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Engineering problems in the operation of microspherical chromium oxide/alumina catalysts for the dehydrogenation of paraffins

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Abstract

We analyze the effects of fluidized bed height, circulation ratio, and pressure drop in a reactor on the operational efficiency of a dehydrogenation unit in order to determine the reasons for a decrease in iso-butylene yield and catalyst circulation ratio, leading to an increase in the concentration of by-products at the iso-butane dehydrogenation plant of OAO Nizhnekamskneftekhim, where a mixture of catalysts with different physicomechanical characteristics (abrasion resistance, bulk density, fractional composition) is used to increase the iso-olefin yield. It is revealed that the main reason for the decrease in the olefin yield is the accelerated drop in pressure in the reactor due to a reduction in the free area of the waste-heat boiler tubes and scrubber grids as a result of the formation of hard-to-remove solid sediments consisting of potassium silicate and components of less durable IM-2201 catalysts (e.g., alumina and chromium oxide) on their walls. The sediment accumulation rate is proportional to the IM-2201 catalyst abrasiveness, which increases after a highly durable impregnated catalyst is added. To prevent an undesirable increase in the pressure, it is forbidden to combine catalysts with different physicochemical characteristics, obtained by the technologies of spray drying and support impregnation. In order to use the more durable impregnated chromium oxide/alumina catalysts separately and provide the required fluidized bed height of no less than 45.0% of the total reactor height, it is necessary to improve their aerodynamic properties, and to optimize their fractional composition in particular. The equilibrium catalyst formed during operation and circulating directly in the reactor/regenerator circuit must contain up to 30 wt % of <40-μm granules in order to guarantee the required height and to form a stable fluidized bed with no splashing at a constant level on the device's upper grid, with less entrainment of fine granules and optimum circulation.

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Keywords

abrasiveness, catalyst, equivalent diameter, fractional composition, microgranules, microspherical chromium oxide/alumina catalysts, paraffin dehydrogenation