Abstract

Power plant components are expected to withstand service at high temperature and pressure for thirty years or more. One of the main failure mechanisms under these conditions is creep. The steel compositions and heat treatments for this application are chosen to confer microstructural stability and creep resistance. Nevertheless, gradual microstructural changes, which eventually degrade the creep properties, occur during the long service life. The topic of this dissertation was selected to concentrate on the welding of 10 - 12 % Cr martensitic creep resistant steels during their applications at elevated temperatures. The studying of this topic is interested because of its higher importance for the development of many important components of the power generation plants. The work on this dissertation is concentrated on the weldability of the 9-12 % Cr steels. Generally the welding task to produce components of these types of steels is connected to three main aspects, the materials used, the technology applied for production and use of these steels as well as their structure, which are considered to be connected to weldability. Based on this, we built up the content of this dissertation according to these aspects.

High alloyed martensitic creep resistant steels, particularly 10 - 12 % Cr group are the most important grades used for the production of components of power plants. An analysis of the effect of boron addition to 9-12 % Cr steels was carried out. The results of this work showed that the combination of the controlled addition of boron, cobalt and tungsten has a significant improvement of the toughness of the steels containing this combination of these elements. Another investigation was applied on two types of this group of steels using the Jominy test to investigate their hardenability. During this test different hardness profiles from the well known profiles for other hardenable steels were obtained for the tested steels. More microscopical investigations have to be applied for more analysis of the reasons of these profiles.

A study was carried out to investigate the application of the preheating technique for welding and the sensitivity to cold cracking for the steel X22CrMoV 12 1. The preheating temperature was calculated according to the method introduced by Prof. L. Beres and the result showed that the application of this method can be applied to avoid cold cracking of the welded joints. We have also used the same preheating calculation method for a welded joint for our W-alloyed steel X20CrMoWV 12 1 1, it was prepared and practically investigated by applying some mechanical tests such as tensile test, bending test, hardness test and the cold cracking CTS test. The results indicated that the martensitic welding method worked out by Prof. Beres can be practically used for this type of steels.

An evaluation of creep property of the steel grade (X22CrMoV 12 1) from miniature-sized specimens was made using a so called small-punch test (SPT). This investigation was concerned with the evaluation of the creep property of the weldments of the tested steel using this testing method. A comparison of creep properties between base material, weld metal, and HAZ of the welded joints of the investigated steel was introduced. The application of SPT is difficult because of the complication of the used testing apparatus. Due to this fact a tensile test on notched samples at elevated temperature (500 °C) was applied for creep resistant steel grades. In this type of testing, notch opening displacement (NOD) was measured to introduce the relationship between the notch opening displacement (NOD_0) at a notch radius R = 0, and

the creep properties of these steels. The obtained master curves (relation between creep properties and NOD_0) from different creep resistant steels have been applied for testing of a welded joint of our investigated W-alloyed steel X20CrMoWV 12 1 1. This application gave a possibility to compare the creep properties of different zones of welded joints for these steels, and to apply a new easy applicable method. The results of dissertation are applicable in the practice, but our suggestion is to continue the investigation of martensitic creep resistant steels for getting more information about them.