*Thematic Section:* Theoretical Research. **Full Paper**
*Subsection:* Physical Chemistry. *Reference Object Identifier* – ROI: jbc-02/18-54-5-63
Publication is available for discussion in the framework of the on-line Internet conference "*Butlerov readings*".
http://butlerov.com/readings/
Submitted on March 15, 2018.

# Adsorption of formaldehyde by synthetic zeolites from aqueous solutions in the presence of orthophosphoric acid in the framework of kinetic models of pseudo-first and pseudo-second orders

© **Grigory A. Ovchinnikov**,[1] **Rail I. Valiev**,[1] **Guzel S. Shamsutdinova**,[1] **Vadim S. Tukhvatshin**,[1]*+ **Radik S. Ilibaev**,[2] and **Rifkat F. Talipov**[1]
[1] *Department of Organic and Bioorganic Chemistry. Bashkir State University. Z. Validi St., 32. Ufa, 450076. Russian Federation. E-mail: vadimtukhvatshin@yandex.ru*
[2] *"Ishimbai Specialized Chemical Catalyst Factory". LLC, Levyy bereg St., 6. Ishimbay, 453203. Russian Federation.*

*Supervising author; +Corresponding author

***Keywords:*** formaldehyde, synthetic zeolites, adsorption kinetics.

## Abstract

A known industrial method for the preparation of isoprene is the "dioxane" process, which involves the condensation of aqueous formaldehyde with 2-methylpropene in the presence of an acidic homogeneous catalyst (orthophosphoric acid) in 4,4-dimethyl-1,3-dioxane (DMD) followed by a thermocatalytic decomposition of the latter into isoprene. Advantages of this method are high purity of the obtained isoprene and low energy costs. However, isomeric isopentene alcohols (3-methyl-3-butenol-1, 3-methyl-2-butenol-1, 3-methyl-3-butenol-2 and cyclic ethers (4-methyl-5,6-dihydro-2*H*-pyran, 4-methylenetetrahydropyran) as by-products, reduce the selectivity of the formation of DMD and the desired isoprene.

In this regard, many methods have been proposed to increase the selectivity of the formation of DMD by reacting formaldehyde with 2-methylpropene using heterogeneous catalysts (silicon dioxide with supported heteropolyacids based on molybdenum, tungsten or vanadium, antimony (V) or bismuth (V) oxides, modified synthetic zeolites). It should be noted that the nature of the adsorption process of reagents (formaldehyde) or the corresponding product (DMD) on heterogeneous catalysts significantly affects the selectivity of the reaction of formaldehyde with 2-methylpropene and the synthesis of isoprene in general.

In this work, we studied the kinetics of adsorption of formaldehyde by synthetic zeolites of the type A and X from aqueous solutions in the presence of phosphoric acid in the framework of the pseudo-first (Lagergren model) and pseudo-second order models. The adequacy of the application of the pseudo-second-order model for describing the kinetics of adsorption of formaldehyde with synthetic zeolites KA, NaA, CaA, CaX, NaX from an aqueous solution in the presence of phosphoric acid is shown, which indicates the presence of sorbate (formaldehyde) interaction with the sorbent (synthetic zeolite).

## References

[1] N.A. Plate, E.V. Slivinsky. Fundamentals of chemistry and monomer technology. *Moscow: Science.* **2002**. 696p. (russian)
[2] S.N. Telalović, J.F. Maheswari, R. Ramanathan, A. Chuah, U. Hanefeld. Chemical communications (Cambridge, England). **2008**. 7345, 4631.
[3] E. Dumitriu, V. Hulea, I. Fechete, C. Catrinescu, A. Auroux, J.F. Lacaze, C. Guimon. Applied Catalysis *A: General.* **1999**. 181. 15.
[4] G.A. Ovchinnikov, V.A. Gorskih, V.S. Tukhvatshin, R.F. Talipov. *News of universities. Chemistry and chemical technology.* **2016**. Vol.59. P.71. (russian)
[5] V.I. Fadeeva, T.N. Shekhovtsova, V.M. Ivanov. Fundamentals of analytical chemistry. Practical guidance. *Moscow: High School.* **2003**. 463p. (russian)
[6] T.A. Krasnov, N.S. Golubeva, O.V. Belyaeva. *Actual problems of modern science.* **2006**. Vol.4. P.143. (russian)