

Article

High-Temperature Tensile Behaviour of GTAW Joints of P92 Steel and Alloy 617 for Two Different Fillers

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Abstract: This study explores the high-temperature (HT) tensile rupture characteristics of a dissimilar gas-tungsten-arc-welded (GTAW) joint between P92 steel and Alloy 617, fabricated using ER62S-B9 and ERNiCrCoMo-1 fillers. The high-temperature tensile tests were performed at elevated temperatures of 550 °C and 650 °C. An optical microscope (OM) and a field emission scanning electron microscope (FESEM) were utilized to characterize the joint. The high-temperature test results indicated that the specimen failed at the P92 base metal/intercritical heat-affected zone (ICHAZ) rather than the weld metal for the ERNiCrCoMo-1 (IN617) filler. This finding confirmed the suitability of the joint for use in the Indian advanced ultra-supercritical (A-USC) program. The fracture surface morphology and presence of precipitates were analysed using an SEM equipped with energy dispersive spectroscopy (EDS). The appearance of the dimples and voids confirmed that both welded fillers underwent ductile–dominant fracture. EDS analysis revealed the presence of Cr-rich $M_{23}C_6$ phases, which was confirmed on the fracture surface of the ER62S-B9 weld (P92-weld). The hardness plot was analysed both in the as-welded condition and after the fracture.

Keywords: dissimilar weld; ER62S-B9; ERNiCrCoMo-1; alloy 617; P92 steel; fracture surface; high-temperature



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1. Introduction

Advanced ultra-supercritical (A-USC) power plants can significantly enhance efficiency, reduce fuel consumption, and lower harmful gas emissions. A-USC plants are being promoted for energy generation in Europe, the US, Japan, China, and India. Ni-based alloys are utilized in A-USC plants for steam temperatures above 700 °C, while martensitic steels (9–12% Cr) are used for lower temperature zones up to 620 °C and 650 °C, respectively [1]. Ni-based alloys, including Alloy 617, Alloy 625, Alloy 740, and Alloy 263, are commonly utilized in turbines, pipes, headers, and tubes for high-temperature components [2–4]. Alloy 617 is considered an ideal material for temperatures above 700 °C due to its exceptional resistance to oxidation and corrosion. However, due to the higher cost of the Ni-based alloys, inexpensive ferritic-grade steel such as P91/P92 BM is preferred for components operating at temperatures below 620 °C [5].

The major problem associated with the dissimilar metal joining (DMJ) of Alloy 617 and P92 steel is a mismatch in the coefficient of thermal expansion (CTE), chemical composition,

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Shingledecker, M. Takeyama, 2019-10-01 Proceedings from EPRI's 9th International Conference on Advances in Materials Technology for Fossil Power Plants and the 2nd International 123HiMAT Conference on High Temperature Materials

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Joining Processes M.G. Nicholas, 1998-09-30 Joining Processes is aimed at scientists and engineers who need to specify effective means of joining metals and ceramics and also for undergraduates whose studies encompass joining processes Joining Processes provides a brief review of the spectrum of joining processes ranging from fusion welding to adhesive bonding followed by a detailed introduction to brazing diffusion bonding and their hybrid processes This book also describes the scientific principles of the joining processes and provides practical information about the optimum selection of joining materials joint designs and processing parameters The effects of both similarities and significant differences of the processes on joint properties are emphasised and illustrated by descriptions of case histories of successful applications **High**

Pressure Science And Technology - Proceedings Of The Joint Xv Airapt And Xxxiii Ehprg International Conference W Trzeciakowski, 1996-07-04 This volume will contain about 40 invited papers and over 200 contributed papers covering all aspects of high pressure research in physics chemistry materials science and biology It will serve as an exhaustive review of recent achievements in these areas and of the topics of major interest The list of subjects include 1 Electronic optical and transport properties of solids 2 Phase transitions structural properties and lattice dynamics 3 Crystal growth and material synthesis 4 Organic synthesis and biological applications 5 Geophysical sciences 6 Instrumentation and metrology 7 Superhard materials 8 Ceramics and sintering 9 Food processing 10 Plasticity and hydroextrusion Contributors include N W Ashcroft USA V Blank Russia E M Cambell USA H G Drickamer USA W B Holzapfel Germany J Karpinski Switzerland H K Mao USA W J Nellis USA W Paul USA E G Ponyatovsky Russia A L Ruoff USA J S Schilling USA O Shimomura Japan I F Silvera USA B Sundquist Sweden **Fatigue of Fiber-reinforced Composites** Anastasios P. Vassilopoulos, Thomas Keller, 2011-07-14 Fatigue has long been recognized as a mechanism that can provoke catastrophic material failure in structural applications and researchers are now turning to the development of prediction tools in order to reduce the cost of

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Handbook of Bolts and Bolted Joints Sayed A. Nassar, John H. Bickford, 2025-03-20 Presenting time tested standards as well as validated emerging knowledge on threaded fasteners and bolted joints this updated edition covers how to design select parts and materials control assembly processes predict behavior and solve on the job problems This handbook examines key issues affecting bolting in the automotive pressure vessel petrochemical aerospace energy and structural steel industries The editors have successfully created a useful rather than scholarly handbook with chapters written in a straightforward how to manner Theory is discussed only when necessary and the handbook's logical organization and thorough index enhance its usefulness Handbook of Bolts and Bolted Joints Second Edition includes updated chapters solved numerical examples and case studies This new edition is an essential handbook for professionals researchers and students in all fields in which threaded joints are used including automotive aerospace structural chemical and naval and ocean engineering as well as agricultural equipment wind turbines and medical devices

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Table of Contents Behaviour Of Joints In High Temperature Materials

1. Understanding the eBook Behaviour Of Joints In High Temperature Materials
 - The Rise of Digital Reading Behaviour Of Joints In High Temperature Materials
 - Advantages of eBooks Over Traditional Books
2. Identifying Behaviour Of Joints In High Temperature Materials
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Behaviour Of Joints In High Temperature Materials
 - User-Friendly Interface
4. Exploring eBook Recommendations from Behaviour Of Joints In High Temperature Materials
 - Personalized Recommendations

- Behaviour Of Joints In High Temperature Materials User Reviews and Ratings
- Behaviour Of Joints In High Temperature Materials and Bestseller Lists
- 5. Accessing Behaviour Of Joints In High Temperature Materials Free and Paid eBooks
 - Behaviour Of Joints In High Temperature Materials Public Domain eBooks
 - Behaviour Of Joints In High Temperature Materials eBook Subscription Services
 - Behaviour Of Joints In High Temperature Materials Budget-Friendly Options
- 6. Navigating Behaviour Of Joints In High Temperature Materials eBook Formats
 - ePub, PDF, MOBI, and More
 - Behaviour Of Joints In High Temperature Materials Compatibility with Devices
 - Behaviour Of Joints In High Temperature Materials Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Behaviour Of Joints In High Temperature Materials
 - Highlighting and Note-Taking Behaviour Of Joints In High Temperature Materials
 - Interactive Elements Behaviour Of Joints In High Temperature Materials
- 8. Staying Engaged with Behaviour Of Joints In High Temperature Materials
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Behaviour Of Joints In High Temperature Materials
- 9. Balancing eBooks and Physical Books Behaviour Of Joints In High Temperature Materials
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Behaviour Of Joints In High Temperature Materials
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Behaviour Of Joints In High Temperature Materials
 - Setting Reading Goals Behaviour Of Joints In High Temperature Materials
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Behaviour Of Joints In High Temperature Materials
 - Fact-Checking eBook Content of Behaviour Of Joints In High Temperature Materials

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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