Chapter

Introductory Chapter: Creep - An Overview of New Research Results

Adam Zieliński, Marek Sroka, Tomasz Tański and Grzegorz Golański

1. Introduction

In classical terms, creep is defined as a process that takes place under constant load, which ensures that stresses are usually within the Hooke's law range, and at elevated temperature. The loads applied to products working under creep conditions cause stresses and strains whose values may change over time, not only as a result of overloads occurring during service, but mainly at the time when loading remains unchanged and results in stresses lower than the yield strength [1].

A characteristic feature of creep is that after strain relief of the material in service, the strain decreases and the so-called strain recovery takes place [2].

In the creep of materials, both plastic and reversible strains occur. As a result of the process, their shapes and dimensions change constantly during service. After the elapse of sufficient time of working under creep conditions, the components are degraded and their further service is prevented [3–5]. The degradation processes start at the moment when the rate of strain changes from its minimum and proportional values to disproportional ones as it is increasing [6].

The service within the time as assumed by designers as well as the extension of the lifetime of the materials and products made from them which have worked the design service life are most often determined by the calculation method based on creep strength data and positive results of comprehensive mechanical tests [7–11]. Among materials, the products operating under creep conditions are of particular importance. In their evaluation, the condition assessment of their materials is important and necessary [12–16]. It is carried out using destructive and non-destructive materials testing the result of which is referred to the available characteristics of materials both in the as-received condition and after service [17–22]. The results of these tests, supported by the extensive material characteristics database, allow for good estimation of the material condition and degree of exhaustion and determination of the time of further trouble-free service until the next scheduled inspection.

However, in a number of cases, to reach the design service life for products working under creep conditions, not only good estimation of their service life but also its determination based on destructive tests in a selected representative test area is required.

Yet, it is not always possible in practice. Therefore, the aspect of knowledge (experience), frequently acquired during long-term scientific and industrial practice, and also supported by thorough cost-effectiveness calculation made for such a procedure, is also important.

The problem in evaluation of creep resistance of materials operated under creep conditions for a long time is the time necessary to perform creep tests for

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the assessment of performance within their design service life and frequently also of the residual life, i.e., the remaining time of service beyond the design service life.

2. Outline of this book

This study presents the results of the research into the creep effect in different materials (ceramics, metallic materials, polymers and organic materials) and presents the method for using the assessment based on creep tests and numerical calculations to determine the actual lifetime. The publication also shows how to use the accelerated creep tests whose duration is reduced by changing one of the parameters in relation to the actual ones for such an assessment.

The development of materials for operation under creep conditions and the related manufacture of products with improved performance are a result of the dynamic worldwide demand for new technologies, and recently also those related to environmental protection. The result of the above-mentioned conditions is the extensive investigations of the properties of new materials carried out by scientists and researchers all over the world. This mainly concerns the components working under the so-called creep conditions, which are characterised by a slow change in the shape of material due to the operation of mainly prolonged permanent stresses, which are lower than the elastic limit of material.

The first part of the book entitled "Creep" concerned the creep effect and research methods applied for materials working under creep conditions. The publication consists of 14 interesting chapters developed by well-known and respected researchers and specialists from different countries. The editors received a lot of positive signals and feedback about high interest in the first part of the book in the scientific community. They were given numerous suggestions to continue the work and not only gather the issues related to the creep effect in a single study but also present the information on the practical application of the discussed methods based on specific examples and technological solutions. This subject has relevance as a significant development of new materials in which the creep effect is a decisive factor for their durability within the design service life has been observed in recent years. Therefore, there is a great demand for knowledge of the actual performance of materials during and beyond the design service life. When continuing their work on the next part of the book, the editors were guided by the words of the great Pole, Stanislaw Staszic: "Science and skills become useful only when they are applied in practice for the public use."

To recapitulate, the book aims to provide readers, including but not limited to MSc and PhD students as well as research personnel and engineers involved in operation of power equipment, with the comprehensive information on changes in the performance of creep-resistant materials during service.

Author details

Adam Zieliński[1], Marek Sroka[2]*, Tomasz Tański[2] and Grzegorz Golański[3]

1 Institute for Ferrous Metallurgy, Gliwice, Poland

2 Institute of Engineering Materials and Biomaterials, Silesian University of Technology, Gliwice, Poland

3 Institute of Materials Engineering, Czestochowa University of Technology, Częstochowa, Poland

*Address all correspondence to: marek.sroka@polsl.pl

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