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Aleksandr Yakovlevich Rozovskii: On the 80th Anniversary of His Birth

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On February 8, 2009, Aleksandr Yakovlevich Rozovskii, an outstanding scientist in chemical kinetics, catalysis, solid state chemistry, and petrochemistry, Professor, and Doctor of Sciences in Chemistry, would have celebrated his 80th birthday.

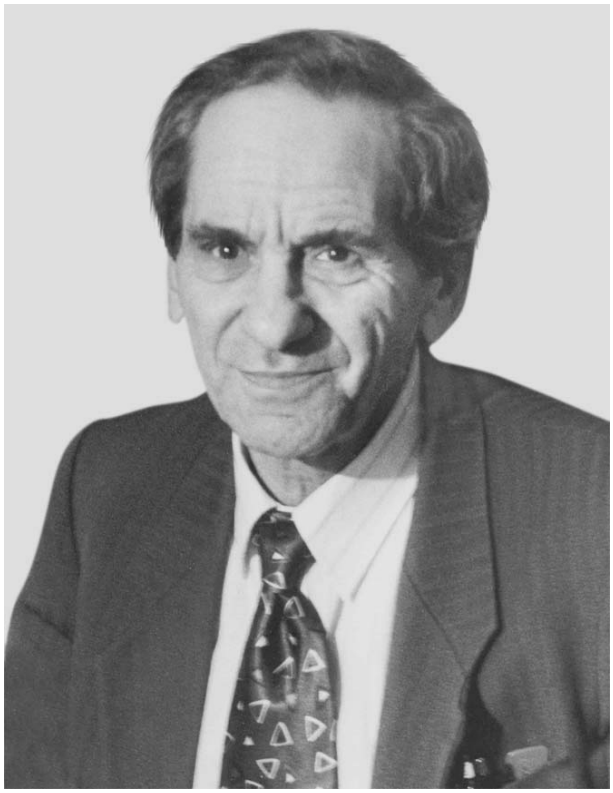
Rozovskii's happy childhood ended when his parents were arrested in 1937. His father was shot, and his mother was sent to a prison camp. In spite of his tragic youth, he was able to enter Moscow State University (Faculty of Chemistry). Early in his university studies, he carried out studies in ammonia synthesis kinetics under the supervision of the prominent physical chemist A.V. Frost. After graduation from the university (1951–1954), he worked in the central laboratory of Orenburg Chemical Plant.

Beginning in 1955, Rozovskii's scientific activity became linked with the Topchiev Institute of Petrochemical Synthesis, where he was promoted to Head of the Laboratory of Kinetics in 1975.

Rozovskii's scientific interests embraced the kinetics and mechanisms of heterogeneous catalytic reactions, the chemistry of surface compounds, and the heterogeneous catalytic synthesis and catalytic conversions of oxygen-containing C_1 compounds. The scientist successfully combined theoretical investigations with direct experiments and logical interpretation of experimental data.

Rozovskii and his team carried out a variety of studies of fundamental importance. For example, Rozovskii developed the kinetic and macrokinetic theories of heterogeneous reactions, which was presented in his monographs *Kinetika topokhimicheskikh reaktsii* (Topochemical Kinetics), Moscow: Khimiya, 1974; *Geterogennye kataliticheskie reaktsii: Kinetika i makrokinetika* (Heterogeneous Catalytic Reactions: Kinetics and Macrokinetics), Moscow: Nauka, 1980.

Based on kinetic and mechanistic studies of catalytic reactions, Rozovskii suggested the concept of the role of the reaction medium in catalytic reactions and discovered the phenomenon of self-regulation in catalytic systems (conjugacy between the transformations of the catalytic sites and the chemical reaction). The existence of this phenomenon was verified experimentally for catalytic syntheses from CO and H_2, CO oxidation, alcohol sulfoesterification, and olefin hydroformylation. These studies were summarized by Rozovskii in his monograph *Katalizator i reaktsionnaya sreda* (Catalyst and the Reaction Medium), Moscow: Nauka, 1988.



Rozovskii and his colleagues carried out systematic studies in solid surface chemistry and the chemistry of surface compounds. He formulated a phenomenological kinetic theory of chemical reactions in surface layers of solids. It was demonstrated by these studies that the formation and conversion of stable surface compounds and strongly chemisorbed intermediates and ultimate products play a significant role within the main pathway of many chemical reactions.

The mechanism of such reactions was studied in greatest detail for methanol synthesis from carbon dioxide over copper-containing catalysts. It was found that a water molecule forms and is adsorbed strongly in each catalytic cycle. The characteristic time of desorption of this molecule from the active site of the catalyst

is as long as tens of hours. According to the classical views of a catalytic reaction (adsorption followed by a reaction and desorption), synthesis on a single site will be terminated upon the formation of the first water molecule. In fact, it turned out that a strongly adsorbed molecule can be removed from the adsorption site through its replacement by a strongly adsorbable molecule (or its fragment) from the gas phase via the formation of an intermediate association species, namely, a two-particle complex (adsorption-assisted desorption).

The determining role of the conversion of strongly adsorbed species was proved experimentally by studying the synthesis and vapor-phase reforming of methanol, its dehydration and dehydrogenation, the dehydrogenation of hydrocarbons and their functionalized derivatives, the reaction between NO and CO, the water gas shift reaction, etc.

In collaboration with Yu.B. Kagan and M.G. Slin'ko, Rozovskii developed a method for kinetic studies of heterogeneous catalytic reactions in terms of the critical conditions for catalyst surface ignition. This method was successfully applied to the Fischer–Tropsch synthesis and, in recent years, to selective CO oxidation.

Rozovskii supervised not only conceptual research, but also kinetic and mechanistic studies of particular catalytic reactions. Some of these studies afforded new technical solutions. For example, a series of studies on the macroscopic mechanism of methanol synthesis, which revealed that methanol results from the hydrogenation of CO_2, not CO, laid the physicochemical foundations for this process, which were presented in the monograph *Teoreticheskie osnovy protsessa sinteza metanola* (Theoretical Foundations of Methanol Synthesis) by A.Ya. Rozovskii and G.I. Lin, Moscow: Khimiya, 1990. The authors constructed theoretical kinetic models based on the mechanism of the reaction and, proceeding from these models, developed a new methanol synthesis technology. This technology raised the productivity of the process per unit volume of the catalyst by a factor of 2 and thus brought it above the world level of that time. In 1995, the Council of Catalysis and Its Industrial Applications awarded Rozovskii a prize for his contribution to methanol synthesis as the best work in catalysis.

In recent years, Rozovskii guided research in the fields of kinetics, reaction mechanisms, methanol dehydrogenation into methyl formate, methanol steam reforming, methanol decomposition into CO and H_2, dimethyl ether (DME) synthesis, selective CO oxidation in the presence of hydrogen, etc. These studies culminated in the development of an efficient one-step technology for DME synthesis from synthesis gas and a technology for methyl formate synthesis from methanol, both exceeding the world level.

The DME synthesis technology is of particular significance. DME can serve as an environmentally friendly motor fuel and/or as the starting material for the synthesis of olefins and antiknock gasoline with improved environmental characteristics. The process based on natural gas conversion has favorable cost–performance characteristics, which is very important at present. Therefore, it can be used to involve synthesis gas obtained by the conversion of coal, vegetable waste, and other materials into chemical processing. For the development of this technology, Rozovskii was awarded the gold metal and a grant at the World Exhibition of Innovation, Research, and New Technology in Brussels in 2000.

Based on the above R & D works, Rozovskii suggested an efficient way of converting natural gas into motor fuels and valuable chemicals via synthesis gas and DME. For a series of publications under the general title "New Concepts in the Kinetics of Catalytic Reactions and Their Use in the Conversion of Natural Gas into Motor Fuels and Valuable Chemicals," he received the Grand Prix from MAIK Nauka/Interperiodica in 1999. In 2004, he received the Balandin Prize from the Presidium of the Russian Academy of Sciences for his research in the kinetics and mechanisms of catalytic conversions of one-carbon molecules. The scientist participated in the startup of a DME/gasoline pilot plant at the Primorskii Science and Technology Center of the Energiya Rocket and Space Corporation.

Rozovskii was a man of great erudition and sharp intellect and was sincerely interested in science. He was the author of over 400 publications, including six monographs, and held a number of inventor certificates and patents. He was the supervisor of more than 20 doctors and candidates of sciences.

Rozovskii was among the most competent experts in various areas of catalysis. He was the organizer of a number of All-Union, Russian, and international conferences and symposia; a member of the Council for Catalysis and the Council for Petroleum Chemistry at the Russian Academy of Sciences; a member of the editorial boards of the journals *Kinetika i Kataliz* (*Kinetics and Catalysis*), *Zhurnal Fizicheskoi Khimii* (*Russian Journal of Physical Chemistry*), and *Kataliz v Promyshlennosti* (*Catalysis in Industry*); and a member of the international editorial council of the journal *Protsessy Neftekhimii i Neftepererabotki* (Processes of Petrochemistry and Oil Refining), edited by the Academy of Sciences of Azerbaijan. Rozovskii was with *Kinetika i Kataliz* from the very founding of the journal.

An excellent polemist, Rozovskii took an active part in conferences and workshops on catalysis and was a well-wishing opponent for degree candidates and helpful to reporters.

For his great services to his native land, Rozovskii was awarded the Order of Friendship, the Medal for Valiant Labor, the Jubilee Medal "850 Years of Mos-

cow," and the honorary title of a Meritorious Scientist of the Russian Federation.

Rozovskii was a real scientist and a fascinating man, and he enjoyed great prestige among domestic and foreign scientists and manufacturers.

The close friends of this scientist remember him as an enthusiast of hiking and skiing. He loved to sit beside a forest campfire, and, lighting one more cigarette from a coal, he used to say that "this way is tastier." He liked to play the guitar and to sing songs with his friends.

Aleksandr Yakovlevich Rozovskii of blessed memory will live forever in the hearts of those who were fortunate enough to know him, to communicate with him, or to be his colleagues.

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