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Development of technology for the production of microspherical alumina support for the alkane dehydrogenation catalyst: III. the effect of the phase composition of microspherical supports on their thermal stability

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Abstract

This publication continues a series of our reports on the optimization of preparation conditions for obtaining a thermally stable support for the alkane dehydrogenation catalyst. The phase composition effect on the stability, particle size distribution, structure, texture, and mechanical properties of supports heated to 1100°C is reported. Microspherical alumina supports obtained by successive thermal and hydrothermal treatments of gibbsite are compared to commercial supports obtained by the thermochemical activation (TCA) of gibbsite. The dimensions of the support granules decrease upon heating because of shrinkage, which is governed by the phase composition of the granules and by the packing of their constituent boehmite and alumina crystallites. Three temperature intervals can be distinguished in the shrinkage of the granules. In region I (<600°C), there is intensive shrinkage via the diffusion glide of crystallites, the mechanical strength of the granules remaining invariable. In region II (600-900°C), the polymorphic transformations of alumina accompanied by sintering via surface diffusion do not affect the dimensions and strength of the granules. In region III (>900-1000°C), shrinkage takes place via coalescent sintering. For commercial manufacturing of microspherical alkane dehydrogenation catalysts and for ensuring their stability at 550-900°C, it is recommended to use alumina supports containing the minimum possible amount of χ-Al2O 3. As the single-phase boehmite support obtained by our technology is heated to 1100°C, its granules shrink by no more than 14.4% and show an attrition resistance of 89% or above. The support based on the gibbsite TCA products, which contains 14-23 wt % χ-Al2O3, is characterized by 3-5% greater granule shrinkage and 6-12% lower mechanical strength. © 2011 Pleiades Publishing, Ltd.

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Keywords

alkane dehydrogenation, alumina and single-phase boehmite supports, coalescent sintering, gibbsite, thermal stability