On-line Quality Control and Experimental Design Analysis for Plastic Injection Moulding

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Tae Eub Kim
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to

Jung Hun, Hyeon Jin and Hoon Ah

Abstract

This thesis describes automatic quality data acquisition and experimental design methods for product quality improvement.
The approach used, focuses on the computer based, process and product quality data acquisition from the shop floor. The collected data was then analysed by the 'design of experiments' method, an advanced statistical quality analysis method, to determine which process parameters influence product quality.

Many advanced statistical quality control methods have been developed for maintaining manufacturing product quality. In spite of this development, most manufacturing organisations depend on downstream statistical quality control methods, such as control charts and sampling inspection. These downstream methods, which require more time to collect quality information after the process, cannot always prevent quality problems, or produce prompt quality improvements.

A case study is presented which is concerned with the implementation of an on-line data collection system and the 'design of experiments' methods. A plastic injection moulding machine was used for this project, using an instrumented mould designed for process data collection, together with interfaced dimension and weight measurement instruments.
The results clearly indicate the process parameters which are important to product quality.

By the use of integrated on-line quality data collection systems and 'design of experiments' methods, rapid reaction to process problems, and quality design activities should be able to be easily adopted by manufacturing industries.

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Chapter 1

Introduction and Overview of Thesis

This chapter describes the object and aims of this research work followed by a summary of each chapter.

1.1 Foreword

This research thesis describes a method of computer based, on-line process and product data collecting to control product quality from the plastic injection moulding machine. The collected quality data is then analysed by the 'design of experiments' method to determine the optimum process input parameters for target quality characteristics.

The on-line quality data collecting method, which is called 'Automatic Quality Data Acquisition System (AQDAS)' in this thesis, were devised and developed to collect the process parameters with special instrumentations, and product quality measurements.

The AQDAS developed through this research, can be applied to a wide range of manufacturing industries with relatively low cost.

1.2 Objectives of the research work

Exhibited dimensional shrinkage on a plastic product is the most difficult product quality problem to control. The reason is that many input parameters affect directly and indirectly the product quality.

The aims of this research are to devise a low cost automatic quality data acquisition system and to determine the optimum level of the input process parameters to achieve target product quality characteristics.

Two main objectives were outlined for this research. They were as follows:

- To devise a computer based, shop floor data collection system for process parameters and product data for a plastic injection moulding machine.

  For the process parameters, the three following parameters were chosen to be measured with special instrumentation.

  - Injection pressure in the mould cavity,
  - Temperature of the polymer when it is injected into the cavity,
  - Temperature of the polymer when it is being injected from the nozzle.

  For the product parameters, the product dimensions and weight were measured.

- To use the 'design of experiment' methodology used to analyse the resultant data and to use the analysed results to optimise the settings for the injection moulding machine.

1.3 Summary of contents

Chapter 2 describes the main units of the injection moulding machine and the operation of its product moulding process. In addition key features of the plastic injection moulding machine and designed mould which were used for this research project are described.

Chapter 3 describes instrumentation methods for computer based shop floor quality data acquisition methods which were devised to collect the process and product quality data for the injection moulding machine and its product.

Chapter 4 describes the implementation of a real time quality data acquisition on the shop floor. The structure of Automatic Quality Data Acquisition System (AQDAS) and its development process was described. The collected process and product data are shown and displayed as graphics.

Chapter 5 describes the design process of experiments and shows experimental design results for product quality characteristics. Optimum input process parameters were suggested for the designed plastic product.

Chapter 6 discusses the achievements from the research project and makes recommendations for further studies.

1.4 General References

The following general references were used for this project.

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