AIT Research

Title: The investigation into the improvement of the thermal conductivity of an additive manufactured blow moulding tool.

Area of research: Additive manufactured tooling.

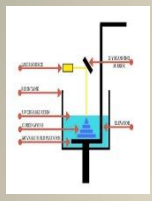
Student name: Alan Mannion.

0000-0002-3842-8323

Supervisor: Dr Sean Lyons.
Co Supervisor: Dr Ian Major

Abstract

The project will be carried out using a mixture of qualitative and quantitative research. The work will cover the establishment of a baseline using traditional tooling followed by the incremental alterations to improve the Additive Manufactured Tooling (AMT). This will be done in steps. The first being the optimisation of the stereolithography (SLA) resin. This step will then be followed by the utilisation of the inherently flexible design capability's of Computer Aided Design (CAD) and SLA 3D printers to create conformal cooling channels.



SLA 3D printing explained.

Stereolithography – more commonly referred to as SLA 3D printing – is one of the most popular and widespread techniques in the world of additive manufacturing. It works by using a high-powered laser to harden liquid resin that is contained in a reservoir to create the desired 3D shape. In a nutshell, this process converts photosensitive liquid into 3D solid plastics in a layer-by-layer fashion using a low-power laser and photopolymerization.

Introduction

The purpose of this project is a exploratory investigation into the use of the latest 3D printing technology for tooling in the polymer industry. The requirement for this research is being driven by the ever-increasing pace of product development in industry. Companies such as Mergon International produce parts for Tesla Vehicles. This vehicle is a prime example of continuously evolving products. This type of business model has a knock-on effect of requiring extremely fast design and manufacture rates. The use of 3D printed material is extremely desirable as a possible solution to this ever more common scenario. Even in other fields such as injection moulding small runs and prototyping could possibly be carried out if tooling could be improved to a more comparable level as to conventional steel/aluminum tooling.

Aims

- To compare a standard SLA tool and conventional blow-moulding tool.
- To compare an SLA tool with advanced cooling to conventional blow-moulding tool.
- Formulate, the best SLA resin to additive ratio possible to increase thermal conductivity.
- Print an SLA tool which is as close as possible to a production tool.
- Carryout characterisation testing at each stage using Dynamic Mechanical Analysis(DMA), Differential Scanning Calorimetry (DSC), Thermal Conductivity Testing and Tenisle Testing .
- Release 3 papers over the course of the research.

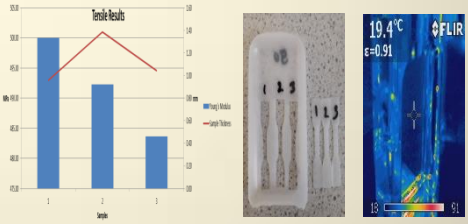
In extrusion blow-molding (EBM), plastic is melted and extruded into a hollow tube (a parison). This parison is then captured by closing it into a cooled metal mold. Air is then blown into the parison, inflating it into the shape of the hollow bottle, container, or part.

Method

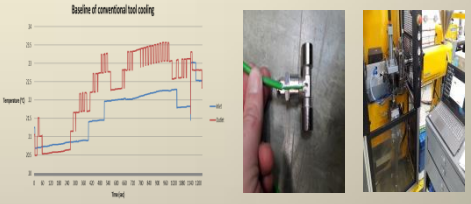
The project will endeavor to follow the below path:

- Establish a stable baselines using traditional tooling and blow-moulding equipment.
- Generate baseline technical data on virgin resin material to asses the impact of thermal additives and annealing.
- Create a comparable CAD model from current tooling and carry out a trial using a non modified SLA tool.
- Characterise above trial samples.
- Create an SLA tool which utilises conformal cooling channels or other advantageous cooling designs.
- Characterise above trial samples.
- Carryout thermal testing on SLA resin which has thermally superior additives incorporated.
- Create an SLA tool which utilises the optimise additive SLA resin ratio.
- Characterise above trial samples.

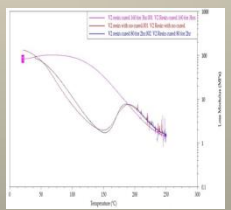
Results to date



Tensile results showing a linear reduction in Young's modulus from sample 1 to 3. This is a average results for the 70 bottles tested.



Absorption of heat in relation to inlet and outlet coolant temperature on traditional tool.



DMA results of virgin resin which had been annealed in a oven at varying temperatures and times. The results showed a unexpected result in regards to the anneal temperature.

Ref; https://www.labtechusa.net/product/bottle-blow-molding-attachment/, all3dp.com/2/stereolithography-3d-printing-simply-explained& M.Haudin, S. &. (2010)