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Effect of Aging Process on Elongation at Break and Morphology of Natural Rubber Latex Film Filled With Nanocrystalline Cellulose and Alkanolamide

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Abstract : Sugarcane bagasse is industrial waste with high content of cellulose whichcan be reused as organic filler in natural rubber latex film. Nanocrystalline cellulose was obtained by acid hydrolysis process from sugarcane bagasse. Alkanolamide is anionic surfactant which derived from RBDPS (Refined Bleached Deodorized Palm Stearin) and used as compatibilizer on natural rubber latex film to improve interaction between natural rubber latex and nanocrystalline cellulose. Research on aging effect of natural rubber latex film filled nanocrystalline cellulose and alkanolamide had been done. Aging process was done at temperature 70 ^{o}C for 24 hours.The result of elongation at break and morphologycal scanning of natural rubber latex film showed that natural rubber latex film filled nanorcrystall cellulose and alkanolamide have good resistance on aging process.
Keywords: Aging, Alkanolamide, Elongation at Break, NanocrystallineCellulose, Natural Rubber Latex.

Introduction

Natural rubber (NR) latex is an important commodity in Indonesia. Natural rubber latex was obtained from *Hevea brasiliensis*and formed suspension of rubber particle (cis-1,4 polyisoprene) and non rubber in water.NR-Latex product generally have weakness as the other polymer such as susceptible to oxidation or degradation due to heat (high temperature) and low mechanical properties as it was formed into thin film. Therefore, on processing of natural rubber latex the use of reinforcement was important as organic and inorganic filler. Cellulose is one of the potential organic filler because it was natural polymer with abundant resources and good properties such as biodegradable, low density and stiff[1].

One of the potential resources of cellulose is sugarcane bagasse. Sugarcane bagasse was huge amount solid waste of sugar plant factory. The volume could reached 30%-40% of cane miller[2]. Sugarcane bagasse consist of 43,6% cellulose, 33,8% hemicellulose, 18,1% lignin, 2,3% ash and 0,8% wax in dry weight[3].

In order to improve the compatibility between natural rubber latex and filler, the addition of compatibilizer agent like alkanolamide was necessary. Alkanolamide is anionic surfactant that can be used to modifynanocrystalline cellulose (NCC) and natural rubber latex.

Experimental

Materials

Raw materials (Sugarcane Waste) were obtained from molasses local market,Jalan Doktor Mansyur, University Of Sumatera Utara (USU), Medan, North Sumatera Indonesia. 60% high ammonia latex was acquired from local market in Medan, Indonesia. Sulphur, zinc oxide (ZnO), zinc diethyldithiocarbamate (ZDEC), and antioxidant (AO) as curative agent for prevulcanization system of NR-Latex were acquired from Farten Technique (M) SdnBhd, Pulau Penang, Malaysia.

Nanocrystalline cellulose filler were obtained from acid hydrolysis of sugarcane bagasse with 45% sulfuric acid. Alkanolamide as compatibilizer were obtained from reaction of RBDPS (Refined Bleached Deodorized Palm Stearin) and dietanolamine.

Preparation of Natural Rubber Latex Film

The fillers of 10% NCC were prepared by dispersion process which consist of NCC, water, and alkanolamide inside ball mill. The alkanolamide was used in amount of 2,5% (weight percent). Then fillers were mixed with NR-Latex compound in prevulcanization process. Table 1 shows the formulation of NR-Latex compound for prevulcanization process.

Table 1.The Formulation of NR-Latex compounds

Compounds	Amount (phr)
60 % High Ammonia Latex	100
50 % Sulfur Dispersion	1.8
50 % ZDEC Dispersion	1.8
30 % ZnO Dispersion	0.5
50 % Antioxidant	1.2
10 % KOH	1.8
Fillers Dispersion System	0; 5; 10; 15

The prevulcanization process was executed at 70 ^{o}C to achieve the curing of the system. The prevulcanization process was completed after the chloroform number has reached number 3. After system had genially prevulcanized, the mixture was settled for 24 hours in order to release the bubbles. After the bubbles are released, the compound was molded into films by coagulation dipping using thin stainless steel plates. Before the molding process was performed, the plates were chronologically dipped into 10% potassium hydroxide solution, 10% acetic acid solution, water, and 10% calcium nitrate solution, and followed by drying the plates in the oven at 100 ^{o}C. After it had dried, the plates were dipped in the latex system and the dwell time was set at 5 seconds. Finally, the film formers were hanged inside the oven at 100°C for 20 minutes and continued with aging treatment in hot air oven at 70^{o}C for 24 hours.

Elongation at Break Test and Morphology Study of Natural Rubber Latex Film

Natural rubber latex film were cut into dumbbell-shaped speciment according to ASTM D 412. Elongation at break test were performed with Instron machine model 3366 at room temperature and speed of 500 mm/minutes. Morphological study were examined by scanning electron microscope (SEM).

Results and Discussion

The obtained nanocrystalline cellulose was rod shaped and 40-160 nm diameter and hundreds nm length. Crystallinity of obtained nanocrystalline cellulose is 92,33%. This high crystallinity shows that the amorphous part of alpha cellulose had been succesfully removed by delignification and bleaching process.

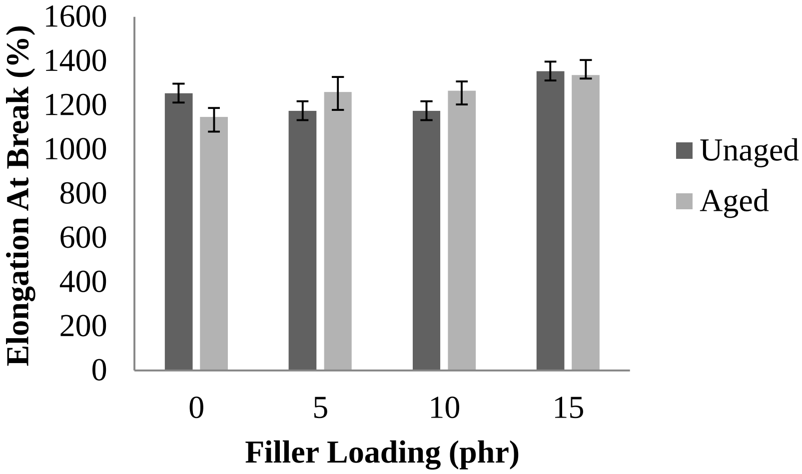


Figure 1. Elongation at break of aged and unaged natural rubber latex film filled with nanocrystalline cellulose

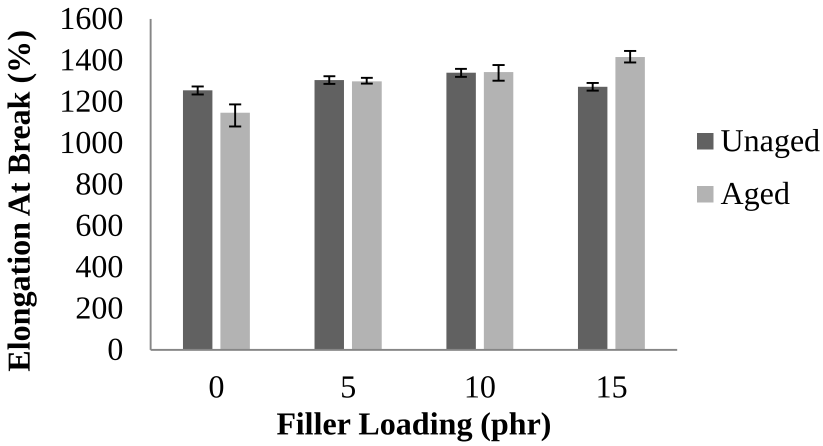


Figure 2. Elongation at break of aged and unaged natural rubber latex film filled with nanocrystallineine cellulose and alkanolamide

Figure 1. shows the elongation at break of natural rubber latex film filled nanocrystalline cellulose without alkanolamide. At load of filler 5 and 10 phr, the elongation at break film after aging were higher than the unaged one. At load of filler 15 phr, the elongation at break film after aging was relatively same. Figure 2. shows that the elongation at break of natural rubber latex film filled nanocrystalline cellulose and alkanolamide at load of filler 5 and 10 phr relatively same and have small improvement at 15 phr after aging compared to those of the unaged film. These phenomenon showed that the addition of nanocrystalline cellulose can improve the resistance towards degradation of natural rubber latex film due to aging process. Generally, aging process will decrease the quality of polymer product, but the natural rubber latex film filled with nanocrystalline cellulose and alkanolamide behave contrary.

The elongation at break value of natural rubber latex film with addition of alkanolamide on filler loading 15 phr after aging was higher than unaged one. This is might be due to the addition of filler loading proportionally the amount of alkanolamide on natural rubber latex film. As surfactant, alkanolamide can reduce the interfacial tension and role as compatibilizer and plastisizer.

Figure 3. shows the effect of filler loading and the addition of alkanolamide on elongation at break natural rubber latex film after aging process. The elongation at break of natural rubber latex film increase in line with the increasing of filler loading. This shows thatnanocrystalline cellulose as fillerswerewell-interacted with natural rubber latex,thus resulting in theproperties improvement of the obtained film.

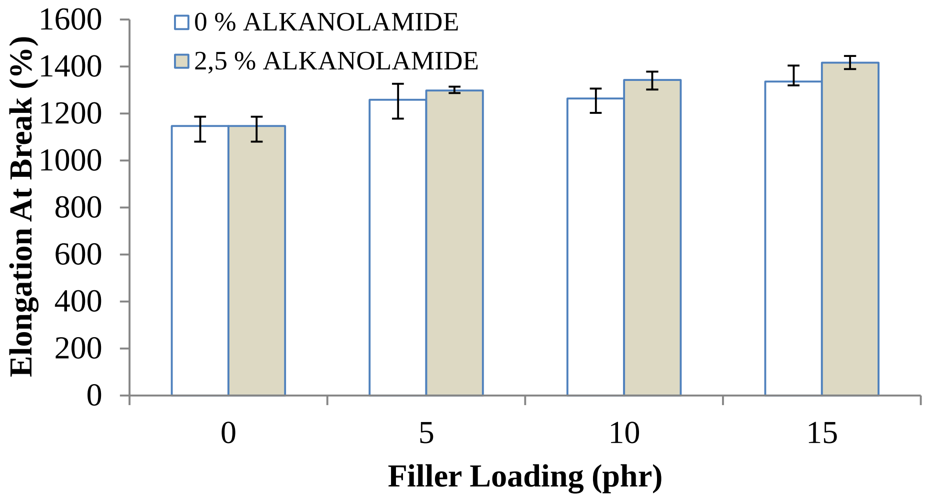
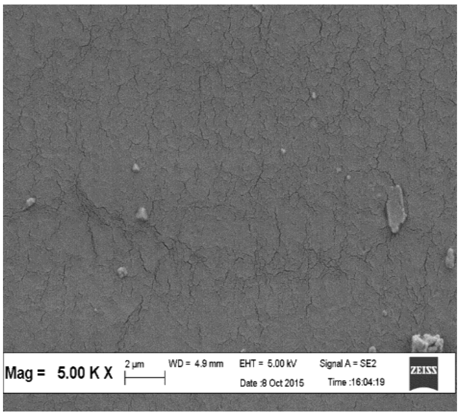


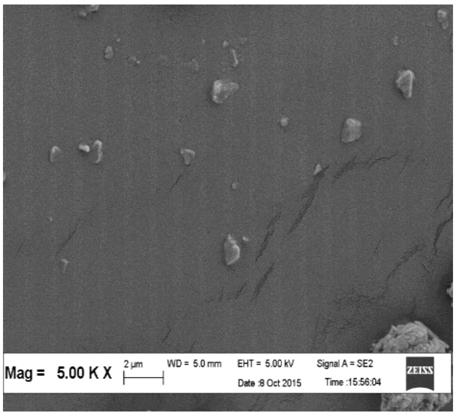
Figure 3. Elongation at break of natural rubber latex film filled with nanocrystallineine cellulose and alkanolamide

The addition of alkanolamide as compatibilizer cause significant enhancement of elongation at break film after aging process compare with film without addition of alkanolamide. Alkanolamide can be used as plasticizer that improve the elasticity of film and increase the elongation at break value[4].

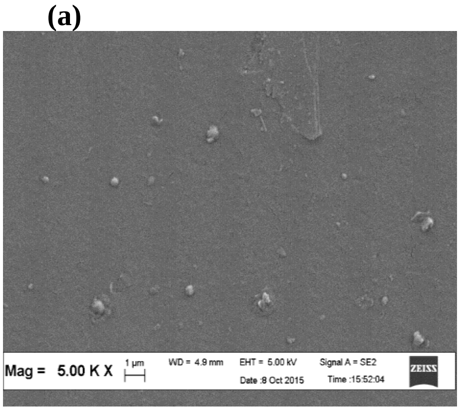
Figure 4. shows the morphology of natural rubber latex film filled nanocrystalline cellulose and alkanolamide.



(a)



(b)



(c)

Figure 4.The morphology images of natural rubber latex film after aging process (a) without addition of nanocrystalline cellulose and alkanolamide (b) with addition of nanocrystalline cellulose (c)with addition of nanocrystalline cellulose and alkanolamide

SEM micrograph shows that all films got crack after aging process. Figure 4 (a) shows that the films have many crack which spread uniformly at the surface of the film fracture. But, different result was obtained from film filled with nanocrystalline cellulose and alkanolamide as showed at figure 4(c), where film only have some damaged part by aging process. The crack was occurred by the movement of filler while the film was heated and constituted damage of matrix itself[5].

Aging process on unfilled natural rubber latex film shows significant effect on its morphology, but the filled natural rubber latex film shows that nanocrystalline cellulose and alkanolamide could restrain the degradation on film significantly due to heat apply while aging process. Good interaction between filler and matrix caused external heat added to film spread evenly on all part of matrix and nanocrystalline cellulose.

Conclusion

Nanocrystalline cellulose is organic filler that have good strengthening effect in natural rubber latex film on aging process. The increasing of filler loading improvethe film ability on holding the decrease of the film quality due to aging process. Alkanolamide could improve the interaction between natural rubber latex and nanocrystalline cellulose and increase the elongation at break value after aging process.

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