TRANSIENT THERMAL ANALYSYS OF METAL IN SAND CASTING

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ABSTRACT

Casting is one of the earliest and cheapest methods know used for the production of most complicated structures. Study on the solidification phenomenon and temperatures of the metal that is casted is important for the casting engineers to avoid defects. Solid works software has been used to obtain temperature and time relationship by transient thermal analysis along with the experimental data. The results obtained from the simulation has been found to be in good agreement with the experimental data.

KEYWORDS

Casting, solidification, transient thermal, temperature, simulation.

INTRODUCTION

Rejections in casting has been a major problem to the foundry men and casting engineers. A great deal of materials, energy, time and labour can be saved by eliminating the defects in casting. Simulation of casting using Solid works software helps in eliminating defects in casting. New techniques can be employed from simulation study that can be further used to improve the quality of cast.

REVIEW OF PRIOR WORK

Numerical methods like finite element analysis, finite difference method and boundary method elements have been used in the past by many researchers. Their achievements and limitations can be summarized below as follows. Similar work is done by CM. Chaudhary [1] and is based on analysis of cylindrical work piece. Work on design and analysis by Akshay ghude [2] helps in development of riser that eliminates porosity. Simulation and experiments have been done both of them found to be in great agreement.

This present work is an attempt of analysis of the transient thermal analysis of aluminium which is rectangular in shape using both software and experiments.

ANALYSIS:

Molten aluminium is poured into the mould at an initial temperature of 701degree Celsius. There are two major process of heat flow happening in this process.

- Conduction : from molten aluminium to sand
- Convection : from sand to air

Care has been taken in drying the mould so that no heat will be transferred to the moisture present in the mould. The main aim is to track the temperature over a period of 60 minutes. The casting is of the dimensions of 25mm in length, 21 mm in breadth and 30mm in width made of aluminium. Solid works 2013 has been used for simulation of the entire process. The solid works model is shown in Fig.1.

PROCEDURE FOR THERMAL ANALYSIS USING SOLIDWORKS:

STEP 1:

Designer module is used for the making of the model using simple techniques like extrusion, mating.

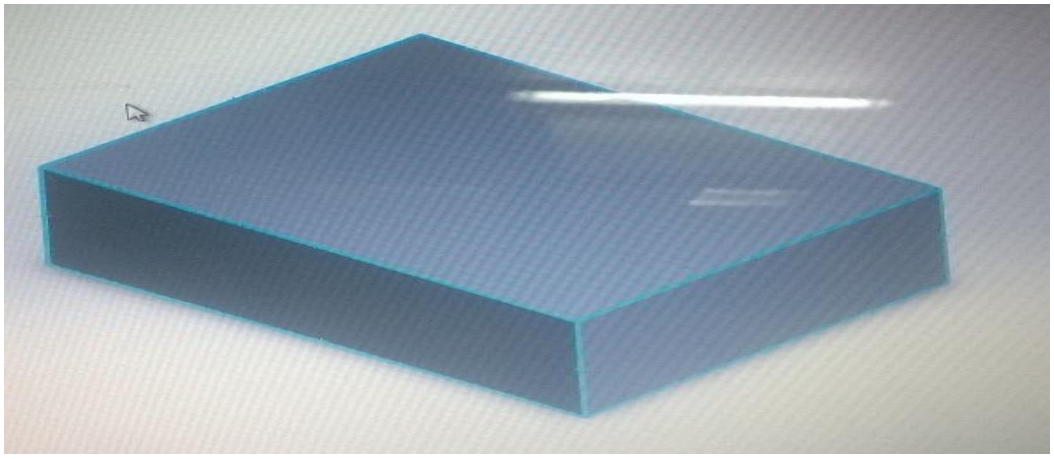

fig.1

STEP 2:

Two materials have been chosen one as mould as sand and cast as aluminium. The peoperties of sand are assumed to be constant which are independent of temperature. Table 1 gives the properties of sand required for analysis.

Table 1. Material properties of sand

Conductivity(k)	0.519W/m^3.K
Density(d)	1495Kg/m^3
Specific heat(s)	1172.304J/Kg. K

Density and specific heat of aluminium are considered to be constant irrespective of temperature whose values are 2650 Kg/m^3 and 921J/Kg. K respectively. The other properties like conductivity are given in the table 2.

Table 2: material properties of aluminium conductivity (k) in W/m K.

At 293 K	240
At 523 K	230
At 831 K	210
At 973 K	100

Step 3:

Accuracy of results depends on the mesh sizing used. Meshing is done at this stage and the model is ready for application of loads.

Step 4:

Convective loads are applied to the boundaries of sand mould. Initial temperature of the cast is taken to be 701 degrees Celsius and of mould is 30 degrees Celsius. The convection coefficient for the sand and air is taken to be 10 $W/m^2 K$

Step 5:

Set the step size for analysis to be 3600 seconds. Boundary condition relate the parameters provided and the model is ready for results. The final results obtained are shown in the following figures.

Isometric view.

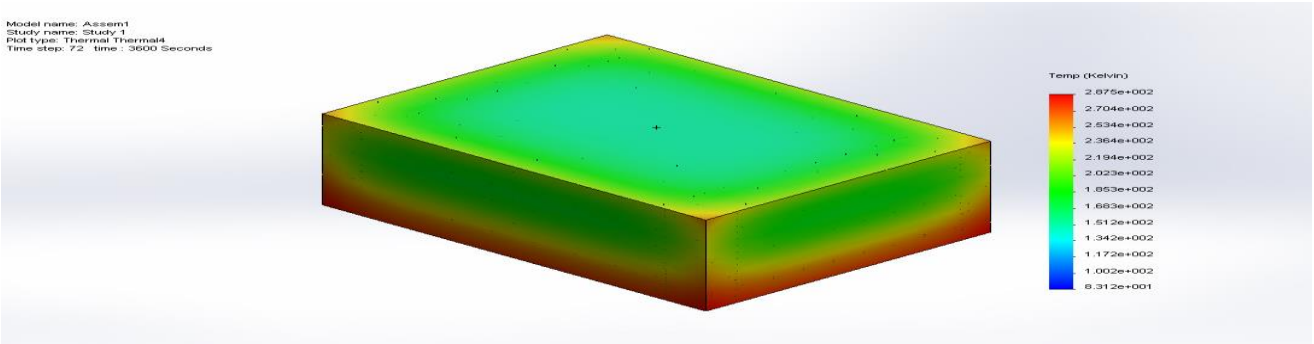

Fig 2.

Front view

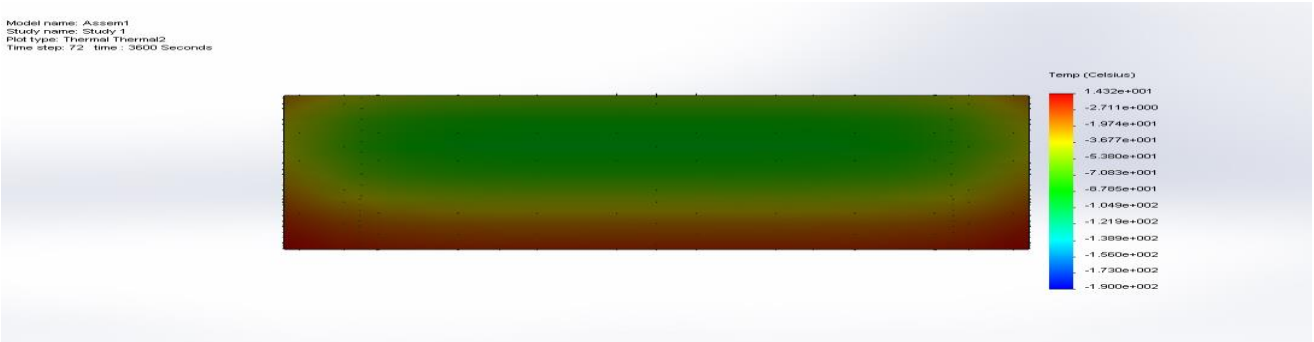

Fig. 3.

Experimental analysis:

The experimental calculation of the temperatures at different times is measured using the standard thermo couple. They are first positioned into the mould before the molten aluminium is being poured. Then the readings are recorded in using the IR thermometer and relevant software.

Fig. 4. Final cast

Taking readings using IR thermometer.

Fig. 5. IR thermometer

Temperature versus time readings are obtained from the solid works software in fig. 6

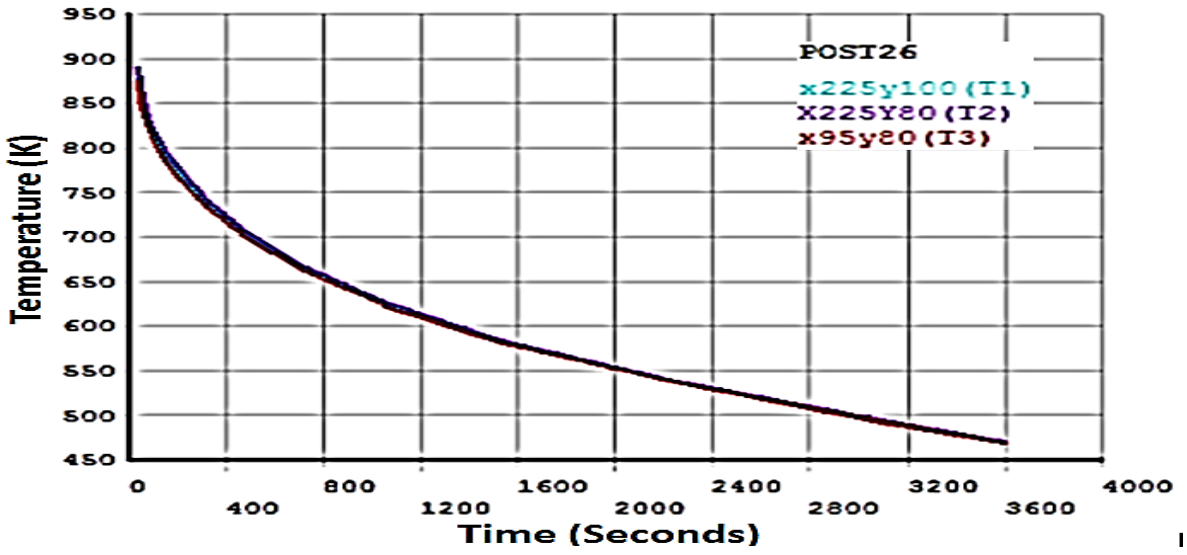

Fig. 6

Graph obtained from the experimental data is shown in fig.7. Temperature in Celsius verses time.

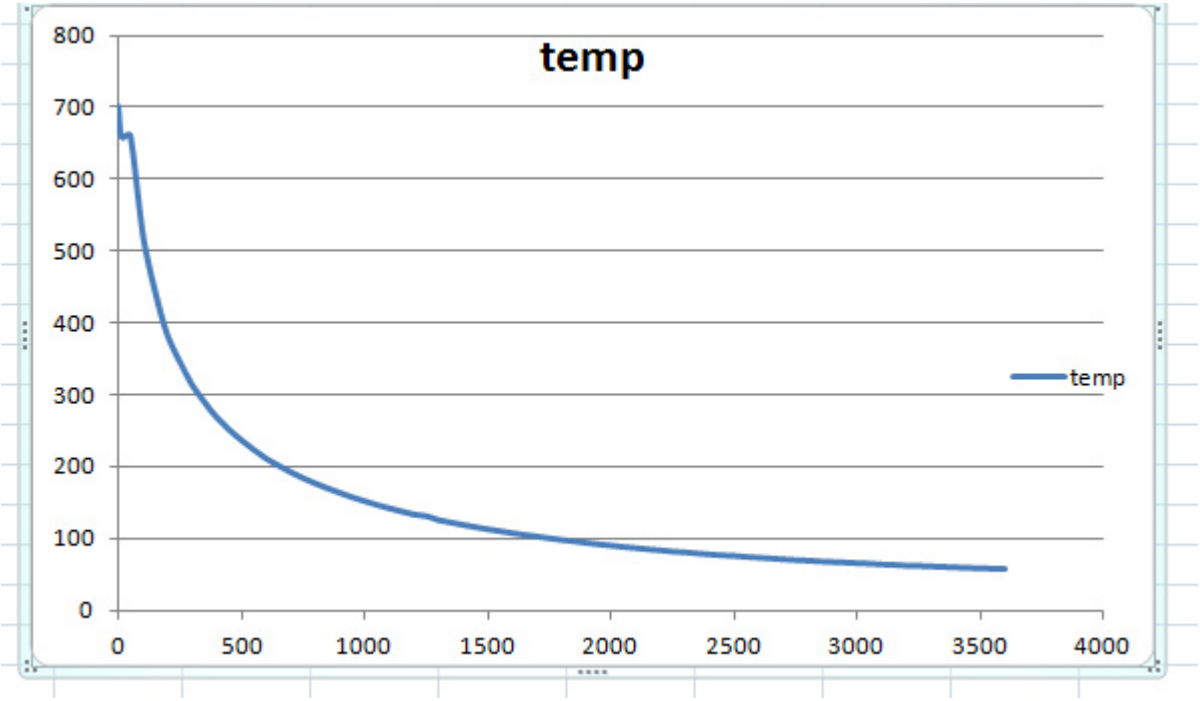

Fig. 7

Results:

The results obtained both from the experiment and analysis by solid works software are found to be in great agreement with each other. These results are very useful increasing the quality of the casting, reduce wastage of material, increasing cost effectivity and increases the speed.

Conclusions:

The simulation by software helps one to imagine the solidification process and the cooling rate. This also helps in the placing of the riser in a correct position and shape. This would be a simpler and economical solution to the smaller foundries to avoid the rejections due casting defects.

References:

[1] Modelling and Simulation with Experimental Validation of Temperature Distribution during Solidification Process in Sand Casting.

[2] Design and analysis of riser for sand casting

[3] Optimal design for two feeders, simulation study for economic feasibility.