Welding Creep-Resisting Steels

Creep resistance of similar and dissimilar weld joints of P91 steel

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ABSTRACT

Two experimental weld joints, a similar weld joint of 9Cr–1Mo steel and a dissimilar weld joint of 9Cr–1Mo and 2.25Cr–1Mo steels, were fabricated by the TIG+E method and post-weld heating was applied. Creep testing was carried out at temperatures ranging from 525 to 625°C in the stress range 40–240 MPa. Creep rupture strength was evaluated using the Larson–Miller parameter. Extended metallography including transmission electron microscopy was performed and critical zones were indicated where fractures were concentrated during the creep exposure. At high temperatures rupture of the dissimilar weldment occurred in the heat affected zone (HAZ) of the weld metal while rupture of the similar weldment was located in the HAZ of the parent material. The processes of recovery seem to be the main causes of decrease in creep rupture strength of both weld joints in comparison to the parent materials.

Keywords: creep-resistant steels, welding, microstructure, transmission electron microscopy

1. INTRODUCTION

The creep-resistant ferritic steels alloyed by chromium and molybdenum are widely used for high temperature applications in fossil-fuel power plants. Modified (9–12)%Cr steels are preferred even for production of components which work at temperatures above 600°C and which have been usually made from austenitic stainless steels. Several new grades (P91, P92, P911) were developed, which are currently used for producing high efficiency power plants. The high strength properties of these grades make it possible to reduce the size and the weight of individual components.

Turbines, boilers and steam piping belong to the most exposed parts of steam power plants. They operate under severe service conditions for several decades. Therefore high mechanical strength, good corrosion resistance and high structural stability of materials used for their production are desired.

The steam piping is exposed to different conditions because of the changing steam parameters. The pipes submitted to temperatures higher than 550°C can be produced from tempered martensitic (9–12)%Cr steels, which are favoured due to their excellent combination of mechanical and oxidation-resistant properties. The other parts of the piping are usually made from creep-resistant low alloy Cr–Mo or Cr–Mo–V steels [1].

Welded joints are commonly susceptible to fracture especially if different materials are welded. Fracture is usually initiated in a specific microscopic region either during fabrication or during service as a result of structural heterogeneity of the weldment [2]. Since cyclic thermal and stress loading after each weld pass effects the steel structure, great attention has to be paid to welding technologies and selection of convenient welding metals.

SKODA POWER a.s. as a steam turbine manufacturer uses P91 grades for forged and cast steels in new high efficiency power plants and also for upgrading existing equipment. In the production of steam piping this steel is welded with low alloyed P22 steel. Two trial weld joints of P91 and P22 steels were carried out, which satisfied all requirements set by technical standards. In this paper additional creep testing and extended metallography accomplished by scanning (SEM) and transmission (TEM) electron microscopy are described. While for similar weld joints the choice of welding consumables is relatively straightforward, for dissimilar welds the choice of filler metal and post-weld heat treatment offers a larger variety of solutions. In this study a dissimilar weld joint of P91 and P22 steels was made using weld metal on the base of low alloy Cr–Mo steel.

2. EXPERIMENTAL PROCEDURES

Two weld joints were fabricated from creep-resistant 9Cr–1Mo steel known as P91 or X10CrMoVNb9-1 steel and 2.25Cr–1Mo steel marked as P22 or 10CrMo9–10 steel. Straight pipes with external diameter 324 mm, thickness 25 mm and length 400 mm were joined by TIG+E method (manual welding under argon atmosphere with a coated electrode). The chemical composition of the parent and the welding materials used is given in Table 1. The parent steels were used in normalized and tempered conditions.

Welding was carried out using internal protection of the weld root by inert gas. Inductive heating with thermal

0960-34093/4/2006

Creep resistant steels are steels designed to withstand a constant load at high temperatures. The most important application of creep resistant steels is components of steam power plants operating . Welding stainless steels.creep-resistant steels, their weldability and properties of welded In comparison with P91 steel, this alloy contains some tungsten (up to 2%).made of creep-resistant steel with 9 to. 12% chromium. For joining this type of steel, martensitic welding is undertaken, which is carried out following preheating .Creep-resistant steels are widely used in the petroleum, chemical and power generation industries. 17 - Creep strength of welded joints of ferritic steels.Creep-resistant-steels are designed to perform satisfactorily for long time at high service temperatures. Their composition requires special precautions, notably.During recent years, a weld repair technique for low alloy CrMoV steel castings, using CrMoV weld metal, which dispenses with preheat and post-weld heat.Selected damage mechanism in creep-exposed welded joints. Implications for industries using welded creep-resistant steels. Future trends.Power station pipelines and other structural fabrications operating at high temperature are predominantly made of creep-resistant steels. These steels may .Creep-resistant steels. Edited by. Fujio Abe, Torsten-Ulf Kern and R. Viswanathan . Implications for industries using welded creep-resistant steels. The effect of potential changes of intercritical microstructure on creep rate at exploitation is discussed. Key words: creep resistant steel,welds, creep rate, HAZ, .The new boron-alloyed 9CrMo-1Co cast steel designated as CB2 is used for intermediate pressure turbine inner casings with steam temperature up to This paper deals with a case study of a radiation tube failure in a fuel hydrogenation refining furnace. The tubes, made of Cr-Mn creep resisting steel, were.PDF The new boron-alloyed 9CrMo-1Co cast steel designated as CB2 is used for intermediate pressure turbine inner casings with steam temperature up to.By registration of thermal cycle during welding and subsequent HAZ simulation Key words: heat resisting steel, heat affected zone, instrumented Charpy test.Within the last years, the beneficial effect of boron addition in order to increase the creep strength of martensitic 912 % Cr steels has been widely investigated.24 Apr - 57 min - Uploaded by bhadeshia Steels which can serve at very high temperatures (in excess of K) with tolerable oxidation.