Cast Iron Composition Measurement by Cooling Curve Analysis

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Abstract -In this paper, the cooling curve analysis or thermal analysis technique during solidification of ferrous and non-ferrous alloys was used. The objective of this study is to determine the effect of varying amounts of inoculants on the thermal analysis of grey cast iron by observing the changes in the shape of the cooling curves. Temperature measurement, an important tool in investigation of solidification, has rarely been used. Temperature measurement using thermocouple (TC) affect on solidification of the casting, especially in thin wall castings where the heat content of the melt is small compared to the cooling power of the TC. This method, reduce the various lengthy time consuming and expensive steps used in determining the composition of the cast product.

Index Terms – Alloyed cast iron,Thermocouple, solidification, cooling curve

I. INTRODUCTION

In the recently years there has been increasing interest in solidification of thin wall ductile cast iron. One of the first applications of thermal analysis (TA) in cast iron was for the estimation of the chemical composition, or more precise of the carbon equivalent (CE). CE includes the contribution of carbon and of the other important elements (Si, Mn, P, S, etc),allowing the multicomponent iron to be treated like a binary Fe-C alloy. The metallographic structure, soundness as well as the properties and service performance of castings depend on their solidification behavior. During the solidification of gray cast iron, two main events can be differentiated, the precipitation of the primary phase and the eutectic phase [4]. Temperature measurement in castings is important tool for estimation of solidification process and it is done by using TC. Most metallurgical reactions occurring at high temperatures involve an interaction between a gas phase and condensed phases, which may be molten liquids or solids. Cooling curve measurement of moltan cast iron by TA thereby determining the CE, carbon content and silicon content of the iron whereby the furnace front administration of the pre-casting processing the casting factory is sufficiently administered for a cupola and the melt charging from the furnace is measured, and a cooling curve measuring cup used in these methods. A cup for measuring a cooling curve by means of thermal analysis of cast iron.

A. Material:

An industrial grade gray cast iron metal was produced with a chemical composition as shown in Table 1.

TABLE I Average chemical composition of the used material

Element	C	Si	Mn	P	S
Wt%	3.31	1.89	0.64	0.018	0.073

II. RELATIVE STUDY OF EXISTING METHODS

A. Induction Coupled Plasma Optical emission Spectrometry(ICP-OES)

ICP-OES is an analytical technique used for the detection of trace metal. This method was developed for the estimation of metal composition. This is a flame technique with a range of flame temperature of 6000 to 10,000K.This method has been validated using RF power of 1150 watts. Plasma flow of 15 L/min and Nebuliser flow of 0.6 L/min and plasma view at axial mode for all the elements. In this method temperature estimated to be in the vicinity of 10,000K.The equipment used in this method are Thermo fisher scientific ICP with optical emission, spectrophotometer and i TEVA software. During the method development metal composition standard prepared of any working concentration was monitered at different possible emission lines for all metal composition by aspirating the solution. Then these emission lines at applied target RF power of 1150w the response for metal composition were evaluated [1]. But this method takes only liquid samples.

B. Electrochemical Method

This method consists of electrochemical cell. This cell consists of two electrical conductors i.e. electrodes dipped in a suitable a electrolyte solution. For development of current in a cell the following conditions necessary as: the electrodes must be connected externally with metal conductor. For movement of ions from one to another preferably via a salt bridge it is necessary the two electrolyte solutions must be in contact with each other. Electron transfer reaction must occur at each of the two electrodes. At the interfaces between the electrolytes and the solid electrodes, a small potential exists which is known as liquid junction potential. If we replace the meter with a low resistance wire the circuit is completed and charge flows. Three distinct results observed under this condition as: a) copper ions migrate away from the electrode into the solution. Sulphate and hydrogen

sulphate ions move towards the metal. b) In the other beaker silver ions move from the solution toward the electrode and anions move away from it. c) Inside the salt bridge charge is carried by potassium ions to the right and chloride ions to the left. Limitation of this process is that metal removal rate is slow; disposal of potentially harmful by products and it requires the handling of dangerous chemicals.

III. PROPOSED SYSTEM

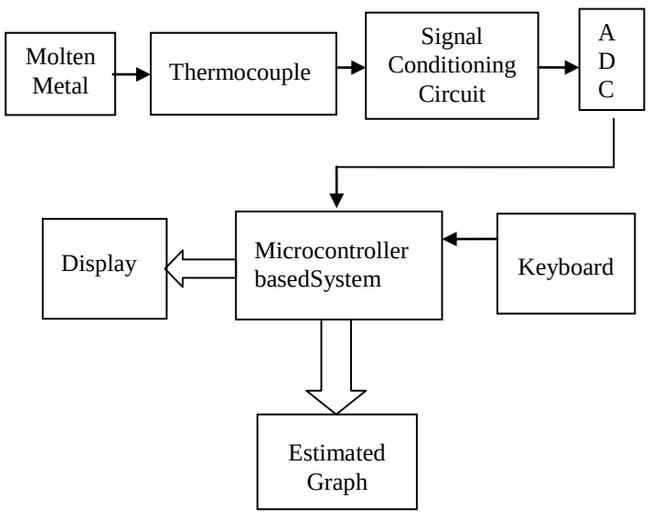

FIG. 1 PROPOSED SYSTEM

A. *Moltan Metal*

The molten metal is input to the system.

B. *Thermocouple:*

A thermocouple produces a temperature- dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature.

C. *Signal Conditioning Circuit*

Signalconditioning circuit required for manipulating an Analog signal in such a way that it meets the requirements of the next stage for further processing. Operational amplifiers are commonly employed to carry out the amplification of the signal in the signal conditioning stage.

D. *Analog to Digital Converter (ADC)*

It converts an input Analog voltage or current to a digital number proportional to the magnitude of the voltage or current.

E. *Microcontroller*

From the analysis of Cooling Cycle, required time period for successive samples storage will be obtained and number of sample will be stored .From the sequence of input data Solidious point and Liquidous point will be obtained. Using analytical tools and equations, composition analysis for Si,C,carbon equivalent will be done.

F. *Keyboard*

For making system interactive.

G. Display

For displaying estimated values and curves.

IV. CONCLUSION

Temperature measurement using thermocouple (TC) affect on solidification of the casting. In proposed system we are suggesting thermocouple as sensor for measuring of temperature. By analysing the cooling curve solidus and liquidus point can be ploated. This will help in estimating composition in molten metal.

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