Thermoplastic Mixture with Oil Palm Fiber Flow Properties in Rheological Behaviour

Mohammad Khalid Wahid[1,2*], Mohd Nazri Ahmad[1], Nurul Ain Maidin[1], Mohd Hairizal Osman[1], Mohd Hidayat Ab Rahman[1], Mohamed Saiful Firdaus Hussin[1]
[1] Faculty of Engineering Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[2]Advanced Manufacturing Centre, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: mohammadkhalid@utem.edu.my

Keywords: rheological; thermoplastic; fiber

ABSTRACT –These investigation were carried out on four types of thermoplastic which are Polypropylene (PP), Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE) and Acrylonitrile Butadiene Styrene (ABS). These thermoplastic materials deal with the results of mixing of the of Oil Palm Mesocarp Fiber. The flow properties in rheological behavior was documented by compared the viscosity and shear rates between pure resin and mixture resin at specific temperature. The results were presented as rheological curves in which the changes in viscosities of the materials at different shear rates were determined.

1. INTRODUCTION

The thermoplastic materials tested in the research were Polypropylene (PP), Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE) and Acrylonitrile Butadiene Styrene (ABS). These thermoplastic materials deal with mixing of the Oil Palm Mesocarp Fiber as natural fiber. Oil Palm Mesocarp Fiber is normally treated as a waste part of the production. Natural materials as fillers of polymers are of increasing potential in modern industrial branches. Their price as well as very good mechanical properties speaks for their use [1]. The natural fiber as a filling material in thermoplastic could be an effective utilization of them and reduce the large of waste [2]. These thermoplastic reflect the advantages of polymer in terms of the following characteristics such as resistance to chemicals, low electrical and thermal conductivity, low density, high strength-to-weight ratio particularly when reinforced, noise reduction, wide choice of colors and transparencies, ease of manufacturing and complexity of design possibilities and relatively low cost [3]. The objectives of this study are to investigate the thermoplastic flow properties of Oil Palm Mesocarp Fiber and thermoplastic composite in the rheological behaviours and to obtain rheological data at viscosity and shear rates on the effect of process.

2. METHODOLOGY

Experiments were conducted by using the capillary rheometer equipment based on ASTM (D3835). Firstly, the Oil Palm Mesocarp Fiber was immersed by distilled water to clear out the dust. Next, the fibers were dried in three days. After fully dried, it is crushed into small pieces (3mm – 5mm) by blender machine. Finally, PP, LDPE, HDPE and ABS (Weight=150g) were blended with the 10%, 20% and 30% of fiber before testing by capillary rheometer machine. The procedure for using the capillary rheometer machine was considered the temperature melt of the material. In the actual processing, the shear stress and shear rate condition applied were closely approximate .For 100% of PP it was tested at 180°C while PP with 10%, 20% and 30% of fiber were tested at 200°C. Next, for 100% of LDPE was tested at 200°C while LDPE with 10%, 20% and 30% of fiber were also tested at 200°C. Then, for 100% of HDPE was tested at 200°C while HDPE with 10%, 20% and 30% of fiber were tested at 230°C. Finally, for 100% of ABS was tested at 200°C while ABS with 10%, 20% and 30% of fiber were tested at 250°C. The viscosity was measured over a shear rate range from 100 1/s to 800 1/s and it depends on each materials. The process was summarized in Table 1.

Table 1: Temperature Conditions

Material	Percentage	Temperature
PP	100%	180°C
	10%	200°C
	20%	
	30%	
LDPE	100%	200°C
	10%	200°C
	20%	
	30%	
HDPE	100%	200°C
	10%	230°C
	20%	
	30%	
ABS	100%	200°C
	10%	250°C
	20%	
	30%	

3. RESULT AND DISCUSSION

Figure 1 show that the viscosity was measured over a shear rate range from 300 1/s to 700 1/s for the PP mixture. The viscosity was decreased to 298.82 Pa.s for 10% OPMF and followed by 20% OPMF at 278.46 Pa.s. It showed viscosity of 16.59 Pa.s for 30% OPMF. Based on Figure 2, it showed the viscosity was measured over a shear rate range from 200 1/s to 600

1/s for LDPE mixture. The viscosity was decreased to 219.23 Pa.s for 10% OPMF followed by 20% OPMF at 120.91 Pa.s and at 46.26 Pa.s for 30% OPMF.

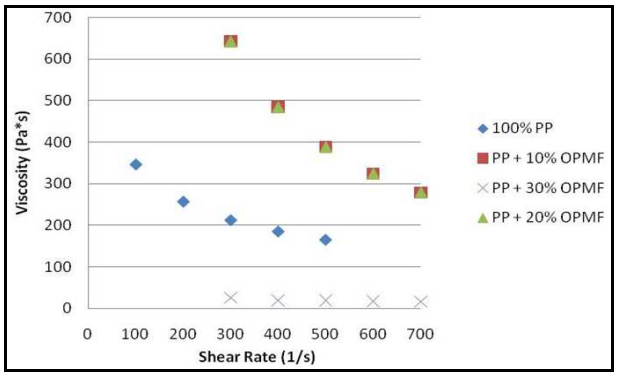

Figure 1

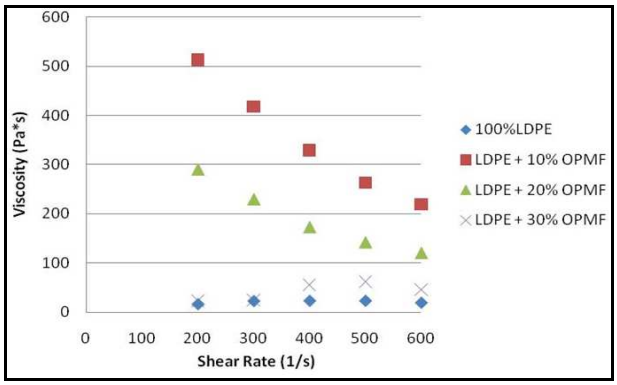

Figure 2

Figure 3 showed that the high density polyethylene (HDPE) mixture with 10%, 20% and 30 % OPMF have a low apparent viscosity which was about 89.10 Pa.s for 10% OPMF, follow by 20% OPMF at 42.77 Pa.s and increased viscosity for 30% OPMF which is about 43.67 Pa.s at higher shear rate which is about 600 1/s.

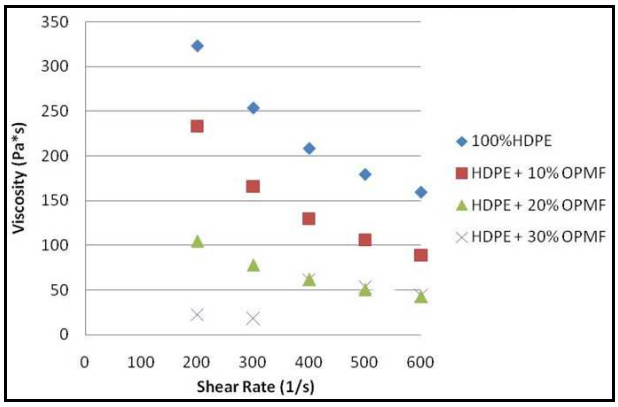

Figure 3

Based on Figure 4, it indicated that the viscosity was measured over a shear rate range from 400 1/s to 800 1/s for ABS mixture. The viscosity was increased to 4.18 Pa.s for 10% OPMF, follow by 20% OPMF at 40.71 Pa.s and 120.59 for 30% OPMF at high shear rate which is about 800 1/s.

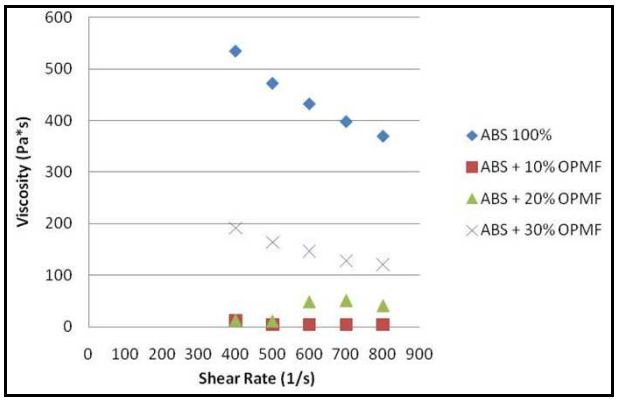

Figure 4

By increasing the percentage of oil palm mesocarp fiber, the results were showed characteristic of flow behavior for polypropylene (PP),low density polyethylene (LDPE), high density polyethylene (HDPE) and ABS mixtures. The effected factor on the rheological behaviour for material was melting temperature. Some materials were quite sensitive to temperature, and showed small variation significant change in viscosity. The amount of fibre during mixing also effected on the result in viscosity. For example, acrylonitrile butadiene styrene (ABS) and the high density polyethylene (HDPE).The result also showed pure resin without OPMF indicated different viscosity at various shear rate

4. CONCLUSION

As conclusion, the results show that the viscosity decreased when the amount of OPMF increased for the polypropylene (PP), the high density polyethylene (HDPE) and the low density polyethylene (LDPE). However, the acrylonitrile butadiene styrene (ABS) mixture was showed different trend because viscosity increased when the amount of OPMF increased. The finding from this research contributed significant knowledge for determining parameter in composite processing.

REFERENCES

[1] Petr Valasek, Alessandro Ruggiero, and Miroslav Muller. Experimental description of strength and tribological characteristic of EFB oil palm fibres/epoxy composites with technologically undemanding preparation. Materials Sciences and Applications MSA, pp 79-88, 2017

[2] Salmah, H., Lim, B and Teh, Rheological and thermal properties of palm kernel shell-filled low-density polyethylene composites with acrylic acid. Journal of Thermoplastic Composite Materials, pp 1155-1167, 2012

[3] Farsi, M. Thermoplastic Matrix Reinforced with Natural Fibers: A Study on Interfacial Behavior. Some Critical Issues for Injection Molding, 2012