

Optimization of Casting Process Parameters using Taguchi Method

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Abstract - Casting process is the most widely used process in manufacturing industries especially in automobile products. Systematic analysis and identification of sources of product defects are essential for successful manufacturing. Foundry industry suffers from the poor quality and productivity due the large number of process parameter. Since the quality of casting parts is mostly influenced by process condition, how to determine the optimum process condition becomes the key to improving part quality. Improvement in casting quality is the process of finding the root cause of occurrence of defects such as sand drop, blow hole, leakage and bad mould in the rejection of casting and taking necessary steps to reduce the defects and hence rejection of casting. In this paper, green sand casting process was optimized by using Taguchi method. An attempt has been made to obtain optimal settings of the casting process parameters in order to yield the optimum quality characteristics of the silicon molybdenum (SiMo) SG iron flange bak castings. Good quality of casting can be achieved by optimization of controllable process parameters such as mould hardness, moisture content, permeability and green compression strength. The effects of these parameters on casting defects and subsequent setting of parameters with the levels have been accomplished by Taguchi's parameter design approach. Taguchi based L₁₆ orthogonal array have been used for the experimentation and result has been carried out using Minitab 16 software for analysis of variance. A statistical analysis of variance (ANOVA) has been performed for which process parameters are significantly affecting the casting rejection percentage. Identify the optimum value of the selected process parameters and verification experiment has been performed.

Index Terms - Optimization, Casting process, Casting defects and Taguchi method

I. INTRODUCTION

Metal casting has been a primary manufacturing process for several centuries during BC and is so even today in the 21st century. Today, its applications include automotive components, spacecraft components and many industrial and domestic components. The principle of manufacturing a casting involves creating a hollow shape of the metallic component to be made inside a sand mould and then pouring the liquid metal directly into the sand-shaped mould. Casting is a very versatile process capable of being used in mass production items in very large shaped pieces, with intricate designs and having properties unobtainable by any other methods. The major activities involved in making a casting are moulding, melting, pouring, solidification, fettling, cleaning, inspection and elimination of defective castings [1].

Metal casting is one of the direct methods of manufacturing the desired geometry of component. More than 60% of the automotive components out of the total are manufactured by metal casting process. Foundry industry suffers from poor quality and productivity due to the large number of the process parameters. Out of different casting methods, green sand casting is the commonly used method for producing automotive components.

Major applications in both ferrous and non ferrous casting material such as, casting engine block, valves, pump, aerospace and so on. Moulding, melting followed by pouring, fettling, inspection and elimination were the major steps followed in casting process. Control during each stage in casting process plays a vital role else it may lead to casting defects like rat-tails, scabs, cracks, blow holes, misrun, shrinkage, porosity, cold shut, scar, hot tears, cracks and so on. In past few decades neural networks were used to tackle production related problems, controlling the process by reducing casting defects, lead times, scrap rate, production cost and to avoid trial and error method, expert dependent advices in optimizing the process [2].

II. LITERATURE REVIEW

The majority of the published articles on the optimization of casting process parameters based on the Taguchi's method are reviewed below.

Haq et al. [3] have optimized the process parameters of CO₂ casting process such as weight of CO₂ gas, mould hardness, sand particle size, and percentage of sodium silicate, sand mixing time, pouring time, pouring height, pouring temperature and cooling time of poured metal using design of experiments method such as Taguchi method.

Karunakar and Datta [1] have applied back propagation neural networks for analysis and prediction of casting defects. In this paper they had applied the neural network to the metal casting for prediction of casting defects such as cold shut, sand drop, slag inclusions and microstructure related defects. Chokkalingam and Nazirudeen [4] have proposed the new approach of casting defect

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Table of Contents Optimization Of Process Parameters By Taguchi Method

1. Understanding the eBook Optimization Of Process Parameters By Taguchi Method
 - The Rise of Digital Reading Optimization Of Process Parameters By Taguchi Method
 - Advantages of eBooks Over Traditional Books
2. Identifying Optimization Of Process Parameters By Taguchi Method
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Optimization Of Process Parameters By Taguchi Method
 - User-Friendly Interface
4. Exploring eBook Recommendations from Optimization Of Process Parameters By Taguchi Method
 - Personalized Recommendations
 - Optimization Of Process Parameters By Taguchi Method User Reviews and Ratings
 - Optimization Of Process Parameters By Taguchi Method and Bestseller Lists
5. Accessing Optimization Of Process Parameters By Taguchi Method Free and Paid eBooks
 - Optimization Of Process Parameters By Taguchi Method Public Domain eBooks
 - Optimization Of Process Parameters By Taguchi Method eBook Subscription Services

- Optimization Of Process Parameters By Taguchi Method Budget-Friendly Options
- 6. Navigating Optimization Of Process Parameters By Taguchi Method eBook Formats
 - ePub, PDF, MOBI, and More
 - Optimization Of Process Parameters By Taguchi Method Compatibility with Devices
 - Optimization Of Process Parameters By Taguchi Method Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Optimization Of Process Parameters By Taguchi Method
 - Highlighting and Note-Taking Optimization Of Process Parameters By Taguchi Method
 - Interactive Elements Optimization Of Process Parameters By Taguchi Method
- 8. Staying Engaged with Optimization Of Process Parameters By Taguchi Method
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Optimization Of Process Parameters By Taguchi Method
- 9. Balancing eBooks and Physical Books Optimization Of Process Parameters By Taguchi Method
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Optimization Of Process Parameters By Taguchi Method
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Optimization Of Process Parameters By Taguchi Method
 - Setting Reading Goals Optimization Of Process Parameters By Taguchi Method
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Optimization Of Process Parameters By Taguchi Method
 - Fact-Checking eBook Content of Optimization Of Process Parameters By Taguchi Method
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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