

Nanocomposites and nanomaterials

The sol-gel synthesis of V_2O_5 - ZrO_2 - SiO_2 nanocomposites and their properties in the gas-phase dehydrogenation of alkane

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Mixed oxides ZrO_2 - SiO_2 due to their mechanical and chemical resistance, surface acidity, high surface area, the developed porous structure find extensive application as advanced materials in the optical industry, ceramics and as sorbents, catalysts and catalyst support materials. However, in practically important dehydrogenation of light alkanes to alkenes and in particular the production of propylene from propane the V_2O_5 / ZrO_2 - SiO_2 catalyst virtually unexplored.

In work it was used the developed technically simple and economically accessible method of sol-gel synthesis spherically granular zirconium silicate nanocomposite from solutions of zirconium carbonate complex and sodium metasilicate, maintaining the molar ratio of the Zr/Si \sim 0.6 in the process of sol formation. Conversion of the sol into spherical grains of gel was performed by dispersing into a water-immiscible organic medium. After washing the obtained hydrogel with water, the translation of its into active H-form, drying at 130 °C and calcination at 450 °C, it was obtained amorphous micro/mesoporous xerogel with pore diameters \sim 1.4, 2.7, 5 nm, a surface area \sim 300 m²/g and the size of spherical particles \sim 200 μ m. The supporting of the active component V_2O_5 on 0,6 ZrO_2 - SiO_2 was performed in two ways: 1 - by impregnating the calcined sample with a solution of ammonium metavanadate in oxalic acid; 2 - by applying this solution on the H-form hydrogel. The samples were then dried and calcined. In the first case, the supporting of 5-15 wt. % V_2O_5 resulted in a decrease of the surface area and pore volume almost doubled. In the second case, these values at the content of 8 - 16 wt. % V_2O_5 decreased slightly. Hydrothermal processing (HTP) pre-dried vanadium-containing hydrogels at 250 °C resulted in a significant increase in the mesopore volume and diameter, their spatial order and higher surface area. HTP in alcohol atmosphere contributed to further growth of these values.

Propane dehydrogenation reaction on V_2O_5 - ZrO_2 - SiO_2 catalysts was carried out in a flow quartz reactor at content of 7 vol. % C_3H_8 in the working mixture and at time of contact 3.5 s. It was shown that the yield of propylene was increased at increasing diameter and volume mesopores of samples. Also, the temperature of attainment the obtained very high propylene yields was significantly reduced.