SUMMARY OF THE DOCTORAL DISSERTATION

The country's energy security is not only related to the guarantee of continuous uninterrupted energy supplies at an affordable price, but also to the availability of the infrastructure and the operational reliability of the generating sources. The first of these factors is provided by nuclear power plants, and in the Polish conditions, by the coal-fired power units. These units contrary to the so-called renewable energy sources (RES) ensure stable, predictable, and continuous access to the produced energy. However, in the other case, the reliability of the elements of machines and devices of a power unit is connected with diagnostic tests, including metallographic tests.

The requirement to limit CO_2 emissions into the atmosphere in the power industry has caused, among others, the construction of 5 new supercritical units in Poland. These units are based primarily on modern heat-resistant steels and alloys. The introduction of modern materials into the power industry is preceded by many years of research to verify the properties of the alloy under study in terms of its potential use as a heat-resistant structural material. Based on metallurgical tests (destructive and non-destructive) of the analyzed alloy, its characteristics and databases are being developed, which in the future may be the basis for assessing the degree and rate of degradation of components and parts made of this material during its actual operation in a power unit.

One of the modern heat-resistant materials intended for critical components is the nickel-based alloy 23Cr-45Ni-6W-Nb-Ti-B (HR6W).

The initial individual research and literature data show that the main process degrading the microstructure and functional properties of alloys with austenitic matrix during their service are the precipitation processes and changes in morphology of the secondary phase precipitates. Thus, the main purpose of the doctoral thesis were the tests and analysis of precipitation processes running in the nickel-based HR6W alloy after long-term ageing at the temperature of 700 and 800°C and time up to 20 000 hours, and their influence on the changes in the mechanical properties.

The research was preceded by a literature review, which consisted of three chapters. The first one contains a description of the requirements of the European Union regarding the share of conventional energy in electricity production in Poland, and also indicates the types of materials used in supercritical operating parameters. The second chapter contains previously

published scientific information on the research material - nickel-based alloy HR6W. The literature part concludes with a chapter containing a description of the mechanisms of degradation of the microstructure of materials used in the power industry, with particular emphasis on austenitic matrix alloys, along with a description of the primary and secondary phase precipitations potentially occurring in the microstructure of these materials.

The research part of the paper begins with a thesis and particular aims of the work. In the following chapters, the scope of individual research is presented, the research material is characterized, and the research methodology is described. The metallographic tests results are then presented for HR6W alloy in the as-received state and after long-term ageing. To determine the influence of long-term effect of temperature on the degradation of the microstructure of the examined alloy, microstructural tests were carried out using optical microscopy, scanning microscopy, and transmission electron microscopy.

The entire study was supplemented with mechanical property tests, including static tensile testing, impact testing, and hardness measurement, in order to determine the impact of microstructure degradation on changes in the mechanical properties of the tested alloy.

The obtained results of individual research allowed building a model of microstructure degradation through determining the sequence of precipitates and preparing a graphical pattern of changes in the microstructure of the given alloy. As the engineering practice shows, the pattern of changes in the microstructure of an alloy used in the power industry is helpful for the material diagnostics to assess the degree of fatigue of the given material that the power boiler elements are made of. What is also used for the correct assessment of the degree of material exhaustion is also the knowledge of long-term influence of temperature on the changes in mechanical properties of the alloy. For the examined creep-resisting nickel-based HR6W alloy, the research has confirmed the thesis about the dominant influence of precipitation processes on the stability of microstructure and mechanical properties.