

Degradation of plastic pipe surfaces in contact with an aggressive acidic environment

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Abstract: Polyethylene (PE) pipes transporting water are vulnerable to aggressive agents which are able to diffuse through buried plastic pipes causing oxidative degradation. The latter may occur as a result of a spontaneous chemical reaction with atmospheric oxygen or as an induced oxidizing reaction with disinfectant agents (i.e. chlorine or hypochlorous acid ions) which are commonly added to municipal water supplies for public health reasons. Basically, PE pipes surfaces undergo undesired oxidation reactions whenever they are in contact with adverse external environments and/or when conveying fluids which tend to modify internal pipe wall structure. In this work, the effects of distilled water and diluted hydrochloric acid at different concentrations on the external and internal surfaces of a high density polyethylene (HDPE-100) pipe are studied. The measured parameters are roughness and hardness in order to appreciate surface quality variances in as-received and degraded materials. Initially the outer surface is rougher than the inner's one but in contact with distilled water, the external surface roughness increased by 6% although the internal face of the tube revealed a small decrease (<5%). When exposed to hydrochloric acid, pipe roughness (μm) showed a substantial increase as a function of increasing medium concentration. Crystallinity ($\%$) measurements confirmed the gap between outer (51.55%) and inner (61.31%) surfaces indicating that degradation has taken place at the structural level when HDPE was in contact with such aggressive agents. On the other hand, it is revealed that after exposure to oxidizing environments, crystallinity dropped by approximately one third when compared to as-received material; therefore reducing resistance to fracture and subsequently pipe lifetime.

Keywords : polyethylene pipe; environment; distilled water; diluted hydrochloric acid; degradation; surface roughness; hardness; crystallinity.