Effects of moisture on glass fiber-reinforced polymer composites

Glass fiber polymer composites are used in wind turbine blades because of their high-specific strength and stiffness, good fatigue properties, and low cost. The wind industry is moving offshore to satisfy economies of scale with larger turbines. High humidity in this environment degrades mechanical performance of wind turbine blades over their lifetime. Here, environmental moisture conditions were simulated by immersing glass fiber-reinforced polymer specimens in salt water for a period of up to 8 years. The mechanical properties of specimens were analyzed before and after immersion to evaluate the degradation mechanisms. Single-fiber tensile testing was also performed at different moisture conditions. The water-diffusion mechanism was studied to quantify the diffusion coefficients as a function of salt concentration, sample geometry, and fiber direction. Three degradation mechanisms were observed: polymer plasticization, fiber stress corrosion, and interface degradation, where the latter was found to be the most detrimental for wind-industry applications.

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