

Complex mathematical model and 3d numerical simulation of heat and mass transfer in metal-hydride reactors

Yankov G. G.

Moscow Power Engineering Institute (Technical University)

A three-dimensional mathematical model of transitional heat and mass transfer in porous hydrogen-absorbing media, accounting for presence of "passive" gas admixtures, is developed. Original technique for evaluation of effective thermal conductivity of porous medium, which consists of microparticles, is suggested.

Numerical simulation of sorption of pure and impure hydrogen is carried out. Three-dimensional fields of temperature, hydrogen concentration in gas and solid, velocity and gas pressure are calculated for the first time. Effect of "passive" gas admixtures on heat and mass transfer and sorption rate in metal hydride reactor is analyzed. It is shown that decrease of effective thermal conductivity and partial hydrogen pressure under decrease of hydrogen concentration effects on the hydrogen sorption rate considerably. It is disclosed that an intensive 3D natural convection takes place in a gas volume of reactor under certain conditions. This natural convection of gas, induced by density gradient, is shown to effect on the processes in the reactor greatly.

Numerical analysis of heat and mass transfer in metal-hydride reactor of hydrogen accumulation and purification systems is made. Sorption and desorption of hydrogen in cylindrical reactors with external cooling and central supply of hydrogen are analyzed including reactors with finned active volume and reactor with external and internal cooling cartridge matrix. Unsteady three dimensional temperature and concentration fields in solid phase are presented. Integral curves representing the dynamic of sorption and desorption are calculated. Data on efficiency of considered reactors are presented and compared.