

Wang, Y.-Y., Liu, M., and Horsley, D., Application of Constraint-Sensitive Fracture Mechanics to the Assessment of Girth Weld Integrity, Proceedings of 4th International Pipeline Conference, Calgary, Alberta, Canada, 2004, Paper No. IPC2004-0525

Abstract

It has been known since the 1960's that the crack-tip fields of specimens containing sharp cracks depend on the mode of loading. Experimental evidence has shown that cracked specimens loaded in bending have lower toughness than the same material loaded in tension. This phenomenon has been attributed to the "constraint effect" on fracture. Modern constraint-sensitive fracture mechanics has brought about fundamental theoretical understandings on the constraint effects. The constraint-sensitive fracture mechanics has moved from academic circles to practical application, as evident by a number of recently published fitness-for-service (FFS) assessment procedures that incorporates the constraint effects. This paper reviews the developments in constraint-sensitive fracture mechanics with the focus on its potential applications to the assessment of pipeline girth weld integrity. The review covers (1) constraint theories and experimental evidences, (2) constraint models for brittle and ductile fracture, and (3) limitations of current constraint models. The paper closes with thoughts on the applications of the constraint models and theories to ductile fracture processes, which are the most relevant to modern linepipes and their welds.

Keywords

ECA, Fitness-for-service, Constraint, Fracture mechanics, Ductile fracture, Brittle fracture, Pipeline