TO JOINT EFFECT OF TEMPERATURE AND NOTCH ROOT RADIUS ON FRACTURE TOUGHNESS

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For low-alloyed cast ferritic steel simultaneous effect of temperature and notch root radius on fracture toughness has been investigated. Due to fact that fracture tests were performed on notched specimens (cylindrical tensile specimens with circumferential notch having three notch root radii), the concept of Notch Fracture Mechanics was applied. Volumetric fracture criterion with two parameters, effective stress and effective distance, was developed. The goal of the work was to quantify the influence of notch radius on transition temperature and notch fracture toughness, and, in addition, to present jointly the role of both these parameters in fracture behaviour.

In the case of the studied cast steel with a low yield stress (375 MPa), effective distance is 3 to 4 times longer than the Creager's effective distance (half of notch radius). The transition region and temperatures are shifted to higher values when notch radius decreases. At temperature higher than a temperature called plateau temperature T_{p} ductile failure appears. The T_{p} temperature is sensitive to notch radius being affected by stress triaxiality. It is possible to define a notch sensitivity compensated temperature $T^* = \sqrt{\varrho/\varrho_{\mathrm{c}}}$. In the transition regime, critical notch stress intensity factor varies linearly with T^*.

Key words : *notch fracture mechanics, fracture toughness, notch effects, stress triaxility, cast ferritic steel, transition behaviour*

1. Introduction

Ferritic steels exhibit a transition from brittle to ductile fracture. This transition is promoted essentially by three factors : temperature, loading rate and stress triaxiality. By increasing temperature, Charpy impact energy rapidly increases at transition and the failure mechanism is changing from cleavage to ductile fracture, which consists of void nucleation, growth and local plastic instability. Cleavage is typical fracture micromechanism at low temperature, ductile failure at high temperature. The change is associated to a peculiar temperature called transition temperature defined by various ways, usually for a conventional value of Charpy energy (e.g. 28 joules for transition temperature $T_{\mathrm{K}\,28}$) [1].

Fracture toughness K_{Ic} increases exponentially with temperature T [2]. This is because the fracture mechanisms needs plastic deformation which is a thermally activated process obeying to Arhenius law. Smooth evolution does not allow to determine on a curve $K_{\mathrm{Ic}} = f(T)$ a transition of fracture mode. A reference temperature T_0 is then defined for a conventional value of $100\,\mathrm{MPa\,m^{1/2}}$ [3].

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