ABSTRACT

Quality achieved by means of process optimization was found useful by many manufactures because it is cost effective in terms of gaining and maintaining a competitive position in the world market.

Sand casting processes like green sand casting and CO₂ casting in general involve a large number of parameters that affect the various casting quality features of products. Some of the parameters are controllable and others are uncontrollable and hence they are essentially responsible for variation in casting quality. Hence, to achieve good and consistent quality not only the average response but the variation as well should be taken into consideration.

In this context, Taguchi method of quality engineering encompasses all stages of process development, whereas the key element for achieving high quality and low cost was by parameter design. Through parameter design, optimal levels of parameters are selected such that the influence of uncontrollable factors causes minimum variation of the system response.

This research work presents the Design of Experiment-based approach which is adopted to obtain an optimal setting of moulding sand and pouring metal related parameters of green sand casting and CO₂ casting processes. The casting parameters identified for green sand casting process are namely moisture content, green strength, ramming pressure, mould hardness, permeability, sand particle size, pouring
temperature, pouring height and cooling time of poured metal, and the
casting parameters identified for CO₂ casting process are namely weight
of CO₂ gas, mould hardness number, sand particle size, percentage of
sodium silicate, sand mixing time, pouring time, pouring height, pouring
temperature, and cooling time of poured metal. The series of
experiments is performed to measure the percentage of rejection for the
green sand casting and CO₂ casting processes. The settings of moulding
sand and pouring metal related green sand casting and CO₂ casting
process parameters have been determined by using Taguchi Design of
Experiment method. Thus, Orthogonal Arrays of Taguchi, Signal-to-
Noise(S/N) ratio and Analysis of Variance (ANOVA) are employed to
find the optimum levels and analyze the effect of casting parameters on
percentage of rejection. The different confirmatory tests with the
optimum level of casting parameters are carried out.

As the Taguchi method does not perform well when the search
space is too large, as such the evolutionary heuristics like GA, SA and
ACA need to be implemented to obtain good quality solutions for the
large search space. The experimental results from the orthogonal array
were used for developing the mathematical model to map the
relationship between process parameters and percentage of rejection for
green sand casting and CO₂ casting processes. The proposed
mathematical model is used to formulate the objective function, which is
the pre-requisite of evolutionary heuristics. By efficacy test comparing
the predicted values with the experimental values, it is found that there
is good agreement between experimental values and predicted values.
The proposed mathematical model is found to be very useful in
optimizing the green sand casting and CO₂ casting process parameters to
obtain the minimum percentage rejection by using evolutionary heuristics. The control parameters of each evolutionary heuristics are satisfactorily studied well and the performance of each evolutionary heuristics is also predicted and inherently compared. A set of confirmation tests with the optimum level of green sand and CO₂ casting parameters is carried out and the impact and effectiveness of evolutionary heuristics is illustrated.