THE INFLUENCE OF HYDROGEN TREATMENT ON DYNAMIC CRACK RESISTANCE OF 10G2SAF STEEL

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This paper describes the results of an investigation on influence of hydrogen ions on fracture properties of 10G2SAF steel under impact loading. The experiments have been performed with precracked Charpy specimens. From the critical load for onset of crack propagation the dynamic fracture toughness values K_{Ic}^{d} have been mesured for both non-treated and hydrogen treated specimens.

INTRODUCTION

The problem of hydrogen effect on fracture resistance of metals is a problem of scientists, engineers, desingners - all those who work to ensure serviceability of machinery and equipment. The needs of contemporary practice and future prospects in development of technogy contribute to this interest.

Among hydrogen effects on various mechanical properties of metals-tensile strength, plasticity, fatigue characteristics, ect, - the initiation and propagation of cracks induced by hydrogen in metals is worth a most profound interest. Due to the hydrogen influence the defects, usually negligible, may become dangerous and cause accidental brittle failure of metals.

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The purpose of this work is to present some results of an investigation on influence of hydrogen ions on fracture resistance of 10G2SAF steel under impact loading.

EXPERIMENTS AND DISCUSION

The object of this study is to establish the embrittlement of 10G2SAF steel after electrolycal hydrogen treatment in 3% H_2SO_4 solution with $J=1.5x10^2$ $A.m^{-2}$ and different time duration for desire concentration of hydrogen ions to be reached in precrack tip region. Charpy fatigue precracked specimens have been used for determining $K_{Ic}{}^d$ rate range from $1x10^3$ to $3x10^5$ $MPa.m^{1/2}.s^{-1}$. This test has been carried out by means of Charpy pendulum according to the method suggested by Kalthoff et al (1). Modified Hopkinson bar and the half Charpy fatigue precracked specimen and the method as described by Stroppe et al (2) have been used for determining $K_{Ic}{}^d$ within the loading rate range $\dot{K}_I$ from $1x10^6$ to $1x10^7$ $MPa.m^{1/2}.s^{-1}$.

The results are summarized in table 1 indicating the change in fracture toughness history. The temperature dependence of $K_{Ic}{}^d$ is presented in Fig.1 for both non-treated and 8 h electrolycal hydrogen treated specimens. Time duration effect of hydrogen treatment on $K_{Ic}{}^d$ dependence is shown in Fig.2.

TABLE 1 - Fracture toughness history after 8 h treatment

	$K_{Ic}{}^d$ $(MPa.m^{1/2})/\dot{K}_I$ $(MPam^{1/2}.s^{-1})$				
	10^3	10^4	10^5	10^6	10^7
Treated	30.7	28.06	31.2	34.3	34.9
non-Tr.	39.4	38.1	38.9	40.2	42.3

CONCLUSIONS

1. The material embrittlement due to the 8 hours electrolycal hydrogen treatment is between 17% to 29% for whole test rate range and is highest at $\dot{K}_I = 3x10^4$ MPa.m$^{1/2}$.s^{-1}.

2. The brittle - to - ductile fracture transition temperature is shifted by 30^o C toward the higher temperature.

3. The mechanism of fracture has not been affected by hydrogen ions treatment.

SUMBOLS USED

$\dot{K}_I$ = loading strain rate (MPa.m$^{1/2}$.s^{-1})

J = curent density (A.m^{-2})

REFERENCE

(1) Kalthoff, J.F., Winkler,S. and Bohme, W.,J. de Physique,tome 46., Aout 1985 pp.C5-179,C5-186.

(2) Stroppe, H., Clos, R. and Schreppel, U., Proc. ECF-7, Vol.II, 1988, pp.634-640.

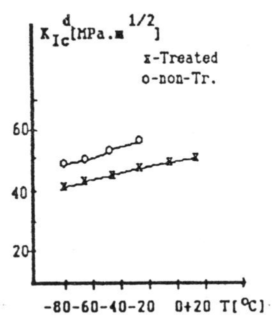

Figure 1 Temperature dependence of K_{Ic}^d

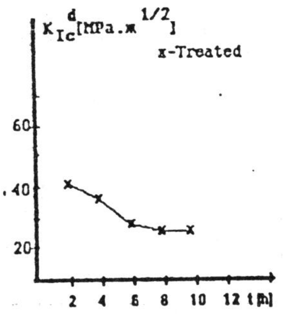

Figure 2 Time duration effect of H.T on K_{Ic}^d