, and compressive strength. The results indicate that the thermal conductivity of the samples produced from two different clays with sawdust addition decreased from 0.1429 W/mk to 0.0417 W/mk. Samples were stable at high temperatures up to 1100°C. The high porous as well as good mechanical strength produced in this study can be used for insulation fire brick in high temperature application

Sneha S. Jaunjal

Refractories are heat reissuance materials that provide the lining for high temperature furnaces and reactors and other processing units. In addition to being resistant to thermal stress and other physical phenomena induced by heat, refractories are usually required to

withstand physical wear and corrosion by chemical agents refractories are often exposed to environments above 538℃. Depending upon the application, refractories must resist chemical attack, withstand molten metal and slag erosion, thermal shock, physical impact, catalytic heat and similar ad adverse conditions, generally while at high temperature. Refractory materials have a crucial impact on the cost and quality of steel product. The diversification on steel products and their cleanliness requirement in recent year increased the demand for high qualityrefractory. This paper is intended to comprehensively give and account of knowledge related to refractory and its failure due to metallic anchoring by the experimental set up. In that we have provided the strain gauge over the metallic anchor which is embedded in refractory material as well as one strain gauge in castable to check the elongation of metallic anchor and castable at certain temperature. The result obtained from this experiment are helpful to understand the actual elongation of refractory material and metallic anchor at certain temperatures and this will help to calculate the life of refractory product for certain industries and to increase the economy of the industries.

Dr Greg Palmer

This paper presented is a review on design and failure of monolithic refractories structure. Refractory has to be decided by the “heat transfer analysis “for the section of refractory material selection and same way by the temperature has to be decided the metallic anchor in oxidization environments. One dimensional heat transfer analysis determines the temperature between the interface layer of refractory material and shell under perfect condition. In one dimensional heat transfer analysis get the temperature between the layers of refractory material but cannot find the temperature profile for the metallic anchor which is embedded in refractory for holding in proper position. It has been shown that the temperature of anchor is critical in refractory lining design and design life. Designing of refractory lining is the engineering challenge but understanding of failure mechanism is enabling improvements in refractory lining life. Anchor spacing and designing is developed by the experience. It has to be applied and “It’s a thumb rule”. Anchor spacing and anchor material quality selection and refractory material selection is very important for increasing the life span of refractory. Our research has shown that anchor design needs to consider maximum process temperature, corrosion of steel when encased in concrete, lining weight the placement of anchor relative to the panel centroid, creep rupture stress at the maximum temperature and thermal strain on the anchor steel. This can be done by non-linear numerical analysis.

N. Patel

This paper presented is a review of factors affecting on the lifespan of cast refractory linings. Refractory play a very important role where shell, comes in contact withtemperature. The number of factors affected to the cast refractory life like engineering and designing, proper selection of refractory material, according to temperature quality (ceramic and metallic) and type of anchor to be selected, type of material to supply, installation of refractory as per installation procedure and operating condition etc. For the installation of refractory material require skilled and experienced worker, technique for installation for different material, knowledge for the material and installation. The proper selection of refractory to be made by the heat transfer calculation for getting the proper life of cast refractory. Life of cast refractory is depending on selection of material supply and installation and made it's end use. A complex combination of knowledge and skills acquired through education and training by all parties involved is required in order to ensure that a cast refractory lining reaches its full design lifespan. In addition, stringent quality control procedures and checks during

every stage of the refractory lining, from conception to maintenance, should be implemented to ensure a maximum-life refractory lining installation.

Michael C Walton and Paul A Plater

This paper presented is on refractory failure and some anchor issues. In this, the selection of proper quality or proper grade of steel to be considered as per temperature. Choice of steel grade to be depends on the high temperature of strength and corrosion etc. During designing and engineering it is necessary to select proper quality of anchor, proper height of anchor and proper quality of welding electrode, with appropriate height and diameter of same. The failure of refractory not happens only because of improper selection of refractory material but also selection of quality of metallic anchor and welding electrode for the same. Before installation, worker must take care of welding surface where welding is done. It must be clean and free from dirt and grease particles. This paper discusses the possible mechanical cause of such failures, with specific reference to weld defects, and sigma phase embrittlement, with its deleterious effect on the creep strength of various stainless steel and alloys used in their manufacture. Recommendations are made as to the correct criteria for material section in these applications.

C. Andrieux , P. Boisse ,Y. Dutheillet, V. Gabis , A. Gasser

This paper is about two layer composite shell for anchored refractory lining computing. In circulating fluidized bed combustors, the refractory linings anchored to the steel structure (casing) are submitted to important thermal loading which conducts to cracking (due to the difference between the thermal coefficients). The composite lining means there are two or three layers of castable over the shell structure. If specimens go with two layer of castable, it has to be selected by the heat transfer calculation and the same way selection of proper anchor with appropriate height for the same lining. By using these forms a specimen can perform bending stress on refractory lining of that specimen. Refractory may be failure due to temperature gradient and thermal expansion difference between two material quality layer of refractory. Due to heating and cooling high level stress occurs within the castable. Initially the hot face material gets exposed to high temperature and second layer will get less affected. The two materials having different temperature gradient and anchor having different temperature gradient. The behaviour of shell, refractory material and anchor must be equivalent and in that case always temperature of anchor is more and different physical behaviour at high temperature. By this paper they have tested the decrease of the stiffness by increasing damages around the anchor only because of temperature gradient. They have tested the direction of crack, and observed it is radial in panel.

3. Objectives:-

A fire brick, firebrick, or refractory is a block of ceramic material used in lining furnaces, kilns, fireboxes, and fireplaces. A refractory brick is built primarily to withstand high temperature, but will also usually have a low thermal conductivity for greater energy efficiency. Usually dense firebricks are used in applications with extreme mechanical, chemical, or thermal stresses, such as the inside of a wood-fired kiln or a furnace, which is subject to abrasion from wood, fluxing from ash or slag, and high temperatures. In other, less harsh situations, such as in an electric- or natural gas-fired kiln, more porous bricks, commonly known as "kiln bricks", are a better choice. They are weaker, but they are much lighter and easier to form and insulate far better than dense bricks. In any case, firebricks should not spall, and their strength should hold up well during rapid temperature changes.

- Fire clay brick is environmentally friendly and belongs to resource recycling bricks, so we can rest assured use fire clay brick. Fire clay bricks won't be harmful to our health.
- Fire clay brick has advantages of fireproof and heat insulation. Used clay brick can be used as concrete so that to save a lot of resources.
- The price of fire clay brick is not as expensive as that of other fire bricks. Light weight brick is more expensive than fire clay brick. Besides, fire clay brick is very cheap and very durable

- Fire clay brick has good moisture-proof function, it also has the advantages of fire insulation, heat insulation and moisture absorption.co

4. Summary of Review:-

1.Information was collected about fire refractory bricks manufacturing. Samples were collected and tested for various design parameters like (Dimension test, thermal conductivity, heat hold capacity).

2. Based on results obtained from collected samples and literature review different material were decided and the samples were manufactured and tested thermal behavior of bricks for different types of bricks various shape of bricks. The heat holding capacity and the thermal expansion is small in hollow bricks.

3. The different types of furnace are used them as per the size and capacity according and the requirement different types of furnace is used but the total heating capacity is depends on the fire bricks refractory material. The material composition and size as well as shape are also effect on the efficiency of furnace. The shape and size changes the heat holding and carrying capacity is changed. And quicker installation is also important factors we are choosing the refractory bricks because it required the more time and sometime refractory bricks are damaged it is easily replaceable shape required. Used the hollow bricks 20-30% reduce the manufacturing cost

4.The performance evaluation of different types of block burner bricks saving labor cost much lighter weight and safer very large thermal density and fewer joint and size variation and easily castable less thermal expansion various types available like due to a the more energy saving compare with solid bricks the Most of the .researchers are used the prescast shape over bricks burner blocks is used the it reducing installation time it is easily castable due to the due to much manufacturing cost is reduced is camper with solid. The life is increased 9-10% most of the bricks used in steel plants.

The studying different type of Shape of fire clay bricks and dimension of bricks the from the test results of manufactured samples material ratios were decided corresponding to maximum strength. Considering the good agreement between the results of prisms and small walls, the use of simpler specimens, such as two-block prisms, may lead to satisfactory results in the evaluation of temperature rise and the residual strength of masonry as a whole, taking into consideration the slenderness effects separately.

Fire clay bricks refractories Rapid change of temperature accepted more durability less thermal conductivity properties present inside the fire clay refractories, increased the overall efficiency of furnace increased and save the energy. when used the hollow shape the is formed by extrusion process the weight cost and installation time is minimize and increasing heat holding capacity with fewer joints to reduced installation cost.

5. References:-

[1] Aeslina Abdul Kadir1 "Density, Strength, Thermal Conductivity and Leachate Characteristics of Light-Weight Fired Clay Bricks Incorporating Cigarette Butts" Vol:3, No:5, 2009 242 ISSR&I 3(5) 2009 1307-6892/7618 Vol:3, No:5, 2009

[2] Sneha S. jaunjal "Behaviour Analysis Of Metallic Anchoring In Refractory With Experimental Set-Up" JARIIE-ISSN (O)-2395-4396 Vol-4 Issue-5 2018

[3] Davi Fagundes Leal "Experimental investigation on structural concrete masonry in fire: emphasis on the thermal behavior and residual strength"Rev. IBRACON Estrut. Mater., vol. 14, no. 4, e14408, 2021

[4] Eugenia Obiageli Obidiegwu " A Simulation and Experimental Investigation of the Thermal Characteristics of Refractory Bricks Produced Using Fireclay and Agroforestry Wastes" Journal of Casting & Materials Engineering Vol. 6 No. 2 (2022) 45–57

[5] G Viruthagiri "Analysis of Insulating Fire Bricks from Mixtures of Clays With Sawdust Addition" IJOAR Volume : 3 | Issue : 6 | June 2013 | ISSN - 2249-555X

[6] "Factors Affected the Performance of the Fire Clay Refractory Bricks", journal gornictwo I Geoinzynieria vol.4,

[7] Dr Greg Palmer "Design and failure of monolithic refractories structure":

[8] N. Patel "factors affecting on the lifespan of cast refractory linings".

[9] Michael C Walton and Paul A Plater: "When refractory failure isn't!-Some anchor issues": RefMet

[10] C. Andrieux , P. Boisse ,Y. Dutheillet, V. Gabis , A. Gasser , J. Rousseau: "Two layer composite shell for anchored refractory lining computing": ECF 12 fracture from defects.

[11] C Andrieux, P Boisse, Y Dutheillet, V Gabis and A Gasser "Damage modelling of refractory concrete under thermal solicitations".

[12] ASM metals handbook "volume 1, properties and selection :steels and High performance alloy".pp708-711.ASM,1990 Sanvik technical datasheet s-1743-ENG "sandvik 2563MA ", March 1999.

[13] TILLACKS,dj & Guthric,J.E. Wrought and" cast heat resistance stainless steel and nickel alloy for the refining and petrochemical industries", Nickel development institute technical series publication #10071.

[14] Andrieux, C , Thesis of university of Orleans , France, 1998

[15] Schnur, D.S., Zabaras, N., "An inverse method for determining elastic material properties and a material interface", International Journal for Numerical Methods in Engineering, Vol. 33, 1992, pp. 2039-2057

[16] Andrieux-Mamdy, "Castable anchoring optimization to improve service life of refractory linings", Proceedings UNITECR'97, New Orleans (USA), 1997, pp. 317-326.