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Catalytic oligomerization of isobutylene at the boiling point of liquid nitrogen

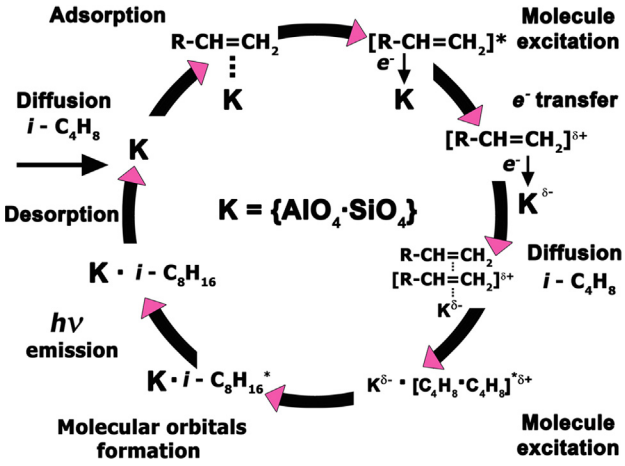
P.A. Gushchin [a,*], V.A. Lubimenko [a], D.A. Petrova [a,b,c], E.V. Ivanov [a], I.M. Kolesnikov [a], V.A. Vinokurov [a]

[a] Department of Physical and Colloid Chemistry, Gubkin University, Moscow 119991, Russia
[b] Chemical Department, Lomonosov Moscow State University, 119991 Moscow, Russia
[c] Skolkovo Institute of Science and Technology, 121205 Moscow, Russia

HIGHLIGHTS

- Isobutylene oligomerization at −195.8 °C results in eco-friendly high-octane compounds.
- Solid aluminum and zirconosilicate compounds are high-effective catalysts.
- Zeolite-aluminosilicate catalysts have a higher catalytic activity.
- Maximum conversion in the reaction reached above 95% with radiation-catalysts.
- Ultra-low temperatures affect the selectivity of dimer which is up to 99%.

GRAPHICAL ABSTRACT



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ABSTRACT

Experimental results on the study of the regularity of isobutylene oligomerization at ultra-low temperatures (−195.8° C) in the presence of solid aluminum and zirconosilicate catalysts have been obtained for the first time. The maximum conversion in the oligomerization reaction of solid isobutylene at the boiling point of liquid nitrogen reached ≈ 90% in the case of an irradiated aluminosilicate catalyst. An increase in catalyst loading increases the selectivity for the yield of 2,3,3-trimethylpentene and 2,3,4-trimethylpentene dimers and reaches almost 99% for the most effective zeolite-aluminosilicate catalyst, eliminating the need for a distillation of the main product 2,3,4-trimethylpentene from the reaction mixtures. A study of the radiation-catalytic oligomerization of isobutylene was conducted. The optimal irradiation range of zeolites varies from 7.0 to 8.2 MRad, providing the isobutylene conversion above 95% due to an increase in the stability of excited active sites of the catalysts. Equations of experimental dependencies were created, based on the differential-integral approach to the analysis of the dependencies mentioned above. The numerical values of the constants in mathematical models of the isobutylene oligomerization reaction are computed. The results are explained considering the physical, molecular kinetic, and thermodynamic mechanisms of the process. The explanation of the mechanism of low-temperature oligomerization is presented by the generalized quantum–mechanical principle. The stepwise cyclic scheme of the catalytic oligomerization reaction is proposed.

* Corresponding author.
E-mail address: guschin.p@mail.ru (P.A. Gushchin).

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