CHAPTER -9

CONCLUSION AND RECOMMENDATION
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9.1 CONCLUSION AND RECOMMENDATION

In first stage of performance enhancement, process factor optimization for controlling pull-down defects is considered. Experiment is conducted in a medium size iron foundry. Castings with incidence of pull-down defects are considered for study. Influencing factors identified are pouring temperature, carbon equivalent, and gating system. Each factor is analyzed with three signal levels as tabulated in Table-5.1 using orthogonal array settings recommended in Table-5.2. The data collected from eighteen experiments is presented in Table-5.3. Average Signal to Noise Ratio estimated is presented in Table-5.4. Robust design factor values are tabulated in Table-5.5.

Estimated robust design factor values are analyzed using ANOVA technique and are tabulated in Table-5.6 and Table-5.7. From the tabulated data, interaction effect study is conducted for the combination of factors and is listed below.

- Pouring Temperature and Carbon Equivalent (U.V)
- Carbon Equivalent and Gating System (V.W)
- Pouring Temperature and Gating System (U.W)

From the study, it is concluded that interaction effect among following factors is very small.

- Pouring Temperature and Carbon Equivalent (U.V)
- ‘Pouring Temperature and Gating System (U.W).

However, it is evident from Table-5.7 that interaction effect among factors ‘Carbon Equivalent and Gating System (V.W)’ is considerable. Identified factors and respective data are pooled together. Pooled data is found acceptable as it passes ‘F-Test’ at a confidence level of 0.1.
Further nine experiments were conducted using optimal factor values and experiment values are presented in Table-5.8. It is concluded that after employing optimal factor values, number of castings with pull-down defect has reduced. Approved percentage of castings has improved from 86.22% to 96.17%. Recommended values of factors for controlling pull-down are tabulated in Table-5.9.

In second stage of performance enhancement, process factor optimization for controlling internal defects is considered. Experiment is conducted in the same foundry. Castings with incidence of internal defects are considered for study. Influencing factors identified are Nodulizer level, Inoculant level, and Carbon equivalent. Each factor is analyzed with three signal levels as tabulated in Table-6.1 using orthogonal array settings recommended in Table-6.2. The data collected from eighteen experiments is presented in Table-6.3. Average Signal to Noise Ratio estimated is presented in Table-6.4. Robust design factor values are tabulated in Table-6.5.

Estimated robust design factor values are analyzed using ANOVA technique and are tabulated in Table-6.6, Table-6.7, and Table-6.8. From the tabulated data, interaction effect study is conducted for the combination of factors and is listed below.

- Nodulizer and Inoculation Level ($U_1 V_1$)
- Inoculation Level and Carbon equivalent ($V_1 W_1$)
- Nodulizer Level and Carbon Equivalent ($U_1 W_1$)

From the study, it is concluded that interaction effect among following factors is very small.

- Nodulizer Level and Carbon Equivalent ($U_1 W_1$)
- Inoculation level and Carbon Equivalent ($V_1 W_1$)
However, it is evident from Table-6.7 that interaction effect within factors Nodulizer and Inoculation Level \((U_1,V_1)\) is considerable. Identified factors and respective data are pooled together. Pooled data is found acceptable as it passes 'F-Test' at confidence level of 0.1.

Further nine experiments were conducted using optimal factor values. It is concluded that after employing optimal factor values, number of castings with internal defect has reduced. Approved percentage of castings has improved from 85.99 % to 100 %. Recommended values of factors for controlling pull-down are tabulated in Table-6.9.

In third stage of performance enhancement, furnace productivity optimization is considered to increase lining life of coreless induction furnace. Experiment is conducted in a medium frequency furnace. Influencing factors identified are Binder level, Sintering type, and Refractory type. Each factor is analyzed with three signal levels as tabulated in Table-7.4 using orthogonal array settings recommended in Table-7.5. The data collected from eighteen experiments is presented in Table-7.6. Average Signal to Noise Ratio estimated is presented in Table-7.7. Robust design factor values are tabulated in Table-7.8.

Estimated robust design factor values are analyzed using ANOVA technique and are tabulated in Table-7.9 and Table-7.10. From the tabulated data, interaction effect study is conducted for the combination of factors and is listed below.

- Binder Level and Sintering Type \((U_2,V_2)\)
- Sintering and Refractory Type \((V_2,W_2)\)
- Binder Level and Refractory Type \((U_2,W_2)\)
From the study, it is concluded that interaction effect among following factors is very small.

- Binder Level and Sintering Type (U₂.V₂)
- Binder Level and Refractory Type (U₂.W₂).

However, it is evident from Table-7.10 that interaction effect among factors ‘Sintering and Refractory Type (V₂.W₂)’ is considerable. Identified factors and respective data are pooled together. Pooled data is found acceptable as it passes ‘F-Test’ at a confidence level of 0.1.

Further nine experiments were conducted using optimal factor values. It is concluded that by employing optimal factor values lining life improved from 115 heats to 185 heats. In addition to improvement in lining life, energy saving of 18 energy units per ton of liquid metal is also observed. Recommended values of factors for controlling pull-down are tabulated in Table-7.11.

In the final stage of performance enhancement, operations of the foundry is carefully studied and concluded that the molding machines and melting furnaces are bottlenecks. A flexible decision support system is developed. DSS helped decision maker in making decisions like the job sequence in which moulds are to be prepared, grouping of moulds into batches for each melt of furnace and decision regarding delivery date to customers. GA based heuristic, which is part of the DSS ensured near optimal schedule. Thus, performance enhancement had been suggested in four areas of foundry activity.
9.2. SCOPE FOR FUTURE WORK

Future scope is always there for every technology. The future scopes to expand the research work done in this area are:

1. This thesis addresses pull-down and internal defects. There are still few more defects, though not major could be studied.
2. Empirical relationship can be arrived for interaction effect among factors.
3. The decision support system could be diversified for other objectives of scheduling.
4. The proposed Genetic Algorithm could be extended for other cross over and mutation operators.