

DESIGN OF A HEATING SYSTEM IN A PLASTIC INJECTION MOLDING MACHINE WITH A WORKING TEMPERATURE OF 250⁰C

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Abstrak.

Sistem kerja proses pemanasan pada mesin plastic injection molding perlu diperhatikan lebih detail. Karena pengaruh temperatur dan jenis material sesuai terhadap kualitas produk. Pada penelitian ini mesin injeksi plastik yang digunakan variasi temperatur menggunakan beberapa variasi yang berbeda, dan diberikan tiga percobaan disetiap variasi temperaturnya 200°C – 250°C dengan penggunaan material plastik 75 gram dengan waktu pemanasan 120-141 detik dan material plastic 150 gram dengan waktu pemanasan 210-250 detik. Temperature control menggunakan REX C100 Controller. Mesin injeksi dapat beroperasi sesuai dengan rancangan yaitu temperatur pemanasan dapat diatur. Implementasi dan pengendalian sistem kontrol menunjukkan respon yang baik. Plastik yang akan dilelehkan berjenis HDPE (High Density polypropylene) dengan temperatur untuk pelelehan plastik tersebut sebesar 250°C.

Kata kunci: perancangan, injeksi, temperatur.

Abstract.

The working system of the heating process on a plastic injection molding machine needs to be considered in more detail. Due to the influence of temperature and the type of material according to the quality of the product. In this study, the plastic injection machine that used a temperature variation used several different variations, and three experiments were given at each temperature variation of 200°C – 250°C using 75 grams of plastic material with a heating time of 120-141 seconds and 150 grams of plastic material with a heating time of 120-141 seconds. Warm-up 210-250 seconds. Temperature control using the REX C100 Controller. The injection machine can operate according to the design. Namely, the heating temperature can be adjusted. Implementation and control of the control system show a good response. The plastic to be melted is of the HDPE (High-Density polypropylene) type with a temperature for melting the plastic of 250°C.

Keywords: design, injection, temperature.

Introduction.

Plastic is a non-biodegradable material, meaning bacteria cannot naturally decompose it. Many plastic products are used only once and then thrown away; as a result, the amount of plastic material waste continues to increase rapidly, negatively impacting the environment and health [1]. One plastic waste widely used in daily needs is HDPE plastic, which is the type and type of plastic used in plastic bottles for mineral water packaging. Therefore, several processes are needed for

processing plastic materials to be used as valuable products and have a sale value. One of the processing processes is using the injection molding method [2].

Making plastic products is done using the Plastic Injection Molding (PIM) method. Plastic injection is forming products from plastic materials of various shapes and sizes. The Injection Molding method is the process of forming workpieces from compound material in the form of granules placed into a hopper and entered into an injection cylinder which is then pushed through a nozzle and sprue bushing into the cavity of a closed mold. After a while, it is cooled, the mold will be opened, and the finished object will be removed with the help of an ejector. Very material suitably is a thermoplastic material. This material will soften due to heating and, vice versa, harden again when cooled. These material changes are only physical, not chemical changes, making it possible to recycle materials as needed. The plastic material that is transferred from the heating cylinder, the temperature ranges from 117⁰C to 274⁰C or according to recommendations from the plastic material manufacturer. The hotter the temperature, the thinner the material (lower viscosity), making it easier to inject into the mold. Each material has a molding temperature character (mold flow index). The softer the formulation, the higher the plastic content, requiring a lower temperature, and the more complicated the formulation, the higher the temperature [3].

There is a hopper or inlet to input the plastic pellets and a nozzle to output the melt. The polymer is fed into the barrel (pipe) in the form of raw and solid particles from the hopper and pushed forward by a strong screw through various temperature-regulated zones, and the raw polymer is gradually heated. The heat is produced by the heater in the barrel, together with the heat released from the friction between the raw polymer and the surface of the barrel and the screw, causing the polymer or plastic pellet to melt and then driven by the screw out of the nozzle, processed for various purposes. In general, the quality of the extruder depends on the uniformity of temperature distribution, the magnitude of the temperature in the barrel, the pressure of the screw or screw, and the homogeneity of the physical mixing. It can produce good extruder quality, but the temperature in each temperature zone must be precisely controlled [4][5].

Plastic injection moulding tools can reduce plastic waste to be recycled into new items, where the plastic is melted down using a band heater heating element. The heater circuit uses a temperature controller which functions to regulate the heater temperature, and the circuit can turn itself off when the heater temperature has exceeded the set temperature limit and will reactivate when the temperature drops [6]. The cycle process for injection moulding consists of four stages: clamping before material injection into the mould. Two parts of the mould must be tightly closed on the machine, and molten plastic injection is injected into the mould and fills the room according to the desired product shape. Cooling is a cooling process of a plastic material after the injection process; ejection is when the mould has opened the mechanism used for the ejection system is to push the hard part of the plastic out of the mould [7].

The manufacture of products made from plastic materials using injection moulding techniques is now often encountered in our daily lives. It opens up business opportunities for entrepreneurs to make products that can be sold, including plastic cup lid products. Based on this, the authors tried to design a heating system circuit in a plastic injection machine using a temperature controller to find out how the circuit works and set the heating temperature and holding time to determine its effect on plastic melting.

Research Methods

Research Design.

The research method is used to find, develop, and test the truth of knowledge. The method must follow the research object and the objectives to be achieved so that the research runs smoothly and systematically [8][9]. In this planning, It must first compile or make a basic concept regarding the heater on the machine that will be made, with some references from the internet, material surveys, and material availability. Next, search by understanding how the heating system works [10][11][12]–[16].

Heating System.

The heating system process applies to an injection engine. The first step is to connect the machine to the supreme power of the electrical panel. In the second step, the heating system processed the plastic pellets into liquid in the furnace. In the third step, the plastic liquid enters the injection machine system for the following process.

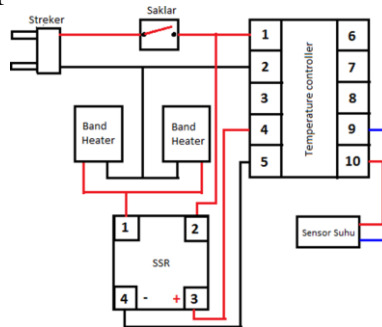


Figure 1. Heating System.

The heating process in this plastic injection machine uses electric power, namely with two band heaters mounted on a barrel, each with a voltage of 220 volts with a diameter of 30 mm and a length of 50 mm, to produce maximum heat to heat the plastic pellets before entering the injector the.



Figure 2. Heater barrels.

Product Design

Plastic must be chopped/cut first to facilitate the plastic molding process, and the plastic used must be dry. A smelter is used to melt/melt plastic; the components used are stainless pipes and band heaters. Check the Temperature sensor and Band Heater to determine whether the sensor is functioning and check the Temperature sensor and Band Heater to find out whether the sensor is functioning or not. The process aims to determine the work performance of the plastic waste smelting tool. The parameters taken at the testing stage are the Weight of the Material. The tool is weighed first so that the amount and weight of the material included in the fusing pipe can be known. Plastic melting temperature, temperature data collection during the melting process, begins when the melting point of the plastic melts in the melting pipe, which is marked by drops of melted plastic from the melting pipe and Melting Process Time, the time used by the plastic to start melting until the melting process is complete.



Figure 4. Plastic injection molding machine.

Results and Discussion.

Component testing.

In the heat test, the barrel is heated without being filled with plastic material. It is done to determine the distribution of heat on the barrel wall without being affected by the presence of plastic material. It will be compared with the amount of heat propagation after calculating the conditions and data during the heat test room temperature 31°C data taken at 15.30 WIB. The temperature of the heating process is set at 250°C.

Tabel 1. Component testing.

Time (minute)	T_{inlet} (°C)	T_{surface} (°C)	T_{monitor} (°C)
1	54.3	58.9	60.7
3	85.8	87.4	90.5
5	115.2	118.5	120.1
7	147.9	149	150.6
10	180.2	183.8	185.3
12	195.5	198.7	200
15	224,5	225	225
16,5	249,4	250	250

Melting Point Testing

This plastic injection molding tool can melt HDPE plastic pellets at a temperature of 200°C-250°C. The capacity of melted plastic pieces can reach 150 grams. From experiment 1, it can be seen that the weight of a plastic material of 75 grams requires different times, namely 141 seconds at a temperature of 200C, 130.5 seconds at a temperature of 225C, and 120 seconds at a temperature of 250C to melt the plastic. In experiment 2, the time needed for 150 grams of material takes 250.5 seconds at a temperature of 200C, 231 seconds at a temperature of 225C, and 210 seconds at 250C. At a temperature of 150C - 190C, the plastic material begins to soften, and at a temperature of 200C is the melting point of the complete melting of the plastic material.

Tabel 2. Melting point testing.

No.	Plastic pellets (gr)		Time (second)	Temperature (°C)
	Inlet	Outlet		
Step 1				
1.	75	69,75	141	200
2.	75	64,5	130,5	225
3.	75	59,25	120	250
Step 2				
1.	150	139,5	250,5	200
2.	150	129	231	225
3.	150	118,5	210	250

Conclusion.

The heater works in plastic injection molding because when the switch is in the “ON” position, the temperature controller will turn on. On the temperature controller, we set the required temperature. Then the relay on the SSR will turn on and connect electricity to the heater. A temperature sensor attached to an aluminum pipe will read the hot temperature. When the temperature reaches a predetermined number, the relay on the SSR will cut off the electricity to the heater. In a plastic injection machine, by varying the temperature uses several different variations, and given three experiments, each temperature variation has the potential to be used for plastic materials weighing 75 grams, which takes 120 - 141 seconds, 150-gram weight takes 210-250.5 seconds, and requires a

temperature of 200°C – 250°C for the plastic to melt completely. For temperature control, the REX C100 Controller is a pretty good choice for measuring temperature. The results of testing the temperature control system using the Thermocouple Probe Cable temperature sensor produce a response as expected and can be applied to the control system. The injection machine can operate according to the design; the heating temperature can be adjusted. The maximum heat/temperature that this injection machine can achieve is 250°C. The reading and control of the control system show a good response. The plastic to be melted is of the HDPE (High-Density polypropylene) type with a temperature for melting the plastic of 250°C

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