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Application of Six Sigma Methodology and Design of Experiments for Process Improvement in Industrial Companies

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Abstract

Six Sigma is regarded as a well-structured methodology for improving the quality of processes and products. The prime objective of Six Sigma is reducing defects by reducing variability in the system. Six Sigma and Design of Experiments (DOE) are used to verify the cause-and-effect relationships between the parameters critical to quality (CTQs) and the critical few factors that drive the process under study.
Objectives of the present work are three folds; the first is to integrate Six Sigma methodology with Design of Experiments as a model for quality improvement. The second is to explore this developed model for the improvement of the quality of plastic injection molding process. This work is applied at the international Engineering union company (IEUC). The Third objective is to explore the Mold Flow simulation software for the simulation and improvement of the plastic injection process.

During this work the Six Sigma DMAIC methodology is applied with many tools for the improvement process. Project charter and SIPOC tools are applied in the define phase with Voice of Customer (VOC) and critical to quality (CTQs). During the measure phase the Sigma level is computed and Pareto principle is applied to find the priority for improvement. During the analyze phase ways to reduce defects were identified .During the Improve phase the DOE is introduced to find the required experiments, factors and its levels that control the injection molding parameters.

Analysis of Variance (ANOVA) method is used for identifying the significant factors affecting the plastic molding process. One of the main defects in the plastic injection molding process is incomplete filling. For this type of defect the significant factors are injection pressure, melting temperature, injection speed, packing pressure.

Mold Flow simulation software used for analysis and simulation of injection molding process. Many runs has performed to find the best parameters for minimizing the defect percentage. Volumetric shrinkage is one of the important type of defects of the injection molding process. Analysis of this type of defect is performed using Mold Flow simulation software integreated with Taguchi method and ANOVA. The Mold Flow simulation showed that the significant factors affecting quality of the product are the melting temperature and mold temperature.

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Content

Subject **Pag. No**

List of Tables

List of Figures

List of Abbreviations

DOE: Design of Expriments

DMAIC: Define, Measure, Analyze, Improve, Control

DFSS: Design for Six Sigma

CTQs: Criticals to Quality

VOC: Voice of Customer

SIPOC: Supplier, Input, Process, Output, Customer

ANOVA: Analysis of Variance

DPMO: Defect per Million Ouppertunities

S/N: Signal to Noise Ratio

SS: Statistical Sum

MS:Mean Square

STD: Standard Diviation