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Diffusion of Drag-Reducing Polymers within a High-Reynolds-Number, Rough-Wall Turbulent Boundary Layer BRIAN ELBING, MARC PERLIN, DAVID DOWLING, MICHAEL SOLOMON, STEVEN CECCIO, University of Michigan — Two experiments were conducted to investigate polymer drag reduction (PDR) within high Reynolds number (to 200 million based on downstream distance), rough-wall turbulent boundary layers. The first experiment was conducted at the U.S. Navy's Large Cavitation Channel on a 12.9 m long flat-plate at speeds to 20 m/s with the surface hydraulically smooth and fully rough. Local skin-friction measurements on the smooth and rough surfaces had maximum PDR levels of 65 and 75 percent, respectively. However, PDR decreased with increasing downstream distance and flow speed more rapidly on the rough surface, and at the top speed no measureable level of PDR was observed. The roughness-induced increased diffusion was quantified with near-wall concentration measurements and the second experiment, which measured concentration profiles on a 0.94 m long flat-plate with three surface conditions: smooth, 240-grit, and 60-grit sandpaper. The increased diffusion does not fully explain the smooth-rough PDR differences observed in the first experiment. Rheological analysis of drawn samples from the first experiment indicates that polymer degradation (chain scission) could be responsible for the remaining loss of rough-wall PDR. These results have implications for the cost effectiveness of PDR for surface ships.

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