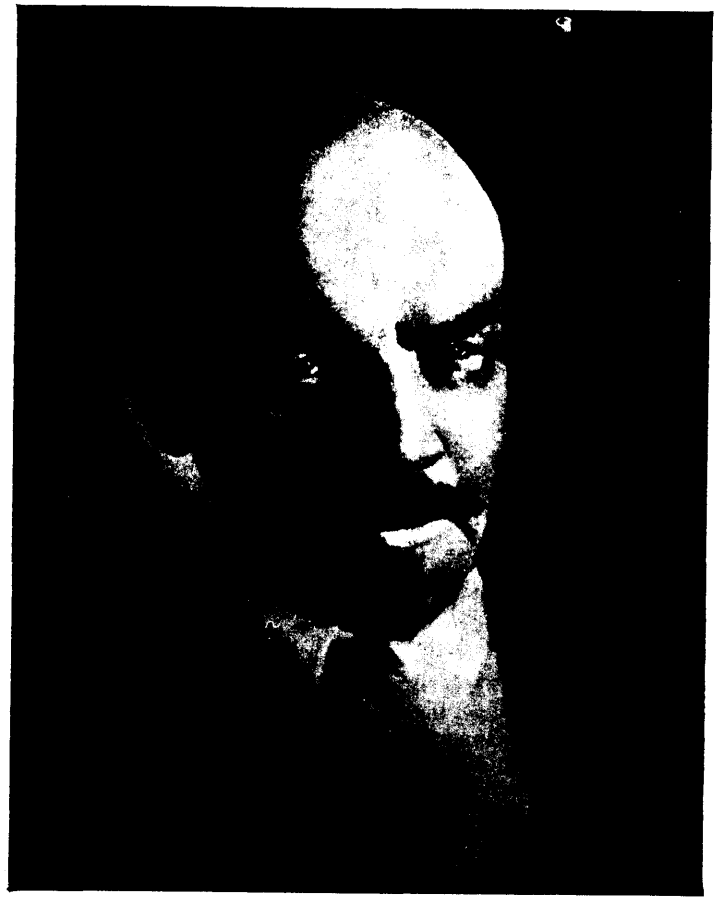
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Vladimir Il'yich Lenin

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Fulfilling V.I.Lenin's outline for the development of Soviet chemistry

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All progressive mankind marks the centenary of the birth of Vladimir Il'yich Lenin, founder of the Communist Party of the Soviet Union and of the first Socialist State, and one of the greatest scientists of our time.

Lenin was the first political figure of world calibre to consider science to be enormously important and to base his concepts of Party and State on thoroughly scientific foundations. It is well known that Lenin's philosophical works—"Materialism and Empirical Criticism", "Philosophical Notebooks" and others—played a very important part in the period between the two Russian revolutions. In these works Lenin also touched on questions of modern science—among them the depth of our knowledge of the outside world, the inter-relation of matter and energy, the transformation of chemical elements.

Lenin paid much attention to the problems of chemistry. Whilst writing his "Materialism and Empirical Criticism", he studied the work of the chemists Ostwald and Liebig, and those philosophers and physicists who had exerted much influence on the development of chemistry—Falaise, Democritus, Gassendi, Newton, Faraday, Helmholtz, and Thomson. In the Sorbonne and Berne libraries Lenin studied the works of Abderhalden, the organic chemist, and Meyer. He was interested in radioactivity, agricultural chemistry, coal chemistry, petrochemistry and geochemistry. He read carefully the works of the gifted agricultural chemist and publicist, Engelhardt, as well as those of Vernadskii, who was one of the founders of geochemistry; he read Planck's "The Principle of the Conservation of Energy", and Boltzmann's papers in the "Vienna Scientific Treatises". The V.I. Lenin Library in the Kremlin contains, besides works on philosophy, history, the law, and economics, many special works dealing with various problems of chemistry and other related sciences: works by Lomonosov, Timiryazev, Vernadskii, Fersman and others.

Lenin also made a study in depth of the problems of the development of the chemical industry. In his work "The Development of Capitalism in Russia" he noted that "chemical production is of the utmost importance for economic development and the growth of the country's productive power" (Complete Works, Vol. 3, p. 476). Subterranean gasification of coal, suggested by Mendeleev and then by the English chemist Ramsey, constituted, in Lenin's view, a gigantic technological revolution which, under Socialism, would help in electrifying factories and railways (Vol. 23, p. 93).

After the October victory Lenin embarked on a scientific plan for the building of a new society. He believed that the country had sufficient natural resources and manpower, and the necessary scope was given to "the national endeavour by the great Revolution—in order to create a truly mighty and prosperous Russia" (Vol. 36, p. 80). Lenin gave an important role to the chemical industry in creating the material and technological basis for Socialism. He wrote: "Increased efficiency of labour requires first of all a proper material basis for heavy industry: increased production of fuel and steel, growth of mechanical engineering and the chemical industry" (Vol. 36, p. 188). Lenin considered Karabugaz, a bay in the Caspian Sea, as the richest source of raw materials for the chemical industry.

On Lenin's initiative, the Supreme Economic Council created a Department of Chemical Industry as early as December 1917. In 1918 Lenin signed the decree prepared by this Department concerning the transfer of a number of chemical and chemico-pharmaceutical enterprises to the ownership of the Russian Republic. Several months later the Council of People's Commissars adopted the decree which nationalised all chemical enterprises. Despite the great hardships besetting the young Republic, considerable sums were assigned in that year for completing the building of the "Provodnik" rubber goods factory in Moscow, for prospecting for phosphorites in the Volga-Kama region and near Aktyubinsk, and for the rebuilding of a number of chemical plants. The Supreme Economic Council did much to assist the Department of Chemical Industry in acquiring raw materials and equipment for chemical laboratories.

In the second half of April 1918 Lenin composed his famous outline plan for scientific and technological progess. This arose as the result of an approach made to the Soviet Government by the Academy of Sciences in March 1918, suggesting that scientists should be drawn into a survey of the country's natural resources. This proposal by the Academy was discussed at a meeting of the Council of People's Commissars on 12 April 1918. The resolution adopted stressed the aim of a "systematic solution of the problems of proper distribution of industry in the country and the most effective utilisation of its economic forces".

In his outline scientific and technological plan, Lenin recommended that the Academy of Sciences be asked to form a series of Commissions of experts in order to work out with all possible speed a plan for reorganising industry and bringing about economic recovery and progress in Russia. This plan had to include a rational siting of industry in relation to accessibility of raw materials and minimising the labour involved in their processing; provision of all the main types of raw materials and industries for the Soviet Russian Republic; special emphasis on the electrification of industry, transport and agriculture; utilisation of inferior types of fuel for producing electric power; and the use of water power and wind-driven motors generally and in agriculture.

Scientists and highly qualified engineers were needed to solve these problems. There were eminent individual scientists in pre-Revolutionary Russia who were working chiefly in academic institutions. Among the chemists there were N.S.Kurnakov, L.A.Chugaev, and I.A.Kablukov (Inorganic Chemistry), D.P.Konovalov, V.A.Kistyakovskii, and E.I.Shpital'skii (Physical Chemistry), N.D.Zelinskii, A.E.Favorskii, and A.E.Chichibabin (Organic Chemistry), N.A.Tananaev, and K.A.Nenadkevich (Analytical Chemistry), V.I.Vernadskii and A.E.Fersman (Geochemistry), D.N.Pryanishnikov (Agricultural Chemistry), V.S.Gulevich (Biochemistry), V.E.Tishchenko and A.A.Yakovkin (Chemical Technology), and V.G.Khlopin (Radiochemistry). These scientists had only a few colleagues, teaching in the various Departments. The material and technological basis for developing research inherited from Tsarist Russia was totally inadequate and became still worse as the result of wartime destruction. This, and the poorly developed network of centres of higher learning prevented

the development of large schools of scientific research in pre-Revolutionary Russia at a time when these were already flourishing abroad.

On Lenin's initiative, and with the active participation of leading Russian scientists, specialised research Institutes, including chemical ones, began to be created from the first months of Soviet power. Among the first ones to be created in 1918 in Petrograd were the Institute of Platinum and Other Noble Metals (Director—L. A. Chugaev) and the Institute of Physico-Chemical Analysis (Director—N. S. Kurnakov) In Moscow the Central Chemical Laboratory was organised under the aegis of the Supreme Economic Council; it subsequently became the L. Ya. Karpov Physico-Chemical Institute. A number of other Institutes followed, including the State Institute of Applied Chemistry, the State Institute of High Pressures, the Scentific-Research Institute of Pure Chemical Reagents, the Institute of Fertilisers.

The VIII Congress of the Russian Communist Party which took place in Moscow in March 1919, included the following in the Party programme: "The Soviet Government has already taken a number of measures designed to advance science and strengthen its links with industry by creating a network of new Institutes of Applied Science, laboratories, experimental stations, pilot plants for testing new technological methods, improvements and inventions, and by registering and organising all available scientific manpower and resources. The Russian Communist Party supports all these measures and aims at their further development and the creation of the most favourable conditions for scientific work relevant to improving the productive forces of the country".

The plan of the State Commission on the Electrification of the Republic was based on Lenin's ideas concerning the material and technological foundations of a Socialist society; this was the first long-term plan for the economic development of the Soviet Republic put forward in 1920 and calculated for 10—15 years. It was devoted mainly to the problem of electrification of Soviet Russia, but it also dealt with the means of developing the principal branches of the country's economy. In particular, it outlined an accelerated growth of the chemical industry. Its production was to show a 2.5-fold increase compared with 1913. At that time it was a gigantic task.

It is well known that before the Revolution the Russian chemical industry was technologically backward, despite the eminence of individual Russian chemists. It was characterised by small-scale production, factories limited to several areas in the European part of the country, absence of a well developed base for raw materials, and shortage of qualified personnel. The chemical industry was immensely dependent on foreign capital. Tsarist Russia, possessing vast deposits of mineral raw material was forced to import pyrites, phosphorites, sulphur, potassium salts and saltpetre. One-third of valuable chemical products and 80% of mineral fertilisers were also imported from abroad. The country had no chemical engineering and not a single college specialising in chemical technology. Suffice it to say that in 1913 there was one graduate chemist per 340,000 population!

The Communist Party and the Soviet Government began in the first years of Soviet power to carry out Lenin's indications for the extensive use of chemistry in the national economy. With the liberation of territories captured by the Whites, measures were taken to restart and reconstruct the oil industry in Baku and the coal chemistry industry in the Donbass, as well as to restore and reorganise the existing basic chemical works.

Besides being concerned about the preservation and utilisation of already existing chemical plants, Lenin gave much attention to new lines of technological development. In 1918 he ordered the evacuation of uranium ore stocks from Petrograd to the Urals. In July 1918 the Council of People's Commissars adopted a resolution on starting a pilot radium plant. The telegram sent to the Urals Economic Council, signed by Lenin, read: "Work on the radium plant must begin forthwith". The first preparation of Soviet radium was obtained in 1921, under the direction of V. G. Khlopin and I. Ya. Bashilov. The problem which had baffled the shareholders of the "Ferganskii Rare Metals Company" before the Revolution was solved. The isolation of radium and the training of highly qualified specialists able to handle highly radioactive substances played an important part twenty years later in organising the atomic industry in the USSR.

In that early period the Council of People's Commissars was much concerned with the production of synthetic materials. It initiated a competition for developing a method of preparation of synthetic rubber. This problem was solved in 1932, when the technique of synthetic rubber production, developed under the direction of S. V. Lebedev, was adopted.

Research into the use of oil shales as chemical raw material for the production of primary shale tar and the preparation of valuable chemicals from it was begun in 1918 on Lenin's personal instigation.

At the same time, on Lenin's instructions, new centres for tertiary education were being established. In the three years from 1918 to 1920 the following institutions came into being: Universities in Tbilissi, the Urals (Sverdlovsk), Erevan and Central Asia (Tashkent), and the Moscow Mining Academy, with increased admissions to already existing tertiary schools. Chemical specialties were extended and chemical Faculties created at the Moscow, Petrograd and other Universities. The training of qualified chemists was extended in Technical Colleges (the Moscow Technical College and the Technological Institute in Petrograd, among others). In 1920 the first specialised Chemical Technological College—the D. I. Mendeleev Institute of Chemical Technology—was opened in Moscow.

These measures made it possible to train in a few years many researchers and chemical engineers for research Institutes, laboratories and industrial concerns. Whereas in early 1925 there were 2750 engineers working in the chemical industries, two years later their number had risen to 4000.

The establishment of new scientific Institutes continued throughout the Civil War and after its end. These included the Radium Institute, the Institute of Applied Mineralogy and Non-Ferrous Metallurgy, the State Institute of Rare Metals, and many other chemically-oriented Institutes. There was considerable expansion of research in the Chemistry Departments of Colleges. A start was made on the organisation of Applied Research and Designing Institutes geared to various branches of industry. Among the first of these were the Urals Chemical Research Institute, the Mining Chemical Institute, the Scientific-Research Institute of Basic Chemical Industry in Kharkov, the Glass Institute, the State Institute of the Nitrogen Industry, the GIPROKHIM Design Institute, and others.

In the not quite seven years during which Lenin led the Soviet State the development of science in our country, and chemistry in particular, received a great stimulus. Lenin's genius and creative initiative played a vital role in this respect. As N. P. Gorbunov, Secretary of the

Council of People's Commissars, wrote subsequently in his memoirs, there is hardly a scientific or technological undertaking in the Soviet Union which has not been associated with Lenin's name.

After Lenin's death, science and industry in the USSR continued to advance along the lines laid down by him. An important step in the advance of science in our country was the transfer in 1934 of the Academy of Sciences of the USSR from Leningrad to Moscow, which led to an expansion of a network of new academic Institutes. The Institute of General and Inorganic Chemistry came into being through the merging of the Institute of Platinum and other Noble Metals with the Institute of Physico-Chemical Analysis and the Chemical Laboratory of the Academy of Sciences. The Institute was subsequently named after N.S.Kurnakov. It became an important centre for advances in Soviet inorganic chemistry. Other Institutes which were created included the Institute of Organic Chemistry, and the Institute of Colloidal and Electro-Chemistry which subsequently became the Institute of Physical Chemistry from which, in turn, the Institute of Electrochemistry split off later. The Institute of Chemical Physics came into the structure of the Academy. Academy bases and branches were being organised; many of these became, in time, Academies of Science of the Republics. At the same time stronger links were being forged between the work of the Academy and practical needs, in accordance with Lenin's testament. In 1938 the Council of the People's Commissars of the USSR proposed that the Academy of Sciences concentrate its attention on the main scientific problems dictated by the development of the Socialist economy and culture.

The development of Soviet chemistry had leaned on the continuously growing might of our chemical industry, mechanical engineering and the national economy as a whole. The State Plan for the Electrification of the Republic was fulfilled ahead of schedule. By 1926 chemical production had reached again the 1913 level. New workshops and factories began to be built for the production of synthetic ammonia, various acids and salts, artifical fertilisers, intermediate products of aniline dye-stuffs industry, etc.

In 1929 the Central Committee of the All-Union Communist Party published its resolution concerning the work of the Northern Chemical Trust, which stressed the importance of further acceleration in the development of the chemical industry. During the First Five-Year Plan (1929-1932) chemical production increased 3.2-fold, outstripping other industries in growth. The development of Soviet chemistry during that period was greatly helped by a national movement in support of a chemical orientation of the national economy which was headed by a number of eminent scientists and resulted in the appointment by the Government of a Committee for promoting this orientation at the Council of People's Commissars of the USSR (1928).

The resolution of the XVII Congress of the All-Union Communist Party put forward the following aim for the Second Five-Year Plan (1933-1937): "To achieve decisive advances in the development of the chemical industry, ensuring an extensive chemical basis for all branches of the national economy and strengthening the country's defences". The resolution urged the adoption by the chemical industry of the newest technological methods (electrolysis, electrothermy, gaseous phase reactions), the use of new raw materials, the creation of a series of new enterprises and further steps in combining the chemical industry with other branches of the national economy. The Second Five-Year Plan achieved a 3-fold increase in chemical production compared with 1932.

A still more extensive programme for the growth of the chemical industry was envisaged in the Third Five-Year Plan, which was interrupted by the treacherous invasion of the Soviet Union by Fascist Germany. Nevertheless, our country had achieved considerable success in the development of the chemical industry during the pre-war Five-Year Plans. Over one hundred large chemical plants were built to produce synthetic ammonia, nitric acid and nitrogeneous fertilisers, sulphuric acid, synthetic rubber, synthetic fibres, potassium and phosphorus fertilisers, aluminium and magnesium compounds for smelting appropriate metals, rare element compounds and many rare metals. The creation of an organic chemical industry was a great achievement. By 1941 the chemical production output had exceeded the 1931 level by a factor of over 20. This proved to be one of the decisive factors in ensuring that the Army and the rear were supplied with all the necessary chemical materials. Soviet chemistry made an important contribution towards the defeat of Germany Fascism and the victory in the Great Patriotic War.

The chemical industry, like other branches of our national economy, suffered greatly from Hitler's invasion. The heroic efforts of the Soviet people during the post-war period made it possible rapidly to restore destroyed factories and build new plants. By 1948 the industry as a whole had returned to the 1940 level and continued to advance. The establishment of new Institutes and research centres continued. In 1957 the Siberian Branch of the Academy of Sciences of the USSR was organised, together with a number of Chemical Institutes. Later, a Research Centre of the Ukrainian Academy of Sciences was created in Donetsk.

As a result of the successful fulfilment and over-fulfilment of four Five-Year Plans (the Fourth, 1946-1950; Fifth, 1951-1955; Sixth, 1956-1960 and Seventh, 1961-1965) the level of chemical production in 1965 had risen 300-fold compared to 1913. The Eighth Five-Year Plan (1966-1970) will see at least a further 1.5-fold increase in chemical production.

Against this background of rapid growth of the chemical industry and allied branches of the national economy there has been an intense development of Soviet chemical science in all directions, many of which had been indicated by Lenin in his time. In a short article one can only mention the most important achievements.

Important discoveries have been made in the field of organic catalysis by N.D. Zelinskii and other outstanding scientists. It became possible to effect various previously unknown transformations of hydrocarbons with the help of specially selected catalysts. Many of these reactions found practical applications in the production of high-quality liquid fuels from oil (catalytic cracking), and served to advance petrochemistry. The multiplet theory of catalysis, put forward by A.A. Balandin, has thrown light on the mechanism of catalytic processes, especially for complex organic reactions.

The growing amount of work on petrochemistry and the processes of oil refining has been accompanied by the establishment of special Research Institutes—the Institute of Petrochemical Synthesis of the Academy of Sciences of the USSR, The Institute of Petrochemical Processes of the Academy of Sciences of the Azerbaidzhan SSR, and others. The achievements of petrochemistry have justified in full the help which Lenin extended to the oil industry in the early period of Soviet power.

A. E. Favorskii and his students, who investigated isomerisation and polymerisation of unsaturated hydrocarbons, did much to fulfill the demands for new synthetic materials made by Lenin and the Council of People's Commissars. This school of scientists developed methods of producing synthetic rubber from divinyl and acetylene, and plastics and adhesives from vinyl acetylene, vinyl esters and other acetylene derivatives. Our chemistry of organic polymers has continued to advance further; its achievements and targets were discussed at the May Plenary Session of the Central Committee of the Communist Party of the Soviet Union in 1957.

The stimulus given to the development of Soviet Organic chemistry after the Great October Socialist Revolution has led to the appearance of new branches of this science. Among these one must mention the chemistry of organoelemental compounds, based on the work of P. P. Shorygin, A. E. Arbuzov and other outstanding Soviet chemists. Organic silicon compounds found extensive application in the preparation of new polymers, lubricating substances and other products. Organic compounds containing atoms of tin, lead, antimony and other metallic elements are used as antiseptics, catalysts and other valuable materials. They have also played an important part in evolving a theory of the structure of organic substances.

In his outline plan for science and technology, Lenin stressed that the young Soviet Republic must aim at being able to provide its own most important raw materials. This aim was pursued on a wide front by large groups of researchers over a period of years. Geological prospecting for the necessary mineral raw materials was associated with experimental work on their technology.

One must mention the work associated with the preparation of aluminium oxide from Tikhvin bauxites which made it possible to organise the production of aluminium by the first Soviet aluminium enterprises—the Volkhovskii and the Dneprov plants. The studies carried out by A. A. Yakovkin on the technology of the production of alumina and by P. F. Antipin on its electrolysis played a very important part in this. Similar work was done on the production of magnesium from carnallite.

In 1922 V. I. Spitsyn and colleagues, working in the Laboratory of Inorganic Chemistry of the Moscow State University, began the study of the chemistry of high-melting rare metals—molybdenum and tungsten. The technology of these metals was studied on samples of native ores and these processes were then translated to an industrial scale at the Baskakov Cable Works in Moscow. In 1925, under the direction of T. M. Aleksenko-Serbin, the country obtained home-produced molybdenum and tungsten wire for the manufacture of electric bulbs and other electrical equipment.

In order to coordinate research into the geology, mineralogy, chemical technology and metallurgy of rare elements, as well as the economic problems associated with these, the Scientific and Technological Section of the Supreme Economic Council established, in 1922, a Bureau to deal with the study and industrial application of rare elements. This Bureau organised the first studies of the chemistry and technology of beryllium, tantalum and the rare earth elements. Later all these resulted in the establishment of industries which had not previously existed in our country. The Bureau's supervisory work passed to the State Institute of Rare Metals when it was established in 1931. Within the latter's walls were developed the scientific foundations for many rare element industries. Among these were the studies directed by M. N. Sobolev on the extraction of vanadium from wastes obtained in the processing of the Urals titanium-magnetite ores. The production of ferrovanadium, established before the start of the Great Patriotic War, ensured the production of high-quality steel alloys for the war effort.

The Institute of Rare Metals organised the production of metallic beryllium, lithium, many rare earth elements, very pure antimony, titanium, germanium and other rare metals. Research into the chemistry of rare elements was also carried out in many scientific Institutes with other designations and in Academic departments. N. P. Sazhin deserves special mention for his contribution to the development of research into the technology of many rare elements.

Platinum metals occupy a special place among the rare elements. Before the Revolution crude platinum was mined in large amounts in Russia, but methods of its refining were not known and it was exported abroad. From there pure platinum and other platinum metals were reimported at great cost. As already mentioned, one of the first Soviet Institutes to be established in 1918 was that for the development of research into the chemistry and technology of platinum and other precious metals. The Institute carried out successfully the targets set by the Soviet Government. Here, under the direction of L. A. Chugaev and I. I. Chernyaev, were begun the investigations which subsequently formed the basis for an original method of platinum refining, which was finally developed at the Institute of General and Inorganic Chemistry of the Academy of Sciences of the USSR. Our country obtained all the platinum metals separately, and in a very pure state.

Rare elements present a particularly good example of the way in which the problem of satisfying all the requirements of our Socialist country in terms of raw materials and manufactured products was taken up by Soviet scientists as a patriotic duty and solved by them. At present the Soviet Union has all the chemical elements which have a practical application.

The Institute of Physico-Chemical Analysis, created under Lenin, carried out under N. S. Kurnakov's direction, an immense task of national importance in studying the salt deposits of our country and the methods of utilising these. Solikamsk, Kara-Bogaz-gol, the soda lakes of Siberia—these are but a few of the subjects studied by researchers at the Institute and later in the Institute of General and Inorganic Chemistry. One must also mention a different line of physico-chemical analysis followed by G. G. Urazov and other colleagues at the Institute. This was the study of metallic systems, which formed the basis for producing high-quality Soviet alloys for aviation and other technological needs. Furthermore, the creative development of methods of physico-chemical analysis which took place in our country after 1917 made an immense contribution to world science.

The part played by Lenin in establishing radium production in Soviet Russia has already been mentioned. The outstanding work directed by V. G. Khlopin put the separation of radium and barium by fractional crystallisation on a scientific basis. The Law of co-crystallisation of micro-admixtures and carriers, discovered by them, threw a new light on the phenomena of isomorphism, and made it possible to use co-precipitation for determining the valency states of elements in unstable compounds and for determining the composition of substances present in minute amounts. At the same time the country was also being provided with radium for medical and research purposes.

The accumulated experience of working with radioactive substances proved later to be extremely important when the problem of organising an atomic industry and preparing pure fissile materials arose in the early Forties. Now the Soviet Union is fully provided with all radioactive elements. Methods have been devised for isolating individual fragment elements used as sources of energy particles (conversion of the heat of radioactive decomposition into electrical energy by means of thermoelectric transducer), in electric charge neutralisers for the textile industry (for neutralising the charges which arise on the thread during spinning) and in other spheres. Industrial production of radioactive isotopes for use in technology and in research has been going on in the Soviet Union for over 20 years.

It would not, of course, be proper to limit this review only to those lines of development in Soviet chemical science which had been directly initiated or supported by Lenin. The Great October Socialist Revolution which took place under Lenin's inspired leadership, brought out new ranks of scientists and engineers from the people and opened before them a wide path of creative activity. They responded to all the new challenges presented by the rapid developments in science and technology. They shared the will to realise Lenin's vision of close ties between science and the practical demands of the national economy.

It has not therefore been an accident that our country became, under the Soviet Government, one of the most important centres of research into the chemistry of complex compounds (I. I. Chernyaev, A. A. Grinberg, and others). Some of the achievements of Soviet chemists include: detailed unravelling of the theory of chain reactions which makes it possible to control the kinetics of chemical processes; creation of an important new aspect of physical chemistry—physico-chemical mechanics with its numerous practical applications; elaboration of the theory of surface phenomena in electrode processes, which is of the utmost importance in clarifying the mechanism of reactions occurring in chemical sources of current; the work of V. A. Kistyakovskii, G. V. Akimov and their students which laid the foundations for the theory of corrosion processes in metals and developed effective anti-corrosion measures; study of adsorption, begun during the First World War by N. D. Zelinskii and N. A. Shilov which led to the discovery of important laws recently used in the synthesis and rational application of new types of sorbents, which have become very important in modern technology (molecular sieves).

The scientific and technological revolution in our country has followed Lenin's outline and brought about a rapid growth in culture and technical education of the population unmatched elsewhere. In 1917 the Russian Physico-Chemical Society had 565 members. At present the D. I. Mendeleev All-Union Chemical Society has a membership of 180 000, and the total number of scientsts and chemical engineers far exceeds this number. Before the Revolution the number of scientists in Russia, Doctors and Masters of Chemical Science did not exceed a few score. Now the Soviet Union has over 1100 Doctors and about 11,000 Candidates of Chemical Science.

It can be said without exaggeration that at present Soviet scientists and engineers, workers and technicians in our chemical industry are able to solve the most complicated problems that the Soviet State may place before them. Our people have achieved these successes by their persistent endeavours under the guidance of the Communist Party. But we shall never forget that it was Lenin who set the course for the development of science and technology in the first Socialist State.