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ANSYS MODELLING AND SIMULATION OF TEMPERATURE DISTRIBUTION IN SAND CASTING

Vikram Pratap Singh Tomar[1], Dushyant Dwivedi[2]
[1,2]vikrant Institute Of Technology And Management Gwalior

Abstract: Solidification of molten metal is s very complex phenomenon and many stages occurs during the casting process, like metal flow, temperature gradient and heat transfer between the mould and casting part. Thermophysical properties of the molten metal and mould cavity affect the casting part quality. Heat loss from the casting to the mould then mould walls to the atmosphere plays vital role in the casting process. In the present study two-dimensional numerical simulation will be carried out utilizing ANSYS software of Aluminium casting in green sand mould. Aluminium thermophysical properties will be considered temperature dependent while green sand mould thermophysical properties will be constant. Convective boundary conditions have been considered at the mould cavity walls which represent the actual physical scenario of the casting process.

I. INTRODUCTION

Metal casting is of theearliest and versatile manufacturing process known to human being in which molten metal is poured into mould cavity and allowed to solidify. After solidification of molten metal the product is taken out from the mould cavity. Using casting process one can create products from few grams size to several hundred tons. Many complex shapes can be produced by casting like engine blocks while it can also be used to produce simple shapes like watch cases. Casting has been widely utilized in manufacturing due to many applications and advantages. Tools required for casting moulds are very simple and cheap and any intricate shape, either external or internal can be casted that would be otherwise challenging or uneconomical to make by other methods. Almost any metal or alloy which can be easily melted is castable.
Casting has many process variations depending upon the material, the type of pattern, mould and the pouring technique like sand casting, investment casting, die casting, squeeze casting and lost foam casting. Sand casting is the most widely used process which can be used to produce intricate parts in almost every metal that can be melted. According to worldwide census of casting production over 75 million metric tons of castings are produced yearly.

For successful production of castings one needs knowledge in the following operations:

- Precise knowledge on making of moulds and patterns
- Melting and filling of molten metal
- Solidification and further cooling to room temperature
- Inspection and quality control

Choudhari et.al, [1] studied heat transfer in casting, from casting to mould, and temperature history in the casting. They concluded that hottest region inside the casting is solidifying is the most crucial time of the casting process. They performed Transient thermal analysis using ANSYS software to study the temperature distribution. They obtained results by simulation software and compared that with the experimental reading of temperature. In the end they concluded that the simulation of casting process helps in finding temperature distribution of different parts of the mould. They also concluded that by conducting simulation cost of casting can be reduced.
Choudhariet. al, [2] found that simulation of the solidification process allows visualization of solidification inside a casting and helps in finding last freezing regions or hot spots. They noticed that simulation also helps in optimizing the placement and design of feeders and feeding aid. They concluded that solidification defect can be minimized after finding optimum location of riser. They determined that simulation can help in optimizing dimensions of riser and casting feeding efficiency. They also validated their results of optimized riser dimensions based on simulation by carrying out actual trials in a foundry. In the end they concluded that utilizing sleeve as a feed aid helps in reducing riser dimensions from 60 mm to 50mm which helps in increasing the casting yield.
Das, S. and Himte R.L., [3] conducted a study on design and analysis of pure iron casting with different moulds. They concluded that it is conceivable to predict distinctive result from a casting procedure before the actual casting process is conducted, which helps in making valuable decisions to consider on the differ casting parameters for better cast item. As it has been said before that if by any methods it is conceivable to anticipate temperature distribution and heat transferafter solidification of casting,defects may kept as least as possible. In the present work it has been demonstrated that FEA programming like ANSYS may assume an essential part in such manner. Transient warm examination and Couple-Field investigation in ANSYS can foresee temperature circulation and warm stretch conveyance in the throwing after hardening precisely. This has been demonstrated by approving a transient warm examination which has been distributed in a presumed diary. In the wake of approving the warm examination, work has been reached out to Couple-Field

Analysis for warm push. On the premise of warm examination result and couple-field investigation result, work may be stretched out for determination of ideal mould layer thickness and best material for mould making or best blend of mould material with ideal thickness mix. In section six couple of changes have been recreated and tried whether they are superior to the arrangement considered in the base paper. As first change sand has been supplanted by mullite and it has been seen that the mould shrinkage is less yet the cast shrinkage is more. Warm stretch in the mullite mould is not exactly the sand mould. For the sand-mullite composite mould shrinkage is slightest and also shrinkage for the cast is likewise minimum. However, the warm push is more than the mullite mould. So advancement should be possible as a future work for best mix of mould materials in a composite mould with ideal thicknesses.

Heat Transfer in Metal Casting

The hot molten metal loses its heat then solidified. The rate of losing heat is controlled by the number of resistances to heat flow.

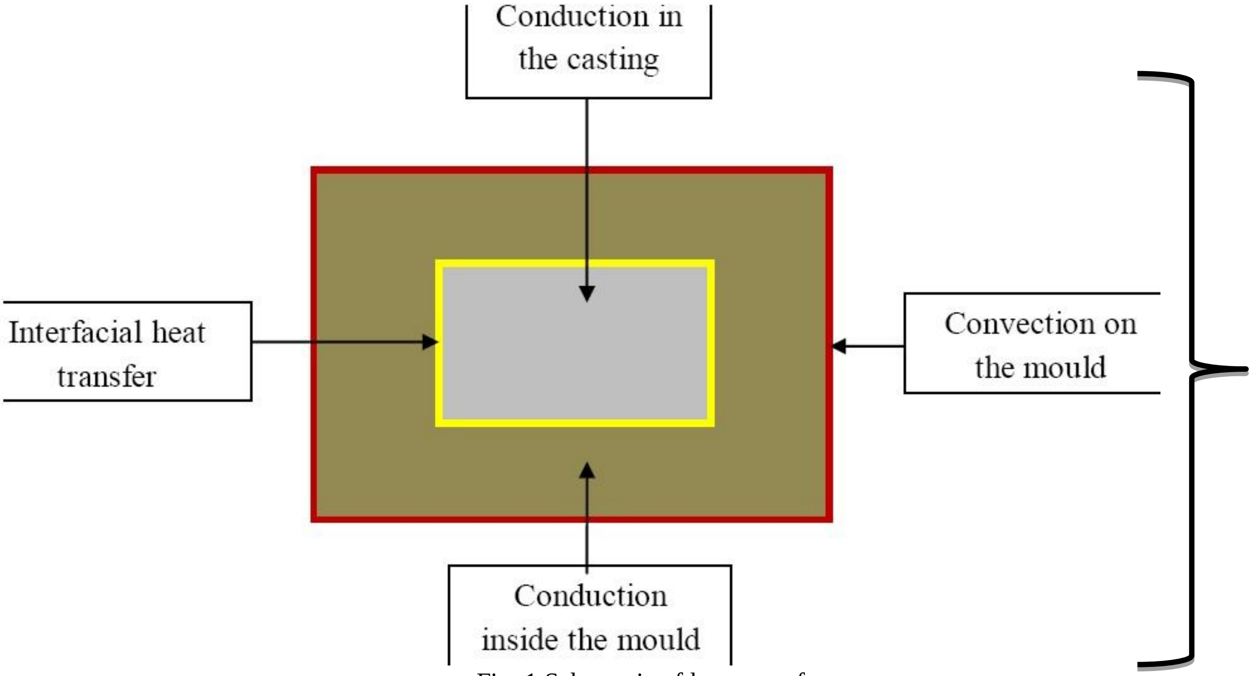

Fig. 1 Schematic of heat transfer

Numerical simulation

Solidification is joined by the release latent heat at the solid-liquid and solid-solid interfaces. Solidification procedure includes phase, for this situation, the enthalpy is the right parameter to portray this process, in light of the fact that, enthalpy included latent heat that speaks to the phase change. Heat conduction partial differential equation for the transient nonlinear state that portrays this process can be represented as

$$k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}\right)=\frac{\partial h}{\partial t} \quad (1)$$

At the interface where molten metal will the mould cavity wall heat transfer by convection has been considered.

Boundary conditions

At x = 0 $\quad q = k\frac{\partial T}{\partial x} = h_f(T - T_\infty)$

At x = L $\quad q = k\frac{\partial T}{\partial x} = -h_f(T - T_\infty)$

At y = 0 $\quad q = k\frac{\partial T}{\partial y} = h_f(T - T_\infty)$ (2)

At y = H $\quad q = k\frac{\partial T}{\partial y} = -h_f(T - T_\infty)$

At z = 0 $\quad q = k\frac{\partial T}{\partial z} = h_f(T - T_\infty)$

At z = W $\quad q = k\frac{\partial T}{\partial z} = -h_f(T - T_\infty)$

Where q = quantity of heat transfer in (W)

k= Thermal conductivity of material (W/m-K)

C_p= Specific heat (KJ/Kg-K)

These properties may betemperature-dependent then eq.1 is transformed into anonlinear transient equation. h_f is the coefficient of convective heattransfer on the mould's external surface, T is the temperature, and $T_\infty$is the temperature of the environment.Using eq. 1 and 2 temperature distribution during solidification can be calculated.

II. GEOMETRIC MODEL

Figure 2 represent the geometry of the model in which the casting will be done. Temperature distribution will be studied of the aluminium with temperature dependent thermal properties. While green sand which has been considered for the mould cavity material is constant. A rectangular part of same length and height has been considered. The model will be divided into different number of parts which will help in finding the temperature distribution accurately.

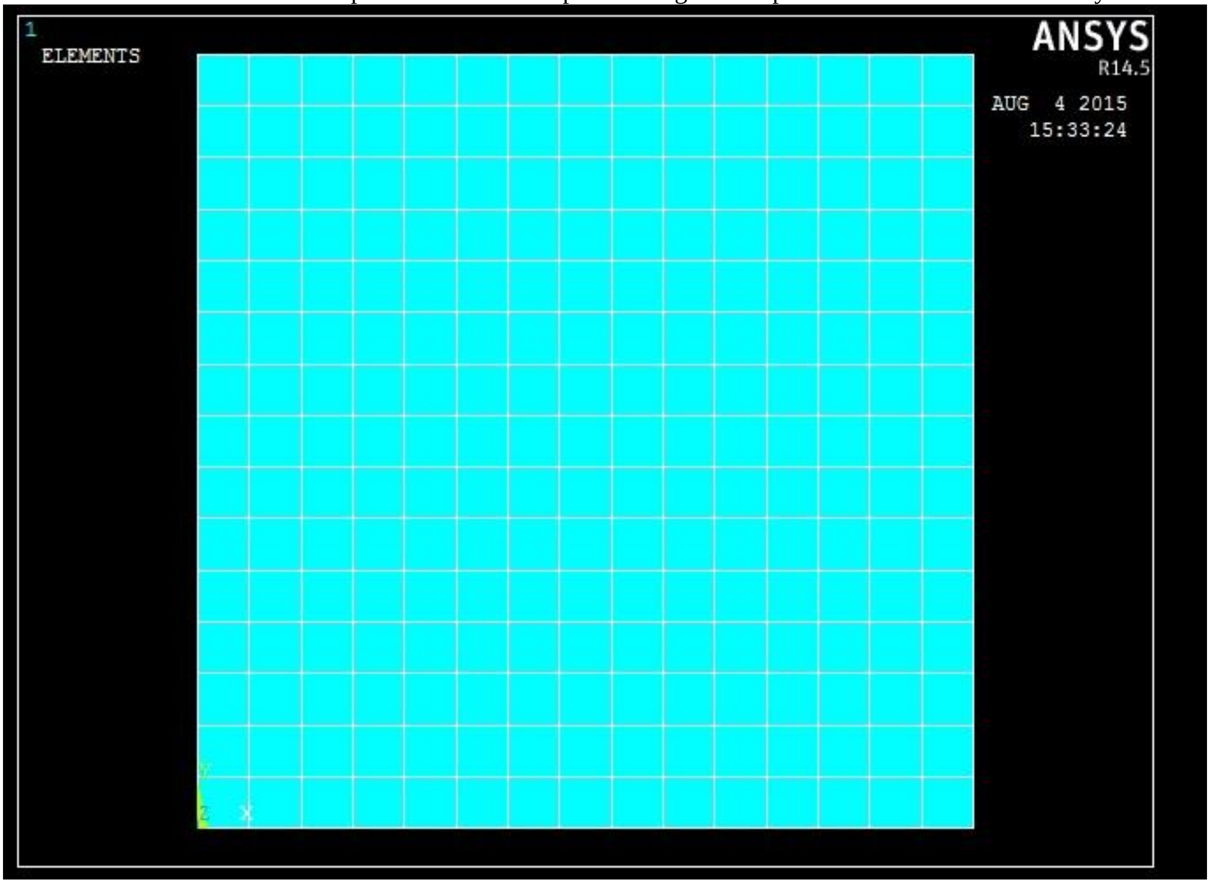

Fig. 2 Model of the casting part

Objective:

Objective of the present work will be to study the transient thermal analysis to obtain the temperature distribution during casting processutilizing ANSYS software. Solidification of pure Al with temperature dependent thermal properties thermal conductivity and enthalpy will be studied in the present work. Green industrial sand thermo-physical properties are constant, and convection phenomenon will be considered on the boundaries.

Thermophysical Properties of sand:

Properties	Green sand
Specific heat (KJ/Kg.K)	1172.3
Density (Kg/m^3)	1494.71
Thermal conductivity (W/m.K)	0.52

Thermophysical Properties of molten metal:

Conductivity (k) for Aluminium (W/m K)	
At 293 K	240
At 523 K	230
At 831 K	210
At 973 K	100
Enthalpy (H) for Aluminium (J/m3)	
At 293 K	7.8886e-031

At 523 K	6.2967e+008
At 831 K	1.7961e+009
At 973 K	2.1527e+009

REFERENCES

[1] Choudhary C. M., Narkhede B. E., Mahajan S.K., *Modelling and Simulation with Experimental Validation of Temperature Distribution during Solidification Process in Sand Casting*. International Journal of Computer Applications. 2013, 78, p.23-29.

[2] C .M. Choudhari, K. J. Padalkar, K. K. Dhumal, B. E. Narkhede, S. K. Mahajan, Defect free casting by using simulation software, Applied Mechanics and Materials, 2013, 313-314, 1130-1134.

[3] Das S &Himte R.L., *Design and Analysis of pure iron casting with different moulds*, International Journal of Modern Engineering Research. 2013, 3(5), p.2875-2877.

[4] Shaha S.K., Haque M.M., *Simulation of Heat Flow in Computational Method and Its*

[5] *Verification on the Structure and Property of Gray Cast Iron*, American Journal of

[6] Applied Sciences, 7(6), 2010, p.795-799.

[7] Masoumi A., *Effect of Gating Design on Mould Filling*, American Foundry Society, USA, 2007.

[8] Campbell J, *Casting*, Butterworth-Heinemann, Oxford, 1991.

[9] Flemings M.C., *Solidification processing*, McGraw-Hill, New York, 1974.

