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A Study of Parameters Affecting Extrusion Process of Wood Plastic Composites

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ABSTRACT

Wood Plastic Composites or WPCs is the wood substitute material which is made of scraps of wood, sawdust, natural fiber and plastic mixed together, (Kristiina and Mohini, 2008) processed by the extrusion. It becomes Wood Plastic Composites which is the new substitute of wood which gets started to be used broadly in Thailand. Anyway, most manufacturers in Thailand still do not have adequate knowledge and knowhow of the production bringing about the lack of quality and efficiency in the process. The study and analysis towards the relation of parameters between Extrusion process, Temperature, Screw speed and Melt pressure of the production process that effects the quality by using width (X axis) and thickness (Y axis). Then the result will be compared to mean score and summarized in order to find the optimal value for the production process and to forecast the change of the quality of Wood Plastic Composites. The objective of this research is to study and analyze the relation between the parameters by using the standard specification of Wood Plastics Composites. The standard dimensions notified by the group of manufacturers are 150 mm x 20 mm, 200 mm x 20 mm and 200 mm x 38 mm. Furthermore, the standard formula is used in the experiment in order to develop the method of production in the industrial sector. As a result of the study, once Temperature, Metering section, Screw speed and Melt pressure increase, the absolute value of variance also rises. The researcher uses the proper scenario to explore which is to use Screw speed at 3 rpm which is the maximum capacity and Temperature during Metering section at 175 °C because it does not significantly effect on the capacity. However, it initiates the low pressure which directly impact on the energy or resource in the production process.

Keywords: Wood Plastic Composites or WPCs, Extrusion process, Melt pressure

INTRODUCTION

For all human-beings, wood is the necessary material in their lives for ages as it could be a habitat construction, furniture like tables, chairs and cabinets which are furnished in the habitats, offices or stores. As you can see, human always

considerably needs to use wood. However, nowadays the amount of forests in the world has been declining. Conversely, the need of wood has been subjected to rise up due to expansion of the city, economy, the increase of population and importantly including the excess needs of human. All these major factors lessen the amount of natural wood and the price upsurge as well.

Therefore, in order to prevent all problems mentioned above, the substitute of wood has initially been invented and researched. This material provides the feeling, texture as well as appearance as natural wood as much as possible. It must be lightweight, durable, weatherproof, able-to-be-nailed, and able-to-be-sawed by way of natural wood. According to the problems and excess needed occurred, currently there is the artificial wood which is composed of plastic and natural fiber in Global. The artificial wood is growth rates averaging 23% per year from 2003 to 2007 and predicted to continue at 26% per year through 2012. (Markarian, 2008) Using the artificial wood as a substitute can reduce the usage of natural wood on top of using recycled plastic and scraps from wood industry. The process of producing Wood Plastic Composites uses the same tools and equipment as the process of molding plastic, yet there are some parameters that need to be controlled to come out with the required product.

In the present work, the parameters in the production process which are Temperature, Metering section and Screw speed in the factory which produces the sample and determine the absolute value of variance between the sample and the standard profile fewer than 5%. The result and analysis could be knowledge and knowhow in order to apply for the actual process in order improve the production of Wood Plastic Composites or WPCs to be more effective.

SCOPE OF THE RESEARCH

This study shows that the parameters which effect on the production are Temperature, Metering section and Screw speed. See the table below.

Table 1 Parameters used in the research

	Melting temperature at metering section (°C)								
	165			170			175		
Screw speed (rpm)	1	2	3	1	2	3	1	2	3

Response variables are Melt temperature at a die, Melt pressure at a die, Melt pressure at a barrel, Capacity and the absolute value of variance between a cross section of products and standard other variables are fixed.

In the production of Wood Plastic Composites, the sample of compound is coded as 'WPC_EEC60C' which contains the compound of plastic and natural fiber in a ratio of 40:60 from the factory.

The wood size 150 mm x 20 mm, 200 mm x 20 mm and 200 mm x 38 mm

Using the extrusion machine SKY WIN Twin Screw 85, L/D ratio 10:32 from the factory which produces the sample.

METHODOLOGY

To study on the theory of Extrusion process and the related theory about Wood Plastic Composites or WPCs.

To design and create the tools to collect data, Temperature with die, Melt pressure with die and barrel.

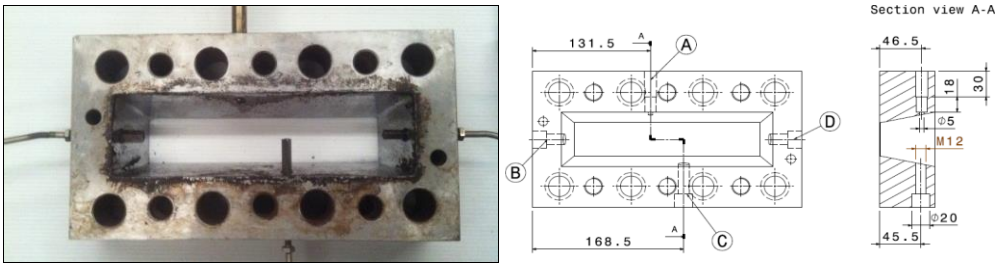

Figure 1 The additional accessories for the installation of temperature measurement and pressure with die tools.
A is the position to install the pressure measurement tool.
B, C, D is the positions to install the temperature measurement tool

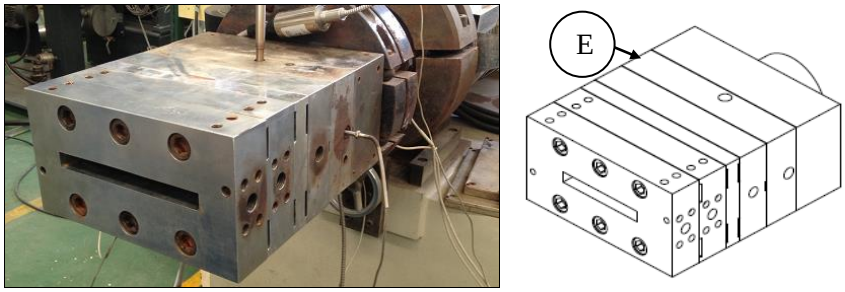

Figure 2 The position for the installation additional accessories
E is the position to install the additional accessories

To collect data from the production process to use in the research.

To bring the data from the experiment to analyze and search for the relation and result of the variables including to draw a statistical conclusion.

RESULTS AND ANALYSIS

In the research, Screw speed at 1, 2 and 3 rpm are used for the test because it is feasible for the machine calibration at the beginning. It is found that there will be the defect almost 100% if Screw speed is lower than 1 and the edge of product will be not complete. The shape of product is not completely the same as the shape of the die, and if using Screw speed is higher than 3 rpm, it is found that the product will be die swell. Since the melt temperature increases (165-175°C), spontaneous heating in the compound is higher. The product will be die swell and its surface will be cracked because the heat releases from inside to the surface.

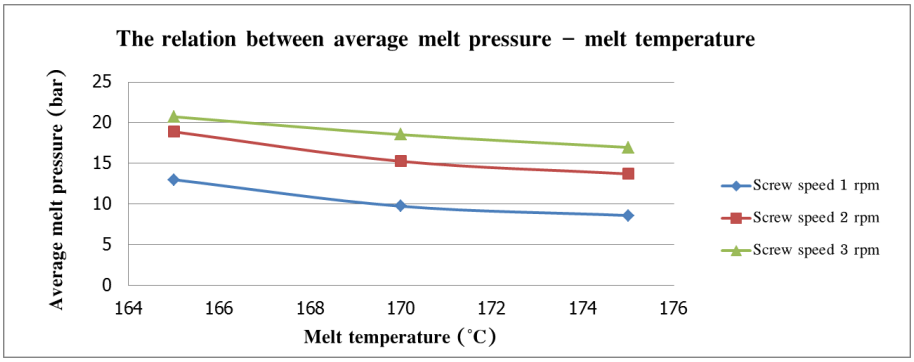

Figure 3 The relation between average melt pressure – melt temperature

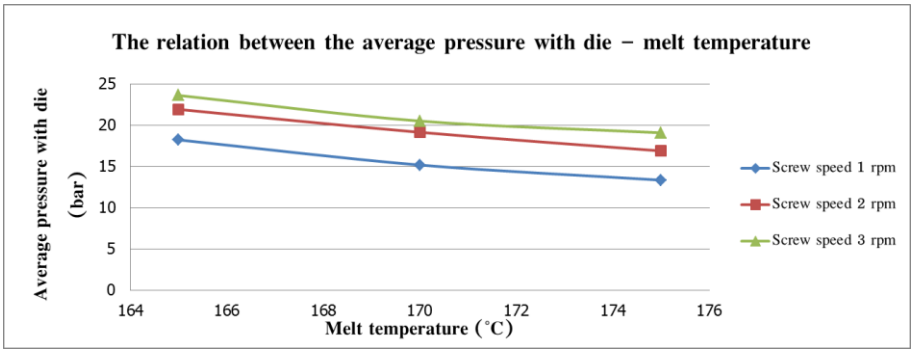

Figure 4 The relation between the average pressure with die – melt temperature

From Figure 3 and 4, the graphs indicate that when the temperature increases, it will effect on the melt pressure, and the pressure with the die reduces. (Lewandowski *et al*., 2011) It is because when the temperature increases, the polymer compound will be able to melt and flow through more easily and also the shear force will decrease. (Titima, *et al*., 2008) Hence, when making a measurement, the melt pressure and die will reduce. When considering on the screw speed, it is showed that, when the screw speed increases, the melt pressure and die is higher than when the speed is low as the increase of screw speed will make the flow rate of polymer rise up. Therefore, the pressure is getting higher. Additionally, it is probably because the timing when the compound receives the heat is shorter when the screw speed is higher.

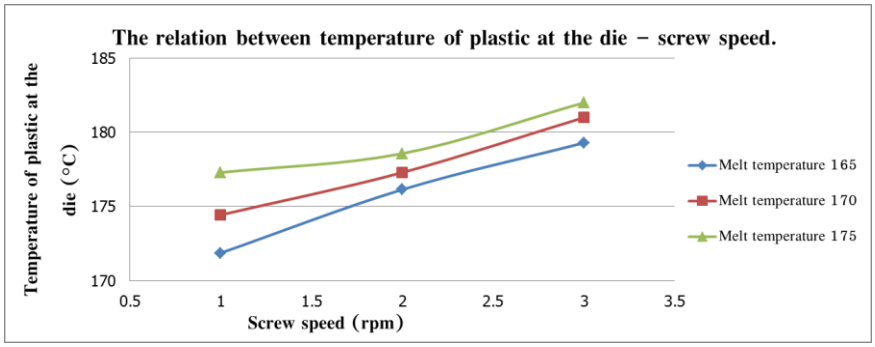

Figure 5 The relation between temperature of plastic at the die – screw speed

Refer to the graph in Figure 5, it is found that, when the screw speed rises up, the temperature of plastic at the die (at the middle position) increases since the screw speed gradually effects on the shear force. Due to the increase of shear force, the heat also gets higher. If the melt temperature is high, it will make the temperature at the die is also higher due to the greater spontaneous heating in the compound.

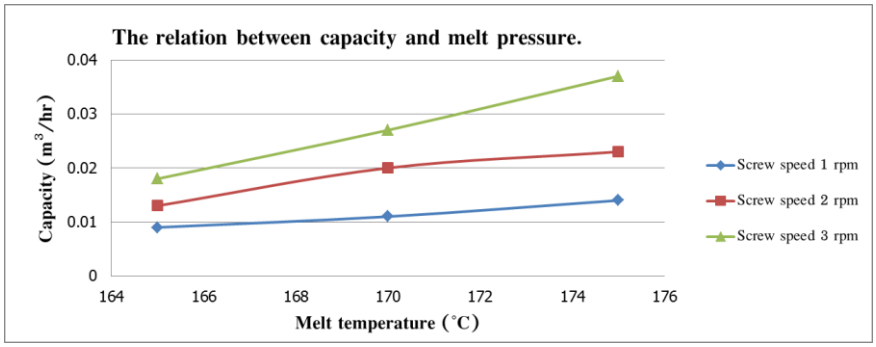

Figure 6 The relation between capacity and melt pressure

Refer to Figure 6, the graph shows that the increase of melt temperature leads to increase in molecular motion causes capacity to be come higher. (Li and Walcott, 2004) It is found that to rise the screw speed will bring about the large amount of drag flow which making the capacity higher.

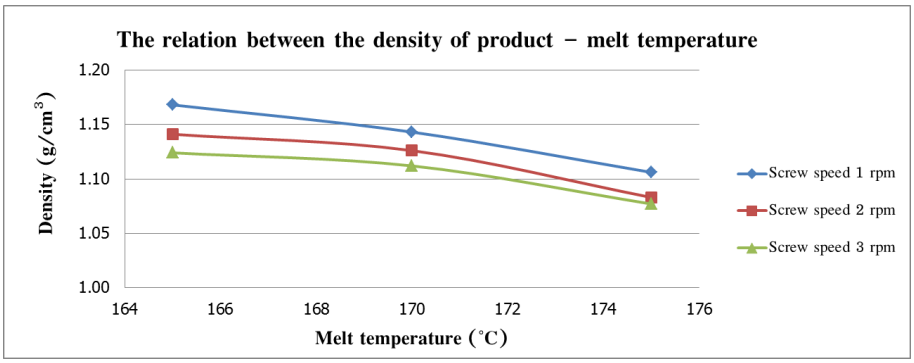

Figure 7 The relation between the density of product – melt temperature

From Figure 7, it demonstrates that when the melt temperature and screw speed rises, it will not significantly effect on the density of product.

SUMMARY

From the research, it can be summarized that when the temperature rises, melt pressure and the pressure at a die will decrease. Conversely, the temperature of plastic at the die will increase. In terms of screw speed, It is found that the increase of screw speed will make the melt pressure, die pressure, the die temperature and capacity higher. (Sadeghian and Golzar, 2008) However, it is also demonstrates that if the temperature of plastic at the die is over than 175 °C, it will result in the die swell as there is too much spontaneous heat. Therefore, refer to the study, the optimal condition is that screw speed is 3 rpm because of screw speed is 1 rpm and 2 rpm products were smaller than the standard size. Screw speed 3 rpm is be able to contribute the maximum capacity. The melt temperature is 175 °C because it does not significantly effect on the capacity. The product will come out perfectly as the die, no die swell, but it will effect on the lowest pressure which directly impacts on energy and cost of the production.

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