UNIVERSITI TEKNOLOGI MARA

ENVIRONMENTAL STRESS CRACKING BEHAVIOUR OF POLYESTER REINFORCED KENAF COMPOSITE

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ABSTRACT

This study was undertaken to investigate physical, mechanical, morphological and thermal properties of polyester filled rubber toughened kenaf composite. The sample were exposed to four difference environments conditions. The condition were artificial sea water (sw), distilled water (ds), natural weathering exposure (exp) and soil buried (Soil). In this study, 25% weight of kenaf fiber were used in the composite. The filler size used in the range of 300-500μm. Polyester resin was modified with 3 phr liquid natural rubber (LNR). The composite board was prepared by adding filler to modified polyester subsequently cross linked using methyl ethyl ketone peroxide (MEKP) and the accelerator cobalt octanoate 1%. The composite board were prepared by using compression moulding technique. The mechanical, chemical and morphology properties were investigated by using DMA, flexural , impact , FT-IR, SEM, hardness, fracture toughness and also water absorption test. All type of conditions exhibit a decrease in mechanical properties of composite with increasing time exposed. For flexural modulus and flexural strength, non- toughened composite in sea water immersion has better modulus of elasticity (MOR) and modulus of rupture (MOE) as compare with others condition. The decrement were only 11.52% for MOR and 10.25% for MOE. Non-toughened composite in distilled water immersion shows better impact properties than other condition with only 8% of decrement. Fracture toughness shows that toughened composite at natural weathering exposure had better result as compare with others condition with decrement were about 5.3%. The hardness value for all condition shows no significant value difference with the range between 80-85 shore D. Water absorption for all conditions increased with increasing of immersion time. There were no new peak observed from FTIR except for soil burial exposure. A new peak was observed at 3400 cm^{-1}- 3200 cm^{-1}. Morphological SEM showed the failure condition of composite mainly due to fibre fracture and fiber pull-out for all conditions. There is a gap between kenaf fibre and matrix for non- toughened composite and it has being observed by SEM. From DMA result, the addition of LNR had reduce T_g value around 16°C-21°C for all exposure condition. For long term used, the addition of LNR help to maintains composite strength and stability thus suitable used for marine applications. While the result was vice versa for natural weathering uses

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TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 RESEARCH BACKGROUND

About 25% of composite plastic failures are related to environmental stress cracking (ESC). ESC can be explained when plastic resin is degraded by chemical agent while under applied stress, and it is the leading towards plastic component failure. It involves a solvent-induced failure mode, in which the synergistic effects of the chemical agent and mechanical stresses will create cracking condition (Jeffry, 2008). Fatigue or also known as creep, is a condition when continuous stress were applied and results in molecular disentanglement within the polymer chains due to the brittle fracture behaviour. Creep failure were common in plastic materials at room temperature due to it viscoelastic properties of polymeric materials. Several steps were involve in the creep failure mechanism that is craze initiation, craze growth that leads to crack initiation and crack extension, and lastly catastrophic fracture. ESC process was rely on the movement and diffusion of the chemical agent into the polymer structure, and because of that, the rate of fluid absorption is a critical parameter in the rate of craze initiation and also crack extension. The more rapidly the chemical agent being absorbed, the faster crazing and subsequent failure in the polymer will it be.

In ESCR, the role of the active environment is to observe the acceleration of sample failure within that condition. It was believed to occur by the absorption of the active environment by the polymer and subsequent 'lubrication' of polymer chains, resulting in earlier failure under Slow Crack Growth (SCG) conditions (Lagaro´n et.al., 1999).

The environment effect is usually considered to be unique. In some environments, it will have large effect produce on the polymer and others have produced no effect at all on the ESC characteristics. For example, water seems has not effected on the polymer properties regarding the ESC (Chan , 1983) . Short chain length alcohols will diffuse inside the polymer and make the polymer swell (Ogata et. al., 1986) . The chemical agent does not directly attack or degrade the polymer. Instead, the chemical penetrates into the molecular structure and interferes with the