CHAPTER 4

PROBLEM IDENTIFICATION

4.1 INTRODUCTION

The trend in the modern manufacturing system all industries are marching towards zero defects principles to obtain better quality products. The quality principles are applied to all process industries. In order to obtain the good quality products within the available resources, the selection of optimal parametric combination plays a very important role.

4.2 SELECTION OF PROBLEM

The literature reveals that many of the researchers have mainly concentrated on machining parameters optimization by using Taguchi and evolutionary heuristics for minimizing the rejection rate. The evolutionary heuristics algorithms are proved as efficient tool for solving parameter optimization problems. The detailed literature review reveals that, the optimization of sand casting process has not been attempted by the researchers. Only a few literatures deal with the casting defect minimization. In general, the die casting process, gear blank casting and sand casting mould related parameters were optimized using robust design technique of Taguchi and evolutionary heuristics like GA and SA. But the sand casting processes particularly green sand and CO₂
casting process were not at all addressed for optimization by any researcher. This scenario has motivated the researcher to carry out the research work as selection of optimal parametric combination for minimizing the percentage rejection for green sand casting and CO₂ casting processes by using Taguchi and evolutionary heuristics like GA, SA and ACO.

An online case study for investigating the parameters that are affecting the final quality of the products in green sand casting and CO₂ casting processes. The case study was conducted at one sand casting industry for the manufacture of SG iron and alloy steel components using green sand casting and CO₂ casting processes, located near Madurai in the South part of Tamilnadu, South India. Already the industry had their own operating standards but, they still did not select the optimal process parameters. Thus, they got a little higher defect percentage than the acceptable level, and the profit gets reduced thereby increasing the manufacturing cost of the product. This research work aims to reduce the percentage of rejection rate by selection of optimal input process parameters.

A detailed study was carried out on the types of defects occurring in the end products and their causes. These casting defects can be minimized in order to obtain quality casting. According to the present study, a number of parameters are associated with the quality of products. Among them, the most important and controllable parameters are selected by conducting brain storming sessions, questionnaire technique and cause and effect analysis. The defects occurred in each stage of the casting process are as follows:
70% in molding process  
20% in pouring process  
7% in melting process  
2% in core shops  
1% in pattern shop

Figure 4.1 Defects occurring in each stage of casting process

From the Figure 4.1, it is clearly shown that 90% of rejections are caused due to moulding sand and pouring metal related parameters only.

4.3. ANALYSIS OF CASTING DEFECTS

A detailed analysis of casting defects which occurred during the molding and pouring process was done, in order to determine the causes for the defects. The defects occurring in the molding and pouring process are given below.

4.3.1 Sand Drops

A sand drop is a portion of the sand drops from the top part of the mould or from other overhanging sections into the mould cavity.
Causes

- Due to weak or improperly rammed sand.
- Existence of low moisture content
- Due to rough and careless handling
- Worn out patterns or patched moulds
- Insufficient draft on the pattern

Suggested remedial measures

- Proper ramming of the moulds can be ensured
- Careful handling
- Avoid sharp corners and deep pockets
- Ensure adequate moisture content can be ensured

4.3.2 Sand Crush

These defects occur on the surfaces of the castings due to the displacement of sand at mould joints or core prints, leading to irregularly shaped cavities or projections on the castings.

Causes

- Worn out patterns or misaligned cope and drag patterns.
- Low green strength and dry strength of sand.
- Badly made mould joints using uneven and excessive pressure on sand face
- Improperly matched or warped molding boxes
- Inaccurately placed cores

Suggested remedial measures

- Proper patterns can be used
- Ensuring proper clamping of the mould boxes
• Use of appropriate sand with adequate green strength
• Proper placing of the cores

4.3.3 Mould Breaking

During the pouring process, the moulds are broken and the causes are identified as follows:

Causes
• Uneven and hard ramming
• Inadequate gating and risers
• Use of sand with high moisture content and low clay content
• Inadequate pouring rate and excessive pouring temperature

Suggested remedial measures
• Ensuring careful and soft ramming
• Use of sand with correct moisture content and clay content
• Increasing the percentage of coal or cereal
• Avoid the usage of very high proportion of new sand
• Maintain adequate pouring rate can be maintained with correct pouring temperature

4.3.4 Loose Ramming

These defects occur due to improper ramming and formation of rough surfaces on the casting
Causes
- Soft-rammed or over-baked cores
- Softly rammed moulds
- Very high pouring temperature
- Very high or low moisture content
- Low flowability

Suggested remedial measures
- Utilizing good and uniform ramming
- Lowering the pouring temperature
- Use of suitable mould or core dressing
- Properly positioned gates and risers

4.3.5 Shift

A pronounced mismatch of the top and bottom parts of the mould causing an inaccurate casting is called a “shift”. Mould shift results due to improper matching at the parting lines.

Causes
- Use of worn out molding box and mould plate causing a twist in the box
- When using half patterns, pins are not centrally located
- Cope and drag patterns are not properly aligned

Suggested remedial measures
- Regular checking of box pins and bushes
- When fitting half patterns, proper care should be taken to ensure accuracy
4.3.6 Swell

These defects occur on the vertical surface of the castings due to liquid metal pressure

Causes
- It may be due to low green strength of mould because of high water content
- When mold is not rammed sufficiently
- Less hardness

Suggested remedial measures
- Ensuring proper ramming of the moulds
- Use of sand with less water content

4.3.7 Cold Shut

A Cold Shut is an interface within a casting that is formed when two metal streams meet without complete fusion.

Causes
- Inadequate metal supply
- Too low mould (or) melt temperature
- Melt may lose sufficient heat resulting in loss of its fluidity

Suggested remedial measures
- To increase pouring temperature
- Ensuring proper pouring height and pouring time
4.3.8 Blow Holes

Blow holes, gas holes are well rounded cavities having a clean and smooth surface. They appear either on the casting surface or in the body of a casting.

Causes
- Excessive moisture content
- Fine grain size of sand
- High clay content
- Hard ramming
- Low pouring temperature and incorrect feeding of casting

Suggested remedial measures
- Proper handling of sand during sand mixing time
- Ensuring proper ramming of the mould
- Ensuring the correct pouring temperature

4.3.9 Shrinks

A shrinkage cavity is a depression or on internal void in a casting.

Causes
- Improper solidification
- Incorrect pouring temperature
- Improper riser

Suggested remedial measures
- Correct pouring temperature can be ensured
- Proper risering system
- Ensuring correct cooling time
4.3.10 Hot Tears

Hot tear appears in the form of irregular crevices with a dark oxidized fracture surface on the casting.

Causes
- Incorrect pouring temperature
- Incorrect gating design
- Non-uniform cooling

Suggested remedial measures
- Ensuring proper pouring temperature
- Improve pattern design
- Correct cooling time can be ensured

4.3.11 Honey Combing

This is an external defect, which consists of number of small cavities in close proximity on the casting surface.

Causes
- Incorrect pouring
- Improper ramming
- Moulding sand not strong

Suggested remedial measures
- Ensuring proper pouring height
- Hard ramming
- Correct gating