

Remnant life prediction of service-exposed 12Cr1MoV superheater tube in power plant

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Keywords: 12Cr1MoV steel; Larson-miller equation, piping in boiler; remnant life

Abstract. Tensile test at ambient temperature, tensile test at high temperature and high temperature tensile creep test were carried out before remnant life prediction. According to the high temperature tensile creep test data, the relationship between working stress, working temperature and rupture life was obtained by MATLAB surface fitting tool. In order to obtain the temperature field and stress field of the superheater tube, ANSYS software was used. Then, the remnant life of the superheater tube was predicted by the extrapolating method and the relationship between working stress, working temperature and rupture life.

Introduction

How to prolong the life of power equipment[1-3] and ensure its normal operation has become an important problem concerned by power field. At the present time, many achievements[4, 5], which have a high value of practical application, have been acquired in the fields of equipment life management and prediction, and equipment condition monitoring and fault diagnosis.

Presently, the methods[6, 7] for remnant life prediction of service-exposed boiler tube can be divided into the following types. The first type is periodic measurement of boiler tube diameter, wall thickness and etc. The second type is based on working temperature, working stress and Robinson rule. The third type is based on the changes of distribution of eutectic carbide and secondary carbide as time goes on. The fourth type is based on high temperature tensile creep test and Larson-miller equation. The fifth type is based on low cycle fatigue test. The sixth type is based on the changes of density and voids. All the methods need to take a lot time. To acquire more reliable result, it is necessary to simultaneously use two or more methods to confirm with each other.

In the paper, we use the finite element software ANSYS to analyze the temperature field and stress field of the 12Cr1MoV, and get the maximum working stress. Based on Larson-miller equation and MATLAB[8] surface fitting tool, the remnant life of the service-exposed 12Cr1MoV superheater tube was predicted.

Experimental details

These experiments include two parts: (1) tensile test at ambient temperature and tensile test at high temperature, (2) high temperature tensile creep tests.

The chemical composition of the experimental material 12Cr1MoV steel was shown in Table 1. The mechanical properties and physical properties were respectively shown in Table 2 and Table 3.

Table 1 Chemical composition of 12Cr1MoV steel

Element	C	Si	Mn	Cr	Mo	V	P	S
Test sample	0.12	0.19	0.60	1.04	0.28	0.18	0.018	0.008
GB 5310-2008	0.08-0.15	0.17-0.37	0.40-0.70	0.9-1.2	0.25-0.35	0.15-0.30	<0.025	<0.01

The test samples were made according to Chinese standard GB/T 2039-1997. The procedure of tensile test at ambient temperature was based on Chinese standard GB/T 228.1-2010. The procedure of tensile test at high temperature was based on Chinese standard GB/T 4338-2006. The tensile test and creep test (Table 4) at high temperature were carried on CSS-3905 electronic high temperature creep testing machine.

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