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EFFECT OF COMBINE MECHANICAL AND THERMAL LOADS ON DEGRADATION OF PRE-INSULATED DISTRICT HEATING PIPES

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Abstract
Focus on ageing and failure mechanisms of district heating (DH) pipes has been intensified since it is recognised as an important element for planning and maintenance of energy infrastructure. Pre-insulted pipes composed of steel service pipe, polyurethane (PUR) insulation and polyethylene casing have dominated market for DH pipes in Europe since 1980's. Ageing of these pipes has been studied since then and various methods have been used for prediction of their life-time. The existing literature and standardisation work have identified thermal and thermo-oxidative degradation mechanisms as the crucial failure mechanism for PUR insulation material. It is known that this degradation mechanisms lead to loss of adhesion between PUR and steel service pipe. Beyond this, DH pipes undergo significant temperature variations due to variations in operating conditions and customer demands, which create besides thermal loads in addition mechanical loads. Our preliminary results have shown that the mechanical stress accelerates thermal and thermo-oxidative degradation of the PUR and significantly affects the rate of deterioration of PUR and lose of adhesion. The degradation of PUR foam, at the interface with a steel pipe was evaluated using measurements of the adhesion strength and alterations in the chemical structure of PUR by Fourier transform infrared spectroscopy. The main conclusion was that the thermal degradation of mechanically stressed DH pipes was significantly faster than that of non-loaded pipes aged at the same temperature. It was also shown that the faster degradation in the mechanically loaded pipes is mainly due not to fatigue but to accelerated chemical degradation of the PUR foam.

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