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HDPE pipes failure analysis and damage modeling

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Abstract

Thermoplastic pipes are used in all the industrial fields such as water, sewage and gas piping systems and other industrial applications, like the transport of minerals and slurries. The choice of the right piping system's material depends on many criteria. First of all, it depends on the conditions of use of each kind of material. Secondly, it depends on the cost of the chosen material and finally the mastering of the material's scenarios of failure. The last criteria are possible through the mastering of the material characteristics and the capability to detect the failure, burst or crack, before its occurrence. The adopted approach must be proactive to facilitate the prediction of the failure and help the maintenance staff to apprehend the piping system's damage at the right time. In this paper, we chose HDPE pipes as material for our study. Then, we led a new approach of failure analysis and prediction using new models. These models are obtained through a modified version of the stress controlled unified theory, a static damage model using burst pressures and a static damage model using the time to failure. For that reason, we used burst pressures of undamaged HDPE pipe instead of ultimate stresses. Then, we created groove notches with different levels of depth. The obtained burst pressures from these pipes have been considered as the residual burst pressures used in our damage models. The representation of the obtained data according to the life fraction gave us an idea about the critical life fraction and then the critical groove depth which can be allowed. This information has been confirmed by three damage models. Then, we determined the different stages of damage to help the predictive maintenance to define the safe intervals of the HDPE pipes' service. Moreover, the three developed models, presented in this paper, represent a simplified approach to assess the damage based on static tests only, without doing any dynamic tests. The developed cost-effective approach can be a tool that can help the industrials to have an anticipative maintenance strategy and respect the safety requirements. Also, it can help them to do quick checks or launch audit mission to the manufacturers' factories for HDPE pipes' quality control and conformity check regarding the codes.

Keywords: HDPE pipe, burst pressure test, notched pipe, cumulative damage, life fraction, static tests.

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