We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

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

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.

IntechOpen

Author details

Adam Zieliński¹, Marek Sroka^{2*}, Tomasz Tański² and Grzegorz Golański³

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

IntechOpen

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

References

- [1] Wójcik Z. Stanislaw Staszic's concept of science. *Dissertations for the History of Education*. 2006;**45**:85-100
- [2] Zieliński A, Dobrzański J, Purzyńska H, Golański G. Properties, structure and creep resistance of austenitic steel Super 304H. *Materials Testing*. 2015;**57**:859-865
- [3] Dziuba-Kałuża M, Zieliński A, Dobrzański J, Sroka M, Urbańczyk P. Residual life of boiler pressure parts made of the 13CrMo4-5 steel after long-term operation in a creep conditions. *Archives of Metallurgy and Materials*. 2018;**63**(2):889-897
- [4] Golanski G, Zielinska-Lipiec A, Zielinski A, Sroka M. Effect of long-term service on microstructure and mechanical properties of martensitic 9% Cr Steel. *Journal of Materials Engineering and Performance*. 2017;**26**(3):1101-1107
- [5] Sroka M, Zieliński A, Dziuba-Kałuża M, Kremzer M, Macek M, Jasiński A. Assessment of the residual life of steam pipeline material beyond the computational working time. *Meta*. 2017;**7**(3):82
- [6] Zieliński A, Golański G, Dobrzański J, Sroka M. Creep resistance of VM12 steel. *Archives of Metallurgy and Materials*. 2016;**61**:1289-1294
- [7] Sroka M, Zieliński A, Miś J. The service life of the repair welded joint of Cr-Mo/Cr-Mo-V. *Archives of Metallurgy and Materials*. 2016;**61**:969-974
- [8] Golański G, Zieliński A, Zielińska-Lipiec A. Degradation of microstructure and mechanical properties in martensitic cast steel after ageing. *Materialwissenschaft und Werkstofftechnik*. 2015;**46**(3):248-255
- [9] Sroka M, Zielinski A, Hernas A, Kania Z, Rozmus R, Tanski T, et al. The effect of long-term impact of elevated temperature on changes in the microstructure of Inconel 740H alloy. *Metal*. 2017;**56**(3-4):333-336
- [10] Dudziak T, Deodeshmukh V, Backert L, Sobczak N, Witkowska M, Ratuszek W, et al. Phase investigations under steam oxidation process at 800°C for 1000 h of advanced steels and Ni-based alloys. *Oxidation of Metals*. 2017;**87**(1-2):139-158
- [11] Zieliński A, Sroka M, Dudziak T. Microstructure and mechanical properties of Inconel 740H after long-term service. *Materials*. 2018;**11**:2130
- [12] Purzyńska H, Golański G, Zieliński A, Dobrzański J, Sroka M. Precipitation study in Ti-stabilised austenitic stainless steel after 207,000 h of service. *Materials at High Temperatures*. 2019. DOI: 10.1080/09603409.2018.1546919
- [13] Zieliński A, Dobrzański J, Purzyńska H, Sikora R, Dziuba-Kałuża M, Kania Z. Evaluation of creep strength of heterogeneous welded joint in HR6W alloy and Sanicro 25 steel. *Archives of Metallurgy and Materials*. 2017;**62**(4):2057-2064
- [14] Sroka M, Nabialek M, Szota M, Zielinski A. The influence of the temperature and ageing time on the NiCr23Co12Mo alloy microstructure. *Revista de Chimie*. 2017;**68**(4):737-741
- [15] Zieliński A, Sroka M, Miczka M, Śliwa A. Forecasting the particle diameter size distribution in P92 (X10CrWMoVNb9-2) steel after long-term ageing at 600 and 650°C. *Archives of Metallurgy and Materials*. 2016;**61**:753-760
- [16] Zieliński A, Golański G, Sroka M. Influence of long-term ageing on

the microstructure and mechanical properties of T24 steel. *Materials Science & Engineering, A: Structural Materials: Properties, Microstructure and Processing*. 2017;**682**:664-672

[17] Zieliński A, Miczka M, Golański G. Forecasting the distribution of precipitate diameters in the presence of changes in the structure of the material. *Archives of Metallurgy and Materials*. 2017;**62**:283-290

[18] Golański G, Jasak J, Zieliński A, Kolan C, Urzysnik M, Wiczorek P. Quantitative analysis of stability of 9%Cr steel microstructure after long-term ageing. *Archives of Metallurgy and Materials*. 2017;**62**(1):273-281

[19] Zieliński A, Golański G, Sroka M, Skupień P. Microstructure and mechanical properties of the T23 steel after long-term ageing at elevated temperature. *Materials at High Temperatures*. 2016;**33**:154-163

[20] Kępa J, Golański G, Zieliński A, Brodziak-Hyska A. Precipitation process in VM12 steel after ageing at 650°C temperature. *Journal of Vibroengineering*. 2012;**59**(4):143-150

[21] Golański G, Lis A, Słania J, Zieliński A. Microstructural aspect of long term service of the austenitic TP347HFG steel. *Archives of Metallurgy and Materials*. 2015;**60**:2901-2904

[22] Zieliński A, Boryczko B, Miczka M, Sroka M. Forecasting in the presence of microstructural changes for the case of P91 steel after long-term ageing. *Archives of Civil and Mechanical Engineering*. 2016;**16**:813-824