Characterization of EIC Cellulose-Polyol Isocyanate Composite for Isolator

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Abstract: ***Isolator is an inexpensive technology in improving energy saving, e.g., in heat pipes. Both Polyol Isocyanate and cellulose are good material examples to use as an isolator material. Each of them has some advantages and disadvantages. Therefore, to get characteristics that are required for an isolator material, a composite of Polyol Isocyanate and cellulose would be created. The result of the composite was then tested for its heat capacity by a Differential Scanning Calorimetry (DSC) and for its heat resistance by a Thermogravimetric Analysis. The determination of heat capacity value was conducted by comparing the experimental measurement and fitting. The highest heat capacity measurement value on the composite 2-3, was 0, 941 kJ/kg K and the lowest on the composite 1-1, was 0, 473 kJ/kg K. The highest heat capacity fitting value on the composite 2-3', was 0, 938 kJ/kg K and the lowest on the composite 2-1', was 0, 461 kJ/kg K. The result of thermogravimetric analysis showed that material decomposition occurred at a temperature of 235°C to 244°C. Meanwhile, the decomposition occurred at a temperature of 236 °C to 246 °C.***

Keyword: Polyol, Diisocyanate, Cellulose, DSC, Thermogravimetric, Cold-press

1. Introduction

Polyol-Isocyanate has a good thermal characteristic of isolator, high resistance on water absorption, relatively high mechanic strength, and low density. The uses of cellulose isolator have been increasing and increasingly popular, being one of the most friendly-environment isolators. Cellulose used in producing the composite was processed from an Imperata Cilyndrica reed Extraction (EIC) [1]. The reed used in the present research was of genus Imperata, family Gramineae, with a habitus of bushes, perennial, 1-1.5 m in high. Its roots contain saponin and tannin, while its leaves contain polyphenol. Meanwhile, Polyol Isocyanate was obtained from a mixture of diisocyanate and polyol.

2. Experimental

2.1 Material

Mixture 1 of EIC cellulosa, mixture 2 of EIC csellulosa, and mixture 3 of EIC cellulose, polyol and diisocyanate.

2.1 Composite Preparation

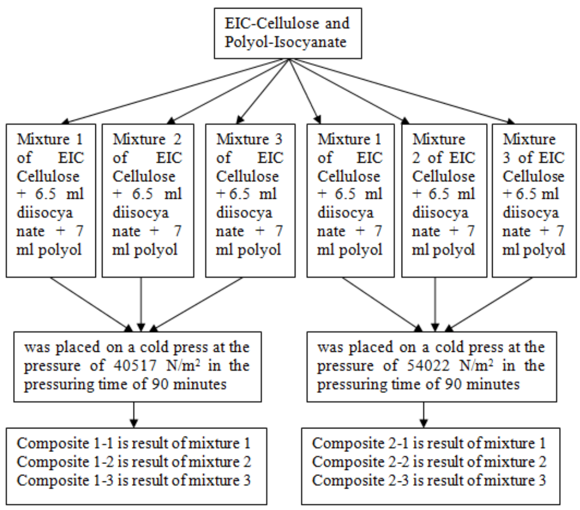

Figure 1: Schematic diagram of the composite of EIC-Cellulose with Polyol Isocyanate [2]

3. Characterization

3.1 Differential Scanning Calorimetry

Differential scanning calorimetry was performed with a heating rate 10°C/min, from 30°C to 400°C.

3.2 Thermogravimetric Analysis

Thermogravimetric Analysis was used to mealoss and the residue amount. The sample were heated from sure the temperature of 5% and 50 % mass 35°C to 400 °C with a heating rate of 5 °C / min.

4. Result and Discussion

4.1 Heat Capacity

The tendencies of heat capacity values on the effect of temperature were shown by graphics as on Figures 1 and 2. Composite 1-1; 1-2; 1-3; 2-1; 2-2; and 2-3 were the heat capacity value by an experimental measurement, and Composite 1-1'; 1-2'; 1-3'; 2-1'; 2-2'; and 2-3' were the heat capacity value obtained from a fitting.

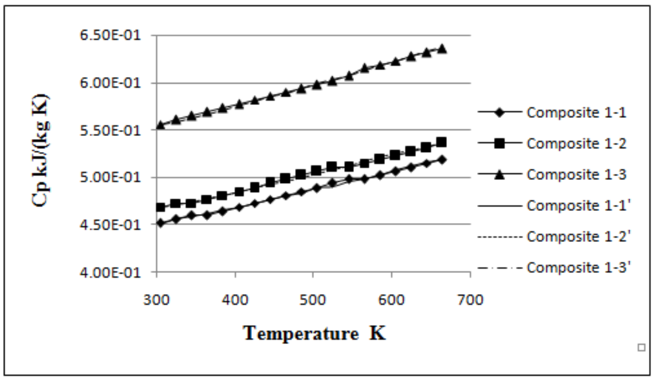

Figure 2: Relationship between temperature and heat capacity of EIC cellulose - polyol isocyanate composite on a cold press at the pressure of 40517 N/m^2

Figure 2 showed that there was a difference of heat capacity value of approximately 0.001 to 0.002 kJ/kg K between one obtained by experimental measurement and one obtained by fitting. The fitting computation was compatible with the result of graphic that indicated a tendency of forming a straight line. Thus, the material of produced composite was affected by the contribution of vibration effect [2], and the contribution of electron effect [3].

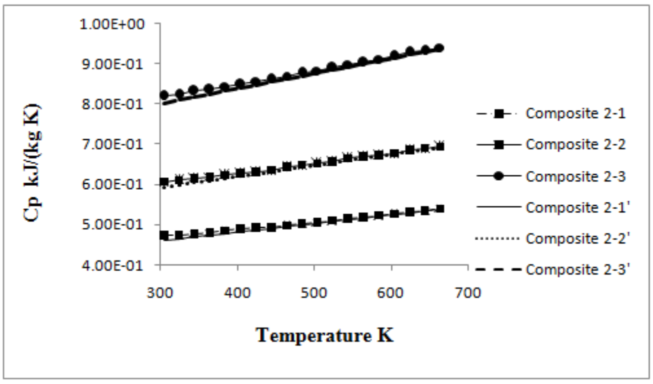

Figure 3: Relationship between temperature and heat capacity of EIC cellulose - polyol isocyanate composite on a cold press at the pressure of 54022 N/m^2

Figure 3 showed that there was a difference of heat capacity value of approximately 0.003 to 0.012 kJ/kg K between one obtained by experimental measurement and one obtained by fitting. Fig. 1 and 2 showed that the higher the temperature, the higher the heat capacity value. This is because the values of heat capacity had never approached a value asymptomatically but rather been steadily growing with each increase in temperature because thermodynamically the values of heat capacity are directly proportional to thermal expansion $(\beta)^2$, that is, the higher the temperature, the higher β value.

4.2 Thermal Gravimetric Analysis (TGA)

The derivative of the decreases in material mass was found to show decomposition process. The result of test was a graphic of the correlation between temperature and the percentage of decrease in mass. TGA test was intended to determine the heat resistance of composite material. The heat resistance is the beginning of the occurrence of decomposition at the on-set. The result of test on the composite material pressed with pressures of 40517 N/m^2 and 54022 N/m^2 was described as a correlation between temperature and mass reduction, as shown in Fig. 1 and 2.

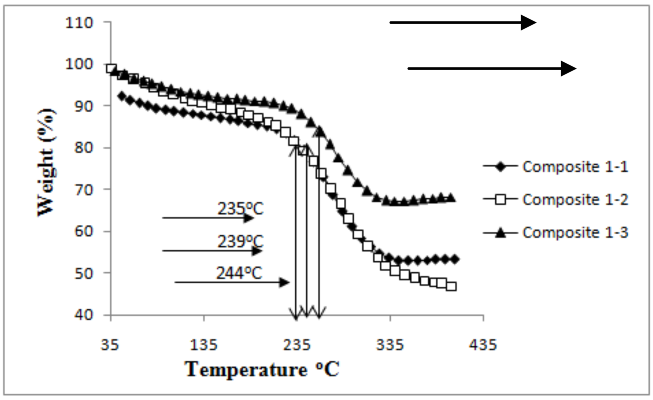

Figure 4: TGA of EIC cellulose- polyol isocyanate composite on a cold press at the pressure of 40517 N/m^2

Figure 4 showed that the material decomposition began to occur at 235°C to 244°C and Fig. 4 showed that the material decomposition began to occur at 236 °C to 246°C. Cellulose usually undergoes degradation from a temperature of 250°C to 400 °C [4]. The parameters affected degradation levels and produced various types and number of olygomer [5]. The result of test indicated that the material was resistant to heat till 246°C. Thus, the material has met one of the thermal isolator at moderate temperatures, 90 – 325°C.

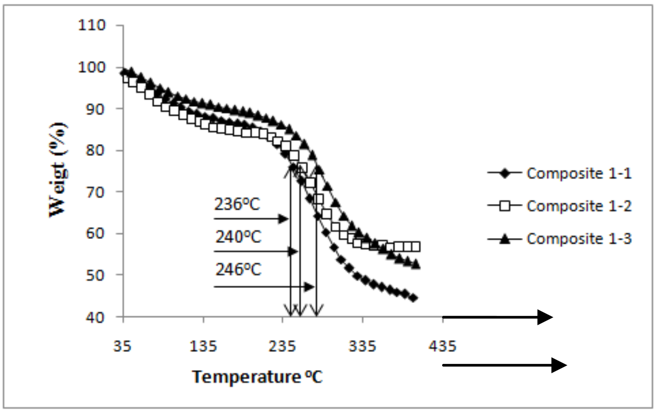

Figure 5: TGA of EIC cellulose- polyol isocyanate composite on a cold press at the pressure of 54022 N/m^2

The result of a TGA test of the composite of EIC cellulose and polyol-isocyanate revealed that before the occurrence of decomposition at a temperature of 235 °C to 246°C a loss of mass had taken place. It was caused by the dissolution of bond in the material which is dissoluble at low temperatures and the existence of volatiles or materials which are dissoluble at low temperatures (below 40°C).

5. Conclusions

It can be concluded that the composite 2-3 was the best results, which have the highest thermal capacity, i.e. 0, 941 kJ/kg.K and the highest resistance of heat at 246°C.

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