MODELING OF THE ALUMINA CLEANING BY MEANS OF HIGH TEMPERATURE EVAPORATION INTO VACUUIM

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Considering a porous granule to be an ensemble of solid micro-particles the mathematical model is developed for the high temperature vacuum cleaning of alumina from ferrous impurity [1]. Three parts of the process are identified: the diffusion in solid, the evaporation into vacuum and the filtration through pores into outer space. Diffusion as a limiting factor is overwhelming compared with evaporation, and this issue makes possible the use of analytical solutions for the treatment of experimental data. The equation describing the abatement of impurity in time is found to be like:

$$\frac{dln(\rho_{AV})}{dt} = -\frac{1}{\chi} \quad \chi = \frac{R}{4}(\frac{\rho^*}{J^*} + \frac{R}{4D}) \quad J^* = \frac{p_{Fe}}{v_T} \quad v_T = \sqrt{\frac{2\pi kT}{m}}$$

Here χ - characteristic time of the cleaning, when the concentration of impurity falls exp(1) times, R - radius of the micro-particle, D - diffusion coefficient for the iron atoms in the alumina, ρ^* - initial uniform density of the impurity, J^* - evaporation flux into vacuum according to the equation of Hertz-Knudsen [2], v_T - thermal velocity of vaporized iron atoms, p_{Fe} - saturated iron vapor pressure accounting the relative density in the solid, m - the mass of the iron atom. The filtration of impurity atoms through pores of the granule, composed of solid spherical micro-particles, is described by the Knudsen diffusion model.

Results of the modeling show that the efficiency of the cleaning (less the time and more the depth) depends on the dimensions of solid micro-particles constituting the granule and on the porosity of granule. Reasonable cleaning time (about several hours) is observed for the radius of micro-particles at the level of 1 micron and for the high porosity of granules (0.3).

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