Surface degradation of HDPE-100 pipe: Effects of some aggressive environments (solvents)

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Abstract : In this study, external and internal surfaces of a high density polyethylene (HDPE-100) pipe are characterized in terms of roughness and hardness in order to understand surface variances in the as-received material and to appreciate surface quality for electrofusion welding or resistance to given aggressive environments. The effects resulting from the action of 3 environmental stress cracking agents that might be in contact with pipe surfaces are studied separately following a specific protocol. In the initial state (as-received pipe), it was found that the outer surface is rougher and harder than the inner surface. In contact with distilled water, the external surface roughness increased slightly by 6% while hardness decreased by 14% although the roughness of the internal face of the tube revealed a small decrease (<5%). The effect of hydrochloric acid was examined with varying concentrations and it was observed that roughness augmented with concentration while hardness remained relatively constant after a major drop by 40% and 32% for outer and inner surfaces respectively. Finally, in the cases of oxidizing agents, dichloromethane (CH2Cl2) and (50:50) mixture of toluene and methanol, a significant disturbance of surface quality is observed and led to a hardness decrease of both outer and inner surfaces of by 20% and 16% respectively. The mechanical properties are also affected as revealed in literature studies. Crystallinitymeasurements confirm the gap between outer (51.55%) and inner (61.31%) surfacesindicating that degradation has taken place at the structural level when HDPE wasin contact with those aggressive agents. After exposure to these environments, results indicate that crystallinity fell approximately one third compared to as-received material, therefore reducing resistance to fracture and pipe lifetime.

Keywords : polyethylene pipe, surface roughness, hardness, degradation, aggressive environments, crystallinity