Einladung
zum
Seminarvortrag

„Plastic Pipe Lifetime Predictions and Accelerated Testing“

by

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Biography

Alexander Chudnovsky is UIC Distinguished Professor Emeritus and Director of Fracture Mechanics & Materials Durability Laboratory at Civil and Materials Engineering Department, The University of Illinois at Chicago, USA.

Professor Chudnovsky is an internationally recognized authority in the fields of Fracture of Solids, Materials Durability and Structural Reliability. His scientific accomplishments include Mathematical Theory of Elastomers, Entropy Criterion of Local Failure, Statistical Fracture Mechanics and Crack Layer Model, a recent development of nonlinear Fracture Mechanics. He has published a monograph and more than 270 technical papers.

Abstract

Plastic Pipe Lifetime Predictions and Accelerated Testing

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A requirement of 50 and 100 years of plastic pipes life expectancy is quite common. One needs to conduct an accelerated testing to determine such life expectancy. The main challenges of accelerated testing are (i) to reproduce the mechanisms of previously observed field failures and (ii) to develop a reliable procedure for extrapolation of a relatively short test data into long-term service conditions. Acceleration of fracture by high stress level turns to be inadequate, since the fracture mechanisms change form ductile at high stress level to stress driven cracking at intermediate stresses and material degradation related brittle fracture at low stresses.

Temperature accelerated testing for lifetime is the most popular technique at the present. This approach, however, also faces a problem associated with the changes in the mechanism and kinetics of slow crack growth (SCG). At a certain combination of load and temperature, a transition from a continuous SCG to discontinuous, stepwise crack propagation has been reported. Optical and scanning electron microscopy observations suggest that the change of SCG mechanism is closely related to the material ability to form a stable process zone (PZ) in front of the growing crack. In engineering plastics PZ usually consists of single or multiple crazes and/or shear bands. The phenomenological relations between average SCG rate and the stress intensity factor in the continuous and stepwise crack growth modes are noticeably different.

The change in the mechanism and kinetics of SCG results from a transition from a ductile to a brittle behavior of microfibers within PZ. It is referred to as ductile–brittle

transition of the second kind (DBT2) based on a resemblance with well-known ductile–brittle transition in dynamic impact resistance. DBT2 implies certain limitations for extrapolation of commonly used high temperature accelerated test data to a relatively low temperature service conditions.

An alternative to conventional accelerated testing approach for intermediate and low stress level is discussed in this presentation. It consists of three steps. The first is a characterization of the defects population that is responsible for fracture initiation. Formulation of constitutive equations of SCG based on specially designed tests is the second step. Numerical simulation of fracture process using constitutive equations developed within the second step and evaluation of the lifetime of plastic pipes is the third step. An example of realization such 3-steps program is presented.