POROUS MEDIA HEAT TRANSFER FOR INJECTION MOLDING

RELATED APPLICATIONS

This application claims priority to and the benefit of U.S. Provisional Application No. 61/839,244, filed Jun. 25, 2013, the contents of which are incorporated by reference herein in their entirety.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

The United States Government has rights in this invention pursuant to Contract No. DE-AC52-07NA27344 between the United States Department of Energy and Lawrence Livermore National Security, LLC for the operation of Lawrence Livermore National Laboratory.

FIELD OF THE INVENTION

This application relates to manufacture via injection molding, and more particularly to the use of porous media to enhance heat transfer in an injection molding cooling system.

BACKGROUND OF THE INVENTION

Injection molding utilizes a ram or screw-type plunger to force molten plastic material into a mold cavity, solidifying the plastic into a shape that has conformed to the contour of the mold. Injection molding is most commonly used to process both thermoplastic and thermosetting polymers, with the former being considerably more prolific in terms of annual material volumes processed. Thermoplastics are prevalent due to characteristics which make them highly suitable for injection molding, such as the ease with which they can be recycled, the versatility allowing thermoplastics to be used in a wide variety of applications, and the ability of the thermoplastics to soften and flow upon heating. Examples of components manufactured using injection molding include disposable razors, plastic toys, medical equipment, auto parts, and the like.

To expedite the solidifying of molten plastic within a mold cavity, a variety of cooling systems can be implemented. For example, coolant fluid can be pumped into an empty cavity thermally coupled to the mold walls. However, such an empty cavity does not provide structural support to the mold itself, increasing the likelihood that the shape of the mold deforms or warps during operation, rendering the mold useless. Cooling rods can be thermally coupled to the mold walls, but heat transfer using thermal rods is less efficient than fluid-based cooling solutions. The faster a set of components can be injected, cooled, and ejected from an injection molding machine, the more components can be made in a given time frame, reducing overall manufacturing time.

SUMMARY OF THE INVENTION

A cooling system for an injection molding device is described herein. The injection molding device includes reciprocal mold components that, when coupled, form one or more mold cavities between the coupled mold components. Molten liquid plastic is injected into the mold cavities, and when the temperature of the injected liquid plastic falls below a solidifying threshold, the resulting solidified mold components are ejected and collected.

To expedite the cooling process, one or more porous mediums are disposed within one or more of the mold components. Each porous medium is thermally coupled to at least one mold cavity. Coolant is pumped into the porous mediums, and thermal energy is transferred from the injected liquid plastic to the coolant via the porous mediums. Coolant can be pumped into the porous mediums via one or more porous medium inlets disposed within the porous mediums. The coolant flows from the porous medium inlets, through the porous mediums, and out of the porous mediums via one or more porous medium outlets. The porous medium inlets can be coupled to a cooling system inlet via a first pipe, and the porous medium outlets can be coupled to a cooling system outlet via second pipe.

Coolant can be pumped from a coolant supply tank storing coolant at a pre-determined cooling temperature below the solidifying temperature with a pump coupled to the coolant supply tank. The pump pumps coolant from the coolant supply tank and into the cooling system inlet. As coolant is pumped from the coolant supply tank and into the porous mediums, coolant within the porous mediums is pumped out of the cooling system outlet and back into the coolant supply tank. The timing and pumping of coolant through the cooling system can be controlled by a controller coupled to the pump, and can be based on the injection of liquid plastic into the mold cavities and the temperature of the injected liquid plastic.

The features and advantages described in the specification are not all inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings and specification. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and may not have been selected to delineate or circumscribe the inventive subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an injection molding environment, according to one embodiment.

FIG. **2***a* illustrates decoupled injection molding mold components, according to one embodiment.

FIG. **2***b* illustrates securely coupled injection molding mold components, according to one embodiment.

FIG. **3** illustrates an injection molding cooling system, according to one embodiment.

FIG. **4** illustrates a porous medium within an injection molding coolant system, according to one embodiment.

FIG. **5** illustrates a porous medium within a mold component, according to one embodiment.

FIG. **6** is a flow chart illustrating a process for cooling molded plastic in an injection molding environment, according to one embodiment.

The figures depict various embodiments for purposes of illustration only. One skilled in the art will readily recognize from the following discussion that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles described herein.

DETAILED DESCRIPTION

Injection Molding and Cooling System Overview

Injection molding utilizes the high-pressure injection of the liquid or fluid raw material (such as a plastic polymer, or "thermoplastics" hereinafter) into a mold to shape the material into the desired shape. Molds can include a single cavity