Evaluation of J-R curves for pipeline API 5L X70 girth weld using SENT specimens.

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The precise evaluation of pipeline structural integrity is very important considering that it involves the transportation of gas, oil and its derivatives. The high ductility of these steels makes necessary the application of Elasto-Plastic Fracture Mechanics methodology due to the occurrence of large amount of plastic deformation at the front of any crack-like defects that may exist. In the elasto-plastic methodology based on J-integral, one very important data is the determination of the crack growth fracture resistance curve, generally called J-R curves. In order to simplify the evaluation of the J-R curves, some standards present methodologies and techniques that make possible the use of just one standard specimen (C(T) or SE(B) for example). However, to facilitate the transfer of the experimental J-R curves to those for actual cracked components, like flawed pipeline, constraint corrected J-R curves must be developed. Some researchers demonstrated that in case of a pipe with a crack, SENT specimen type best represents this constrain situation, but unfortunately this type of specimen is not contemplated by any standard to provide J-R curves. The present work is aiming to provide data input including J-R curves of a API 5L X70 pipeline girth weld at various situations like base material, weld bead and HAZ. The tests were carried out at room temperature, using SENT specimens, the unloading compliance methodology (one specimen) and using an extensometer coupled at the crack mouth, CMOD. SENT specimens were removed from a API 5L X70 plate with constant H/W ratio, two different W/B (2,5 e 1) and with a shallow and deep crack (a/W of 0.2 and 0.5) and 20% side grooves. The specimens removed from the pipe girth weld, were smaller in size but with similar side grooves and H/W ratio, B/W = 2.5, W = 14 mm and a/W = 0.2. The employed experimental methodology allowed the obtaining of J-R curves that were analyzed and compared with some data from literature. Shallow cracks (a/W=0.2) provides slightly higher values of J-integral than the specimens with a/W= 0.5. It was also observed that specimens with large dimensions (removed from plates) provided similar J-R curves than those directly removed from pipes (small dimensions). The results are discussed in detail.

Keywords: SENT specimen, API 5L X70 steel, J-R curves, Fracture Toughness.