EFFECTS OF OXYGEN AND HYDROGEN AT LOW PRESSURE ON THE MECHANICAL PROPERTIES OF V-Cr-Ti ALLOYS – J. R. DiStefano, B. A. Pint, J. H. DeVan (Oak Ridge National Laboratory), H. D. Röhrig (Projektleitung Kernfusion, Forschungszentrum Karlsruhe), and L. D. Chitwood (Oak Ridge National Laboratory)

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The interest in vanadium alloys as a first-wall material in fusion reactors led to a study of the effects of oxygen and hydrogen on the mechanical properties of two V-Cr-Ti alloys. At temperatures of interest, reaction with small amounts of hydrogen or oxygen in the environment can lead to deleterious effects on the mechanical properties.

Hydrogen in V-Cr-Ti alloy affects its room temperature tensile properties. In the absence of an increase in oxygen concentration, matrix hardening, and a slight effect on total elongation were noted up to ~400 ppm (~2.2 at. %) hydrogen in the alloys. At higher concentrations, brittle behavior rapidly occurred.

In air at 0.1 MPa (1 atm), oxygen uptake was logarithmically dependent on exposure time at 400°C and parabolically dependent at 500°C. At lower oxygen partial pressures ($\leq 100^{-2}$ Pa), oxygen uptake at 400°C was below measurable limits after the first 10-25 h. At the lower pressures, the rate of uptake at 500°C was also parabolic, but the rate was much lower than in air and did not vary over the pressure range 10^{-2} to 10^{-4} Pa. The primary effect of oxidation at 500°C on room temperature tensile properties was to reduce ductility. There was little or no effect on yield strength or ultimate tensile strength.

Exposure of V-Cr-Ti alloys to low partial pressures of oxygen at high temperature resulted in oxygen absorption and internal oxidation. Characterization of a V-4Cr-4Ti alloy after oxidation and homogenization at 500°C revealed a microstructure with ultrafine oxide precipitates throughout the matrix and along the grain boundaries. However, bordering the grain boundaries was a zone denuded inn precipitates. Heat treatment at 950°C following oxidation resulted in large TiO_x precipitates in the matrix and grain boundaries. However, the denuded zone adjacent to the boundaries was retained. Tensile ductility of the V-Cr-Ti alloys was reduced by exposure to low pressure oxygen under the test temperature and pressure conditions. However, heat treatment at 950°C following oxidation was generally effective in recovering ductility irrespective of the initial annealing treatment or grain size.