KP1

AN OVERVIEW OF CORROSION ISSUES IN SUPERCRITICAL FLUIDS

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Supercritical fluids have wide fields of applications. Whatever is the supercritical fluid, the performance of structural materials used in process apparatus is a key issue for industrial applications. An overview is carried out on the corrosion behavior of metallic metals and alloys under pressure and temperature conditions appropriate for supercritical fluids. Steels, including stainless steels, and nickel base alloys are the main alloys investigated in supercritical environments. High general corrosion rates are reported together with localized corrosion phenomena (pitting, cracks).

In supercritical water (SCW), the review highlights how SCW density changes the corrosion mechanisms with a gas-like process (oxidation) at "low" densities (below around 100 $kg.m^{-3}$) and a liquid-like phenomenon (electrochemical process) at higher densities. Beside the density, temperature and impurities play key roles. SCW with its high oxidizing power and its large solvent capabilities is promised to a strong development if corrosion issues, even with high quality alloys, are solved.

In other supercritical fluids (SCF) like supercritical CO_2, methane, ethane…, authors observed in general that no corrosion occurs in pure SCF but the water content is a key parameter regarding metals and alloys behavior. In particular, the presence of a liquid water phase leads not only to an increase of the general corrosion but also to localize attacks including significant pitting or cracks. Measurement and modeling of the solubility of water in SCF is needed to prevent corrosion caused by moisture condensation and to determine the dosage of chemical inhibitors. Temperature and pollutants are the two other major factors leading to increase corrosion rates.

Several protection strategies have been implemented. They include the selection of materials as function of the temperature and the use of inhibitors as function of the impurities (species and concentrations). Several corrosion models have been developed for steels and are discussed and compared.