SYNTHESIS AND SWELLING BEHAVIOR OF AGRO-WASTE BASED SUPERABSORBENT COMPOSITES

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Abstract. *Superabsorbent polymer composites (SPC) based on acrylic acid and rice husk (RH) was synthesized through a solution polymerization to improve water absorbency and reduce production cost. The SPC was characterized using Fourier transform infrared spectroscopy (FTIR). The objectives of this research to synthesis RH based SPC by determine the effect of amount RH, and cross-linker agent N,N'-methylenebisacrylamide (MBA), towards swelling behavior of SPC in water and saline solution. Experiments have been done by used RH contents in range of 576 to 864 mg and for amount of MBA content evaluate in range of 11.44 to 22.88 mg. The swelling behaviors have been investigated by measured the water absorption of rice husk-g-poly (acrylic acid). The water absorbency determined by using tea-bag method. The result showed as the amount of RH was increased, the water absorbency also increase. The maximum absorbency 4.8745 g/g in distilled water was obtained. The effect of MBA content result show the water absorption increases with increase of the cross-linker amount in the range of from 11.44 to 14.3 mg. Then, water absorption decreases with further increased of cross-linker amount. The maximum absorbency of 4.221 g/g in distilled water was obtained. The swelling behavior in saline solution also has been investigated. The result shows that water absorbency give insignificant value in saline solution compare to absorbency value in distilled water.*

Keywords: *Superabsorbent composites,swelling behavior,water absorbency,rice husk*

Introduction

Superabsorbent polymers are lightly cross linked hydrophilic polymers that have ability to absorb, swell and retain large quantities of water. With the superior properties, superabsorbent polymers are applying in many sectors compared to the traditional absorbent such as sponge, cotton and pulp [7]. SPC are originally divided into two main classes which are synthetic (petrochemical-based) and natural. Most of the superabsorbent polymers composite are frequently produced from acrylic acid (AA) and acrylamide (AM) as the salt via solution polymerization techniques [8].

In recent years, the preparation of superabsorbent polymers composites (SPC) has great attention because of their relatively low production cost and high water absorbency [1]. In this context, rice husk (RH) will be filled in the SPC. RH is an agricultural waste material abundantly available in Malaysia which is one of rice-producing countries. RH is suitable being use as filler in the SPC because RH is a hydrophilic material that can absorb amount of water. The hydrophilic characteristics of RH have been reviewed. Besides that, RH is biodegradable waste therefore the SPC with RH filler will be easy to dispose.The objective of this research to synthesis rice husk based superabsorbent. Study swelling behavior rice husk-g-poly (acrylic acid) in water and saline solution.

Material and methods

Reagents: Monomer that was used for the production of SPC are acrylic acid (AA) and Acrylamide (AM) was bought from R&M Chemicals. As initiator Ammonium peroxodisulfate (APS) analytical grade bought from Merck, Germany and *N,N*-methylene-diacrylamide (MBA) as crosslinker agent was bought from Merck, Germany was used as purchased. Rice husk was obtained from a local Bernas rice mill at Peringat, Kelantan was milled through 320-mesh screen. All the solution was prepared with distilled water.

Experimental procedures: 4 ml acrylic acid was dissolved in 15 ml distilled water and then neutralized with 6 ml of sodium hydroxide solution (5 M) in a four-neck flask equipped with a stirrer, condenser, thermometer, and nitrogen line.0.576 g of Rice husk powder was added in the solution. Under a nitrogen atmosphere, 14.3 mg of crosslinker (NMBA) was added to the mixture solution and the mixed solution was stirred at room temperature for 30 min. The water bath was heated slowly to 70 °C with effective stirring after radical 71.3 mg of initiator APS was introduced to the mixed solution. After 3 h of the reaction, the resulting product was washed several times with distilled water, dried in oven at 70 °C to a constant weight.

Characterization of rice husk-g-poly (acrylic acid):

FTIR have been used to characterize the composition of rice husk-g-poly (acrylic acid).

Swelling behavior testing :In swelling behavior rice husk-g-poly (acrylic acid) was determined by water and saline solution absorbency.Water and saline solution absorbency measurement was performed by weighing the initial mass of composite (m_o) and was been determined at the time t (m_t) of gel was immersed in the water and saline solution at the room temperature[5]. Q represent the absorbency.

$$Q = \left[\frac{m_t - m_o}{m_o} \right] \qquad \text{Equation 3.1}$$

The water absorbency determine using tea-bag method. This method is the most conventional, fast, and suitable for limited amounts of samples (W_0= 0.01 g +/- 0.005). The rice husk-g-poly (acrylic acid) sample was placed into a tea-bag and the bag was dipped in an excess amount of water or saline solution. The swelling capacity is calculated by equation (3.1). The method's precision had been determined to be around ±3.5% [3].

Results and Discussion

Fourier Transform Infrared Spectroscopy (FTIR):

FTIR spectra of rice husk-g-poly (acrylic acid) and rice husk specimen were presented in Figure 3.2. The spectrum of rice husk in Figure 1.1(a) presents the wave numbers in the region of 3250-3500 cm-1, 1700-1750 cm-1 and 1400-1600 cm-1, assigned to O-H stretching, C=O stretching of hemicelluloses and lignin and C=C stretching of aromatic carbon. The FTIR spectrum in Figure 1.1(b) clearly shows the vibrational bands of rice husk compositions in the rice husk-g-poly (acrylic acid). From this result show that the rice husks mix together with the superabsorbent.

Effect of Rice Husk content to water absorbency:

Effect of amount of rice husk towards water absorbency has been done as shown in Figure 1.2. The maximum absorbency 4.8745 g/g in distilled water was obtained and the water absorbency increased with the increase of RH amount from 576 to 792 mg. As amount of RH increase, the amount of hemicelluloses and cellulose also increase. As the result, the water absorbency also increases as the hydrophilic element in rice husk-g-poly (acrylic acid) increase. Then swelling capacity of superabsorbent composite decreased with further increase of the amount of RH. According to Simone *et al.*, (2009) by increase RH concentration and water contact time was greatly increased water absorption [6]. That's mean rice husk-g-poly (acrylic acid) need more time in order to reach equilibrium state of swelling so that it can absorb more water.

Effect of crosslinker content to water absorbency:

The influence of the amount of the cross-linker on the water absorbency was shown in Figure 1.3. The maximum absorbency 4.221 g/g in distilled water was obtained. From the Figure 1.3 shows the water absorption increases with the increase of crosslinker amount in the range of 11.44 to 14.3 mg. Then, water absorption decreases with the further increased of cross-linker amount. This is because the decrease in the space between the copolymer chains. As the result structure fail be expanded and hold a large amount of water[2,9].This occurred according to Flory's network theory; the cross-linking density is a key factor influencing water absorbency of superabsorbent polymers composite.

Absorbency comparison between distilled water and saline solution: The swelling ability of rice husk-g-poly (acrylic acid) in salt solution (0.5 M) less than the swelling values in distilled water. These phenomena known undesired swelling loss is often attributed to a charge screening effect of additional cations, which cause a non-perfect anion-anion electrostatic repulsion [4]. Then, lead to decreased osmotic pressure (ionic pressure) different between the rice husk-g-poly (acrylic acid) network and the external solution. That's mean the rice husk-g-poly (acrylic acid) fail to absorb a lot amount of water in present of cations. The result shows in figure 1.4 and 1.5.

Conclusion

This new synthesis of rice husk based superabsorbent composite has been achieved. By varied a few parameter like crosslinker and amount of rice husk, optimum condition to provide better swelling behavior were obtained. This could be a new way to replace synthetic superabsorbent composite become more environmental friendly. Furthermore, a lot of parameter haven't been investigated yet that should be done in future.

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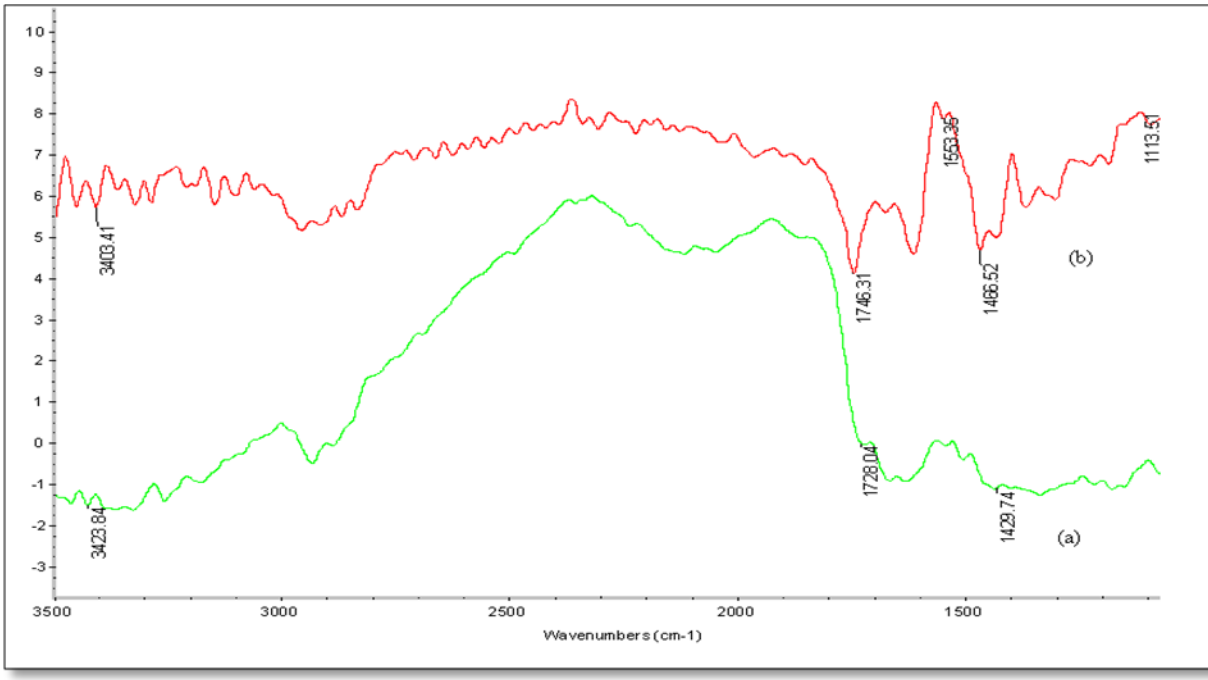

Figure 1.1: FTIR spectra for (a) Rice Husk and (b) Rice Husk-g-poly (Acrylic Acid)

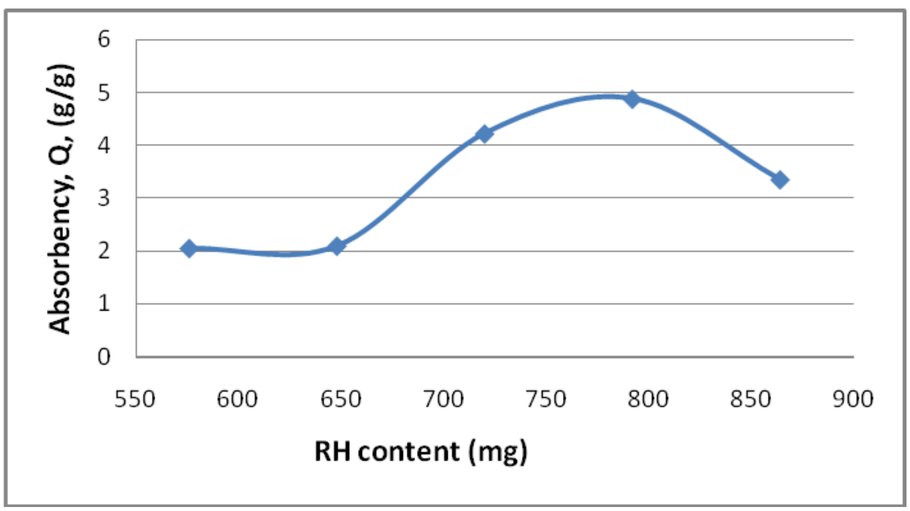

Figure 1.2: Effect of amount rice husk in water absorbency

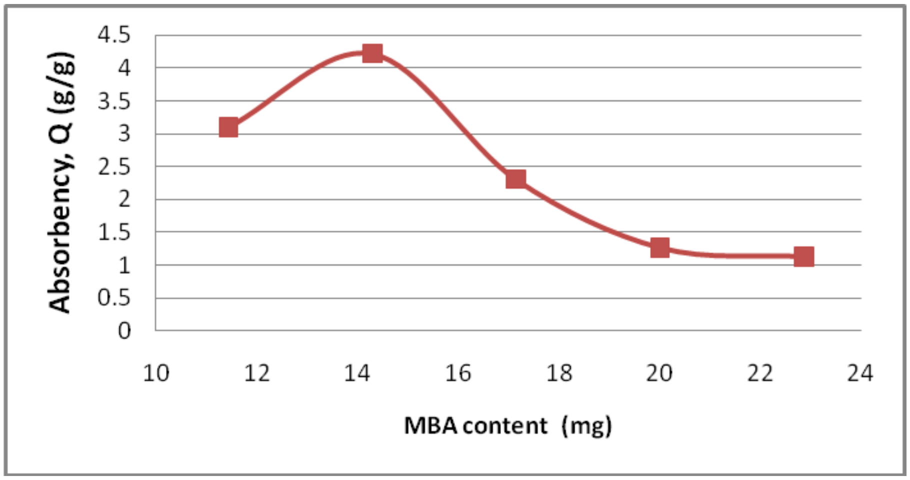

Figure 1.3: Effect of amount MBA in water absorbency

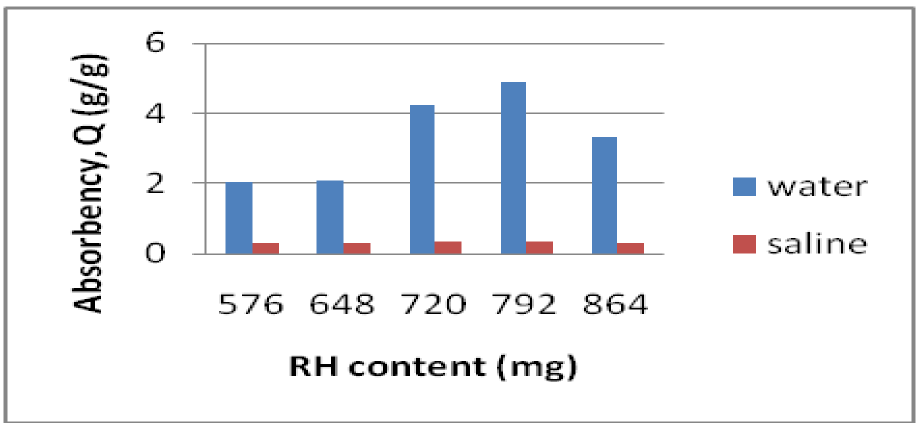

Figure 1.4: Compare water and saline solution based on RH content

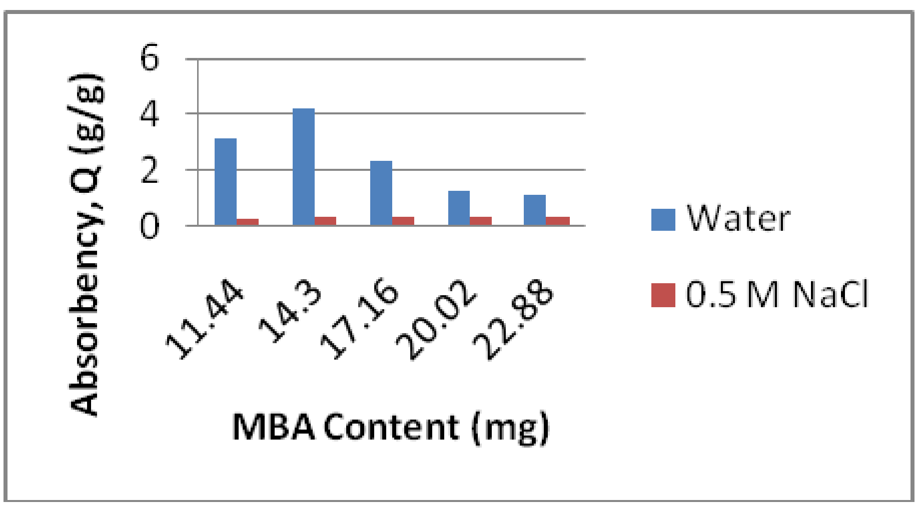

Figure 1.5: Compare water and saline solution based on MBA content