INFLUENCE OF CHITOSAN ON PROCESSING CHARACTERISTICS OF POLYETHYLENE/KENAF BIOCOMPOSITES

Ahmad Adlie Shamsuri and Muhammad Izzuddin Syariff Tan

Introduction

Kenaf core fibre (KCF) was utilized as primary filler and chitosan was used as secondary filler, whereas low-density polyethylene (LDPE) was applied as polymer matrix for preparation of hybridized natural fibres polymer biocomposites. The use of dual natural fillers is very promising due to they can mutually assist between each other in the reinforcement of the biocomposites (Shamsuri et al. 2015). The main purpose of this research is to identify the influence of chitosan addition on the processing characteristics of the LDPE/KCF biocomposites. The main difference between chitosan and KCF is that chitosan has anti-microbial character, easy to acquire (derived from shrimp shell), and biocompatible as well (Nazarudin et al. 2011).

Materials and Method

LDPE (coating grade) was purchased from the Lotte Chemical Titan (M) Sdn. Bhd., Malaysia. KCF (420 µm) was obtained from the National Kenaf and Tobacco Board, Malaysia. Chitosan was procured from the Sigma-Aldrich (M) Sdn. Bhd., Malaysia. All materials were consumed as attained without further refinement (Shamsuri et al. 2014). Brabender internal mixer machine was used to prepare the biocomposites. The machine was equipped with a real-time processing recorder. The compositing was done at a temperature of 150°C, and the rotor speed was fixed at 60 rpm. First of all, 24 g of LDPE was inserted into the mixing chamber, and allowed to melt for 3 minutes. After that, 16 g of KCF was added into the chamber, and permitted to composite for 6 minutes. Finally, chitosan was incorporated into the composite, and allowed to blend for 6 minutes. The period of the whole process was 15 minutes (Shamsuri et al. 2015). The contents of the chitosan were varied from 3 to 18 wt.%. The biocomposite containing only LDPE and KCF was also processed for comparison purposes.

Results and Discussion

Processing torque is one of the processing characteristics, it has been recorded during the processing of the materials. Figure 1 showed the processing torque-time curves of the LDPE/KCF biocomposites with different contents of chitosan. The increased torque curves at around the first minute for all samples are due to the unmelted LDPE that increased the resistance on the internal mixer rotors. The curves then decreased at around the second minute because the melting of LDPE took place. The torque curves started to increase again at around the fourth minute after KCF added to all samples. This is due to it required more force for distributing the KCF filler in the molten LDPE. Then, the torques obviously started to decrease again when the KCF thoroughly dispresed in the LDPE matrix.

The processing torque for the sample with 0 wt.% of chitosan was decreased and persisted almost unchanged at a certain level until the end of mixing time. For the sample with 3 wt.% of chitosan, there was a slight increase of the processing torque at around the tenth minute compared to the previous sample. It showed that a small amount of friction from the chitosan acting on the molten biocomposites. On the other hand, for the samples with 6 to 18 wt.% of chitosan, there were significant increases in the processing torques due to large amounts of friction exerted on the molten biocomposites. Nevertheless, the torques was slowly decreased once the chitosan is completely dispersed in the molten biocomposites (Shamsuri et al. 2014). Then, the torques of all samples started to maintain stable at around the thirteen minute until the end of processing. This is due to the LDPE, KCF and chitosan have been mixed well during the processing (Sudari et al. 2015).

Figure 2 demonstrated the influence of chitosan on the stabilization torque of the LDPE/KCF biocomposites. The torque values specifically at the fifteenth minute were regarded as the stabilization torque values (Shamsuri et al. 2015). The diverse values of stabilization torque were based on the fact that the contents of chitosan added into mixing chamber are varied with one another.

In figure 2, the graphs showed that the stabilization torques increased for the samples added with chitosan from 3 to 18 wt.%. Moreover, for the biocomposites with more chitosan they tend to have higher stabilization torques compared to the samples with less chitosan although at similar loading of LDPE/KCF. This is due to the more addition of secondary filler to the biocomposites, the higher viscosity of the molten biocomposites attained (Shamsuri et al. 2015).

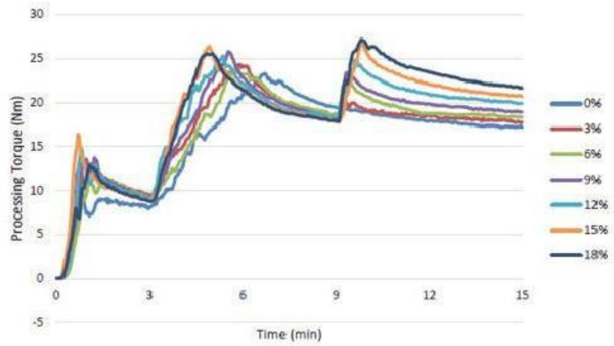

Figure 1. Processing torque-time curves of the LDPE/KCF biocomposites

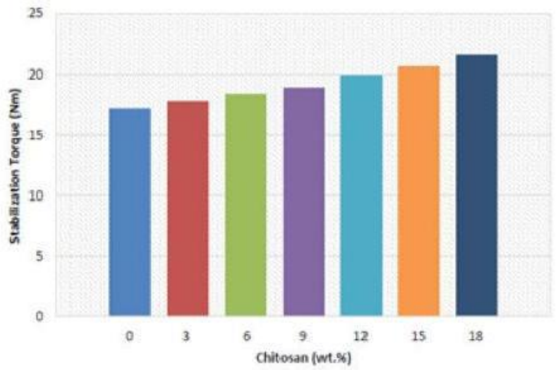

Figure 2. Stabilization torque-chitosan graphs of the LDPE/KCF biocomposites

Conclusion

From this research, the LDPE/KCF biocomposites added with chitosan as secondary filler were successfully processed. It can be seen that the processing torque and stabilization torque have increased after chitosan added to the biocomposites. This is due to the fact that the addition of chitosan has exerted some amounts of friction on the molten biocomposites. Therefore, with the addition of chitosan, it enhanced the melt viscosity of the biocomposites. This concluded that the LDPE/KCF biocomposites with chitosan added as secondary filler can potentially develop stiffer products as compared to the one without chitosan.

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Author:
Dr. Ahmad Adlie Shamsuri
Research Officer
Laboratory of Biocomposite Technology
Institute of Tropical Forestry & Forest Product (INTROP)
University Putra Malaysia
email: adlie@upm.edu.my