ABSTRACT

For many applications, it may be useful to be able to estimate creep properties of a material from simpler testing procedures such as tensile tests than the conventional creep testing procedures. Most alloys used for creep service conditions are in a hardened condition and thus tertiary creep, controlled by micro structural degradation, is dominant. The object of the study was to investigate a reasonably simple method for estimating the creep behavior of a low alloy 1% Cr, 0.25 % Mo steel from tensile yield data. The study involved performing of series of investigations, including age hardening, tensile and creep tests.

Microstructural degradation was monitored from specimens held in a furnace for different times and temperatures, which were then tested in tension at room temperatures. Tensile tests were carried out at different temperatures and strain rates and the data used to determine material parameters for use in kinetic equations describing deformation. For comparison, creep curves were obtained from both creep tests and tensile tests results. Tests on furnace aged specimens were used to quantify softening due to material degradation and formulate a structure evolution and kinetic expressions used to determine creep curves.

The modified equation by Dorn was used to determine the material parameters and to predict flow characteristics. Two sets of mechanisms were observed. At low temperature and high stress (above 550MPa) dislocation by glide mechanism was investigated. At higher temperatures and low stress (below 550MPa), some form of power law creep was observed. Glide mechanism was investigated and material parameters $\acute{\sigma}$, n and activation volume v, were calculated. The calculated value of $\acute{\sigma}$ was assumed for both plastic deformation and the softening kinetics.

A reasonably good estimate of the creep behavior of the low alloy steel used in this investigation in which tertiary creep dominates can be calculated from tensile yield stress values. Furthermore, the creep rate and recovery have similar stress dependences, with the stress and temperature dependence

similar to that predicted by recovery theory. The value of activation energy observed for creep for this alloy is in line with the processes which could be related to self diffusion.

In order to justify the significance of this study, four existing empirical models are discussed, highlighting their merits and demerits with respect to the models used in this study. These are θ-Projection, Damage Mechanics, Estrin-Mecking and the Internal Stress Methods. Generally, in this class of alloys, recovery process occurs under an effective stress (i.e. an applied stress less the internal stress). Thus the possibility of using tensile data obtained in this study in the internals stress model was explored. The model could replicate the one used in this study if the change in internal stress value σ_o is assumed to be negligible. This could be assumed to be true for tensile data at high stresses and low temperature especially during secondary creep rate when the internal stress approximates to the applied stress and at short test durations.