Mgr inż. Karol Sówka

Doctoral dissertation:

"Analiza trwałości eksploatacyjnej złączy spawanych z żarowytrzymałej stali P92"

ABSTRACT

This doctoral dissertation analyses the operational durability of pipe welded joints made of P92 steel (X10CrWMoVNb9-2) used in modern power plants operating in supercritical parameters. The joint's operational durability is influenced by many factors, and its assessment should be based on the largest possible number of research techniques, including microstructural studies, mechanical properties tests, and creep tests. P92 steel is mainly used for components of steam pipelines, such as main steam pipelines, operating at temperatures reaching up to 610°C.

The theoretical part of the dissertation describes the main directions of development of the Polish energy sector and its current state. The main groups of materials used in modern energy, including martensitic steels, particularly the examined P92 steel, are discussed. The technological aspects of welded tubular joints' fabrication and non-destructive testing are presented. Methods for assessing the operational durability of the material of pressure parts are described, with particular emphasis on the diagnostics of the degradation degree of components operating above the threshold temperature.

In the research part, a comprehensive process was followed to obtain the results of welded tubular joints in their initial state and after long-term annealing at 600°C and 650°C for 3000 and 10000 hours. Material characteristics including microstructural state, mechanical properties, creep resistance, and precipitation analysis for each examined material state were provided. This process involved a thorough understanding of the morphological features of the material in its initial state and X-ray analysis of the chemical composition of micro-areas, leading to precise precipitation identification. Quantitative analysis of microstructure images in all zones of the joint was the basis for conducting a basic statistical analysis. The results of the creep strength tests allowed us to determine the loss of operational durability of the examined joints depending on the annealing time and temperature, ensuring the validity and reliability of our findings.

The obtained material characteristics form a reasonable basis for developing quality-technological procedures and implementing standards of conduct into industrial practice in cases of failures or other events disrupting the energy production process in power plants. The characteristic cards in the developed form can help estimate the loss of operational durability without detailed information about the actual operating parameters of the object. Comparing the microstructural state of the material on the object can help predict the time of further safe operation of welded pipe joints.

K. Sówka