

## 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

**Keqin Ding, Shenfang Yuan, Zhishen  
Wu**



## **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

**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

**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

*Remaining Useful Life (RUL) Prediction of electrolytic Capacitor using Artificial Intelligence* Cherry Bhargava, Shivani Gulati, 2018-09-17 Master s Thesis from the year 2017 in the subject Computer Sciences Artificial Intelligence grade 9 00 Lovely Professional University Punjab Lovely professional university Punjab course M Tech language English abstract Residual life prediction is the technique which demonstrates how reliable a particular electronic system or component works under in specific operating conditions The remaining useful life relies on the failure rate of a component and on the operating conditions of a device This failure rate drifts for the duration of the life of the item with time Life is an important aspect while choosing the electronic hardware Residual life estimation and life prediction are two distinct terms The importance of life estimation is to evaluate the remaining useful life of a specific component under the different stress parameters As an increasing number of components are integrated on to a chip the chances of failure increase as the different parts have their own stress factors and different working conditions So the condition monitoring strategies are utilized which enhances the reliability of a component and a suitable move to be made before any harmful breakdown happens The electronic circuits need a failure estimation technique to protect the system from unavoidable failures Residual life estimation of electronic components is an important fact these days as electronic components and devices becomes a great need of society Residual life prediction is predicting the remaining useful life of a component or device based on various failure factors of any component and it also depends on the operating conditions Many methods for predicting the life of electronic components have been developed The life of electronic components can be predicted by creating an intelligent system for the failure analysis The capability to predict the life of electronic components is a key to prevent the sudden costly failure and it will increase the overall performance and reliability of a system So remaining useful life prediction is an important factor for every active and passive electronic component such as resistor capacitor and diode etc

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, Shenfang 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](#) , **Advances in Machinery, Materials Science and Engineering Application IX** Min Chen, Marco Giorgetti, Bo Jin, Ramesh K. Agarwal, 2023-11-15 New engineering materials techniques and applications are constantly being researched and developed and keeping up to speed with the latest advances is crucial for engineers if they are to successfully address the challenges they face in their work This book presents the selected proceedings of MMSE2023 the 9th International Conference on Advances in Machinery Materials Science and Engineering Applications jointly organized by the SAE Supmeca France and China University of Geosciences Wuhan and held on 22 and 23 July 2023 in Wuhan China For the past 12 years this annual conference has collated recent advances and experiences identified emerging trends and provided a platform for participants from academia and industry to exchange information and views helping to address the world s machinery and engineering challenges The book contains 4 sections mechanical engineering material science and manufacturing technology electrical engineering automation and control modeling simulation and optimization techniques in engineering and advanced engineering technologies and applications A total of 241 submissions were received for MMSE2023 of which 151 papers were selected for the conference and for publication by means of a rigorous international peer review process These papers present exciting ideas and methods that will open novel research directions for different communities Offering a current overview of the latest research

and applications in machinery and materials science engineering the book will be of interest to all those working in the field

*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 measurement at different scales Optical methods for dynamic tests Optical methods for and with MEMS and NEMS Thermomechanics and infrared imaging Imaging methods applied to biomaterials and soft materials Applied photoelasticity Optical measurement systems using polarized light Hybrid imaging techniques Contouring of surfaces Novel optical techniques *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 will also provide valuable insights into the use of AI tools and algorithms for designing intelligent systems to tackle Industry 5.0 issues It is of great value to readers interested in understanding the integration of Blockchain edge computing 5G and its sister technologies with IIoT and the research scope to solve Industry 5.0 issues      Proceedings of the 6th China Aeronautical Science and Technology Conference Chinese Soc. of

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**Intelligent Manufacturing and Energy Sustainability** P. H. V. Sessa 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

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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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