

A  
DISSERTATION REPORT  
ON  
**Effect of Chemical Composition and PWHT on  
Microstructure and Mechanical Properties of  
Welded P91 Steel**

Submitted in partial fulfillment of the requirements  
of the degree of

**(Master of Technology)**

by

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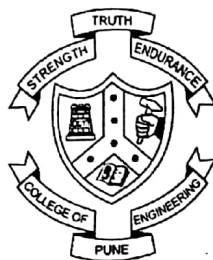
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## Abstract

P91 steel is developed for the ultra-critical boilers used in power plants due to its excellent properties of oxidation resistance, low co-efficient of thermal expansion and high creep strength. In this study, P91 steel weldments were fabricated on mild steel base plate using SMAW process. The chemical composition and PWHT parameters (temperature: 730°C-800°C and time: 2-4 h) were varied within the permissible range of ASME and their effect on the microstructure and mechanical properties was studied. Higher addition of alloying elements, namely, carbon, nitrogen and vanadium lead to increase in the tensile strength and hardness of the weld. While, the addition of nickel caused an increase in the toughness value. For all the samples, the resultant microstructure was tempered martensite with carbides and carbonitrides precipitates. Grain refinement was noticed only for samples containing higher addition of vanadium. Lowering down the PWHT temperature reduced the tempered martensite content and vice versa. Increase in PWHT temperature up to 800°C-2h resulted in an increase in toughness to 112 J vis-à-vis samples given PWHT at 730°C-2h showing a value of 19 J at room temperature. For the same set of samples, the tensile strength dropped from 864MPa to 604MPa. Abrupt change in trend of properties was noted for 800°C-2h samples, indicative of some phase change after 780°C. It was observed that the PWHT has more pronounced effect on microstructure and mechanical properties than variation of the chemical composition.

**Keywords:** *P91, Welding, PWHT, Microstructure, Toughness, Tensile strength*