ABSTRACT

Metal casting requires control of a very large number of variables to get a product of desired quality. Melting and moulding are the two very important steps in this process. Due to the presence of a very large number of variables in each step, the process characteristics are often not deterministic in nature. Hence in this work use of artificial neural networks, regression analysis and genetic algorithms has been attempted to model the phenomena associated with melting of cast iron in a cupola, green sand and sodium silicate process of moulding, hot tear formation in aluminum – tin alloys and incidence of defects in steel castings.

Cupola is still the most preferred mode of melting cast irons, though it involves almost 25 variables controllable to varying degrees, which affect the quality and the composition of the out-coming molten metal. Parameters like melt rate, chemical composition, and temperature of the molten metal as well as the composition of the stack gases need to be controlled throughout the melting process. Experimental data were collected from a prototype cupola and artificial neural networks have been successfully used by selecting an appropriate network architecture to model the input and output parameters of the cupola furnace. The input parameters could also be optimized using genetic algorithms. The results further show that the loss of alloying elements through slag can be minimized, which would, in turn, result in higher productivity.

Green sand mould characteristics present a very difficult task to predict. Experiments were conducted on green sand moulding. Artificial neural networks were used to model the parameters with an objective of controlling the properties. Genetic algorithms were also tried to model realization of the desired properties. The results showed that genetic algorithms could precisely control the mould properties when compared to artificial neural networks. Similar work was also done on cement hardened sodium silicate bonded sand moulding process. Here apart from the use of artificial neural networks and genetic algorithms, regression analysis was carried out for the purpose of obtaining a

mathematical model. Regression analysis has helped the author to conclude that the silica to soda ratio highly increases compression strength and friability and decreases the retained strength.

Experiments were performed to understand the mechanism of hot tearing in Al-Sn alloys. The role of grain refinement and presence of Fe and Ni on hot tearing was investigated using SEM. The results were modelled using artificial neural networks, regression analysis and genetic algorithms. It was concluded that grain refinement could reduce hot tearing up to a certain extent. Presence of Fe and Ni could be beneficial in preventing hot tearing by forming iron or nickel aluminide to act as anchors for the grains.

Data on the incidence of defects like hot cracks, min-run, scab and air lock in steel castings were collected from a foundry and the same were modelled using artificial neural networks. It was concluded that the occurrence of any particular type of defect could be successfully predicted using neural networks in most of the cases.

KEY WORDS: Metal Casting, Cupola Furnace, Green Sand Design, Hot Tears, Sodium Silicate Moulding, Defects Analysis, Artificial Neural Networks, Regression Analysis, Genetic Algorithms, Modelling and Optimization.