Effect of Long-term Post-weld Heat Treatment on the Microstructure and Mechanical Properties of P91 Weld Metal

C.R. Das[1], A.K. Bhaduri1[*], V. Thomas Paul[1], P. Krishnamraju[2], S.K. Albert[1] and R. Balakrishnan[1]
[1] Indira Gandhi Centre for Atomic Research, Kalpakkam 603102, India
[2] Department of Metallurgical and Materials Engineering, National Institute of Technology, Tiruchirapalli 620 015, India
*Email: bhaduri@igcar.gov.in

ABSTRACT

Modified 9Cr-1Mo (P91) steel is used in fossil-fuel fired power plants due to its good thermo- physical, weldability, fabricability and high temperature mechanical properties. Toughness of the P91 weld metal, deposited by the shielded metal arc welding (SMAW) process, is reported to be lower than that deposited by the gas tungsten arc welding (GTAW) process. In spite of this, considering the higher deposition rate and economics, the SMAW process is very popular in industry. Thus, achieving adequate toughness in the P91 weld metal deposited using the SMAW process is an important requirement to qualify the weld joints.

Weld joints were prepared using the SMAW process and subjected to post-weld heat treatment (PWHT) at 760°C for durations of 3, 10 and 100 hours. Micro-structural observations revealed coarsening of the lath martensite and the precipitates accompanied by an increase in toughness with increase in PWHT duration from 3 to 10 hours. The effect of PWHT duration on sub-zero toughness was found to be significant, with the sub-zero toughness increasing with increase in PWHT duration upto 10 hours and then decreasing on PWHT for 100 hours. Increase in sub-zero toughness could be attributed to adequate tempering, while the decrease in toughness on PWHT for 100 hours was attributable to the formation of fresh martensite during cooling from the PWHT temperature. This variation of toughness of the SMA weld metal with duration of PWHT needs better understanding from the view point of the composition of the weld metal. Detailed microstructural analysis was carried out to understand the reasons for the variations in the mechanical properties. This paper presents and discusses the results of this experimental investigation.