

## Article

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

Amit Kumar <sup>1</sup> , Sachin Sirohi <sup>2,\*</sup> , Shailesh Mani Pandey <sup>3</sup>, Pradeep Kumar <sup>4</sup>, Dariusz Fydrych <sup>5,\*</sup>   
and Chandan Pandey <sup>1</sup> 

- <sup>1</sup> Mechanical Department, Indian Institute of Technology Jodhpur, N.H. 62 Nagaur Road, Karwar 342007, India; kumar.173468@iitj.ac.in (A.K.); jcpandey@iitj.ac.in (C.P.)
  - <sup>2</sup> Mechanical Department, SRM Institute of Science and Technology, Delhi NCR Campus, Modinagar 201204, India
  - <sup>3</sup> Department of Mechanical Engineering, National Institute of Technology, Patna 800005, India; smp.sme@nitp.ac.in
  - <sup>4</sup> Mechanical and Industrial Engineering Department, Indian Institute of Technology Roorkee, Roorkee 247667, India; kumarfme@gmail.com
  - <sup>5</sup> Institute of Manufacturing and Materials Technology, Faculty of Mechanical Engineering and Ship Technology, Gdańsk University of Technology, Gabriela Narutowicza Street 11/12, 80-233 Gdańsk, Poland
- \* Correspondence: sachins@srmist.edu.in (S.S.); darfydry@p.p.gdansk.pl (D.F.)

**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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