UNIVERSITI TEKNOLOGI MARA

PREPARATION AND CHARACTERIZATION OF CASTOR OIL-BASED AND POLY PROPYLENEOXY SUCROSE BASED POLYURETHANE GROUTING MATERIALS FILLED WITH CARBON FROM WASTE TYRES

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Grouting is an excellent method to repair and strengthen the loosen and broken matrices such as sink holes, crack and leaks in concrete structures. Castor-based polyurethane is considered as alternative replacement for petrochemical-based polyurethane in the industry as castor polyol is a renewable source and environment friendly compared to petrochemical-based polyol. Carbon from waste tyres (WCT) provide alternative to commercial carbon black as a reinforcement to enhance the physical, mechanical and thermal properties of PU as it is much cheaper and its utilization helps to reduce concern regarding dumping of waste tyres. Therefore, this study was conducted to investigate the optimum isocyanate : polyol (NCO:OH) ratio and to compare the physical, rheology, mechanical and morphology properties between castor-based PU and petrochemical-based PU. This research also study the effect of WCT loading on physical, mechanical, morphology and thermal properties of PU composites. Castor-based PU (CPUG) and petrochemical-based PU (PPUG) were produced using five different NCO:OH ratio which were 2:1, 2.2:1, 2.4:1, 2.6:1 and 2.8:1 composition. CPUG and PPUG with NCO:OH ratio of 2.6:1 were reinforced with WCT as the finding show that it had the optimum physical, rheological and mechanical properties of PUG. WCT was dried and sieved before being added in the mixture and the loading was varied at 2, 4 and 6 wt%. The samples were analysed on foam reaction time, density, rheology, hardness, flexural, compression, FESEM, TGA, DSC and FTIR-ATR analysis. The foam reaction time for both type of PUG were in the range of commercial PU grout processing parameter (cream time: 2-4s , rise time:180-367s, tack free time:190-475s). CPUG and PPUG with NCO:OH ratio of 2.6:1 gave the optimum rheology index (1.31cm/g & 2.4cm/g). The free rise density and core density for both type of PUG were in the range of 139.80-305.20kg/m^3 which were comparable with commercial PU grout's density (90-360kg/m^3). The optimum hardness was achieved by CPUG and PPUG with NCO:OH ratio of 2.6:1 (30.83 & 43.84 shore D). CPUG with NCO:OH ratio of 2.6:1 gave optimum value of flexural strength and modulus (11.01MPa & 1069.50 MPa) while for PPUG, the optimum value was achieved by PPUG with NCO:OH ratio of 2.8:1 (18.88MPa & 2394MPa). The maximum value for compression strength and compression modulus were achieved by CPUG with NCO:OH ratio of 2.8:1 (2.59MPa & 35.47MPa) while for PPUG, the optimum value was achieved by PPUG with NCO:OH ratio of 2.6:1 (6.74MPa & 59.16MPa). FESEM micrograph showed both type of PUG had closed cellular foams with spherical and polyhedral shape. The foam reaction time for both type of PUC was in the range of commercial PU grout processing parameter (cream time:3-4s, rise time: 150-340s, tack free time 230-425s). CPUC and PPUC with 2wt% of WCT loading gave the optimum rheology index (2.275cm/g & 1.229cm/g), hardness value (21.58 shore D & 29.92 shore D), flexural strength (6.39MPa & 7.15MPa), flexural modulus (518MPa & 859.65MPa), compression strength (2.59MPa & 8.66MPa) and compression modulus (35.47MPa & 108.53MPa). The addition of 4wt% of WCT gave the maximum T_1 onset temperature for both type of PUC (295.9ºC & 283.7 ºC). This indicated that CPUC and PPUC with 4wt% of WCT loading had the optimum thermal stability. DSC micrograph of both type of PUC showed the presence of two peak which were T_g and T_m indicated that PU produced in this research was a thermoplastic PU which had a semi-crystalline structure with high amorphous region.

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