

Remnant life prediction of service-exposed 12Cr1MoV superheater tube in power plant

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Abstract. Tensile test at ambient temperature, tensile test at high temperature and high temperature tensile creep test were carried out before remnant life prediction. According to the high temperature tensile creep test data, the relationship between working stress, working temperature and rupture life was obtained by MATLAB surface fitting tool. In order to obtain the temperature field and stress field of the superheater tube, ANSYS software was used. Then, the remnant life of the superheater tube was predicted by the extrapolating method and the relationship between working stress, working temperature and rupture life.

Introduction

How to prolong the life of power equipment[1-3] and ensure its normal operation has become an important problem concerned by power field. At the present time, many achievements[4, 5], which have a high value of practical application, have been acquired in the fields of equipment life management and prediction, and equipment condition monitoring and fault diagnosis.

Presently, the methods[6, 7] for remnant life prediction of service-exposed boiler tube can be divided into the following types. The first type is periodic measurement of boiler tube diameter, wall thickness and etc. The second type is based on working temperature, working stress and Robinson rule. The third type is based on the changes of distribution of eutectic carbide and secondary carbide as time goes on. The fourth type is based on high temperature tensile creep test and Larson-miller equation. The fifth type is based on low cycle fatigue test. The sixth type is based on the changes of density and voids. All the methods need to take a lot time. To acquire more reliable result, it is necessary to simultaneously use two or more methods to confirm with each other.

In the paper, we use the finite element software ANSYS to analyze the temperature field and stress field of the 12Cr1MoV, and get the maximum working stress. Based on Larson-miller equation and MATLAB[8] surface fitting tool, the remnant life of the service-exposed 12Cr1MoV superheater tube was predicted.

Experimental details

These experiments include two parts: (1) tensile test at ambient temperature and tensile test at high temperature, (2) high temperature tensile creep tests.

The chemical composition of the experimental material 12Cr1MoV steel was shown in Table 1. The mechanical properties and physical properties were respectively shown in Table 2 and Table 3.

Table 1 Chemical composition of 12Cr1MoV steel

Element	C	Si	Mn	Cr	Mo	V	P	S
Test sample	0.12	0.19	0.60	1.04	0.28	0.18	0.018	0.008
GB 5310-2008	0.08-0.15	0.17-0.37	0.40-0.70	0.9-1.2	0.25-0.35	0.15-0.30	<0.025	<0.01

The test samples were made according to Chinese standard GB/T 2039-1997. The procedure of tensile test at ambient temperature was based on Chinese standard GB/T 228.1-2010. The procedure of tensile test at high temperature was based on Chinese standard GB/T 4338-2006. The tensile test and creep test (Table 4) at high temperature were carried on CSS-3905 electronic high temperature creep testing machine.

Remnant Life Prediction

**Joseph Mathew, Lin Ma, Andy
Tan, Margot Weijnen, Jay Lee**



Remnant Life Prediction:

Remanent Life Prediction PEP (Professional Engineering Publishers),1998-03-13 The need to repair or replace structural components can lead to considerable expense if the plant has to be taken out of service whilst these operations are carried out This text discusses methodologies which accurately and safely predict the remaining life of components

Residual Life Prediction and Optimal Maintenance Decision for a Piece of Equipment Changhua Hu,Hongdong Fan,Zhaoqiang Wang,2021-07-30 This book addresses remaining life prediction and predictive maintenance of equipment It systematically summarizes the key research findings made by the author and his team and focuses on how to create equipment performance degradation and residual life prediction models based on the performance monitoring data produced by currently used and historical equipment Some of the theoretical results covered here have been used to make remaining life predictions and maintenance related decisions for aerospace products such as gyros and platforms Given its scope the book offers a valuable reference guide for those pursuing theoretical or applied research in the areas of fault diagnosis and fault tolerant control remaining life prediction and maintenance decision making

Condition-Based Maintenance and Residual Life Prediction Chandan Deep Singh,Davinder Singh,Kanwal Jit Singh,Harleen Kaur,2025-03-10 Condition Based Maintenance and Residual Life Prediction is essential for those looking to effectively implement condition based maintenance strategies and enhance fault detection through a comprehensive understanding of vibration data analysis and residual life prediction addressing key challenges in the field Issues related to condition based maintenance include its high initial cost new techniques that can be difficult to implement due to resistance older equipment that can be difficult to retrofit with sensors and monitoring equipment and difficult to access equipment during production that is difficult to spot measure Keeping the above issues in mind a general handbook for condition based maintenance and residual life prediction is required to carry out in fault detection Condition Based Maintenance and Residual Life Prediction aims to develop analyze and model condition based maintenance and residual life prediction through vibration data The analysis of vibration responses will aid in developing a fault detection system The sources of vibration may be due to the presence of different types of defects such as cracks in the shaft a bent shaft or misalignment of shafts This will give designers a diagnostic tool for predicting the trends of vibration conditions leading to early fault detection The devised tool will be capable of quantifying the amplitude of vibration based on the severity of defects With the features available in the devised diagnostic tool the proposed model can be used for design predictive maintenance and condition based maintenance

Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery Yaguo Lei,2016-11-02 Intelligent Fault Diagnosis and Remaining Useful Life Prediction of Rotating Machinery provides a comprehensive introduction of intelligent fault diagnosis and RUL prediction based on the current achievements of the author s research group The main contents include multi domain signal processing and feature extraction intelligent diagnosis models clustering algorithms hybrid

intelligent diagnosis strategies and RUL prediction approaches etc This book presents fundamental theories and advanced methods of identifying the occurrence locations and degrees of faults and also includes information on how to predict the RUL of rotating machinery Besides experimental demonstrations many application cases are presented and illustrated to test the methods mentioned in the book This valuable reference provides an essential guide on machinery fault diagnosis that helps readers understand basic concepts and fundamental theories Academic researchers with mechanical engineering or computer science backgrounds and engineers or practitioners who are in charge of machine safety operation and maintenance will find this book very useful Provides a detailed background and roadmap of intelligent diagnosis and RUL prediction of rotating machinery involving fault mechanisms vibration characteristics health indicators and diagnosis and prognostics Presents basic theories advanced methods and the latest contributions in the field of intelligent fault diagnosis and RUL prediction Includes numerous application cases and the methods algorithms and models introduced in the book are demonstrated by industrial experiences *Asset Condition, Information Systems and Decision Models* Joe E.

Amadi-Echendu,Kerry Brown,Roger Willett,Joseph Mathew,2012-11-05 *Asset Condition Information Systems and Decision Models* is the second volume of the Engineering Asset Management Review Series The manuscripts provide examples of implementations of asset information systems as well as some practical applications of condition data for diagnostics and prognostics The increasing trend is towards prognostics rather than diagnostics hence the need for assessment and decision models that promote the conversion of condition data into prognostic information to improve life cycle planning for engineered assets The research papers included here serve to support the on going development of Condition Monitoring standards This volume comprises selected papers from the 1st 2nd and 3rd World Congresses on Engineering Asset Management which were convened under the auspices of ISEAM in collaboration with a number of organisations including CIEAM Australia Asset Management Council Australia BINDT UK and Chinese Academy of Sciences Beijing University of Chemical Technology China *Asset Condition Information Systems and Decision Models* will be of particular interest to finance maintenance and operations personnel whose roles directly affect the capability value of engineering asset base as well as asset managers in both industry and government *Report 19: Considerations for Use in Managing the Aging of Nuclear Power Plant Concrete Structures: State-of-the-Art Report of RILEM Technical Committee 160-MLN* Dan J. Naus,1999

Structural Health Monitoring and Integrity Management Keqin Ding,Shenfeng Yuan,Zhishen Wu,2015-05-29 *Structural Health Monitoring and Integrity Management* is a collection of the papers presented at the 2nd International Conference of Structural Health Monitoring and Integrity Management ICSHMIM2014 Nanjing China 24 26 September 2014 and addresses the most recent developments in the field of Structural Health Monitoring SHM and integrity ma **Futuristic Materials ,**

Engineering Asset Management and Infrastructure Sustainability Joseph Mathew,Lin Ma,Andy Tan,Margot Weijnen,Jay Lee,2012-05-11 *Engineering Asset Management 2010* represents state of the art trends and developments in the

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Imaging Methods for Novel Materials and Challenging Applications, Volume 3 Helena Jin,Cesar A. Sciammarella,Cosme Furlong,Sanichiro Yoshida,2025-08-07 Imaging Methods for Novel Materials and Challenging Applications Volume 3 Proceedings of the 2012 Annual Conference on Experimental and Applied Mechanics the third volume of seven from the Conference brings together 62 contributions to this important area of research and engineering The collection presents early findings and case studies on fundamental and applied aspects of Experimental and Applied Mechanics including papers on Role of optical interferometry in advancement of material characterization Three dimensional imaging and volumetric correlation Digital holography and experimental mechanics Digital image correlation Metrology and displacement

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Life Cycle Analysis and Assessment in Civil Engineering: Towards an Integrated Vision Robby Caspeele, Luc Taerwe, Dan Frangopol, 2018-10-31 This volume contains the papers presented at IALCCE2018 the Sixth International Symposium on Life Cycle Civil Engineering IALCCE2018 held in Ghent Belgium October 28 31 2018 It consists of a book of extended abstracts and a USB device with full papers including the Fazlur R Khan lecture 8 keynote lectures and 390 technical papers from all over the world Contributions relate to design inspection assessment maintenance or optimization in the framework of life cycle analysis of civil engineering structures and infrastructure systems Life cycle aspects that are developed and discussed range from structural safety and durability to sustainability serviceability robustness and resilience Applications relate to buildings bridges and viaducts highways and runways tunnels and underground structures off shore and marine structures dams and hydraulic structures prefabricated design infrastructure systems etc During the IALCCE2018 conference a particular focus is put on the cross fertilization between different sub areas of expertise and the development of an overall vision for life cycle analysis in civil engineering The aim of the editors is to provide a valuable source of cutting edge information for anyone interested in life cycle analysis and assessment in civil engineering including researchers practising engineers consultants contractors decision makers and representatives from local authorities

Cyclic Stress-strain Behavior--analysis, Experimentation, and Failure Prediction, 1971 Methods for the Assessment of the Structural Integrity of Components and Structures D. Lidbury, 2024-11-01 This book includes key features arising from structural analysis in the NESC I benchmark experiment from the second International Conference on NDE in Relation to Structural Integrity for Nuclear and Pressurized Components New Orleans Creep and Fracture of Engineering Materials and Structures: Proceedings of the 9th International Conference: Proceedings of the 9th International Conference J.D. Parker, 2024-11-01 This volume contains the 75 papers from the Proceedings of the 9th International Conference on Creep and Fracture of Engineering Materials and Structures held at University of Wales Swansea 1st April 4th April 2001

Industry 5.0 Indranil Sarkar, Abhishek Hazra, Poonam Maurya, 2025-07-17 This edited book aims to comprehensively examine the current research trend state of the art IoT applications deployment issues potential challenges and future research scopes related to Industry 5.0 and Industry 5.0 enabled technologies such as Blockchain edge computing 5G and cloud computing The book aims to provide a thorough understanding of the application specifications and related issues of IoT in the fields of healthcare 5.0 predictive maintenance sustainable cities and transportation systems Readers of the book will gain valuable insights into applying the concepts to real world applications and will be introduced to the latest tools software and simulations available for experimenting with Industry 5.0 and ideas about diverse IIoT data analysis The book

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Intelligent Manufacturing and Energy Sustainability P. H. V. Sesha Talpa Sai, Srikar Potnuru, Mehmet Avcar, Vishesh Ranjan Kar, 2023-11-27 This book includes best selected high quality research papers presented at the International Conference on Intelligent Manufacturing and Energy Sustainability ICIMES 2023 held at the Department of Mechanical Engineering Malla Reddy College of Engineering Technology MRCET Hyderabad India during June 23-24, 2023. It covers topics in the areas of automation manufacturing technology and energy sustainability and also includes original works in the intelligent systems manufacturing mechanical electrical aeronautical materials automobile bioenergy and energy sustainability.

Comprehensive Structural Integrity Ian Milne, R. O. Ritchie, B.L. Karihaloo, 2003-07-25 The aim of this major reference work is to provide a first point of entry to the literature for the researchers in any field relating to structural integrity in the form of a definitive research reference tool which links the various sub disciplines that comprise the whole of structural integrity. Special emphasis will be given to the interaction between mechanics and materials and structural integrity applications. Because of the interdisciplinary and applied nature of the work it will be of interest to mechanical engineers and materials scientists from both academic and industrial backgrounds including bioengineering interface engineering and nanotechnology. The scope of this work encompasses but is not restricted to fracture mechanics fatigue creep materials dynamics environmental degradation numerical methods failure mechanisms and damage mechanics interfacial fracture and nano technology structural analysis surface behaviour and heart valves. The structures under consideration include pressure vessels and piping off shore structures gas installations and pipelines chemical plants aircraft railways bridges plates and shells electronic circuits interfaces nanotechnology artificial organs biomaterial prostheses cast structures mining and more. Case studies will form an integral part of the work.

Life-Cycle and Sustainability of Civil Infrastructure Systems Alfred Strauss, Dan Frangopol, Konrad Bergmeister, 2012-09-18 Life Cycle and Sustainability of Civil Infrastructure Systems contains the lectures and papers

presented at the Third International Symposium on Life Cycle Civil Engineering IALCCE 2012 held in one of Vienna's most famous venues the Hofburg Palace October 3rd 6th 2012 This volume consists of a book of extended abstracts 516 pp and a DVD ROM

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