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Design and development mini compression molding for teaching and learning

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ABSTRACT

Compression molding is a major technology in the plastic industry, and the one of the original processing techniques for manufacturing plastic. The current study was aimed to design and fabrication of mini compression molding machine for use in laboratory workshop or education institution. This machine was designed and fabricated to reduce the cost of expensive purchasing and cost maintenance of compression molding machines used in the industry. Mini compression molding provides for study of implemented to facilitate the production process of plastic products according to the mold provided. This machine used an oven as a heater to melt the resin in the mold provided and car jack as pressure to compress the resin after melting. The parameter has been considered is a temperature and pressure of the process of flow raw material into the cavity and period time of melting. Based on the test, the optimize of temperature suitable for heating the polypropylene plastic (PP) to melt is at 250°C, while the best time to melt of at 250°C is within 15 minutes. From the results obtained based on the quality of mold produced by the mini compression molding machine, the fabricated machine performance was satisfactory and can be used locally institution and industrially in small scale. This Mini compression molding used in Manufacturing lab in PSMZA for subject of DJF2012 (Manufacturing Workshop Practice 2) as development aids in Teaching and Learning.

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Introduction

Compression molding is a technique to develop variety of composite products and can produce complex composite without use CNC machining(Warden, 2018). In (Warnock, 2015) explained the compression molding of composite material has been used in industry since 1940 caused by suitability for high volume production, repeatability, and, more recently, production of superior surface finish. Compression mold are rated by their closing force capacities. There is can be manual, semiautomatic or fully automatic. The compression molding preform temperature, molding temperature, molding pressure, molding time and cooling time are the most important design parameters. Cavity depth is important to increase the proper molded density (Ornaghi Jr, Bolner, Fiorio, Zattera, & Amico, 2010).

Compression molding commonly used in manufacturing thermoset part. The raw material for compression molding is regularly in the form of granules, putty like mases. The main concept of manufacturing process for plastic molding is placing a polymer in a molten state into the mold cavity so that

the polymer can take the required shape with the help of varying temperature and pressure. The mold is then closed, and pressure is applied to force the materials to fill the cavity. A hydraulic ram is often utilized to produce sufficient force during the molding process. The heat and pressure are maintained with the period time until the plastic is used (Orhorhoro, Atuma, & Adeniyi, 2016).

In (Shamsuri, 2015) describes technique in process of compression molding involves three steps of procedures specifically: 1) Preheating samples at specific temperature for certain times to soften them; 2) Compressing preheated samples at the same temperature to match to the mold shape; 3) Cooling compressed samples under pressure for intervals to cool the sample.

In principle, a compression molding machine is a kind of press which is oriented vertically with two molding halves top and bottom halves. Generally, hydraulic mechanism is used for pressure application in compression molding. The controlling parameters in compression molding method to develop superior and desired properties of the composite. Recently in (Ruž barský & Ž arnovský, 2013) all the three dimensions of the model pressure, temperature and time of application are critical and have to be optimized effectively to achieve tailored composite product as every dimension of the model is equally important to other one.

Compression molds and tooling are more expensive because the mold are made of hard metal and can be highly polished to obtained good surface finish (Sozer & Advani, 2010). Additionally, for compression molding, maintaining the highest part quality must coincide with faster processing and more efficient and material usage(Kutz, 2011). According to (Syahirah, Hazwani, Faizin, Farhan, & Atikah), subsequent for machining and finishing are minimal using compression molding and the labor cost of are reduced. In (Wulfsberg et al., 2014) describes some of advantages compression molding is more uniform density, low cost, uniform shrinkage due to uniform flow when the material being compressed, improved impact strength, dimensional accuracy and internal stress and warping are minimized.

The concept of manufacturing process for plastic product using compression molding has a strong comprehensiveness and practically when its deliver with theoretically for student. However, in current teaching process, most theoretical course is separated from practical operation. In (Li, 2018) described the blind lecture teachers easily lead to cramming education phenomenon, it is because the acceptance and poor learning effect for student is low. By reforming the practically method student has a firm of knowledge and allowing them to achieve teaching objective.

Method

The main objective of this project is to design and fabrication of mini compression molding machine for use in laboratory workshop or education institution. The size compression molding machine in industry is large and heavy for lifting and it is not suitable for education purpose. This mini compression molding can produce small size and limited of the product using plastic material. Besides that, mini compression molding machine, which is small, and easy to lift anywhere for used a new equipment/tool in laboratory, educational and institution. The design of mini compression molding was generated in Figure 1.

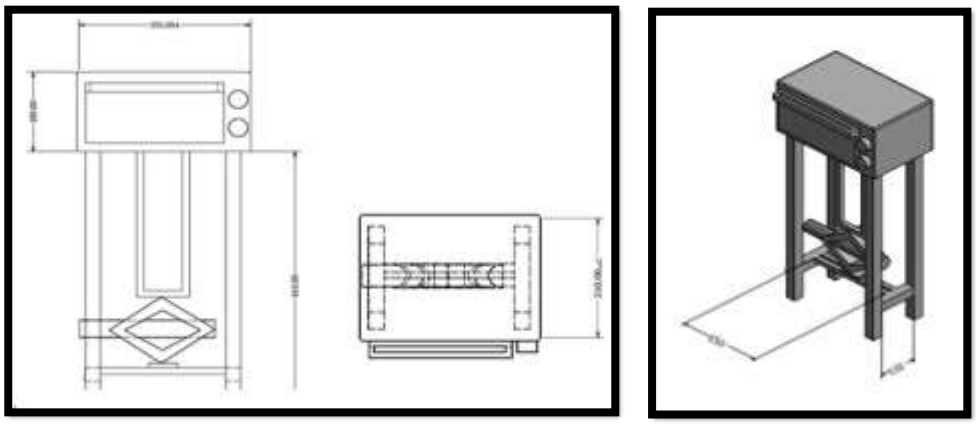

Figure 1. Design of mini compression molding

The hollow steel was choice as a main of material selected to assembly of mini compression molding for the base of machine. Based on product design, the hollow steel was a cut and connected to oven as an equipment of to ensure that there is application of heat for the sole purpose of acquiring the required shape of the mould cavity with high dimensional accuracy. For the base product, hollow iron is welded to another part to assembly with supported car jack for the purpose to compress the mold after the resin was melt. The complete of mini compression molding machine is shown in Figure 2.

Figure 2. Mini compression molding machine

Based on the flowchart in Figure 3, it shows the basic step of procedures to use the mini compression molding. First, the preparation of plastic granules such as polyethylene plastic are places in between the molding plates. After ON the oven, parameter of the temperature and time has been setup using oven knob. The mold close under heat temperature using oven as heater to melt the granules of Polypropylene. After the resin completely melt, car jack use to compress the mold. The mold was open, and the quality of the final product has been testing to find optimize of parameter setting for temperature and time with the completely melting of the resin. If the quality of the product not perfectly melting, the temperature and time is setup again until the final product is in good condition.

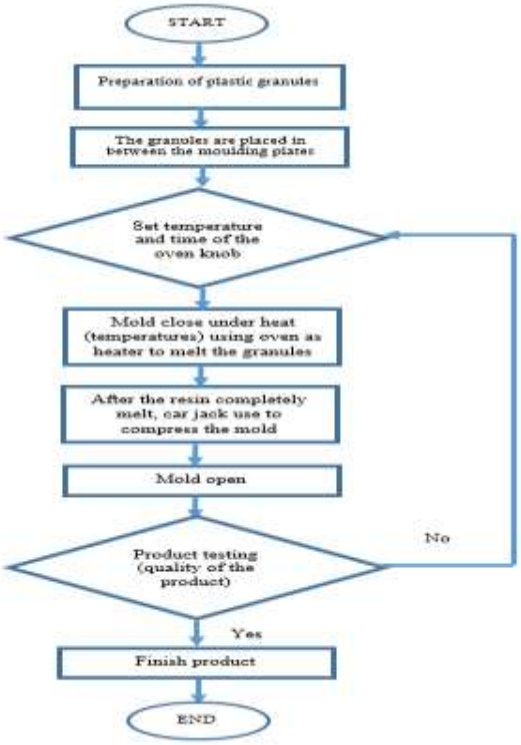

Figure 3. Flowchart for the process of mini compression molding

Results and Discussions

In this project, fabrication of mini compression molding machine carried out for performance evaluation. This project produces a machine where it is implemented to facilitate the production process of plastic products according to the mold provided. This project uses an oven as a heater to melt the resin in the mold provided and car jack as pressure to compress the resin after melting. With the manufacturing process, it was essential to choose (polypropylene) that can withstand the quality of the final product. As a result of the project that has been implemented and two types of testing have been performed on mini compression molding. It was crucial to find out if there were any defects in the final product and the perfect melting with the optimize parameter based on temperature and time.

Effect of temperature testing

The first test is carried out on the 3-trial sample with different temperature and the time is constant. Based on the Fig 4, the result of the 3-trial shown, the resin not fully melt with using 200°C and 225°C does not fully melt in 15 minutes. Even though the polypropylene melting point is 160°C, the surrounding temperature might affect the temperature of the machine during the testing process. This is because there are no refractory materials around the oven to prevent heat loss. However, the trial 3, the resin can fully melt using this 250°C temperature proving that the temperature of 250°C resins can be melting because the temperature is enough even with surrounding heat loss. However, the trial 3, the resin has complete melting when the temperature at 250°C is within 15 minutes. Analysis of temperature testing shown in Figure 4.

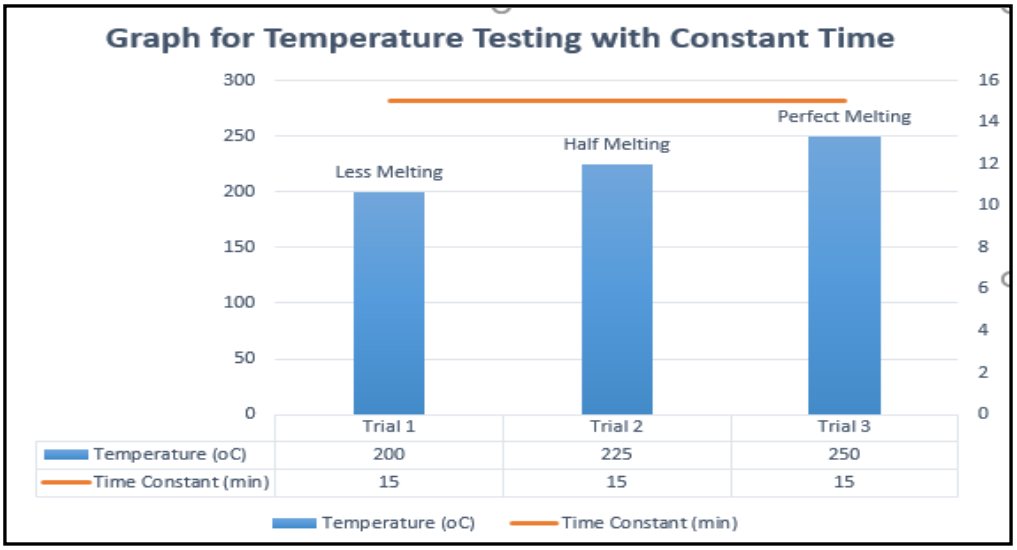

Figure 4. Analysis of the temperature testing

Effect of Time testing

The second test is the different time with constant of the temperature with 3 trial for the sample of polypropylene. Refer Fig 5, the result shown for comparison of 3 trial used 250°C as constant temperature with the different time of setting parameter. For the trial 1, the result shown, the resin not complete melting in 5 minutes with 250°C temperature. The same problem occurred for the trial 2, the resin does not fully melt using 10 minutes because it is not enough time to melt of the granules. The complete melting of the resin shown in trial 3 with the 250°C temperature and the time is 15 minutes. The result of analysis time testing shown in Figure 5.

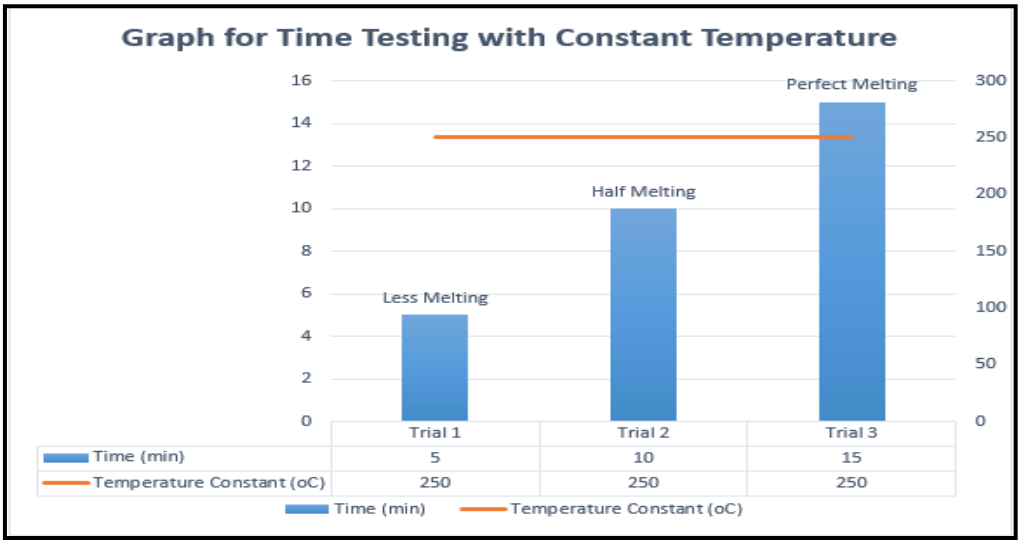

Figure 5. Analysis of the time testing

Final product testing

The quality of the final product also shown in Figure 6 with the 3 trial of the product sample with the different of setting parameter. The product attention become less melting when the temperature is 200°C and the time 15 minutes. This is because the heater not enough to melt the polypropylene resin.

In the sample 2, the result shown the quality of product was half melted when the temperature setting is 225°C and time is worn in 15 minutes. This effect because the heater required more heater to melting the resin. Finally, in the sample 3 shown the product complete melting with the 250°C temperature and the time is 15minutes. The product attention become melting complete because the heater is enough to melting the resin.

Less melting Half melting Perfect melting

Figure 6. Quality of final product for melting resin.

Conclusions

In a nutshell, through this project it can be concluded the "Mini Compression Molding" is a new creation without changing the original way of Compression Molding Process. This machine can have provided convenience to the users of an education and the fabricated machine performance was satisfactory and can be used locally institution and industrially in small scale. Test performance was carried out on the fabricated mini compression molding machine. Polypropylene materials in granules were complete melted 250^{0}C. The time to melt of the resin is 15 minutes. Mini compression machine can be used for to demonstrate of manufacturing process of plastic product. This machine also can be used as prototype for study of optimize parameter

considered of temperature, pressure and period of time for various types of plastic. Besides that, this machine can be improving the development product in Teaching and Learning. Lecturer will be able to organize the Outcome Based Education (OBE) concept in the classroom using mini compression machine. Students can be handling this machine individually and also practice the concept of OBE in learning process.

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