ABSTRACT

Trial-and-error methods in foundries to determine optimum molding sand properties consume more time and result in reduced productivity, high rejection, and cost. Hence, current research is focused towards development and application of modelling and optimization tools. In foundry, there is requirement of mound properties with conflicting nature (that is, minimize: gas evolution and collapsibility; maximize: compression strength, mound hardness, and permeability) and determining best combination among them is often a difficult task. Optimization of resin-bonded molding sand system is discussed in this book chapter. Six different case studies are considered by assigning different combination of weight fractions for multiple objective functions and corresponding desirability (Do) values are determined for DFA, GA, PSO, and MOPSO-CD. The obtained highest desirability value is considered as the optimum solution. Better performance of non-traditional tools might be due to parallel computing approach. GA and PSO have yielded almost similar results, whereas MOPSO-CD produced better results.
INTRODUCTION AND LITERATURE REVIEW

The foundry aims to produce good quality castings at reduced cost, by minimizing the incidence of many possible casting defects. To achieve the said objectives, one should have strong knowledge of process mechanics and dynamics through which the castings are made. Metal casting process involves pattern making, mould preparation, melting and pouring. Sand moulds offer greater technical advantage for the production of large tonnage castings at a low cost. Sand casting is a versatile manufacturing process, as it is used to cast high temperature metals and alloys namely, iron, copper and nickel by Saikaew and Wiengwiset (2012). The process control in casting process is often influenced by a large number of control variables (that is, quantity of binder, sand grain size and shape, degree of ramming, curing time and so on) in sand moulds. The sand mixed with a binder accommodates to hold particles of varied size and shapes, which are being compacted around a pattern to form the cavity in the sand. The casting quality or defects are related directly to sand mould properties namely, compression strength, mould hardness, permeability, gas evolution, and collapsibility. The sand mould properties are to be controlled through a proper choice of moulding sand ingredients and processing method of moulding sand mixture.

Traditional Experimental Method

Trial and error experiments are considered as the most preferred and widely applied method in major class of the foundries by Acharya and Vadher (2016). Clay bonded sand (i.e. green sand) moulds are most preferred with regard to economic aspects. The possible defects in green sand moulding process are, blow holes, pin hole, gas and shrinkage porosity, poor surface finish and dimensional accuracy, scabs, rat tails, slag inclusion, mis-run, and so on (Kumaravadivel & Natarajan, 2013). The casting defects are related directly to sand mould properties. The type of sand moulds selected based on the type of metal to be cast, cost, reclaimability of silica sand, casting shape, size and thickness, and dimensional accuracy. Barlow (1966) studied the hardness influence in preventing the mould wall movement. Further, they also tried to develop interrelationship among mould hardness (MH) with permeability (P) and strength in high pressure moulding. Sriganesh, Seshadri and Ramachandran (1966) reported that, the degree of packing (i.e., compaction) of bonded sand grains was dependent mainly on the angularity, shape, and size (i.e. coarse or fine) of sand grains. The results also showed that, a degree of packing had reduced with the addition of bonding material. They failed to include many important factors and provide mathematical support for the analysis.

Resin-bonded sand moulds and cores produce better moulding sand properties and dimensionally accurate castings than green sand moulds, provided the technical moulding parameters are optimized accurately by Khandelwal and Ravi (2016). Barghaoui et al., (2017) investigated the resin bonding behavior and foundry sand cores at different temperatures (i.e. 28 °C to 450 °C). Sand grain size and mould coating have strong influence on fluidity of the molten alloy, which in turn affects the rate of casting solidification by Jafari et al., (2010). Mould filling ability is influenced directly by section thickness of castings (Jafari et al., 2010). Mould coating had showed a significant impact as compared to the grain size, in yielding better mechanical and metallurgical properties. Philips (1970) had made an attempt to develop the influence of chemicals and mulling time on green compression strength and baked shear strength. It is to be noted that, the distribution of sand grain size play a major role in determining the clay and water requirements in the moulding sand system. However, they failed to provide supportive experimental work in their report. Gardner (1948) investigated the degree of ramming and moisture per-