

ADVANCES IN MATERIALS ENGINEERING

Volume 2

Edited By:
Md Abdul Maleque
Iskandar Idris Yaacob
Zahurin Halim



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The Effect of R-ratio on Fatigue Crack Propagation in Un-plasticized PVC and Modified PVC

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Abstract. The cyclic fatigue crack behavior of polyvinyl chloride (PVC), with (PVC-M) and without (PVC-U) chlorinated polyethylene (CPE) impact modifier, was studied. The effect of impact modifier upon fatigue crack growth rate was evaluated at R-ratios of 0.1, 0.2 and 0.6. It was shown that the addition of CPE changed the sensitivity of PVC to R-ratio. Different fracture surface characteristics were also observed in PVC-M.

Introduction

The stress intensity ratio (R) is one of the parameter that affects fatigue of polymer. It refers to the ratio of minimum (K_{\min}) to maximum (K_{\max}) stress intensity factors ($R=K_{\min}/K_{\max}$). In general, polymers like PMMA [1-2] and HDPE [3] show higher crack growth rates with higher stress intensity ratio or mean levels. This result signifies that the fatigue crack propagation rate of polymer was dependent on both the range of the applied stress intensity factor and its mean value.

Nevertheless, the fatigue crack growth rate in rubber toughened polycarbonate/copolyester blends is unaffected by the R-ratio and subsequently the mean stress levels [4]. Furthermore, studies by Kim et al. [5] and Balika and Lang, [6] on PVC-U pipes showed that the increment of crack growth rate for R-ratio ≤ 0.5 is only minor. In contrast, a work by Balika et al., [7] for PE-HD pipes, has shown high dependency on the R-ratio. According to Hertzberg and Manson [8], higher crack growth rates at higher R-ratios are the result of greater creep crack extension associated with higher K_{\max} levels and also due to the maximum stress intensity factor which approaches the critical limiting value for the material.

In this chapter the effect of R-ratios on fatigue behavior of unplasticized PVC (PVC-U) and modified PVC (PVC-M). In this case the PVC-M was incorporated with impact modifier that is chlorinated polyethylene (CPE).

Experimental Procedure

Materials

Un-plasticized PVC (PVC-U) and modified PVC (PVC-M) were supplied by IPLEX Pipelines Pty (Australia). A similar formulation was used for both types of pipes as listed in Table 1, except that the PVC-M samples contained 6 pphr CPE. Pipes with outer diameter