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A new method for the automated design of cooling systems in injection molds

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Abstract

This paper presents a new method for the automatic design of the cooling system in injection molds, based on the discrete geometry of the plastic part. In a first phase the new algorithm recognizes the discrete topology of the part, obtaining its depth map and detecting flat, concave regions and slender details which are difficult to cool. The algorithm performs an automatic analysis of the heat transfer, taking into account functional parameters, in order to guarantee a uniform cooling of the part. Based firstly on the limit range distance from which the horizontal straight channels lose cooling effectiveness and secondly on the depth map data, the algorithm provides an optimal layout for the cooling system of the part by adapting it to its geometry. By means of adapting the precision of the algorithm to the molded geometry, both horizontal straight channels for low concavity areas and baffle matrixes for concave regions are used. In a second phase, the parameters of the cooling system such as channel diameter, channel separation etc, are dimensioned by means of genetic optimization algorithms. A second genetic optimization algorithm ensures uniformity and balance in the layout of the cooling system for the plastic part. The result is the design of the cooling system for the plastic part with the same performance as the conformal system. A constant distance between the cooling channels and the part surface is maintained, and at the same time the manufacturing of the mold using CNC techniques and traditional metal materials could be achieved. Complementarily, the algorithm performs an interference analysis with other parts of the mold such as the ejection system. The method does not need a subsequent CAE analysis since it takes into account functional and technical parameters related to heat transfer in its design, thus ensuring its functionality. The algorithm is independent of the CAD modeler used to create the part since it performs a recognition analysis of the part surfaces, being able to be implemented in any CAD system. The data obtained in the design can be used additionally in later applications including the automated design of the injection mold.

Keywords: Cooling System, Injection molding, Discrete Geometry, Surfaces geometric recognition, Genetic Optimization

1. Introduction

The plastic injection molding process begins with the injection of the thermoplastic material at a high temperature into the cavity formed by both mold cavities. Once inside the mold the plastic is compacted, cooling until it acquires the solidification temperature that allows the geometry of the piece to be maintained without deformation. The duration of the molding cycle as such is not enough to dissipate the heat of the injected plastic by means of heat conduction through the metal material of the mold. Thus, in order to improve the efficiency of the process, the mold is cooled using a set of hollow channels made in both cavities through which a cooling fluid performs a better heat exchange. At present there are several possibilities in relation to the design of the cooling channels of the plastic injection mold. The choice of design depends mainly on three factors: the geometric characteristics of the plastic part, the size of the mold and the manufacturing technology required by each cooling system. Taking these factors into account, cooling systems can be designed by means of conventional cooling models or conformal systems, adapted to the part geometry. The conventional systems have the advantage of their low cost of manufacture since they use traditional machining techniques. Nevertheless, they have a limited application only to slender parts with flat geometries, and without deep concavities. Unlike traditional cooling channels, the conformal cooling channels maintain a constant distance between the surface of the mold cavities in contact with the part and the cooling circuit, thus obtaining precise temperature control in parts with complex surfaces. The conformal method requires Rapid