

Warpage Prediction in Injection Molding Using Artificial Neural Network

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Abstract

Finding optimal parameters setting which produce minimum warpage value in injection molding always a big challenging. The traditional method which based on trial and error and workers knowledge and experiences required a lot of time and costs. Artificial Neural Network (ANN) is a modelling technique which has been used widely in many areas. In this study, ANN is used as modelling technique in predicting the optimal parameters setting that lead to minimum warpage value in injection molding. As the results, ANN model successfully improves the warpage value by 0.02% compare to experiment result with 39.68°C for cooling temperature, 2.183s for injection time, 97.43% for V/P switchover and 39.07°C for mold temperature.

Keywords: Warpage, Injection molding, Artificial Neural Network

1. Introduction

Injection molding is a popular method for producing complex plastic part and suitable for mass production. It has been used widely in various field of economy (Li et al., 2009). Injection molding has several advantages such as has the ability to produce complicated geometries product shape and excellent accuracy of product in single production step, short cycle time and very long mold life, has the ability to produce excellent quality product, light weight, high production rate and low cost and it is an economic method to produce mass production (Chen & Liu, 1999; Goodship, 2004; Koh & Lee, 2002; Oktem et al., 2007; Stanek et al., 2011).

In injection molding, there are six steps involved which are (Drobny, 2014; Rosato et al., 2000):

- i. **Start plastication.** The plastic material is feed into hopper and transfer into barrel. In this step, the plastic material will be melted and the screw will be spin along with melted plastic material and transfer it in front of screw tip called screw chamber.
- ii. **End plastication.** The screw will stop when enough plastic material in screw chamber.
- iii. **Mold closing.** The mold clamp is closing.
- iv. **Start injection.** The screw move forward and push the melted plastic material in mold cavity. In this step, the screw did not spin.
- v. **End injection.** The mold consists of hot melted plastic material being cooled from melt temperature. In this step, the plastication in step (i) is making preparation for the next injection.
- vi. **Molding ejection.** The mold will be open and finishing plastic product can be ejecting after go through the cooling procedure. The injection molding steps is end. New injection can start from step (ii).

During injection molding process, defects of the product which affect the quality such as warpage may occur. Warpage is the non-desired shaped which produce after the plastic product ejected from the mold. One of the methods to overcome this problem is by selecting the optimal parameters in injection molding which can minimize the warpage value (Shi et al., 2013).

Traditionally, selection of combination parameters in injection molding is based on trial and error and workers knowledge and experiences (Cheng et al., 2013). These methods required a lot of time and costs. Moreover, inexperienced workers may undergo difficulty in selecting optimal parameters. Artificial Neural Network (ANN) is one of promising technique in finding the optimal parameters which lead to minimum warpage value. ANN has the ability to represent almost every function that maps an input to an output. This means that even the difficult nonlinear problems can be solved by using ANN. In addition, compared to conventional approaches ANN is more successful and fast in learning from examples.

This paper discusses the implementation of ANN in finding the combination of optimal parameters setting in minimizing the warpage value in injection molding. Hence the objectives of this paper are:

- i. To estimate minimum warpage value in injection molding using ANN technique.
- ii. To estimate optimal parameters setting namely cooling temperature, injection time, V/P switchover and mold temperature that lead to minimum warpage value in injection molding using ANN technique.

2. Artificial Neural Network (ANN)

Artificial Neural Network (ANN) was inspired from biological system of human brain. ANN has been widely used