SEA WATER EFFECTS ON POLYMERIC COMPOSITES- A COMPARATIVE STUDY

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Abstract

The purpose of the current research is to investigate two aspects of water ingress and water-induced damage into polymeric composites. The first topic concerns the relationship between physical aging and the ingress of sea water into several kinds of these materials, while the second aspect aims at ranking the comparative effects of sea water, tap water and distilled water on composite.Each material were immersed in simulated sea water in temperature controlled containers at 50˚C. Weight gain and weight loss measurements employing metler electronic scale are used as a function of time and the effect of physical aging was separated. The comparative effects of sea water tap water and distilled water on the sorption capacity of T700/vinylester composite, as well as on its material properties are in progress at the present time.

1 General Introduction

The investigations reported herein are motivated by an increasing interest in applying polymeric composites and sandwich layups to naval craft. Such craft, especially submersibles, are exposed to sea water for long durations, whereby both water ingress mechanisms and water induced degradations are of certain concern.

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2 Materials and Experimental Setup

The study of sea-water induced aging of polymetric composites utilized uni-directionally reinforced $[0^\circ]_6$ AS4/3501-6 graphite/epoxy, $[0^\circ]_6$ E-glass/NCT 301 and $[0^\circ]_4$ E-glass/SP1003 materials. Six replicate coupons with in-plane dimensions 12 mm×100 mm of each material were immersed in simulated sea water in temperature controlled containers at 50˚C. Weight gain and weight loss measurements employing metler electronic scales were taken 1, 4, 9, 16 and 24 hours, followed by bi-weekly then weekly intervals beyond the onset of immersion and drying.

Similar weight gain and weight loss measurements are currently in progress for a four layer symmetric layup of bi-axially reinforced Torays Torayca T700 12k fiber tow/vinylester polymeric composite that is in common use as a facing in sandwich layups. Six replicate coupons, with in-plane measurements of 20 mm×200 mm are immersed in sea water, tap water, and distilled water at 50˚C. Smaller samples, of square dimensions 20 mm×20 mm are immersed as above for weight gain measurement.

3 Test plans and Some Results

The effect of physical aging was investigated by separating the samples of each of the aforementioned three composites into two groups. The first group underwent immersion in sea water for five weeks, followed by sequential drying and re-immersion for additional periods of five weeks each. Thus the total exposure history of the first group lasted 15 weeks from inception. The second group was allowed to age in a dry environment for ten weeks and subsequently subjected to the same exposure history as the first one.

Weight-gain results, some of which are shown in Figs 1., 2., and 3. indicate that while the ten week delay in exposure of the AS4/3501-6 and the E-glass/SP 1003 composites had not affected the water ingress into those materials the same delay did reduce the water sorption capacity of E-glass/NCT 301 lay up. This reduction is consistent with the idea

that physical aging reduces the free volume within polymers-which would tend to lower their fluid sorption ability.[1]

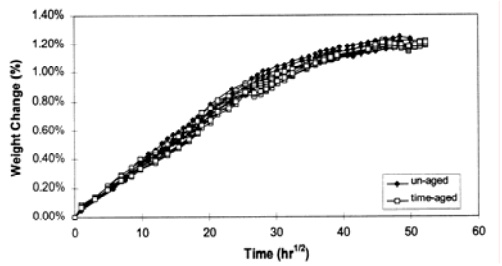

Fig. 1 Weight gain data for AS4/3501-6

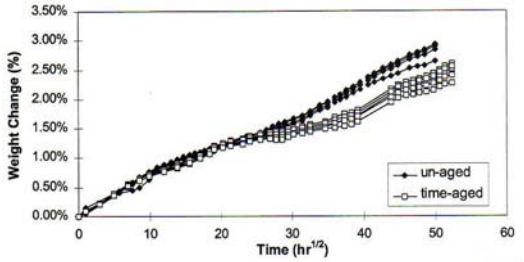

Fig. 2 Weight gain data for E-glass/NTC301

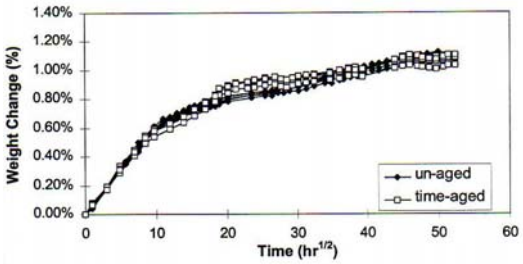

Fig. 3 Weight gain data for E-glass/SP 1003
♦ Un-aged □ Time aged

Additional observations of weight gain, weight-loss and weight re-absorption data were consistent with previously reported results that show the presence of "hysteresis loops" that occur under cyclic exposure.[2],[3]

The comparative effects of sea water tap water and distilled water on the sorption capacity of T700/vinylester composite, as well as on its material properties are in progress at the present time. Results are expected in the near future. Previous studies on the comparative effects of tap water and demineralized water on randomly reinforced composites suggested that tap water was less aggressive than demineralized one.

References

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