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Comparative Analysis of the use of Band Heaters and Infrared Heaters to Save Energy on Injection Molding Machines Type Borche Bi 320T

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Abstract This study aims to compare the energy efficiency between the use of a heaterband and an infrared heater on an injection molding machine type borche bi320T. The injection molding machine is one of the main pieces of equipmentin the manufacturing process of plastic products and plays an important rolein shaping various consumer and industrial products. One of the critical aspects of the operation of injection molding machines is the significant energy consumption, especially related to heating. This study was conductedby measuring the energy consumption of both types of heaters under the same operational conditions. The results showed that the energy consumption of using a band heater was 46.9 kW, while the infrared heater was 38.9 kW, significantly more energy efficient by 17.1% compared to theband heater. Although the initial installation cost of the infrared heater is 87% higher than that of the band heater, the energy savings generated from the infrared heater can reduce operating costs by approximately $39 millionper year. Higher energy efficiency means lower electricity costs and, thus, more efficient total production costs. The use of infrared heaters also has a positive impact on the environment. Reduced energy consumption means reduced greenhouse gas emissions from power generation. Therefore, besides the economic benefits, the use of infrared heaters is also in line withsustainability and environmentally friendly practices.

Keywords Energy, Heater, Injection Molding

1. INTRODUCTION

The growth of the manufacturing industry, especially in the plastic production sector, has shown a significant increase in recent years. The injection molding machine, being the main equipment in the manufacturing process of plastic products, plays an important role in shaping various consumer and industrial products.

The use of plastic in Indonesia is gaining popularity due to its strong and weather-resistant properties. The need for plastic consumption in Indonesia is considerable, with the Indonesian Olefin Aromatic and Plastic Industry Association (Inaplas) noting that plastic consumption in 2020 will reach 6.2 million tons. Almost all human activities use plastic, such as household appliances, product packaging, beverage bottles, or cosmetic equipment. With the great need for, interest in, and purchasing power of people's plastic consumption, companies in the plastic packaging field areinnovating their products to improve efficiency and sustainability.

One of the crucial aspects of the operation of an injection molding machine is the significant energy consumption, especially related to heating. Heating is a key step in melting the plastic material before the injection process, and efficiency in the heating process greatly affects production costs as well as environmental impact.

To support the move towards Industry 5.0, which refers to the continued development of

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technology-driven industrial evolution. It is the next step after Industry 4.0, which focuses on automation, connectivity, and the use of data in the production process. The two main heating technologies commonly used in injection molding machines, namely heater bands andinfrared heaters, are of interest. The selection of the right heating technology can potentially have a major impact on energy efficiency and operational cost savings.

Although there has been a lot of literature that discusses energy efficiency in injection molding machines, the comparison between the use of a heater band and an infrared heater on the Borche Bi 320T type injection molding machine still requires further research. Therefore, this study aims to conduct an in-depth comparative analysis of the two heating technologies, with a focus on the energy-saving aspects of the Borche Bi 320T injection molding machine. By understanding the performance differences between band heaters and infrared heaters on such machines, it is expected that this research can contribute to the development of best practices in the selection of environmentally friendly and economically efficient heating technologies for the plastics manufacturing industry, particularly in the context of injection molding machines.

2. METHOD

The method used in this research is an experimental method with the help of Excel software, where the research carries out observations, data collection, processing, and looks at the results of the comparison between band heaters and infrared heaters on the energy savings obtained. Not only that, electricity costs will also be calculated, which will also be seen in the economic analysis in several ways.

3. RESULTS AND DISCUSSION

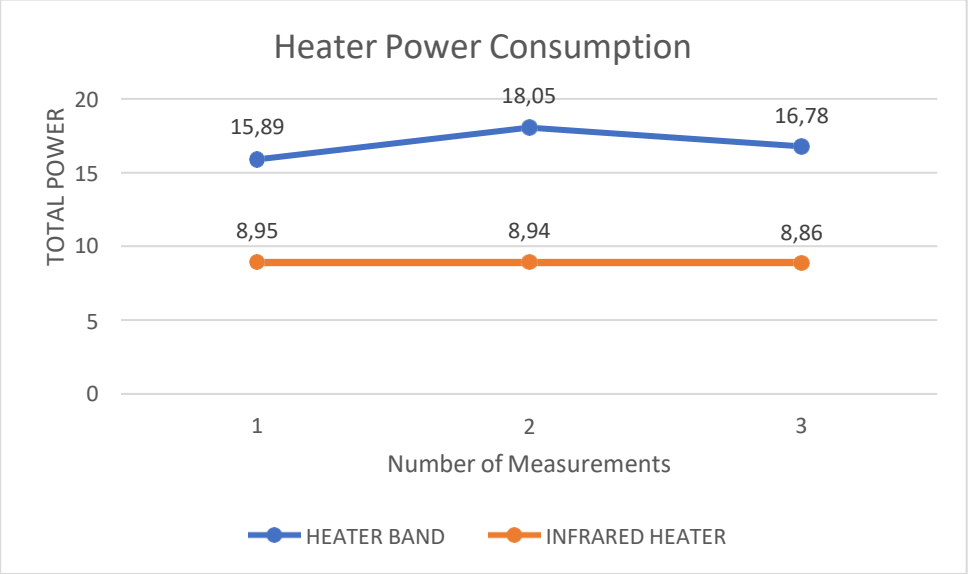
Data Result

Measurement of energy consumption using accurate and calibrated measuring instruments. Themeasurement results are obtained in the form of energy consumption data, which will be calculated to obtain a clear comparison value. The following is the measurement data obtained:

Table 1

Power Consumtion (kW)									
NO.	Time (minuts)	*HEATER BAND*			Total	*INFRARED HEATER*			Total
		R	S	T		R	S	T	
		5,92	3,5	6,47	**15,89**	3,34	2,65	2,96	**8,95**
2.	30	6,11	5,15	6,79	**18,05**	3,3	2,68	2,96	**8,94**
3.		6,23	5,12	5,43	**16,78**	3,31	2,62	2,93	**8,86**
				AVG	**16,9**			**AVG**	**8,9**

The measurement results show that the use of an infrared heater is significantly more energy efficient than the band heater. For the use of the band heater, it can be seen that the power used is quite high compared to the infrared heater. We can make a graph to make it easier to see the difference in power between the two heaters:



Picture 1

Electricity cost calculation

By reducing energy consumption, the use of infrared heaters also has an impact on reducing operating costs. In order to know the savings obtained, the calculation of electricity costs in the form ofrupiah will be carried out. This can be described as follows:

Table 2

Calculation	Heater band	Infrared heater	Satuan
Elektrik motor rate	30	30	**kW**
Heating	16,9	8,9	**kW**
Total machine kWh consumtion	46,9	38,9	**kW/hour**
(%) of electric reduction		**17,1%**	**%**
Saving Calculation			
Tarif PLN/kW (idr)	1.122	1.122	**IDR/kW**
(kW) x 1.122 x 60% utilitas	31.573	26.187	**IDR/hour**
Comparation energy cost/day	757.754	628.500	**24 hour/day**
Comparation energy cost/month	18.943.848	15.712.488	**25hari/month**
Comparation energy cost/year	**227.326.176**	**188.549.856**	**IDR/year**
	Saving IDR/Unit	**38.776.320**	

Comparison of the use of a heater band and an infrared heater

Based on the above calculations and field case studies, the following are some comparisons of the use of heating elements between heater bands and infrared heaters on injection molding machines type borche bi 320T can be described as follows:

Table 3

No.	**Description**	**Heater Band**	**Infrared Heater**
1.	Purchase cost	Rp. 250.000/unit heater(x8) Rp. 2.000.000	Rp. 4.200.000/unit heater(x4) Rp. 16.800.000
2.	Cost of replacement parts	250k/pc	50k/pcs
3.	Energy efficiency	3.6 Kw	1.9 Kw
4.	Lifespan	± 6 month	± 2 year
5.	Safety	Unsafe	Safe
6.	Outside temperature of the heater	>130 °C	±92 °C
7.	Environmental considerations	- heat emission	- Reduces greenhouse effect

Economic Analysis

This research not only discusses the comparison of energy consumption in each heater but willalso discuss economic analysis. This is needed for companies or other parties as a consideration that may later make a change from a band heater to an infrared heater.

The things that can be done to consider companies or other parties before replacing the heaterare economic analyses, which can be described as follows:

Table 4

No.	Heater Band			Infrared Heater		
	Description	**Unit**	**Price**	**Description**	**Unit**	**Price**
			Fixed Costs			
1.	Installation	1 unit	**250.000**	Installation	1 unit	**4.200.000**
2.	Heater Element	1 pcs	**250.000**	Infrared Lamp	1 pcs	**50.000**
3.	Electricity cost	Year	**227.326.176**	Electricity Cost	Year	**188.549.856**
4.	Downtime cost	30 minuts	**842.400**	Downtime cost	15 minuts	**421.200**
	Total		**228.668.576**	**Total**		**193.221.056**

4. CONCLUSION

The following are the conclusions that can be obtained from the comparative analysis of the useof heater bands and infrared heaters to save energy on injection molding machines of type Borche 320T.

1. Based on the results of research on the use of heater bands to save energy on injection moldingmachines, the type borche bi 320T has a very high power consumption twice as much as infraredheaters.
2. Based on the results of research on the use of infrared heaters to save energy on injection molding machines of type Borche B 320T, there is a decrease in power consumption of approximately 17.1%.
3. Based on the results of the calculation of electricity costs from the two heaters, the cost per yearwill experience a fairly high cost reduction of approximately $39 million.

4. Based on the comparison of the use of heater bands and infrared heaters, although the initial cost of installing infrared heaters is higher than that of heater bands, the energy savings generated from infrared heaters can reduce operating costs. The use of infrared heaters also hasa positive impact on the environment. One of the impacts of using an infrared heater that can befelt by employees around the machine is the temperature on the outside of the heater, which canbe concluded to have a difference of up to ±38 °C.
5. Based on the economic analysis of the comparison of heater bands and infrared heaters, in termsof installation and installation costs, it is classified as a high infrared heater of 87%. But the costof replacing spare parts is lower, and the service life of infrared heaters is longer. The use of infrared heaters also has a positive impact, namely reducing greenhouse gas emissions and beingrelatively safer when used.

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