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Transient thermal analysis of modified emergency container

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Abstract—Conventional emergency containers used in steel industry are of less capacity and they had to line with refractory lining which is not economical and time killing process and even the material used for the container is replaced by spheroidal graphite iron instead of cast iron. The intension of this paper is to replace the conventional one with modified emergency container and thus to avoid refractories also to increase the capacity and optimized design for easy handling of the device. The proposed one may subjected to enormous thermal loads hence thermal analysis is carried on the container before its construction. We make use of software ANSYS 10.0 to simulate the model. This paper analyses whether the changing emergency container can be fit for the intensity demand or not so that it could provide the important theory gist to the corporation.
Key words—Slag, emergency container, spheroidal graphite iron, refractories, thermal analysis.

I. INTRODUCTION

An emergency container in a steel plant is a closed vessel is used to store slag of molten steel. Slag is co-product of steel making. Generally emergency containers in the steel industry are made of cast iron which is brittle in nature have more impact resistance. conventional model have a tetrahedral structure and there is no provision for carrying the container with the help of cranes which brings difficulties while handling slag in container and they usually have less capacity usually 6 to 8 tons. The refractory lining which is used insulate the crucible to protect from thermal shocks takes long time to make up the refractories before filling the receptacle with the hot slag and removing refractory lining after emptying the vessel. Optimized model have to be built in order to overcome such snags a revised model is intended.

Temperature distribution of the receptacle is derived with time and thus a cessation is made whether the repository can be processed further.

II. MODELLING

The design is achieved by using NX-UNIGRAPICS, an advanced high end CAD/CAM/CAE software package 10.0 versions. The software has a provision has to extract the design in different formats, here the completed design is extracted in IGES format, hence the design can easily imported into ANASYS. The container is similar to a flat cone having bottom and top diameters as 2030mm and 2550mm .The thickness of the container is 100mm and the height is 1200mm.The vessel has four lifting bails fitted so that the vessel can be carried by overhead crane.

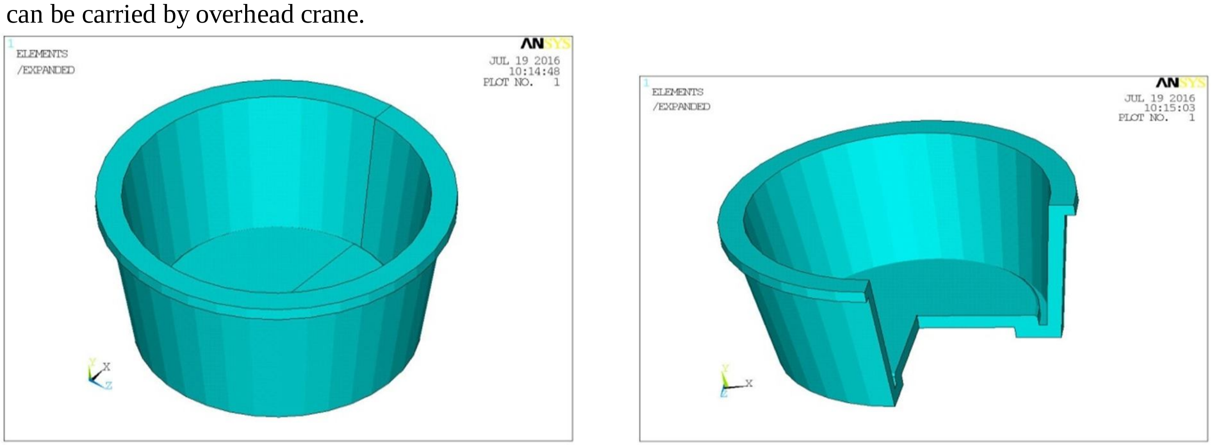

Fig. 1 3D model of emergency container assembly

III. LIMITATIONS OF MODEL

Though the model designed in NX satisfies our requirement, due to its massive component dimension and knotty structure, executing the model in ANASYS such a massive component leads to immoderate amount of software calculations. Consequently

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the model is elucidated as symmetric structure, and then 1/4th of the model is selected for scrutiny.

IV. MODELLING THE METHOD

The axisymmetric structure thus designated for the analysis is uncomplicated but examination is done on obligatory parts. Slag when entered into the container having temperature of nearly 15500 C. The tempera.ture of the slag is considered as the input thermal load on inner wall of the container wall. The temperature of on the inner wall is considered to transfer through the container wall as conduction to the outer wall and there it is subjected to convection.

V. MATERIAL ATTRIBUTES OF THE CONTAINER METAL

Choosing material is the indispensable part of constructing an emergency container, the vessel may subject to large impact when slag is poured into the crucible. Hot slag of huge temperatures are to be carried by the container and even the temperature inside the container has to be transferred to the outer wall of the container as early as possible and thus temperature is subjected to the convection with the air on the outside surface. Material having high thermal conductivity must be preferred in order to transfer temperature at high rates through the metal. Therefore spheroidal graphite iron is selected as suitable material for the container having good impact resistance and also having proficient thermal conductivity.

TABLE I

PROPERTIES OF VARIOUS TYPES OF GREY CAST IRON COMPARED WITH SPHEROIDAL GRAPHITE CAST IRON

property	Grey cast iron	Difference	Cast iron graphite in veins	Difference	Spheroidal graphite cast iron
Tensile strength(MPa)	235	113%	500	30%	650
Elasticity Modulus(Gpa)	110	27%	140	18%	165
Fatigue strength (MPa)	100	105%	205	29%	265
Thermal conductivity(W/mk)	48	-27%	35	-20%	28
Hardness(Hv)	208	13%	240	20%	286
Yield Strength (0.2%)	160	138%	380	12%	425

VI. MESHING THE MODEL

The Meshing used for discretization of the solid model. It is the most important part of analysis and can determined the efficiency and effectiveness of analysis. Meshing means creating a mesh of some grid-points called nodes. It is done with a variety of tools & options available in the software. The results are calculated by solving the relevant governing equations numerically at each of the nodes of the mesh. The governing equations are almost always partial differential equations and finite element method is used to find solution to such equations. The procedure for generating a mesh of nodes and elements consisting of three main steps as setting element attributes, mesh controls and generate the mesh. Before you generate a mesh of nodes and elements, you must first define the appropriate element attributes.

VII. LOAD AND SOLVE

Considering the axis-symmetric structure of the solid container and assuming the slag is poured up to certain height into the container. The temperature is applied along the surface of the container. The temperature of the slag is considered nearly 1723k.Covection is applied on outer surface of the container .Here heat transfer coefficient of air is considered as 30w/sq.mk. Thermal analysis carried on the container Transient Thermal analysis. Now taking radiation into consideration radiation effect is considered to take account of radiation losses taking Stephen boltzman constant 0.1712e-8.

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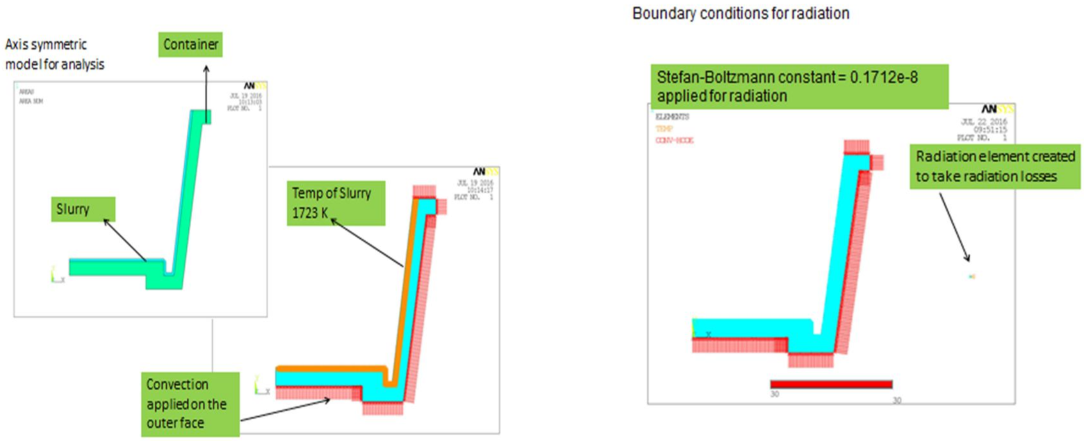

Fig . 1 Boundary conditions applied to the container

VIII. RESULTS AND DISCUSSION

Assuming the slurry is poured to certain height above the surface of the container and convection is applied along the surface of the container also radiation element created to take radiation losses into consideration. Results are plotted in span of 1hour.we can observe after 2seconds after subjecting container to the hot slag the max temperature is observed along the inner surface of the container is 1773k and min temperature is 308k along the outer surface .After 10 seconds the outer wall of the container has slight temperature change and it is increased to 470k from 308k.At 600 seconds the middle bottom and outer surface of the container has temperature is 688.256k and 519.25k temperatures, here the maximum temperature is distributed all over the container.At 1200seconds the temperature of the container is starts decreasing here the bottom middle temperature is 502.63k and outer wall temperature is 394k .After 1800 seconds the middle bottom of the container has maximum temperature 0f 409.47k and top edge has minimum temperature of 330.55k also the diminishing of temperature continues after 2400seconds with minimum and maximum temperatures of 319.86k and 361.39k.At 3600seconds i.e. 1hour top edge of the container has temperature of 308k and middle of the container surface has temperature has 308.65k to 314.63k.The bottom of the container ,the temperature varies from 322.92 from middle and at the bottom edge it is 317.95.After 1hour it is observed that the maximum and minimum temperature of the container is 48.850C and 340C which we can considered as room temperatures.

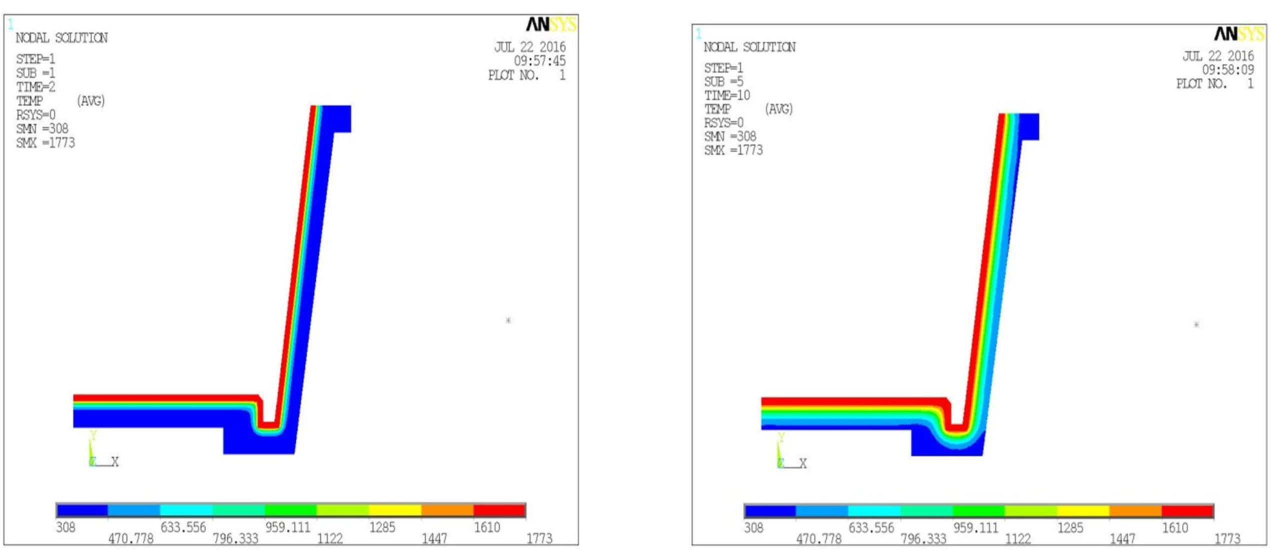

Fig. 3 Temperature distribution of the container after 2seconds and 10 seconds

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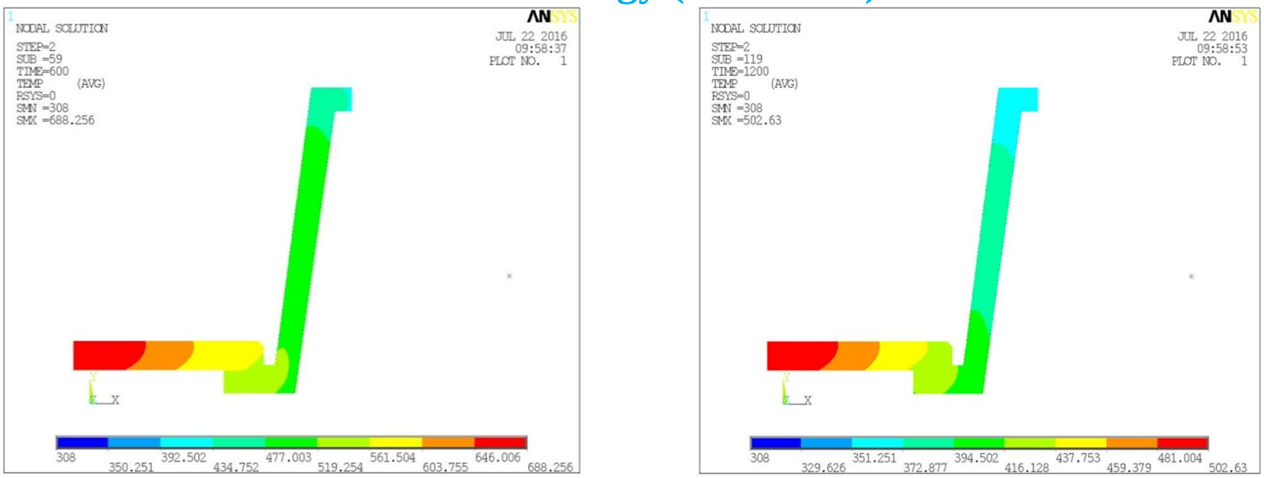

Fig. 4 Temperature distribution of the container after 600 seconds and 1200 seconds

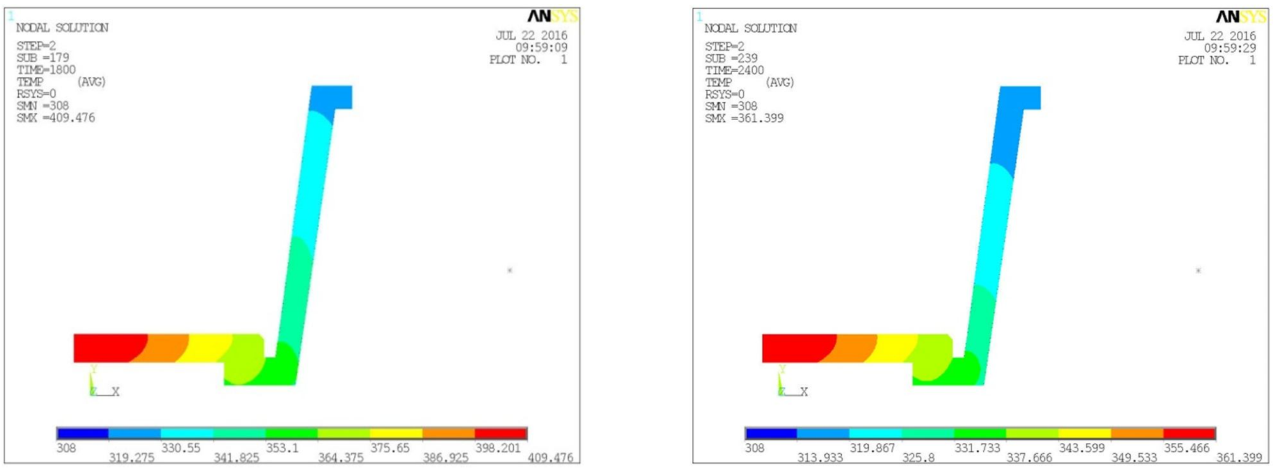

Fig. 5 Temperature distribution of the container after 1800 seconds and 2400 seconds

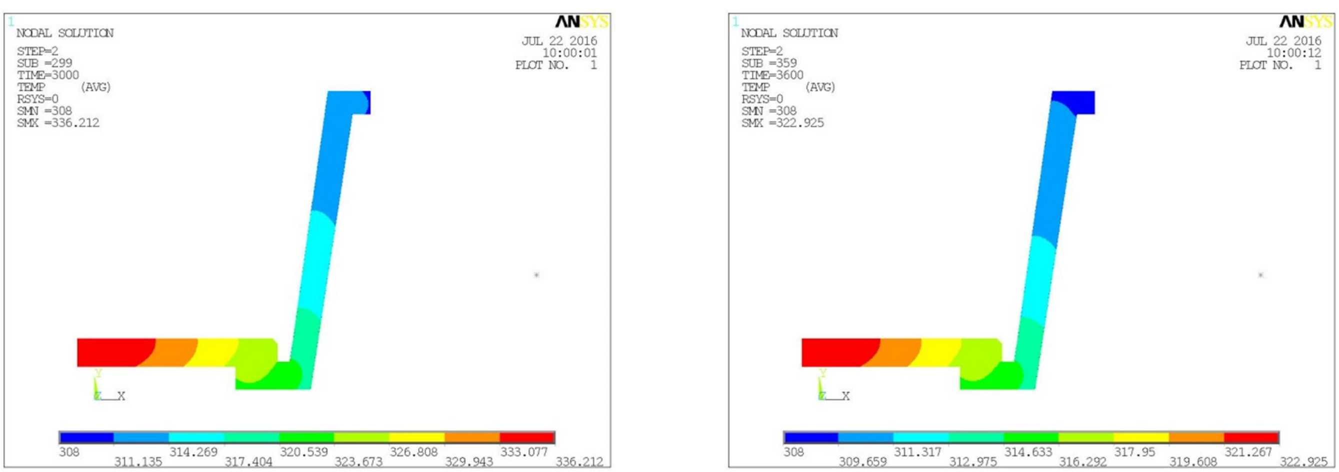

Fig. 6 Temperature distribution of the container after 1800 seconds and 2400 seconds

IX. CONCLUSIONS

From the simulation results we can perceive that the maximum and minimum temperatures of the container during one hour does

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not exceed the melting point of the container metal i.e. is 1422.15k of spheroidal graphite iron. The slag temperature 1723k is immediately distributing throughout the container due high thermal conductivity of the metal used for the container and thus subjected to convection, thus temperature of the container escapes into atmosphere with in short time. Within one hour after the container is subjected to hot slag the container is at room temperature. Consequently we can conclude that the modified emergency is safe under required operating conditions.

ANSYS can be used for thermal analysis considering convection and radiation losses of the container, hence this gives accurate results which are similar to practical case.

REFERENCES

[1] Shan Li, Yuqi Wang,Bo GAO and Lei Wang.Finite element analysis to the reformation structure of 75 ton iron ladle based on ANSYS-workbench.Advanced Materials Research Vols.479-481(2012)PP 2120-2123,Trans Tech Publications,Switzerland.

[2] Jianping Wang,Chenglong Liu,Peng Lu,Fugui Ma.ANSYS-based Finite Element Analysis on Automotive Panel Drawing Die.Advanced Materials Research Vols 314-316 pp 554-557,Trans Tech Publications,Switzerland.

[3] TIAN Hong-yu,CHEN Fu-rong,XIE Rui-jun,LI shi-hui.Finite Element Analysis of 100 t Hot Metal Ladle in Procee of Tipping,Journal of iron and steel research, international,2010,179110,19-23.

[4] Shan LI,Bo Gao,Yuqi Wang and Lei Wang.Research on UG Overturning Characteristic of 75t iron Ladle.Advanced Materials Research Vols 479-481920130 pp 2037-2040,Trans Publications ,Switzerland.

[5] Kazumichi Shimizu,Yaer Xinba,Masahibto Tanaka and Hideki Shudai.Mechanical Properties of Spheroidal Graphite Cast Iron Made by Reduced Pressure Frozen Mold Casting Process.Materials Transactions,Vol.50.No.5(2009)pp.1128 to 1134,The japan institute of metals.

[6] M.HAFIZ .Mechanical properties of SG-iron with different matrix structure.Journal of Materials Science 36(2001)1293-1300.

[7] Andre Zimmer,Alvaro Niedersberg Correia Lima,Rfael Mello Trommer,Saulo ROCA Braganca,Carlos perez Bergmann.Heat Transfer in Steelmaking Ladle.Journal of Iron And Steel,Research,International,2008,15(3),11-14,60.

[8] Ekrem Buyukkaya,Thermal analysis of functionally graded coating Alsi Alloy And Steel pistons.Surface &Coatings Technology 202(2008)3856-3865.

[9] Ali Belhocine,Mostefa Bouchetara,Thermal Analysis Of a Solid Brake Disk.Applied Thermal Engineering 32(2012)59-67.

[10] M.suri Babu ,Dr.B.Subbaratnam .Finite Element Analysis Of Steam Boiler Used In Power Plants SSRG International Journal of Mechanical Engineering (SSRG-IJME)-Volume 1 Issue 6 october 2014.

[11] Lingwei Lv Advanced Materials Research Vols. 1030-1032 (2014) pp 653-656 © (2014) Trans Tech Publications, Switzerland doi:10.4028/www.scientific.net/AMR.1030-1032.653 Thermal analysis module of ANSYS

[12] Ansys v.14.0, Ansys user manual. ANSYS, Inc., Houston, USA, 1996.

[13] V.M.M.Thilak, R.Krishnaraj, Dr.M.Sakthivel, K.Kanthavel, Deepan Marudachalam M.G, R.Palani. Transient Thermal and Structural Analysis of the Rotor Disc of Disc Brake. International Journal of Scientific & Engineering Research Volume 2, Issue 8, August-2011ISSN 2229-5518