SYNTHESIS AND PROPERTIES OF ECO-FRIENDLY NOVOLAC PHENOLIC RESIN FROM LIQUEFIED COIR HUSK

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Contents

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Ruj. Kami : 600-RMI/RACE 16/6/2(8/2012)
Tarikh : 11 November 2014

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Puan

KELULUSAN PERMOHONAN PELANJUTAN TEMPOH PENYELIDIKAN KALI PERTAMA

Tajuk Projek	:	Synthesis And Properties Of Eco-Friendly Novolac Phenolic Resin From Liquified Coconut Coir Husk
Kod Projek	:	600-RMI/RACE 16/6/2(8/2012)
Ketua Projek	:	Puan Nor Mazlina Binti Abdul Wahab

Dengan segala hormatnya, perkara di atas adalah dirujuk.

2. Dimaklumkan berdasarkan kepada Mesyuarat Jawatankuasa Pengurusan Penyelidikan RMI Bil.13/2014 pada 11 November 2014 telah memutuskan pelanjutan tempoh penyelidikan kali pertama bagi projek penyelidikan seperti di atas telah **diluluskan**. Berikut adalah butiran kelulusan yang dibenarkan:-

Perkara	Tarikh Mula	Tarikh Tamat	Tempoh
Tempoh Asal	1 December 2012	30 November 2014	24 Bulan
Tempoh Lanjutan	30 November 2014	30 Mei 2015	6 Bulan

3. Puan juga diminta menghantar strategi perbelanjaan untuk tempoh lanjutan dan menggunakan keseluruhan peruntukan projek penyelidikan dengan penuh kebijaksanaan dengan mengikut garis panduan dan prosedur kewangan yang telah ditetapkan.

4. Sehubungan dengan kelulusan pelanjutan tempoh penyelidikan ini juga, diharap dapat membantu Puan dalam menghasilkan projek penyelidikan yang lebih baik dan lancar serta menamatkan dan menyempurnakan projek penyelidikan di dalam tempoh lanjutan yang diberikan.

Sekian, harap maklum dan terima kasih.

"SELAMAT MENJALANKAN PENYELIDIKAN DENGAN JAYANYA"

Yang benar,

PROFESOR DR. HADARIAH BAHRON
Penolong Naib Canselor (Penyelidikan)

s.k.:

Puan nkah

5.2 Enhanced Executive Summary

Coconut Coir Husk (CCH) is a potentially outstanding fiber due to its high lignin content comparable to other types of natural fibers. The lignin was extracted by Klason lignin method and obtained 38.1% lignin. The obtained lignin was then used as feedstock in synthesized phenolic resin called Phenolated CCH. In order to study the free phenol and phenol conversion in the resinification process, the CCH with varies loading (3%, 5% and 7%) were studied. Thermal analysis also was carried out in order to identify the thermal properties of the CCH and the extracted lignin. Fourier transform infra-red (FTIR) was use to confirmed extracted lignin by identification of important peaks of phenolic structure present in the lignin. The important peaks were phenolic and methylol at 3378 cm^{-1},3350 cm^{-1} , aromatic C=C stretch at 1611 cm^{-1} , 1610 cm^{-1} and adjacent 5H phenol at 613 cm^{-1}, 596 cm^{-1}.

Meanwhile, the free phenol and phenol conversion were calculated by using High performance Liquid Chromatography (HPLC). The results found that calculated free phenol in conventional novolac resin shows the lowest percentage i.e 0.39 % as compared to Phenolated CCH that have 5.49, 4.78 and 4.71 % of free phenol at 3, 5 and 7% CCH loading, respectively. Meanwhile, phenol conversion for conventional novolac resin sample shows that there are 99.61 % of phenol converted into novolac resin, whereas phenol conversion for Phenolated CCH at 3, 5 and 7 % CCH are 94.51, 95.22 and 95.28 %, respectively. As to identify the thermal properties, Differential Scanning Calorimetry (DSC) and Thermogravimetry (TGA) were used in this studied. The extracted lignin showed thermally more stable than CCH due to removal of cellulose from the CCH fiber and also had potential to use as filler for fire retardant material.

5.3 Introduction

With an environmental concern, renewable and sustainable materials should be considered to substitute petroleum based product. Recently, biomass from natural biomass fiber such as wood had been studied extensively in order to minimize the usage of petroleum based (Pan *et al.,* 2007; Pan *et al.,* 2008; Pan *et al.,* 2009; Van Dam *et al.,* 2004). However, Min *et al.,* (2011) reported that the residue content developed by degraded of cellulose in wood at 150°C adversely effect the quality of product. Therefore, the other natural biomass fiber such as coconut coir husk (CCH) from coconut fruit can be an alternative as feedstock for the synthesis of new environmentally friendly or green polymers.

Coconut trees (Cocos nucifera L.) grew abundantly in tropical areas and are widely known for their important usage based on their different parts (Abdul Khalil *et al.,* 2006). Coir fibre is obtained from the outer layer of the coconut fruit which is called husk, with composition of 59% lignin, 33% cellulose and 8% hemicelluloses (Luong *et al.,* 2012 & Jin *et al.,* 2011). The husk is easy to get and low in cost. In Arau, the villagers burn the coconut husk for smoke to repel mosquitoes, but in industry and commercialization, it is widely used in the production of ropes, mats and brushes. The composition of lignin in CCH was higher than wood source which contain 12-39% (Justiz-Smith *et al.,* 2008). The thermal stability of cellulose fiber in CCH was 215 °C (Fahma *et al.,* 2010 & Mothe & De-Miranda, 2009) and the lignin decomposition starting at 380 °C.

There are various applications of phenolformladehyde resin. First, it can be used in resin form as a bonding agent. Then, the liquid resin can be dried and ground to form a molding powder. This molding powder is usually used in molding electrical fittings (Wei *et al.,* 2007). The fast development in the plastic industry may have a serious impact on petroleum usage as a precursor. Since phenolic resins use phenol as a precursor in their formulation, it makes the phenolic resins expensive. Alternatively, the phenol can be possibly replaced by lignin since its structure is quite similar with that of phenol. Thus, lignin has been studied as a substitute for phenol in the synthesis of phenol-formaldehyde (Pan *et al.,* 2007)