

A Celebration of Inorganic Lives: Interview with Ilya I. Moiseev[☆]

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Ilya I. Moiseev is a Professor of Inorganic Chemistry at the Gubkin State University of Oil and Gas (Moscow) and Head of Metal-complex Catalysis Laboratory at the N.S. Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences (RAS). He was born to a Jewish family in Moscow in 1929. His father Josef (Iosif) Moiseev was a worker at the oldest Moscow automobile plant AMO (now Likhachev Plant). His mother Doba Turovskaya was a teacher at a nursery school. In 1947, Ilya Moiseev joined the M.V. Lomonosov Institute of Fine Chemical Technology (Moscow), where he studied chemistry (and, in particular, acetylene hydration reaction catalyzed by mercury salts) with Professor Rafail Flid. In 1952, Moiseev was graduated as engineer specialized in chemistry and technology of heavy organic synthesis. After graduation he was obliged (by contract) to serve as an engineer at a State Institution for Designing of Chemical Enterprises for 3 years (1952–1955) but was allowed to continue his study with Professor Flid at the M.V. Lomonosov Institute in his free time and without salary. He received Candidate of Sciences degree (an equivalent of PhD) from the M.V. Lomonosov Institute of Fine Chemical Technology in 1958 and the Doctor of Sciences (similar to habilitation) degree from the N.S. Kurnakov Institute in 1967. From 1955, Moiseev worked with Professor Yakov Syrkin's group initially at the Institute of Physical Chemistry and later on at the N.S. Kurnakov Institute of General and Inorganic Chemistry, RAS. Here he pioneered studies on palladium chemistry. He and his coworkers were the first to oxidize alkenes into alkenyl ethers (the Moiseev reaction), they synthesized and characterized by X-ray diffraction a number of palladium low-molecular clusters with Pd-atoms in non-

common oxidation states (+1 and +1/2), prepared and characterized by indirect technique giant Pd-clusters which contain more than 500 Pd-atoms in metal core, brought to light a number of organic reactions catalyzed with the clusters, discovered polar decompositions of hydrogen peroxide catalyzed by vanadium(+5) complexes to form singlet dioxygen and ozone, reductive dehydration of alcohols to form alkanes. In 1974, Moiseev established the Laboratory of Catalysis with Metal Complexes at the N.S. Kurnakov Institute and headed it for approximately 30 years. He is the Vice-president of the Russian Chemical Society, Head of the Department of Structure and Reactivity of Coordination Compounds at the N.S. Kurnakov Institute, Chairman of Scientific Council of Natural Gas Chemistry, RAS, Honorary Research Associate, A.V. Topchiev Institute of Petrochemical Synthesis, RAS. He served as a Visiting Professor at Istituto Donegani, Italy (1990), Netherlands Institute of Catalysis (1995), Institute of Petrol Chemistry at Rein-Westfälische Technische Hochschule, Germany (1996), Delft Technical University, The Netherlands (1997). Moiseev was elected as Corresponding Member, RAS, in 1990 and a Full Member (Academician), RAS, in 1992. He is a member of Academia Europaea (London), European Academy of Arts and Science (Vienna), Academy of Sciences, Arts and Humanities (Paris). He was awarded with Order of the Red Banner of Labour (1986), Order of Honor (1999), A.P. Karpinsky Prize (A. Toepfer foundation, FVS Stiftung, Hamburg, 1999), Triumph-Prize (Independent Foundation, Moscow, 2002), State Prize (Russian Federation, Moscow, 2002). Moiseev is Honorary Workman of Gas Industry (2004), Honorary Workman of Professional Education (2004), Mendeleev Lecturer (St. Petersburg State University, Mendeleev Centre, 1998). Ilya Moiseev is author or co-author of three monographs and more than 500 original research papers and reviews. He is married to Raissa Birman (now Moiseeva) and they have one daughter, a chemist.

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**1. Where were you born? Who were your parents?
Had there been scientists in your family?**

I was born in Moscow in 1929. At that time my parents had a small room in a house in the Arbat Square. I was born in this prestigious place right in the heart of Moscow. My father didn't have a higher education. But he was a remarkable engineer and a very talented organiser. He worked in the AMO factory, which produced automobiles. In 1941, he went to the war. He continued to fight near Prague for several days, even after the peace treaty had already been signed in Berlin in May 1945. He was lucky — he was fighting in the anti-tank artillery and was just injured. To serve in this kind of force and to survive was great luck! After World War II father worked in the food industry. Mum was a nursery school teacher, graduated from the Moscow Lenin's Pedagogical Institute by correspondence and worked in nursery schools all of her life.

2. What effect did wartime have on your life?

It was a difficult time but I didn't break my school education, even although I had to take on a part of the domestic duties. Moscow was bombarded from the beginning of August 1941 and my mother — who was pregnant and expecting my sister — and I were evacuated to Orenburg Region. When the evacuation started, we didn't know where we will get our new home because everything was regulated by local authorities upon arrival in a given region. Somehow or other we ended up in a small village more than 1000 km away from Moscow.

3. Did you have a short childhood?

It was rather short! Before the war, before I was 12, it was happy and cloudless. I am an only child, I am cared for, but also a lot is expected from me — in terms of education, and in terms of behaviour. I was taught from childhood that I must have duties. A child must not be idle and must read a lot. When the war started, I was already 12, and for me adult life began. Now my duties included feeding the goat and bringing firewood from the forest and water from the

well. Two years later we returned to Moscow, and I started working, at the same time studying at school. I worked in a woodworking factory. I did it not even for money, but for the food ration card. My little sister had to be fed. If I was just studying, I would get the dependency ration card — that is, a very small amount of food. A lot more food was given for the worker's card, which I started receiving on beginning work in the factory.

4. There were different types of ration cards?

Yes, there were “workers”, “dependency” and “children” cards. And in between the first two there was a so-called “non-manual workers” card. Mum received this. I earned very little, but it wasn't important. However, for the workers' card I was given 550 g of bread per day. For the “non-manual workers” card less was given — 400–450 g of bread, and for the dependency card — only 330 g. And that was for 1 day! In addition to the bread ration cards, there were, in principle, cards for receiving fats, meat products, cereals. However, these products were often not available, and because of that you had to stand in huge queues. It was easier to buy bread than meat products and cereals, even though there were still queues. But at least bread was delivered regularly. As a rule, we didn't eat all of the bread, but saved up a few cards, so then we could sell them and buy other products for my little sister. She was the centre of our life, our family. But she wasn't spoiled, and grew up to be a hard-working person, became a musician. In the beginning of the war we sold everything that we took with us in the evacuation, except the most vital necessities for the family, and one other thing. It was a piece of fabric for a suit, which my father was awarded with before the war. We saved the fabric during all the war years: “When dad returns, he would need a decent suit, in which he would go to work”. At that time we didn't even suspect that after the war the most beautiful and respected clothes would be his army uniform.

5. And was the suit made?

No. In the year 1948, nevertheless, we sold the fabric, so that we could buy a piano for my sister. This piece of fabric was very expensive. Of course, we could have bought a ready-made suit. But ready-made clothes were of very bad quality, badly sewn. In those days, to look proper, a suit had to be made, and by a good tailor for that matter. And this valuable piece of fabric was sold, and the next day a currency reform broke out. All of the money turned into dust. From the whole sum necessary for buying a piano, only one tenth was left. But the piano was still bought. We borrowed from everyone from whom we could borrow, and returned the debts for many years after.



Photo 1. Prof. Ilya I. Moiseev and his wife Raissa (1965).

6. Your youth coincided with the last years of Stalin's life, the last turn of repressions. What kind of times were those?

One story. This happened with my friend. It was the beginning of the 1950s, several years before Stalin's death. I was studying, since 1947, at the Institute of Fine Chemical Technology,¹ my friend had entered the Conservatoire. He went for a walk with his flatmate. This flatmate had been to war and, to his misfortune, brought with him an unregistered handgun as a souvenir. They reached Kropotkinskaya Street, and a car with Stalin in it passed by them. The car was going very slowly. And my friend said to his companion: "Look how slowly he's going, why, he could be killed". And these words of his became fatal. When they reached the crossing between Kropotkinskaya Street and Bul'varnoye Kol'tso, a car with Ministry of the State Security (MGB) agents was already waiting for them, and they were arrested. It seems that the agents were there along Stalin's entire route. In those days arrests happened in the blink of an eye.

They were questioned so harshly, that my friend's flatmate confessed that he had a handgun. What is more, under torture he said something that didn't really happen — that his father brought another handgun from the civil war. And can you imagine, the agents dug up the earthen floor in his barn, where, according to the testimony, the weapon was kept. In the end my friend was sentenced to 10 years in a strict-security prison camp in Vorkuta in the north of the USSR. He was amnestied shortly after Stalin's death (1953) and returned home before the expiry of the camp sentence.

¹ In USSR, traditionally there was one classic University for the given region and other educational institutions were called Institutes. Many of them were renamed to Technical Universities after the Perestroika Time.

7. The times were terrible. But was there anything bright in your life?

Yes. It was my love. In the year 1947, I started attending a student's scientific group. And during one of the holidays I met a girl in the Institute. Four years later we got married (Photo 1). This is my brightest and happiest memory of those times. My future wife and I studied chemistry with Professor Flid, a very bright personality. We were both affected by his stimulating influence and spent a lot of time in the laboratory together. It was not acceptable to come to the laboratory later than Professor arrived and leave it before his departure. This custom sometimes led to misunderstandings. For example, we registered our marriage at the municipality on February 4th, 1951, but did not celebrate our wedding that day because it was a regular working day and we stayed in the laboratory in spite of the registration! Actually, Professor Flid was our good friend and when we told him this story later on he was very confused and disappointed.

8. And did you take an interest in chemistry while you were still at school?

No. For some time I didn't know chemistry at all. I didn't even understand the simplest reactions, for example, $\text{NaOH} + \text{HCl}$. As a result of this reaction you get NaCl and H_2O . That is, when a hydroxide-ion of the alkali reacts with the proton of the acid, you get water. The cation of the base joins the anion of the acid — giving salt. I just didn't get this simple explanation. I didn't understand why these particular products are formed, and not any other combination of elements! After the year 1945, when World War II ended, men who used to serve in the army started to return to schools. They kept discipline and gave marks, which were adequate to our knowledge. A front-line soldier, Sergei N. Uspensky, came to our school. He was very demanding. And in the 9th

form I faced a 2, that is “unsatisfactory” mark, for a term. He didn’t give me the 2, I had a good reputation and as a whole I studied well, I even expected a “Gold Medal”,² even though I didn’t get it. And Uspensky declared that he was giving me a 3, that is “lowest satisfactory” mark, “in advance”. I realized that it was time to take some measures. And in the end I did manage to understand why NaOH reacts with HCl giving salt and water.

9. Did your parents want you to become a chemist?

No, they really wanted me to become a physician. But firstly, I was always frightened by the responsibility, which the doctor has for a person’s life. I understood that my technical error also could end sadly. But the engineer still can, having realized the mistake in time, to confess and to put everything right. But when you’ve operated on a human, removed something from him, you can’t change anything. Secondly, I visited the library of the medical department of the Moscow State University. And I saw how people sat with gigantic books, painstakingly studying the human anatomy. But I wanted from science creative work and independence, that is, the opportunity to make my own conclusions, based on certain principles. Huge amounts of information for mechanical memorizing didn’t attract me.

10. So why then did you choose chemistry?

By process of elimination! Like I already said, medicine didn’t attract me. Humanities at that time were too controlled by the communist party. This always frightened me off. The father of my friend, a man who had a very good humanitarian education, was an expert on a book — “Anti-During” by Engels.³ He knew every comma in it. During each re-edition, when something had to be changed for political reasons, he was responsible for those changes. All of his life was concentrated on one book. This kind of path didn’t suit me. I knew that I wasn’t good enough in mathematics to apply for an education in mathematics or physics in the building that is right opposite us in the window.⁴ What’s more, I understood well that I wouldn’t be accepted there because I am a Jew. In the year 1947, the wave of anti-Semitism was already beginning, and carried on right to this day. I know two very intelligent chemists who, being Jews, went to the Institute of Fine Chemical Technology with me, and then were transferred to the Moscow State University.

It was impossible for a Jew to enter Moscow State University the usual way. I entered the Institute of Fine Chemical Technology, but didn’t get transferred to the Moscow State University.

11. Who was your main teacher in science?

First of all it was Yakov K. Syrkin. In search for my future profession in 1946, I attended various lecture-halls, listening to lectures on different subjects. One lecture was read by a Corresponding Member (and later a Full Member) of the USSR Academy of Science Professor Syrkin, who at that time was working at the Institute of Fine Chemical Technology and also had a position at L.Ya. Karpov Physicochemical Institute in Moscow. He was a short, thin, plain-looking man. But a brilliant lecturer! His ability to think logically was very captivating. When a young man falls in love with a girl, there are masses of physiological factors that explain the attraction. But when a person follows a teacher, he is lead by the personality. This happened to me, and I was enthralled by his personality. Syrkin gave lectures to schoolchildren about atomic energy and about the structure of matter. His speciality was quantum chemistry — a branch of mathematics especially developed to explain the nature of chemical bonding. Syrkin was a specialist in the field of Structure Theory. He developed methods to investigate matter, magnetic methods, methods of studying the polarity of molecules.

12. Who else influenced your development as a scientist?

Nikolai A. Preobrazhensky and Rafail M. Flid from the Institute of Fine Chemical Technology. I followed the Professors, chose the institute of higher education where these remarkable people taught. Preobrazhensky was an outstanding scientist, but he found time to visit schools together with representatives of the administration and give talks to final-year pupils about chemistry. And Flid was my research supervisor. The thing is that for a long time Syrkin wasn’t allowed to have post-graduates and research associates. Syrkin was an object of persecution by those days’ “zealots” of Russian science. He was accused of “cosmopolitism”. Even though the meaning of the word “cosmopolitism” is the same in English and in Russian, but by the label “cosmopolitism” communist functionaries in the Soviet Union implied a scornful attitude to national culture and traditions, to the extent of their full denial. In those years Zionism and “cosmopolitism” were almost synonyms and it was presumed by the functionaries that it was the Jews — and Syrkin was a Jew — who had a scornful attitude to national culture. This was the extreme display of nationalism. Syrkin, indeed, didn’t show in his works enough of the role of Russian chemical scientists, and he himself admitted that it was wrong.

² Both in the former Soviet Union and in today’s Russia, school pupils who, during the last 2 years of school, study and pass exams only with the “excellent” grade, receive a government award, i.e. the Gold Medal.

³ One of the founders of the communist theory, a friend of Karl Marx.

⁴ From Moiseev’s office window opens a view on the central building of the Moscow State University.

13. At that time few people in the Soviet Union were interested in the history of Russian science, isn't that so?

Yes, you are right! This was the common mistake of many people. I will give you one example. Do you know when Moscow State University was named after Lomonosov?⁵ Only in the year 1947! And why not before? The University, after all, was more than 200 years old during the period of the battle with cosmopolitanism. Because at that time nobody paid enough attention to the history of national science. Lomonosov himself was “discovered” by Boris N. Menshutkin.⁶ And the best book on the history of *Russian* chemistry for that time was written by a *Latvian*, Paul Walden [1], a member of the Emperor's St. Petersburg Academy.

14. Was the persecution of Professor Syrkin caused only by his insufficient attention to the history of science?

No, not only and not mainly because of that! Syrkin was accused not so much of “cosmopolitanism”, as of “idealism”. Oh, party officials easily found their political ideology in chemistry! In chemistry there was a theory on the structure of chemical compounds (and Syrkin was a specialist in the field of structure and the nature of chemical bonding). Here is a benzene molecule. It consists of six carbon atoms, which sit in the knots of the hexagon, and six hydrogen atoms. The carbon has a valency of four. And in this hexagon each carbon atom only has three adjacent atoms. One is missing. You can compensate this drawback in the formula by double-bonding together the carbon atoms. And now I am asking you: why did you join them like that? After all, it is possible to join them in a different way — so that each carbon atom is joined by a double bond with its neighbour to the right, and not to the left. One may ask: where is the truth? Nowhere. Both formulae are correct, and at the same time inaccurate, and the real structure is the superposition of one formula on the other. But it is because of this that problems for chemists started.

The chemists were told: “You are operating with thought-up formulae to describe real, existing things. This is idealism. *And it doesn't fit in with Marxism-Leninism!*” This discussion on the Structure Theory received a wide response around the world. And one outstanding English chemist wrote: “Imagine that I, when describing a certain existing gentleman Mr. Smith, say that he has some features of Don Quixote and Sherlock Holmes. He resembles one and the other. In reality,

neither Don Quixote nor Sherlock Holmes ever existed; on the other hand, Mr. Smith is an existing subject. So where is the mistake? Did I really somewhere violate the truth? After all, after I had appealed to these made-up characters, the real state of affairs became a little bit clearer. You understood better what Mr. Smith is like”. But these arguments didn't convince those who battled against “idealism” and “cosmopolitanism”. And Syrkin was the object of this battle.

15. And why, in your opinion, did the communist party interfere with science?

I think that this was a sort of display of careerism. Actually, it didn't matter much whether people used the Resonance Theory or not, but party officials made a career out of it. They exposed what in their opinion didn't fit in with Marxism-Leninism, which meant that they were worthy of reward. And this campaign was initiated by careerists and ill-educated people.

16. What were the possible consequences of an accusation in “cosmopolitanism” or “idealism”?

I could give you a number of examples, but I will limit myself to just one. Professor Dyatkina (Syrkin's pupil and his faithful friend) lost her job due to her devotion to the resonance theory and wide use of it in her studies. She was an outstanding theoretician and a brilliant lecturer. Nevertheless, she was sacked and could not find a job for several years. Many scientists – biologists, biochemists and chemists – had to work as stokers in boiler-rooms, as street cleaners. But losing a job wasn't the worst that could happen.

17. When Syrkin was accused of cosmopolitanism, how did his pupils behave?

Some of his pupils behaved without the most appropriate attitude towards the teacher. This led Syrkin to the following formula: “A decent person is a person who commits a meanness with disgust”. As a result, Syrkin was scared. Don't forget that, immediately before the campaign on the Resonance Theory a ruination of biological science happened. Many people who studied genetics were left out in the street. Many were arrested. Once, when we celebrated Syrkin's birthday Dyatkina said: “You know, you are a lucky person. You have never served time in prison”.

18. Where were you assigned after graduation in 1952?

At that time a free choice of workplace was completely impossible. However, I could not have been assigned to some

⁵ Mikhail Vasilyevich Lomonosov (1711–1765) is regarded as the “father” of Russian natural science. His studies were in the fields of mathematics, physics, chemistry, Earth sciences and astronomy.

⁶ Prof. B.N. Menshutkin (1874–1938) published a detailed biography of Lomonosov in 1904. His father was N.A. Menshutkin (1842–1907), Professor of Chemistry of the St. Petersburg University, well-known by the Menshutkin Reaction, i.e. alkylation of amines.

faraway place, because I was already married, my daughter had been born. As it happened, my friend, Yuri B. Vol'kenshtein, also a Jew, and I were directed to work in a research institute. The head of the personnel department of this institute, lieutenant colonel of the Ministry of Internal Affairs, came and said that he needed intelligent men for project work. Different divisions recommended to him my friend Vol'kenshtein and me. But at the same time they specially pointed out our ethnic origin. To which he replied: "To me this is completely indifferent, I need hard-working people".

19. A progressive position for those times

For those times it was simply revolutionary! But the lieutenant colonel of the Ministry of Internal Affairs could sometimes allow small deviations from the general party's hard-line. Meanwhile at that time Jews used to be left without jobs at all and had to move away from large cities, such as Moscow and Leningrad. Many of my friends moved to small towns, like to Dzerzhinsk, Gor'kovskaya region. But we were sent to a research institute, and I worked there for three years from 1952 to 1955. In the evenings I used to go to the Institute of Fine Chemical Technology and continue experimental work. For this work, I, naturally, didn't receive any money. I was happy that Professor Flid allocated me a workplace—about half a workbench.

They valued me a lot in the research institute, regularly awarded me with bonuses and didn't want to let me go. But in 1955 Syrkin, a Corresponding Member who didn't work in the Academy of Science had an opportunity to employ a *literature reviewer*. Traditionally, science in Russia was divided into two systems—University and the Academy of Science. As a rule, members of the Academy worked in scientific research institutes of this organisation and were in charge of large laboratories. But if a member of the Academy taught in some University and didn't work in the Academy system, he could be provided with a literature reviewer to help. In Soviet Russia science was so well financed that outstanding scientists could even allow themselves to have personal assistants; these were positions that were totally unbelievable both for the West and for today's Russia.

20. Did this position assume scientific research work?

No! A literature reviewer was to save the time of an outstanding scientist. I can give an example—the Nobel Prize winner Nikolai N. Semenov had a literature reviewer. Semenov, I think, has never read in any European language. I suspect that he has never read anything in Russian either. He was an extraordinarily talented person, who remembered everything by ear and generated ideas verbally—they were written down by others. Sarah S. Polak supplied him with literature. She read all the necessary papers and gave a brief account of the essence of them.

Syrkin, who read quickly and fluently in French, German and English, didn't actually need a literature reviewer. Syrkin needed me for other purposes. When the battle with the Resonance Theory started, he was struck by an idea of a general theoretical scale. For the development of the idea he needed chemical examples. In other words, someone had to look for these examples in literature and help him with the preparing articles. Syrkin was so generous that he took me as a co-author. And I was no longer just a literature reviewer, who was carrying out some sort of technical functions. Together we wrote several reviews, and they were published in the "Uspekhi Khimii" ("Russian Chemical Reviews") journal. For me this was very important schooling.

21. Did you have to read foreign literature?

I couldn't read in English then. And when I started working with him, he asked me: "Which language?" I answered: "German". It turned out that that wasn't enough: English was needed. But how? Syrkin said to me: "Very simple. I will give you a book, and you will translate it". This turned out to be the best way to learn a language. It was a book by Michael J.S. Dewar "The Electronic Theory of Organic Chemistry" (1949). An absolutely marvellous book. At first I was translating word by word, line by line. I became slightly familiar with the grammar, so that I could understand the links between words and verbs tenses. Later I didn't need to look into a dictionary after each line, then—after each page, and I translated this book in a month and it was a huge pleasure. After Dewar's book I understood the meaning of the work that I was doing in Flid's laboratory in the evenings after the research institute.

An idea occurred to me, to some extent, of revolutionary nature. I wrote a plan of what is now called a "project", and carried out the first experiments. The idea was to synthesize acetaldehyde, an important intermediate of the chemical industry, from ethene, and not acetylene, as was usual. Ethene was about one and a half times cheaper than acetylene, the practical benefit was obvious. And it was a breakthrough—one of the components of the technological revolution, which happened in the 20th century—the displacement of acetylene from chemistry by ethene. I am a living witness of this process.

I came to Syrkin and showed him what I had found. And in fact I had discovered a new reaction—the oxidation of alkenes by the salts of palladium. It was the year 1957. I said to Syrkin: "Look what I have found. This is a whole new direction. Let's work on this course. Here is the plan". Syrkin replied: "The plan is very good, but this is work for many years, and I would really like you to obtain your PhD degree. Tell me, could what you did with Flid be presented as a PhD thesis?" Flid took this idea very actively, he needed to work on his Doctor of Science's thesis. And he understood well, that the plan of my PhD thesis is basically a plan of his Doctor's, the idea just needed to be developed. He supported

me, and I obtained my degree. And after that I could work on the subject “the chemistry of palladium and alkenes”.

22. Weren't you worried about delaying the announcement of your rights to the discovery?

Of course, I didn't want to put off the idea for long—I really wanted to work with these compounds and see what happens next. When I thought up this idea about the salts of palladium, I thought that I was the only one in the world, who could come up with this idea. But it turned out, that in Germany, in the city of Munich another chemist came to this in a totally different way. This chemist was Dr. Hafner. The difference between us was the following: he worked from chemical observations, and I—from theory, from the ideas that I obtained from Dewar's book and from the studies to which he referred. In other words, it was the result of logical deductions and theoretical calculations. Hafner, an outstanding scientist, worked in a company, which was called “Wacker-Chemie”, named after its founder, Alexander Wacker. Hafner and his manager Dr. Smidt published their work before me, and the process was given the name “Wacker-process” (Scheme 1). But, to be honest, I wouldn't have been able to carry the process out to the end; it was technically impossible with my equipment.

After we (M.N. Vargaftik, Photo 2, my first colleague, and I) obtained our first result in the Syrkin's laboratory, and the German work wasn't yet published, I suggested applying to the Ministry of Chemical Industry and the Ministry of Education for help. The theoretician Syrkin, whom nobody considered as a practical person, went around Ministries, and was refused with different excuses: all the ethene was needed for polyethylene. In the year 1957 Ziegler and Natta discovered how ethene could be polymerised into polyethylene. They received the Nobel Prize for this work in 1963. Our government, personally Kosygin (at that time Soviet Prime Minister), took this problem under their control. All of the ethene was used for the production of polyethylene and my idea kept being rejected: “All this is of no use: your catalysts are too corro-



Photo 2. Prof. Moiseev with his co-workers near the Institute of General and Inorganic Chemistry, Moscow, May 2004. From left to right: Natalya I. Moiseeva (daughter of Prof. Moiseev), Alexander E. Gekhman (behind), Ilya I. Moiseev, Mikhail N. Vargaftik.

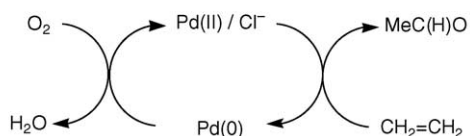
sively active, nothing will come of it”. The situation changed radically after the German article was published [2]. It became clear as day that, at least some of the ethene could be used for the production of acetaldehyde, that it is economically profitable, that there really is a problem of corrosion, but it could be tackled — after all, there are special materials, for example, metallic titanium, with which the problem could be overcome. This was how the psychology of our manufacturers changed, under the influence of the published German work. A stimulus to catch up with the West had emerged. My article came out several months later [3].

23. How did you manage to publish it so quickly?

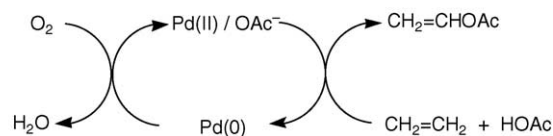
Oh, that is an interesting story! Nikolai N. Semenov, a Nobel Prize winner, helped us. This is how it happened: after the Germans published their article about the Wacker-process in 1959, we decided that the data on the synthesis of vinyl acetate had to be published quickly. Syrkin decided to phone Semenov, so that he would write a covering note asking for an urgent publication. His word counted for a lot. By that time Semenov had already received the Nobel Prize, but the most important thing was something else. Semenov played cards with Nikita Khrushchev — the General Secretary of the Communist Party. From time to time they met at Khrushchev's home. A while later Semenov's note played its part again. I would like to tell that story.

There was a chemist in the USSR called Giller. A very interesting figure, an underground communist, who fought for communist rule in Latvia, and later, when that regime was established in Latvia with the help of the Soviet army, he founded and became the first Head of the Institute of Organic Synthesis in Riga. Giller, if my memory doesn't fail me, went to England in 1963 and visited the company ICI

Wacker Process



Moiseev Reaction



Scheme 1.

(Imperial Chemical Industries), where he was reproached “You, Soviet scientists are careless about your work! For example, Moiseev published an article on the synthesis of vinyl acetate from ethene. And if he hadn’t done that, we would have paid him 12 million pounds”. They exaggerated, of course! Giller, of course, didn’t pay attention to it, but the translator took notes on everything, and on returning to Moscow wrote a report, which by accident ended up on the working desk of Suslov (at that time secretary of the Communist party, who, due to his strong, shadowy influence on politics was at that time called “the grey cardinal”). And Suslov ordered: “Investigate this”. On the very next day I was called to the Government Committee of Science and Technology. I remember very well, how I sat in the basement of this building and gave evidence about how we could publish such a wonderful reaction, for which we could receive so many mythical millions. I wrote that, firstly, we have an USSR Application [4]. And secondly, we published this work in a respected journal — Doklady Akademii Nauk. Then they looked at all the accompanying materials for the article in this journal. When they saw Semenov’s note, we were left alone.

24. From today’s position — what prevented your from publishing the article before the employees of Wacker-Chemie?

In those times publishing work rapidly was prevented by the attitudes of the authorities common at that time. On one hand, Syrkin was told that nothing would come of it, and that’s why he would not be provided with help. And on the other hand there were suspicions that the work could have a practical value and therefore must be kept a secret from enemies, and must not be made public. As a result we published our work later, and the Germans became interested in it so much, that they even came over to meet me (Photo 3). The thing is, that we managed to develop the idea. If ethene is oxidised by water, you get acetaldehyde. But if you oxidise it in acetic acid, you get vinyl acetate. In fact, the reaction doesn’t proceed in acetic acid. You need to add a very simple compound, i.e. sodium acetate (Scheme 1). Then the reaction will start. This is what our German colleagues didn’t understand at the time.⁷ What’s more, they wrote in their article that they



Photo 3. Prof. I.I. Moiseev (left) and Dr. Josef Sedlmeier (Wacker-Chemie) (right) near Moscow State University building (1963).

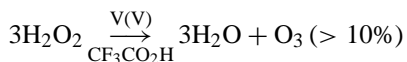
tried to carry out the reaction in acetic acid and they didn’t get anything. Despite that, I conducted the reaction and got results.

Today, of course, there is a cheaper way to produce acetic acid from methanol rather than from acetaldehyde. However, the reaction of the production of vinyl acetate from ethene is still profitable to this day. And this reaction bears my name [5,6].

25. Could you select your major achievements done besides the Moiseev reaction?

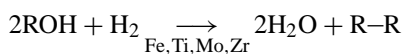
I have been lucky enough to touch several remarkable chemical events during my scientific carrier. Among them is the formation of singlet (rather than a triplet!) dioxygen upon decomposition of hydrogen peroxide (in a collaboration with Alexander E. Gekhman, Photo 2) (Scheme 2) [7].

Then, the formation of ozone (in a mixture with dioxygen) upon decomposition of H_2O_2 (in a collaboration with Natalya I. Moiseeva, Photo 2, and Aleksander E. Gekhman) [8]:



Synthesis and characterization of the giant cluster with the metal skeleton counting of more than 500 palladium atoms (in a collaboration with Mikhail N. Vargaftik, Photo 2, Fig. 1). This cluster catalyzes a variety of reactions [9,10].

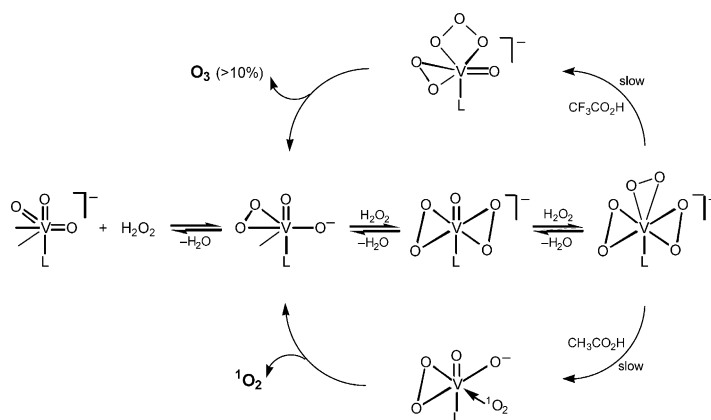
Reductive dehydration of alcohols (in a collaboration with Mark V. Tsodikov and Aleksander E. Gekhman) [11]:



Ethanol under these conditions gives a mixture of hydrocarbons, mostly of the iso-structure (Scheme 3).

This mixture is practically ready petrol!

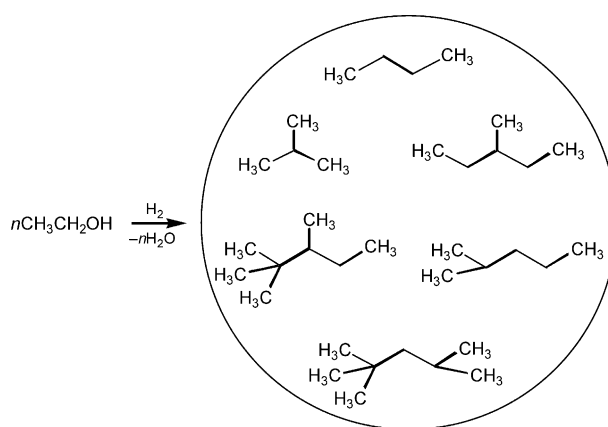
⁷ The Interviewers contacted Dr. Reinhard Jira, one of the scientists involved in the discovery of the Wacker-process, and he kindly wrote a few lines for this interview: “Prof. Moiseev’s statement in the interview concerning the Wacker process is, seen from his point of view, correct. At the time, he could not have known that the reaction had already been discovered in our laboratory in 1956. The first patent application was filed on January 4th, 1957, but it was published only in 1959, as an article in *Angewandte Chemie*. The patent already includes all the features of the catalytic process. On the other hand, the synthesis of vinylacetate is undoubtedly Prof. Moiseev’s achievement. Although we also thought about this reaction, we were so very much engaged in the elaboration of a process for the commercial production of acetaldehyde that we gave up research on this field after the first experimental failure. Our congratulations to Prof. Moiseev!”.



Scheme 2.

26. These were your achievements. And were there any mistakes?

Yes, there were. In the year 1956, when I was working in Syrkin's group, it seemed to me that I could develop a whole new process of synthesis of acetic acid from acetone. In those times in chemical industry acetone was in excess, they didn't know what to do with it. And I thought: maybe I will oxidise acetone into acetic acid. I expected that I would at least get methyl acetate. But I didn't read everything in books and didn't take everything into account. The thing is, that acetone with hydrogen peroxide form cyclic peroxides, which explode on exposure to acid. I synthesised this peroxide, which exploded in my hands. My hand and eye were injured. This unpleasant incident could have ended very badly, but, luckily, everything turned out fine.



Scheme 3.

27. Probably, you were often invited abroad?

Yes, but I wasn't allowed out abroad. In the year 1986 there was a conference in England, to which I was keenly awaited. I was to give a plenary lecture, I was one of the key participants. But our ambassador to England, who is now a very big democrat, gave an order not to let out any scientists individually, without an escort of someone else. They didn't necessarily have to be security agents, but just another person. I made an arrangement with a friend, the head of a large institute, but at the last moment he couldn't go, and the business trip was called off. These cases happened pretty often.

In the year 1969, when the century since Mendeleev's discovery was celebrated, a symposium was organised in Minneapolis, Minnesota state, USA (ACS Symposium sponsored by the Division of Petroleum Chemistry). In fact I was to be the main speaker. But I wasn't allowed to go. I sent my presentation there and it was read by another person (P.M. Henry). What's more, I even sent a comment on another presentation on isomerisation in the presence of palladium compounds. I already had studies that revealed the essence of the process. My comment was published in the proceedings. So, virtually I was present: my talk and my remark were published in the proceedings, but I wasn't there myself.

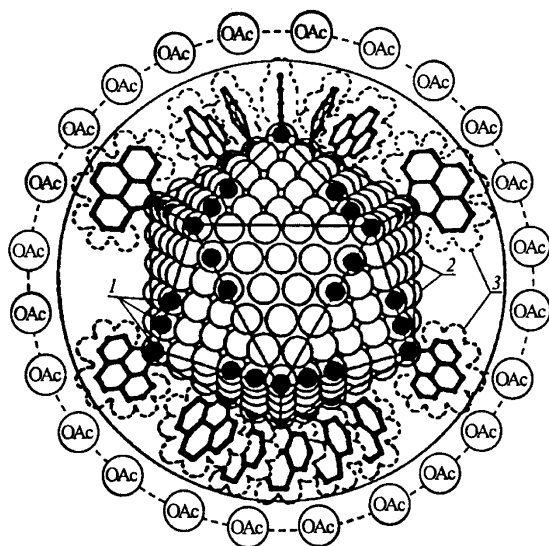


Fig. 1. Idealized structure of the Pd-561 cluster: 1—Pd atoms coordinated to phenanthroline ligands; 2—Pd atoms accessible for coordination of the anions substrate or solvent molecules; 3—van der Waals' contours of the coordinated phenanthroline ligands (reproduced from Ref. [8] with permission of the copyright holder).

28. How many times did you have to attend symposiums abroad virtually?

I don't even want to count! Many. But even this "virtual presence" proved fruitful. After that conference an Italian Renato Ugo, the author of the presentation that I commented on, sent me an invitation to become a member of the editorial board of the continuous publication, "Aspects of Homogenous Catalysis", that he issued. For me this was a great honour, and, of course, I should have agreed straight away. But I was always let down by my discipline. By that time I was already working in the Institute of General and Inorganic Chemistry, and I went to the head of the Institute, Zhavononkov, who also was a highly disciplined person. He decided to send an inquiry to the Administration of External Relations of the Academy of Science. There was no answer. We inquired at the Central Committee of the Communist Party of the USSR. They also didn't hurry with an answer. Meanwhile, Renato Ugo bombarded me with letters, after all, he needed to publish the first volume of his issue, and he wanted my consent. I again went to Zhavoronkov, and he said: "You can't answer without the permission of the Administration of External Relations, there will be troubles". And I had to answer Ugo, that I didn't receive a reply from the Administration of External Relations. And the issue of "Aspects of Homogenous Catalysis" came out without my name in it.

29. And what if you just agreed without consulting the authorities?

Everything would be fine. As they say, there are experimental data. At the same time a brilliant Soviet chemist, Mark E. Vol'pin (Photo 4), the author of nitrogen fixation at low temperatures, received a similar invitation. Mark was known for inexhaustible optimism, even if the situation seemed hopeless, he saw something positive in it, and always saw ways out of the most difficult situations. I said to him: "Mark,



Photo 4. Prof. I.I. Moiseev (left) and Prof. M.E. Vol'pin (right) (1986).



Photo 5. Fourth International Symposium on Homogeneous Catalysis, Leningrad, USSR (1984). From left to right: Profs. M.E. Vol'pin, H. Kaesz, H. Pracejus, I.I. Moiseev.

I didn't receive any permission, and didn't reply to Ugo". To which he said: "You shouldn't have waited for anything. You should have just thanked Ugo. If you thank him, colleagues abroad understand that everything's all right. And our authorities cannot find any fault: formally you didn't give any agreement, you just said thank you". Mark was a good friend of mine and was very worried about my slow-wittedness.

30. Did you use this little trick later on?

Yes, once. There is an international symposium on homogenous catalysis. It exists to this day (Photo 5). I was elected there, and at first I, again, didn't reply, and then Mark said to me: "Don't be foolish, just thank them". And I was included in the International Adviser Board, and I am still a member to this day.

31. When did you go abroad for the first time?

I went abroad for the first time in the year 1968, on a tourist trip — I went to Bulgaria with my wife. At that time in the USSR there was an unwritten law: the first time you went abroad had to be a tourist trip to a socialist country. The first scientific business trip was a year later, I went to Germany, Berlin and Rostok.

32. Probably, your appearance made a sensation after so many years of "virtual presence"?

Yes. But that was in German Democratic Republic, and I was expected in the Federal Republic of Germany. I went to a capitalist country (in the terminology of the time) for the first time in the year 1978. It was to France, Paris and Lyon. Igor V. Kalechits, the Head of the Department of the Government

Committee of Science and Technology was on very good terms with me. He took me under his own responsibility on a trip to Paris, having included me in a delegation of the USSR Government Committee of Science and Technology. There were no problems with visas. I filled in all the forms without problems. But in the delegation there was one lady who was supposed to watch over everyone, and she almost had a heart attack because of me. Early in the morning I pulled on tracksuit pants and jogged in the streets of Paris — I was used to jogging at home! Why should Paris be different to Moscow? When I came back I saw that this lady was as white as chalk. She thought that I ran away and defected to the West.

The trip went very well, we were well received. Kalechits was very pleased that he included me — it gave a scientific charm to the whole delegation.

Somewhere in-between these two trips, in 1979, was my first visit to the USA to a Gordon Conference on inorganic chemistry. But it wasn't me who was invited there, but a very good theoretician from Moldavia, Isaac B. Bersuker. Bersuker was told in the Academy: "You won't go anywhere by yourself, name someone who will go with you — you will be allowed to go together". He named me. Zhavoronkov actively supported this, and that is how I went to the Gordon Conference. Paradox: on our own neither I, nor Bersuker were allowed anywhere abroad. And together — by all means. During the conference I met outstanding foreign chemists: Kirschner, Lever, Reedijk and the future Nobel Prize winner Lehn. There I also met Nobel Prize winner Roald Hoffman.

Then there was another trip to the States, in the very beginning of 1990s, this time with Mark Vol'pin, when we visited many of the outstanding laboratories of the USA in a month and visited, e.g., F. Basolo, J.E. Bercaw, D.S. Breslow, D. Forster, J. Halpern, R. Hoffmann, H.D. Kaesz, J.A. Labinger, G.A. Olah, G.K.S. Prakash, G.A. Samorjay, D.F. Shriver, B.M. Trost, and P.T. Wolczanski. It turned out, as it's called, "in a gallop around Europe", but now, remembering the places and the people that we met, I understand, that we were shown to the great laboratories and the great chemists of that time.

33. You witnessed a change of epochs. Was there a period of time in our country, when there were the most favourable conditions for scientists?

That was the Soviet period. Despite the fact that we weren't allowed abroad, or were let out extremely rarely and selectively, it was then when equipment and reagents were available, we experienced almost no problems with funding. Yes, we complained all the time that the government didn't give the three and a half percent of the budget that we were supposed to receive. But there was one thing that needs to be pointed out. The position of a scientist was considered prestigious. Now in Russia the gen-

eral downfall of interest towards science from the public is obvious. I would say, totally unjustified. All this makes the life of a scientist in the free market less comfortable.

In Russia nowadays the brain drain abroad has almost ceased. It is already not as interesting and attractive as before. But we still have an internal brain drain. It is still tempting to leave science and get a job in some company. Three young people already left me in such a way.

34. Does that mean that the common today ideology of pragmatism isn't compatible with science?

In any case, it doesn't benefit science. A scientist is to some extent a hermit. Let's look back on what I have told you. After all, I did not "attach" myself to an outstanding scientist, under whose wing I would certainly prosper. I have seen examples of that too. People consciously went to those, who would help them to make a good career. Instead I joined a persecuted person, because I was captivated by the man's personality. I didn't want anything "for myself", but I found it interesting to work with my supervisors. And this is an important moment in a scientist's development. One of our great physicists Artsimovich said in Soviet times, that "science is a way to satisfy one's own curiosity at the government's expense". He is right, unfortunately. But this is the only way to advance science, and if not the only, then one of a few. If a person is not interested in his work, then all the other stimuli are nothing. Hang a money-bag in front of him — and he would think only of money. First of all, he must be interested in the science field within which he is working. And everything else, honestly, comes second (Photo 6).



Photo 6. Prof. I.I. Moiseev (right) half a year before his 75th jubilee with Nobel Prize winner R. Noyori (left, holding the first sample of ruthenium obtained by Karl Klaus) and Prof. O.M. Nefedov (center) in Kazan at the Butlerov Museum, September 2003.

35. We have just celebrated your 75th anniversary (Photo 6). What is the secret of your capacity for work and unbelievable energy at this age?

I think I am led by my passion for science, for my chemistry. I could talk about science for hours. Maybe, I should even keep an eye on myself and see that I'm not turning into a senile chatterbox who talks too much. With age people talk too much. The brilliant chemist Ilya I. Chernyaev (the “father” of the *trans*-effect) said: “if you thought of something — don't say it, if you've said it — don't write it down, if you've written it — don't sign it. If you've signed — blame yourself”.

36. You have many regalia and awards, achievements. . . Would you exchange all that for being 18 years old?

Immediately! And I would start everything all over again.

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