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Synthesis of zeolite and γ-alumina nano particles as ceramic membrane for desalination

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Membrane-based desalination technology is one of the solutions to provide clean water supplies. This technology can resolve the shortage from ground and surface water supplies, to meet the needs of growing human population. Ceramic materials gamma alumina (γ-Al_2O_3) and zeolites are known to have mechanical strength, thermal and chemical stability better than organic materials, as well as having the characteristics of high surface area and molecular sieve, which can potentially be used as desalination membrane. In this work γ-Al_2O_3 and zeolite nanoparticles were synthesized and then were coated on the surface of the porous geopolymer support to be used as desalination membranes. The γ-Al_2O_3 was synthesized using polyethyleneglycol (PEG) 6000 as template (γ-Al_2O_3+PEG) through aging in ultrasonic bath for 4 hours in form of white powder. resulting morphology particles was rod with diameter about 10-20 nm and 40-70 nm in length, surface area reached to 326.26 m^2/g, total pore volume of 0.10 cm^3/g and average pore diameter about 2.10 nm. Zeolite nanoparticles were obtained with composition $6Na_2O$: $0,55Al_2O_3$: SiO_2: $150H_2O$ in the form of white powder with particle size varied in the range of 100-400 nm, surface area reached to 97.32 m^2/g, total pore volume of 0.80 cm3/g and average pore diameter of 11.19 nm. The support was made of geopolymer materials (natural zeolites, silica sand and activated carbon with metakaoline as binder) and has porous structure, with dimensions size ±5 cm in diameter and ±0,8 cm in thickness. The membranes were prepared by three kinds of coatings, the γ-Al_2O_3 coating (Al membrane), zeolite coating (Z membrane), and of γ-Al_2O_3 and zeolite (Al+Z membrane). The performance of membranes was evaluated by measuring the rejection and flux values of saline water NaCl 1% (w/v) that was passed through the membrane. Zeolite membrane (Z membrane) demonstrated the highest salt rejection, amounted to 87.88%, whereas the membrane consist of γ-Al_2O_3 and zeolite (Al+Z membrane) resulted in rejection of 68%. The γ-Al_2O_3 membrane (Al membrane) resulted in the lowest rejection, reached to 57.14%. The highest flux was obtained by the Al membrane, reached to 3.43x103 L/m^2h on the 54.29% rejection value; whereas the Z membrane resulted in 3.28x103 L/m^2h and 87.88% on flux and rejection values, and the Al+Z membrane showed the lowest flux of 2.91x103 L/m^2h at 62% rejection value. It can be concluded that the synthesized γ-Al_2O_3 and zeolite is an alternative ceramic materials to be used as desalination membrane.

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Nanostructure evolution as cause and effect of self-recovering section of RPV steel radiation embrittlement kinetics

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Influence of neutron irradiation on reactor pressure vessel (RPV) steel degradation are examined with reference to the possible reasons of the substantial experimental data scatter and furthermore–nonstandard (non-monotonous) and oscillatory embrittlement behavior. In our glance, this phenomenon may be explained by nanostructure evolution of steel during irradiation that results in presence of the wavelike recovering component in the embrittlement kinetics. We suppose that the main factor affecting steel anomalous embrittlement is fast neutron intensity (dose rate or flux), flux effect manifestation depends on state-of-the-art fluence level. At low fluencies radiation degradation has to exceed normative value, then approaches to normative meaning and finally became sub normative. In our opinion, controversy in the estimation on neutron flux on radiation degradation impact may be explained by presence of the wavelike component in the embrittlement kinetics. Therefore flux effect manifestation depends on fluence level. Owing to nanostructure evolution at low fluencies radiation degradation has to exceed normative value, then approaches to normative meaning and finally became sub normative. Paradoxically as a result of dose rate effect manifestation peripheral RPV's zones in some range of fluencies have to be damaged to a large extent than situated closely to core. We suppose that at some stages of irradiation damaged metal have to be partially restored by irradiation i.e. neutron bombardment. Nascent during irradiation nanostructure undergo occurring once or periodical evolution in a direction of both degradation and recovery of the initial properties. According to our hypothesis, at some stage(s) of metal nanostructure degradation neutron bombardment became recovering factor.

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