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Development of technology for the production of microspherical alumina support for the alkane dehydrogenation catalyst: II. the influence of hydrothermal treatment conditions on the operational characteristics of microspherical alumina support and chromium oxide/alumina catalyst for the dehydrogenation of iso-butane

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Abstract

For the purpose of improving the mechanical strength and reducing the abrasive activity of micro-spherical chromium oxide/alumina catalysts for the processes of alkane dehydrogenation in fluidized bed, we have developed technology for the production of new highly durable boehmite support with the use of technical aluminum trihydrate as an initial raw material. The technology includes two consecutive stages: the dehydration of aluminum trihydrate and the subsequent hydrothermal treatment of dehydration product into boehmite. Part II covers the results on the influence of conditions for the hydrothermal treatment of aluminum trihydrate dehydration products in an industrial autoclave of special construction on the phase composition, physicomechanical and structural characteristics of boehmite support, the acidic properties of its respective oxide form and chromium oxide/alumina catalyst based on this support and also on the catalytic properties of this catalyst in the reaction of iso-butane dehydrogenation into iso-butylene. It has been shown that differently sized boehmite crystallites and also gibbsite are formed in the volume of microgranule under hydrothermal conditions of χ-Al2O3 dehydration depending on a chosen regime (temperature, time). For the production of iso-butane dehydrogenation selective chromium oxide/alumina catalyst with the minimal content of strong acidic sites, catalyzing the cracking reactions, it is necessary to provide such hydration conditions, under which large (43-47 nm) boehmite crystals are formed. The appearance of strong acidic sites is caused by small boehmite crystals and the presence of nonhydrated χ-Al 2O3 phase. In the absence of the impurity gibbsite phase, the highly durable microgranules of boehmite support and catalyst are formed. The conditions, providing the complete χ-Al2O3 hydration into macrocrystalline boehmite, have been defined. The application of the developed two-stage technology gives the iso-butylene yield of 45-49%, the selectivity of 88-90%, and the abrasivity of 0.10 g/(m2 h). The given technology for the production of catalyst is realized in an industrial unit with the capacity of 100 t per month at OAO Karpov Mendeleevsk Chemical Plant (Mendeleevsk). Industrial catalyst lots are currently under operation at the Synthetic Isoprene Rubber Plant of OAO Nizhnekamskneftekhim. © 2010 Pleiades Publishing, Ltd.

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