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Experimental study of the creep lifetime of the butt-welded 1.25Cr0.5Mo steel pipes

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1 Introduction

High temperature pressurized pipes have a vast application in power generation and petrochemical plants. Also, the trend to increase the thermal efficiency of these systems leads to the use of high level working temperature. Therefore, it is necessary to study the creep behaviour of the high temperature alloys which are used in these systems. In this paper, physical parameters for the creep constitutive equations for three different layers (parent, HAZ, Weld) of a but-welded joint of low alloy ferritic steel 1.25Cr0.5Mo have been determined using experimental data. This alloy is used mostly in power generation and petrochemical industries due to its high temperature creep resistance.

In structural components after long-term service at elevated temperature, fracture occurred not in the base metal but mainly in the weldment. Recently, nucleation and propagation of creep voids and cracks in the heat affected zone (HAZ) of weldments after long-term service has become a world wide problem to solve. Research to elucidate its mechanisms is being actively carried out. [1-3]

2 Experimental tests

The samples for creep tests have been obtained directly from the new pipe wall material of the super-heater with outer diameter of 51 mm and pipe thickness of 4.5 mm. Chemical composition of the pipe material (1.25Cr0.5Mo) is given in Table 1. The test specimens have been machined out from the pipe wall according to the ASTM E8M. [4]

Table 1. Chemical composition of low alloy ferritic steel 1.25Cr0.5Mo (Astm A213 [20]) in percent

Element	C	Mn	P	S	Si	Cr	Mo
%	0.05-0.15	0.3-0.6	0.025(max)	0.025(max)	0.5-1.0	1-1.5	0.44-0.65

Creep tests have been carried out using 3000 kg, SATEC creep test machine according to the ASTM E139 [5] standard. Figure 1 presents the variation of creep strain with time for some of the tests.

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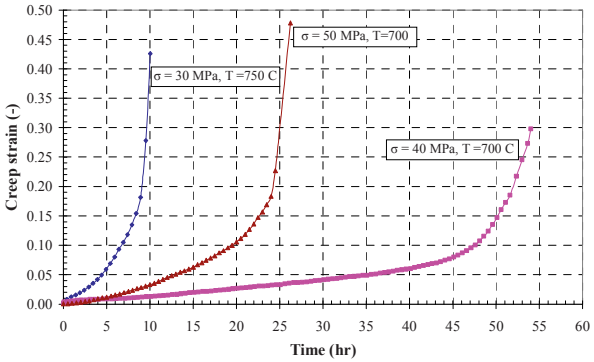

Fig. 1. Creep strain vs. time for creep tests of low alloy ferritic steel 1.25Cr0.5Mo

3 Calculating constitutive parameters

The experimental data have also been used to obtain the constitutive parameters using numerical optimization techniques. Also the temperature and stress dependency of the creep lifetime for this alloy has been investigated using Larson-Miller and Monkman-Grant parameters. The results show good agreement with other test data such as ASTM and API. Finally, these constitutive equations have been used to study the creep behaviour of the super-heater pipe weldment.

4 Conclusions

The results show that the super-heater tube has been over designed in terms of the creep lifetime. However, by increasing the pressure or temperature, the creep crack initiation site transfers from inner wall-HAZ at nominal working condition to the outer wall-HAZ position.

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