

Development and Simulation for Casting Process by using Auto-Cast Software - A Review

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Abstract— The paper is focused on the research of mechanical development and simulation for casting process by using auto cast software. Research is aimed at to reduce, minimum pouring time, shrinkage in order to achieve higher quality casting by maintaining temperature with help of different methodology like pouring position angle, migrating from the furnace to mold.

Key words: Pouring Process, Furnace, Auto-Cast Software

I. INTRODUCTION

Casting is a manufacturing process in which a liquid material is usually poured in to mold, which contain a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as casting, which is rejected or broken out of the mold to complete the process. Casting material are usually metal or various cold setting materials that cure after mixing of two or more component together. The overall goal of this project is to develop and evaluate the performance of molten metal pouring system.

We know different casting processes like sand casting, gravity die casting, low pressure die casting, pressure die casting, counter pressure die casting, and centrifugal casting, spin casting, lost wax and lost foam casting.^[1]



Fig. 1: Casting

II. CASTING PROCESS

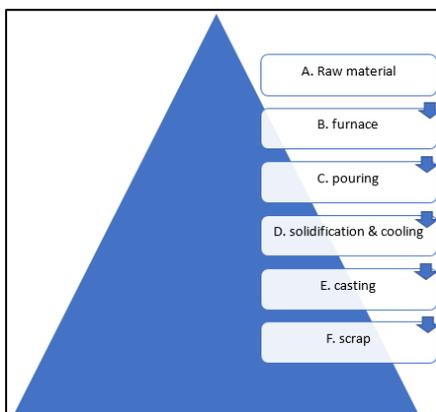


Fig. 2: Casting process flow diagram

Casting is a manufacturing process in which a liquid material is usually poured into a mold, to show below flow diagram of casting process.

A. Raw materials

The metal casting has performed more than 6000 years.it includes liquid metal into a mold which are use cool and harden materials into the various desired shape.it is also deals for application that include different complex shape, then it's very highly reliable.

Metal foams are engineered materials with a unique combination of physical and mechanical properties, yielding an attractive material for use in the aerospace, automotive, and biomedical industries, among several previously identified applications. So, alloy metal are used in mold. ^{[2], [3]}

B. Furnace

Furnace is a device that is use to melting metals its change of properties for melting metal, its one type of oven. In commonly used for industrial purpose (casting industries) Induction Furnaces, Electric arc furnace, etc. An induction furnace is an electrical device in which the heat is applied through the induction heating of metal. In which to create electromagnetic filed use of eddy current. ^[4]

The coil creates a rapidly reversing magnetic field that penetrates the metal. The magnetic field induces eddy currents, circular electric currents, inside the metal, by electromagnetic induction. The eddy currents, flowing through the electrical resistance of the bulk metal, heat it by Joule heating. In ferromagnetic materials like iron, the material may also be heated by magnetic hysteresis, the reversal of the molecular magnetic dipoles in the metal. Once melted, the eddy currents cause vigorous stirring of the melt, assuring good mixing.



Fig. 3: Induction furnace

C. Pouring

In casting process metal filled in mold this metal filled process is called pouring process.

In pouring process molten metal pour in mold to different methods. In which important factor is pouring position.^[5]

To consider as, in the vertically parted automatic green sand casting process the pouring position of mould string is an important parameter to be decided before pouring the mould string to avoid casting defects like fins and metal run out.

Derivation of mathematical form of optimum pouring position

Expression for pouring position:

$$L \geq \frac{PPU * H_A}{\mu} \left(\frac{\rho_M}{\rho_S} + \frac{1}{SM} \right)$$

Where, PPU = Pattern plate utilization factor

H_A = Average metallostatic height (meter)

μ = Coefficient of Friction between mould string

ρ_M = Density of the metal = 7000 kg/m³

ρ_S = Density of Squeezed moulding sand = 1500 kg/m³

S = Factor of safety

Expression for pouring position clearly indicates that optimum pouring position depends on metallostatic height, sand metal ratio and pattern plate utilization.^[6]

Vacuum casting allows the fabrication of pieces in small- batches and individual production at low prices and in short time. Investments to improve manufacturing technologies for the development of new products. These technologies include CAD software to design complex geometries, and allowed the solution of problems and are being used to assist medical applications.

The air bubbles volume accumulated in the parts, depends on the number of the vents and also the position of these on the parts. Using the measurements it was established dimensional errors for the plane surfaces.^[7]

Investment casting process in which poured into the pouring tank of wax molding machine. This wax can be poured into the die either horizontally or vertically (Horizontal wax molding machine and Vertical molding machine). In Horizontal molding machine its: we should keep the temperatures difference for the Inject Tank temperature for the molding machine is from 54 to 59 degree Celsius and the block temperature of the molding machine is from 53 to 58 degree Celsius. In the vertical molding machine its: we should keep the temperatures difference for the Inject Tank temperature for the molding machine is from 65 to 69 degree Celsius and the block temperature of the molding machine is from 54 to 59 degree Celsius.^[8]

Cooling time of the wax pattern depends on its size of the investment casting. For the small component (6 inches) it is usually 60 second and for the big components (above 8 inches) it will take usually 3 to 4 minutes. After cooling then wax pattern is repaired using Micro wax in which diesel is also mixed for ease. Repairing is done so as to remove minuet defects or small holes. After all this waxing process the mould is allowed to cool. Room temperature of Mould cooling- 19-21°C.^[9]

Centrifugally casting in which varying the speed of rotation are carried out then better results could be obtained by design of experiment of the centrifugally casting input

parameter and optimizes the outputs of cast materials. There is no need of runners and risers. The centrifugal casting process consists of pouring the molten metal at a suitable temperature into a rapidly rotating mould or die.^[10]

D. Solidification & Cooling

In pouring process related to molten metal so it's consideration on cooling curve. A cooling curve is alien graph that represents the change of phase of Matter, in which solid to liquid. The independent variable (X-axis) is time and the dependent variable (Y-axis) is temperature. Show below diagram:

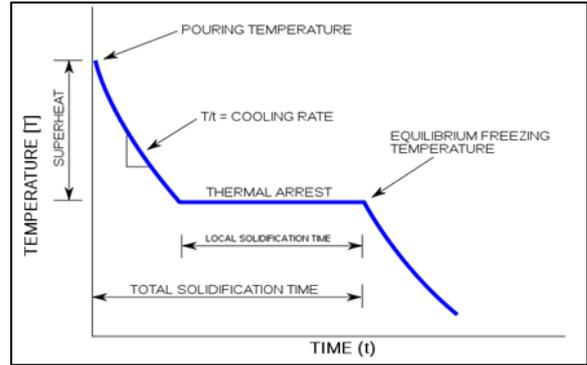


Fig. 4: Cooling curve of a pure metal^[11]

E. Auto-cast

Auto-cast is a software program for casting methods design, simulation and optimization. It uses geometric reasoning for automating the design of casting methods elements – cores, mold cavity layout, feeders and gating channels. Auto CAST is the world's most intuitive, incredibly fast and truly integrated casting software for method design, simulation and optimization.in which:

- Improve the quality and yield of existing casting.
- Develop new casting quickly, without foundry trials.
- Reduce the cost in collaboration with customers.

Here we will be analysis by auto cast software and we will gate best results, in comparison of both actual data (industrial) and theoretical data (auto cast software). Then we will say which process to give us high efficiency as well as quality and productivity

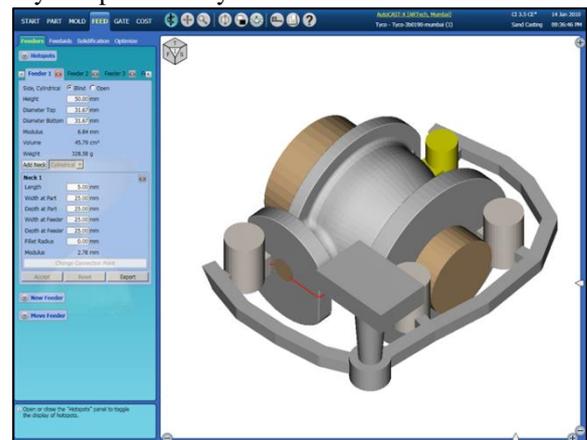


Fig. 5: auto cast software^[12]

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Casting process in most important in manufacturing, to use different technique for improve the productivity and quality of product. In which most important things is pouring metal

process time and temperature. It's important factor for casting. We have taken information for above paper for analysis pouring process time and temperature and also defect of product. Here we are showing different process to decrease the turbulence for improve the quality and productivity of product. In pouring process time is decreasing due to maintain the distance, than we have working base on maintain the temperature for molten metal when it's migrate one place to other place.

REFERENCES

- [1] Kumar V Proprieter of Tara sree engineering and investment casting consultant. Awarded as emerging foundry man of India.
- [2] J. Banhart, *Progr. Mater. Sci.* 46 (2001) 559–632.
- [3] H.P. Degischer, B. Kriszt, *Handbook of Cellular Metals, Production, Processing and Applications*, Wiley–VCH/Verlag GmbH, Weinheim, Germany, 2002.
- [4] Laughton, M.A.; Warne, D.F. (2002). *Electrical Engineer's Reference book*, 16th Ed. Newnes. pp. 17-19. ISBN 0080523544
- [5] Variation of green sand molding, Flaskless molding, www.engineershandbook.com
- [6] Per Larson, "Iron melt flow in thin walled section cast in vertically parted green sand mould", Industrial research project at DISA Industries, Technical University of Denmark
- [7] Gibson, I., Cheung, L.K., Chow, S.P., Sheung, W.L., Beh, S.L., Savalani, W. and LEE, S.H., The use of rapid prototyping to assist medical applications, *Rapid Prototyping Journal*, 12, 1, pp 53–58, 2006.
- [8] Singh R, Singh S (2013) Effect of process parameters on surface hardness, dimensional accuracy and surface roughness of investment cast components. *Journal of Mechanical Science and Technology* 27: 191-197.
- [9] Piwonka TS (1993) *Modelling and Control of Casting. Welding and Advanced Solidification Processes VI*. TMS Publications.
- [10] J. Datta, Ed. *Aluminium Schlüssel: Key to Aluminum Alloy: 6th ed.* Aluminum Verlag, Düsseldorf, Germany, 2002.
- [11] http://www.sutcast.com/Libraries/Events_2010/cooling_curve2.sflb.ashx.
- [12] <http://www.autocast.co.in/img/index-2.png>.