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CHRONICLE

Aleksandr Yakovlevich Rozovskii (On the Occasion of His 75th Birthday)

Aleksandr Yakovlevich Rozovskii, a famous scientist in the field of chemical kinetics, catalysis, petrochemistry, and solid-state chemistry, recently celebrated his 75th birthday.

After Moscow State University (1951), and his work at a chemical plant (1951–1955), all of his scientific activities have been associated with the Topchiev Institute of Petrochemical Synthesis, Russian Academy of Sciences (the former Institute of Oil of the USSR Academy of Sciences), where he has held the position of the Head of Laboratory of Kinetics since 1975.

In solid-state chemistry, he developed a modern theory of the kinetics and macrokinetics of heterogeneous reactions, especially reactions with solid substances (gas–solid and liquid–solid), and the methods for the kinetic analysis of these reactions. He also studied various reactions of metal oxide reduction, oxidation, and others. The results of his studies were generalized in the monographs *Kinetics of Topochemical Reactions* (1974) and *Heterogeneous Chemical Reactions: Kinetics and Macrokinetics* (1980), which are known both in Russia and abroad.

Based on his kinetic and mechanistic studies of catalytic reactions, he advanced a new concept on the role of the medium in catalytic reactions and discovered the effect of self-control in catalytic systems. The regularities of catalytic reactions stemming from the abovementioned concept have been analyzed, and the corresponding kinetic methods have been developed. These theoretical and experimental studies were described in the monograph *A Catalyst and Reaction Medium* (1988).

Detailed studies have been carried out under Rozovskii's supervision on the chemistry of catalyst surfaces and surface species. Experimental methods have been developed that enable kinetic studies of surface and surface species transformations. A number of redox and other transformations of surface and surface species have been studied using model systems and real catalysts. The phenomenological theory of chemical reaction kinetics in the surface layers of solids has been formulated and new approaches to catalyst preparation have been developed.

The most interesting and surprising result of studies into surface species transformations was a radical change in the insight into the possible pathways of heterogeneous catalytic reactions. The most detailed analysis of such reactions has been carried out using methanol synthesis as an example (together with G.I. Lin and others).

The reactions of associated substitution were first proposed by V.V. Sadovnikov (1974) to explain data on the dehydrogenation of cyclohexene to benzene. In the late 1970s in Rozovskii's laboratory, reactions known nowadays as adsorption substitution were carried out in independent experiments for various pairs of components of a reaction mixture in methanol synthesis with characteristic time measurements. The key role of strongly chemisorbed species has been experimentally proven for the reaction of methanol synthesis, steam reforming of methanol, its dehydration and dehydrogenation, dehydrogenation of hydrocarbons and their functionalized derivatives, the water-gas shift reaction, the reaction of NO with CO, and others.

The appearance of reaction mechanisms of this new type required revising the kinetics apparatus due to the appearance of additional nonlinearities. Such an apparatus has been developed and successfully applied to the analysis of the above reactions.

Together with Yu.B. Kagan and M.G. Slin'ko, A.Ya. Rozovskii has developed a new method for kinetic studies of heterogeneous catalytic reactions based on the critical parameters for the ignition of the catalyst surface. This method is based on D.A. Frank-Kamenetskii's approach, but the fundamental variable is the gas temperature at the moment of ignition, which can readily be measured, rather than the surface temperature, which is hard to measure. The method has been applied with success to the Fischer–Tropsch synthesis and more recently (in 2003) to selective CO oxidation.

In addition to fundamental scientific developments, Rozovskii carried out kinetic and mechanistic studies of many specific catalytic reactions, which ended with new technological solutions. In the above-mentioned studies on methanol synthesis, a radically new macroscopic mechanism has been discovered (methanol is formed by CO_2 hydrogenation, not CO). In the subsequent studies, a detailed mechanism of the reactions has been determined and theoretical (mechanism-based) kinetic models have been built. He also developed the modern physicochemical foundations of the methanol synthesis process. These findings were generalized in the monograph *Theoretical Foundations of Methanol Synthesis Process* (1990), written in coauthorship with G.I. Lin. Virtually all the main results of this series of studies were ahead of contemporary

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Russian and foreign findings and they were further confirmed by experiments in other laboratories. Based on fundamental studies, Rozovskii developed a new technology of methanol synthesis that doubled the catalyst unit-volume productivity. This technology was better than its foreign analogs. In 1995, his series of studies on methanol synthesis won a prize of the Council on Catalysis and Its Industrial Use for the best work on catalysis.

Together with the Borekov Institute of Catalysis, Semenov Institute of Chemical Physics, and the Department of Chemistry of Moscow State University, Rozovskii participated in the design of new catalysts and methods for cleaning industrial gaseous waste, including non-ammonia-based de-NOx, and catalysts for environmentally clean flame-free combustion of fuel, which can be used for the removal of toxic admixtures.

In recent years, Rozovskii supervised kinetic and mechanistic studies of methanol dehydrogenation into methyl formate, steam reforming of methanol and its decomposition into CO and H_2, dimethyl ether synthesis, selective CO oxidation in the presence of hydrogen, and other reactions. Based on these studies, new, highly efficient processes of one-step syngas conversion into dimethyl ether and methyl formate synthesis from methanol were developed. These processes are better than their foreign analogs.

Synthesis of dimethyl ether, which is an environmentally friendly motor fuel and a starting material for the synthesis of olefins and high-octane gasoline with improved environmental characteristics, is of special importance. The process performance is very high. It is based on natural gas and can be used to involve hydrogen-poor syngas produced by coal and biomass processing into chemical conversions. This work received a gold medal and a grant at the World Exhibition of Innovations and New Technologies (Brussels, 2000).

Based on the above developments, an efficient method for the processing of natural gas into motor fuel and valuable chemical products via the scheme natural gas $\longrightarrow$ syngas $\longrightarrow$ dimethyl ether $\longrightarrow$ gasoline has been proposed. With Rozovskii's participation, this method was implemented on a pilot scale at the Primorskii NTTs RKK Energiya. The fundamentals of these studies were published in a series of papers under the common title *New Concepts of Kinetics of Catalytic Reactions and Their Use in the Processes of Natural Gas Conversion into Motor Fuel and Valuable Chemical Products* and received the Grand Prize of IAPC Nauka/Interperiodica in 1999.

Rozovskii is the author of more than 400 scientific publications, including 6 monographs and a number of patents and inventions. More than 20 of his disciples have received Cand. Sci. and Dr. Sci. degrees.

Rozovskii was among the organizers of several All-Union and international meetings. He is a member of the Scientific Councils on Catalysis, and Petrochemistry of the Russian Academy of Sciences. He is a member of the editorial boards of *Kinetika i Kataliz* (Kinetics and Catalysis), *Zhurnal Fizicheskoi Khimii* (Russian Journal of Physical Chemistry), *Kataliz v Promyshlennosti* (Catalysis in Industry), a member of international editorial council of *Protsessy Neftekhimii i Neftepererabotki* (Processes of Petrochemistry and Oil Refining) published by the Academy of Science of Azerbaijan, and a member of several specialized councils.

Rozovskii was given the title of Distinguished Scientist of the Russian Federation, awarded a medal For Labor Heroism and In the Memory of 850 Years of Moscow.

The editorial board of Kinetics and Catalysis, with which he has collaborated from the day the journal was founded, cordially wishes Aleksandr Yakovlevich Rozovskii many happy returns of the day and further professional success.