1.1.14. CREEP DAMAGE EVALUATION OF CR-MO STEEL BY MAGNETIC NDE TECHNIQUES

Mitra A., Mohapatra J.N., Panda A.K., Materials Science & Technology Division
National Metallurgical Laboratory (Council of Scientific & Industrial Research),
Jamshedpur-831007, India

Cr-Mo steel is very commonly used material for pressure vessels and piping components. This steel owing to its high temperature strength, good creep resistance and excellent corrosion resistance finds potential applications in thermal environments. Initial heat-treatment is carried to get stable microstructure. However, prolonged exposure of these materials under high temperature and stress causes microstructural changes, which ultimately lead to failure of the components. In the present study, modified 9Cr-1Mo steel has been investigated using Magnetic Hysteresis Loop (MHL) measurement and Magnetic Barkhausen Emissions (MBE) technique. The material was subjected to accelerated creep test at 600°C / 125 MPa for different duration. The measurement was taken by interrupting the creep test.

It was observed that variation in creep strain rate with the creep life is divided into three regions. The variation of creep strain rate suggests that in the present material, 25% of the total life was in the primary creep and 70% of the total life was in the secondary creep and the remaining portion was in the tertiary creep region. In the primary creep region there was a decrease in rms value of the MBE signals and a corresponding increase in coercivity. This magnetic hardening is attributed to the formation of large number of MC type of carbides. These fine carbides restrict the domain wall motion to form small amplitude Barkhausen pulses and make the material magnetically harder. This was marked by decrease in MBE rms voltage and an increase in coercivity.

The growth of carbides and formation of larger carbides at the expense of smaller carbides decreases the pinning centers for domain wall motion and inter particle distance increases. So the magnetic softening occurred in the material which was observed as an increase in rms voltage and a decrease in coercivity in the secondary creep stage of the material.

In the tertiary creep region, the rapid growth of M23C6 type carbides takes place. Formation of Laves phase and Z-phase takes and micro cracks occur at the grain boundaries which provide demagnetising field to the applied magnetization. Due to such demagnetizing field the rate of increase in rms voltage decreased in the tertiary creep region. In this region coercivity of the material also increased and drastic fall of remanence (Mr) was observed. Transmission Electron Microscopy study was also carried out to identify the various phases. The present results indicate that magnetic NDE technique is a potential tool for creep damage study.