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MOSCOW CONFERENCE ON PEACEFUL UTILIZATION OF ATOMIC ENERGY

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Problems connected with the peaceful utilization of atomic energy were discussed on 2,3, and 5 July 1955, at sessions of the Departments of Physico-mathematical, Chemical, Biological, and Technical Sciences, Academy of Sciences USSR.

The session of the Department of Physicomathematical Sciences devoted much attention to the consideration of the physical basis of the operation of uranium-graphite reactors. In view of the fact that by means of these reactors a direct chain reaction of the fission of atomic nuclei was realized for the first time in the USSR and the energy evolved in the process used for industrial purposes, the interest evinced in a detailed exposition of this process is quite understandable.

The first report, which was given by I. M. Frank, Corresponding Member of the Academy of Sciences USSR, and entitled "Multiplication of Neutrons in Uranium Graphite Systems," served as a general introduction to the following reports, in which the results of experimental and theoretical investigations of the system uranium-graphite at various concentrations of uranium and different temperatures of carrying out the nuclear reaction were elucidated. These reports were given by D. T. Ad'yasevich, L. V. Groshev, O. I. Kozinets, L. Ye. Lazareva, K. D. Tolstov, Ye. L. Feynberg, I. M. Frank, F. L. Shapiro, and I. V. Shtranikh.

The reports presented at the session demonstrated that the different physical parameters of the system uranium-graphite have been investigated thoroughly. Fine details such as the role played by the water layers used for the cooling of the uranium slabs [literally "blocks"] and the significance of the clearance in the graphite which is necessary when the slabs are cooled with gas have been investigated. The temperature dependence of different factors which determine the reactivity of the system has also been measured. Experimental work dealing with the measurement of the resonance absorption of neutrons at various thicknesses of uranium slabs [literally "diameters of the uranium blocks"] has been discussed in detail in reports given by M. V. Yegiazarov, V. S. Dikarev, V. G. Madeyev, and N. A. Burgov.

The results of these experiments are in close agreement with the theoretical assumptions that have been made. Because the uranium [imbedded] in the moderator has the structure of large blocks, it was possible to reduce considerably the resonance absorption and to obtain for the uranium-graphite system coefficients of multiplication significantly larger than unity. The method of investigation that had been used was explained in all reports. A number of data were obtained with the aid of the so-called prism method.

Experimental data which are of major importance for the calculation and construction of reactors that are to be used for the generation of energy were subjected to detailed consideration. In reports given by S. Ya. Nikitin, S. I. Sukhoruchkin, and N. E. Galanina, the dependence of the effective quantity of secondary neutrons on the energy of the captured primary neutrons was considered. The conclusion was made that there are significant differences in the effective quantity of secondary neutrons originating as a result of the capture of neutrons by different levels of substances undergoing fission.

In the second part of the report the so-called neutron transformer was described which serves as a source of neutrons having intermediate energies. P. A. Spivak, E. G. Yerozolimskiy, I. Ye. Kutikov, G. A. Dorofeyev, E. N. Lavrenchik, and Yu. P. Dobrynin cited results obtained in measuring the effective number of neutrons emitted by the isotopes uranium-235, uranium-233, and plutonium-239. Data obtained by the comparative measurement of the average number of neutrons emitted in the fission of various isotopes of uranium and plutonium were described in a report by V. I. Kalashnikova, V. P. Zakharova, V. I. Lebedeva, L. A. Mikaelyan, P. Ye. Spivak, and M. I. Pevzner.

The attention which the session paid to an important property of fissionable nuclei, namely the number of emitted secondary neutrons per captured neutron and particularly the dependence of this number of neutrons on the energy of the captured neutron is completely understandable. The importance of this phenomenon is due to the fact that the nucleus of the fissionable element, on capturing a neutron, may split and yield neutrons in the process of splitting or, on capturing the neutron, may not undergo any fission, but be transmuted into another isotope of the same element. The second process is not only useless by reason of the fact that no secondary neutrons arise, but downright harmful because the captured neutron is wasted.

The interrelationship between the two processes changes, depending on the resonance level at which the neutron is captured; in other words, depending on the energy possessed by the neutron which is captured. Investigations demonstrate that in relatively hot reactors, in which the average energy of the neutrons is somewhat higher, the coefficient of multiplication is lower than in cold reactors. This circumstance must be taken into consideration in the calculation of reactors which are to be used for the generation of energy. Furthermore, the measurements which have been carried out make it possible to arrive at interesting conclusions which are of a purely scientific nature and which have a bearing on the nuclear levels of fissionable elements.

The uranium-graphite reactors are not the only systems which are suitable for the generation of electrical energy. At present, now that the problems of the industrial production of heavy water and of enriched uranium have been solved, other systems can also be designed. G. N. Flerov, Corresponding Member of the Academy of Sciences USSR, reported on work done at the Academy of Sciences USSR on reactors charged with uranium-235, plutonium-239, and a hydrogen moderator.

The theoretical basis of the calculation of an energy-furnishing reactor in which uranium and ordinary water are used was also considered. Some characteristics of this reactor, which have been discussed in reports by S. M. Feynberg, G. A. Stolyarov, L. V. Komissarov, V. P. Katkov, and U. V. Nikol'skiy, indicate its promising nature for applications aimed at the generation of energy. The calculations and experimental data show that when the slabs of uranium are placed very close to each other the coefficient of multiplication in a reactor of this type can be greatly increased.

Several reports were devoted to investigations of the spectra of alpha-radiation emitted during the radioactive decay of heavy elements (L. L. Gol'din, Ye F. Tret'yakov, G. I. Novikova, S. A. Baranov, and K. N. Shlyagin). With the use of this method, data on the energy levels of heavy nuclei such as neptunium-237 and americium-242 were obtained. Results of investigations of the spectra of gamma-rays emitted during the capture of thermal neutrons in some heavy nuclei were cited in a report by V. P. Ad'yasevich, L. D. Groshev, and A. M. Demidov. U. G. Abov reported on results of investigations made by him with the aid of a crystal neutron spectrometer.

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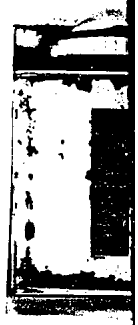


At the final meeting, a report by V. I. Klimenkov and U. N. Aleksenko was given which dealt with the modification of the properties of graphite under the action exerted by neutron radiation. It has been established that under the effect of radiation not only the physicochemical characteristics of graphite undergo certain changes but also its volume. X-ray diagrams which formed a part of the report indicated that there is a significant change in the crystal structure of graphite. The results of investigations on the changes to which graphite is subjected under the action of neutrons are of significance not only in the designing of uranium-graphite reactors but also of great importance from the standpoint of physics of the solid state.

Reports were also given on the neutron yield in the photo-splitting of uranium and thorium (L. Ye. Lazareva, V. I. Gavirilov, D. N. Valuyev, and G. N. Zatsepina and on a method which makes it possible to measure doses of radiation with the use of scintillation phosphors (V. V. Antonov-Romanovskiy, I. B. Keirim-Markus, Z. A. Trapeznikova, and M. S. Poroshina).

In the concluding report given at the session of the Department of Physico-mathematical Sciences, Academician A. R. Alikhanov emphasized that the information presented at this session cannot by any means be considered completely representative of the results achieved by Soviet physicists in the field of peaceful utilization of atomic energy, because a considerable number of USSR reports will be published for the first time in connection with the international conference at Geneva.

The session which has been held definitely gave to science much that is useful and the material presented at the session on the whole was also of interest taken by itself. In view of the fact that the system consisting of naturally occurring uranium and graphite is one of the simplest for carrying out a nuclear chain reaction, the properties of this system were considered in great detail. However, this does not mean that now when we have reached the stage at which the most economical and practical system for the generation of electrical energy has to be solved an the problems of the industrial production of heavy water and enriched uranium have already been solved, this system should be given the greatest attention.

One of the possible solutions of the problem consists in carrying out the chain reaction with the aid of a uranium-water reactor in which enriched uranium is used.

In view of the fact that in a reactor of this type the participation of neutrons having energies somewhat higher than the thermal energy will be great, the processes of fission and of the capture of neutrons in uranium and plutonium at these higher energies acquire a great significance. According to A. I. Alikhanov it follows from this that the data on measurements of the cross section of neutron capture in the energy range of 0.03 — 2 electron volts cited by U. G. Abov represents information of considerable interest. However, one must note that the data of Abov in regard to the capture of neutrons having an energy close to 0.3 electron volts are to some extent at variance with the results of measurements made by other investigators. It is of interest to establish the reason for this difference in the results and to determine the actual value of the cross section of capture at a maximum resonance when the energy of the neutrons amounts to 0.3 electron volts.

Reports dealing with the investigation of radiation spectra emitted by heavy elements have shown that Bohr's ideas of the rotational level in elongated nuclei is capable of bearing results and makes it possible to achieve further progress in the systematization of nuclear levels.

This work and also investigations on the photo-splitting of nuclei are of great interest from the scientific standpoint, as has been mentioned by Alihanov. He reiterated that although we may study practical applications, we still must pay close attention to problems of the structure of the nucleus and of its levels.

Foreign scientists took part in the work of the session conducted by the Department of Physicomathematical sciences. Among them were Professors Saha (India), Nils Fontell (Finland), Weng Kan-ch'ang (China), Sigvard Arne Eklund (Sweden), Mao Khha (Burma), Mahmud Ahman ash-Shirbini (Egypt), Pavle Savic and Drago Grdenic (Yugoslavia), Mahmud Hasati (Iran), Arne Lundby (Norway), Benjamin Bloch (Israel), Fujioka (Japan), and others.

The papers given at the general meeting of the Department of Chemical Sciences dealt with three principal fields: (1) radiation chemistry, (2) the action of high-energy particles on the nuclei of chemical elements, and (3) the application of isotopes in chemical research.

V. L. Karpov discussed the problem of the action of nuclear radiation on high-polymer substances. In connection with the production of atomic energy, it has become possible to use the sources of nuclear radiation of high activity for the irradiation of polymer substances. This treatment brings about radical changes in the properties of the material being irradiated.

For instance, the high polymer may be transformed into a nonfusible and insoluble substance (this is the so-called radiochemical vulcanization) or its resistance to heat may be raised. In other cases complete destruction of the polymer takes place under the effects of radiation. Investigations of this type are particularly important for the correct selection of polymeric substances (plastics, elastomers, etc.) that are to be used under conditions involving exposure to radiation fields of high activity.

In a report by N. A. Bakh, experimental data were summarized that had been obtained at the Academy of Sciences USSR in the investigation of the action of various types of radiation on aqueous solutions of inorganic salts. In the light of several systems discussed, the interrelationship between the establishment of stationary conditions in the liquid medium and the emission of gaseous products of radiolysis was considered. The author of the paper emphasized that the multiplicity of redox processes which originate in aqueous solutions of inorganic salts under the action of radiation may be utilized not only for the solution of problems which have a direct relation to radiochemistry: they are also of importance for the elucidation of more general problems pertaining to the behavior of inorganic salts in aqueous solutions during reactions connected with electron transitions.

M. A. Proskurnin, V. D. Orekhov, and Ye V. Barelko in their report demonstrated that successful study of radiochemical processes is possible only when the mechanism of the phenomena of sensitization of the required reactions is clearly understood. The combination of several different reactions of oxidation or of conjugated oxidation-reduction taking place in aqueous solutions subjected to the action of radiation makes it possible to increase considerably the yield, i. e., to increase the effectiveness of the utilization of the energy of radiation.

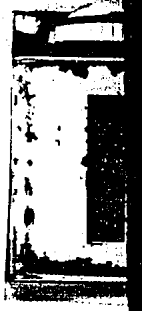
Using as examples the formation of ozone and the oxidation of nitrogen under the action of gamma radiation having an energy of 200-300 kiloelectronvolts and electrons with an energy of 10-400 electron volts, S. Ya. Pshezhitskiy discussed the dependence between the processes of the formation of ions and of the activation of molecules on the one hand, and the kinetics and other quantitative characteristics of radiation-induced reactions on the other hand.

In a report by N. A. Perfilov, N. S. Ivanov, O. V. Lozhkin, V. I. Ostroumov, and V. P. Shamov the results of investigations of the fission of nuclei of uranium, bismuth, and tungsten as a result of the action of fast protons and slow mesons on these nuclei were outlined. A report given by A. K. Virogradov, I. P. Alimarin (Corresponding Member of the Academy of Sciences USSR), V. I. Baranov, T. V. Baranova, A. K. Lavrukhina, F. B. Pavlotskaya, and L. D. Krasavina dealt with work on the fission of the nuclei of bismuth, thorium, uranium, and copper under the action of different particles having high energies. The results of the investigation by radiochemical methods of the fission of tungsten by deuterons with an energy of 280,000,000 electron volts were described in a report by B. V. Kurchatov, V. N. Mekhedov, M. Ya Kuznetsova, and L. N. Kurchatova.

The reactions of deep fission of the nuclei of copper, lanthanum, and bismuth was characterized in a report by N. A. Murin, V. K. Preobrazhenskiy and others. The radiochemical investigation of the products of the fission of silver by means of high-energy particles was described in a report by B. V. Kurchatov, V. N. Mekhedov, and I. Borisov, M. Ya. Kuznetsova, L. N. Kurchatova, and L. V. Chistyakova. G. M. Kukvadze, L. N. Gol'din, M. P. Anikin, and B. V. Ershler gave data on the yields of cerium and neodimium when these elements form as fragments in the fission of uranium-233.

The authors of the papers indicated that as a result of the investigations in question Soviet scientists have discovered a great number of new radioactive isotopes. The experimental data cited in the reports have made it possible to arrive at certain new ideas in regard to the mechanism of the transformations which occur when complex nuclei have been bombarded with high-energy particles. Radiochemical data have enabled us to evaluate the probability of the occurrence of emission splitting, of fission at an excited level, and of the deep splitting of nuclei. The data described served as a basis for the formulation of new concepts pertaining to the systematization of the nuclei of chemical elements.

In a report by A. I. Brodskiy, Corresponding Member of the Academy of Sciences USSR, a summary was given of the results of investigations carried out by Soviet scientists on the application of stable and of radioactive isotopes for the study of the structure of chemical compounds, of the mechanism of chemical reactions, and of the reactivity of substances. As shown by the author of this report, the investigation of isotope exchange makes it possible to obtain more precise data than those obtained by any other method which enable us to solve the problem of the interdependence between the reactivity and the chemical structure of substances, this being a problem which is of the greatest importance for theoretical chemistry.



A. A. Grinberg, Corresponding Member of the Academy of Sciences USSR, gave a critical review of work with the application of radioactive isotopes done by Soviet and foreign investigators on the structure of complex compounds and the mechanism of their formation. Because of the increased importance of complex compounds in various fields of chemistry and biology, the data in question are of great theoretical and practical significance.

E. I. Kuznetsov has shown that in addition to inorganic coprecipitants, organic coprecipitants have acquired considerable importance during recent years. The organic coprecipitants make it possible to isolate microquantities of elements from very dilute substances. This is of great significance for the isolation of radioactive tracers in a radiochemically pure state. Very extensive investigations in this field have been carried out in the USSR.

In reports by G. P. Miklukhin and Ye. N. Gur'yanova, the results of investigations of the mobility of sulfur atoms in various organic sulfur compounds were described. Organic compounds of sulfur occur frequently among substances encountered in nature and have the most diverse applications in chemical technology. For that reason it is very important to establish the nature of the interrelationships which determine the mobility of sulfur atoms depending on the structure of the molecules in which they are contained.

S. T. Konobeyskiy, Corresponding Member of the Academy of Sciences USSR, reported for the first time results of investigations by methods of physicochemical analysis of the alloys of plutonium with nickel, manganese, iron, silver, and other chemical elements. These investigations made it possible to establish certain regularities in alloys formed by plutonium with other elements. These results are of great theoretical importance.

The reports presented at this session were subjected to a detailed discussion. A group of foreign scientists participated in the session. Among the foreign scientists who participated were Prof Ternis Barendregt, Dr Torbjoern Sikkeland (Norway), Prof Stig Meltker Claesson (Sweden), Prof Eberhard Leibnitz (German Democratic Republic), Prof Jan Hendrik de Boer (Netherlands), Jaromir Maly (Czechoslovakia), Drago Radovanovic, Doctor of Chemical Sciences, and Prof Pavle Savic (Yugoslavia), Dr Jagji Shankar (India), and Professors Erich Schmid and Berta Karlik (Austria).

The concluding address of the session, which was given by M. M. Dubinin, Academician-Secretary of the Department of Chemical Sciences, summarized the results of the session as follows. Soviet scientists, said Dubinin, are very glad of the opportunity to share with others results of investigations on the utilization of atomic energy and to learn about the experience in this type of work acquired by scientists of other countries. This exchange may lay the foundation for international cooperation among scientists and for the development of ways to use atomic energy to the advantage of humanity as a whole. The Soviet scientists will greet the opportunities to develop further scientific contacts with foreign scientists [in order to exchange information] pertaining to all basic directions of scientific activities carried out at institutes of the Department of Chemical Sciences. The most effective form of this cooperation would be mutual visits to scientific institutions of the countries involved and participation in mutually-held scientific meetings.

In the work done by the session of the Department of Biological Sciences, major attention was paid to the utilization of nuclear radiation in the food industry and in agriculture.

The problem of radiation sterilization in the food industry was discussed in a report by N. M. Mysel', Doctor of Biological Sciences. Microscopic, physiological, and biochemical investigations have established that after cold sterilization of food products (i. e., sterilization carried out by exposing these products to ionizing radiation), as distinguished from hot sterilization (i. e., sterilization by heat), the bacterial cells for some time continue to carry out a number of biological functions. They resorb oxygen, carry out some enzymatic processes, and even make attempts to grow, although they finally die nevertheless. The promising nature of radiation pasteurization (i. e., partial sterilization) is due to the fact that only relatively low doses of radiation 85,000-90,000 roentgen) are required to accomplish it, while at the same time, the number of microorganisms is reduced by 85-95% and there is no significant change in the composition of the products which have been sterilized. Radiation pasteurization makes possible to prolong the time during which the products can be stored, for instance in refrigerators.

Still lower doses of ionizing radiation may stimulate some practically useful metabolic processes in microorganisms. Thus, R. D. Gal'tsova succeeded by applying relatively low doses of X rays in increasing by a factor of nearly 3 the yield of ergosterol obtained in the biosynthesis of this substance with the aid of yeast cells. This effect is brought about because of interference with the fat metabolism of the yeast.

Ye. N. Zaostrovskaya placed preparations of radioactive cobalt into layers of vegetables or potatoes kept in storage. As a result of the irradiation of the vegetables by doses of gamma rays amounting to 5,000-55,000 roentgen, a delay in the sprouting of the vegetables until the fall was obtained. In some cases there was a delay in sprouting amounting to more than a year.

Very complex and at the same time very attractive is the problem of raising the yields of agricultural crops by exposing the plants to the action of rays emitted by artificial radioactive isotopes and naturally occurring radioactive substances. With this aim in view, P. A. Vlasyuk, Active Member of the Academy of Sciences Ukrainian SSR, and N. G. Zhezhel', Doctor of Agricultural Sciences, applied very low doses of radioactive substances, which exceeded the quantity of the substances normally contained in the soil by a factor [literally "order"] of only 1-2. This original method, which according to the data presented by the authors of the paper is very promising, is based on the theoretical postulates of V. I. Vernadskiy, who was of the opinion that small doses of ionizing radiation represent a factor which has a genetic influence on living organisms.

In a number of reports, the results obtained by Soviet radiobiologists in work on the elucidation of the mechanism of the biological action of ionizing radiation were discussed. Hitherto it has not been possible to establish by direct methods the occurrence of any changes in proteins which have been subjected to doses of radiation large enough to produce severe injury in living organisms. A. G. Pasynskiy has shown that the use of compounds containing radioactive sulfur tracer atoms increases the sensitivity of the measurements by a factor of 50-100. As a result of the increased precision of measurement achieved with the aid of radioactive sulfur, it became possible to establish for the first time that the primary action of radiation does not consist in the induction of chemical changes in the protein molecules (in the sense that peptide bonds are broken or rearrangements of cyclic groups take place), but the transfer of the irradiated system into an excited and activated state, a phenomenon which is accompanied by changes in the physical and chemical properties of the system in question.

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A. M. Kuzin, Doctor of Biological Sciences, in a report on the biochemical basis of the biological action exerted by ionizing radiation, cited new data pertaining to changes occurring in the macromolecules of nucleoproteins and proteins. He discussed depolymerization of nucleic acids from the standpoint of its bearing on the sensitivity of tissues to radiation and dwelt on the connection between the modification of adsorptive properties of high-polymer substances in living tissue and the activity of enzymatic systems. A knowledge of these primary changes is of importance for an understanding of the biological reactions of the living organism to irradiation.

Prof L. T. Breslavets described the results of physiological investigations which have shown that the sensitivity of various organelles of the cell to ionizing radiation depends on the particular organ and tissue of which the cell is a part.

New data on the connection between local irradiation with X rays of various subdivisions of the central nervous system and changes in the composition of peripheral blood were contained in a report given by P. F. Minayev. The changes in the peripheral blood were found identical with those observed subsequently to injury produced by general exposure of the organism to radiation.

Extensive work dealing with the relationships governing the action of radiation on the fertility of animals which has been carried out by N. I. Nuzhdin, Corresponding Member Academy of Sciences USSR, and his collaborators confirmed in particular that continuous exposure to a dose of radiation which is accepted at present as a permissible (0.05 roentgen per working day) has no effect on the fertility of the animals irradiated.

Prof E. Ya Grayevskiy reported results of investigations dealing with protection of the animal organism from the harmful effects of ionizing radiation.

He demonstrated that oxygen plays a decisive role in the initial chain of phenomena inflicting damage on the organism which represent stages in the affliction of the organism by reason of its exposure to radiation.

Academician L. A. Orbeli discussed problems involved in the investigation of the effect of ionizing radiation on the animal organism. He emphasized particularly the important role of reflex phenomena and also of the reactions of lymphoid tissue and endocrine glands in the chain reaction of the development of radiation sickness. He called attention to the cyclic nature of the processes which take place in the animal organism within the general scope of radiation effects.

In Orbeli's report experimental data obtained by his collaborators were cited which deal with the possible ways in which radiation afflictions may develop.

Work dealing with the use of radiation emitted by radioactive substances for the investigation of vital processes taking place in animals and plants was extensively represented in the reports given at the session.

By using tracer atoms, the detailed aspects of the metabolism of various parts of the glycogen molecule in the liver of healthy animals and animals suffering from diabetes were studied. In this work, which was carried out by E. N. Stepanenko, Doctor of Biological Sciences, it was established that in cases of A-avitaminosis, contrary to the generally held opinion, no significant shifts

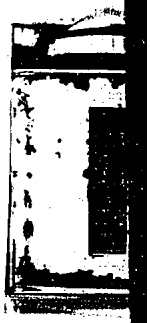
in the sulfur content of different organs and tissues take place. Furthermore, it was found that the process of ceratinization does not take place by reason of the synthesis of new proteins which are richer in sulfur but because of the formation of disulfide bridges by the thiol groups of the proteins that are already present. This work has been carried out by Prof S. D. Balakhovskiy and I. V. Kuznethova. The specific role of sulfhydryl groups in the transmission of nerve excitation was proven and the interrelationships between certain chemical substances which act as nerve impulse mediators and other substances which block the action of these mediators was established. The work mentioned above has been done by Kh. S. Koshtoyants, Corresponding Member of the Academy of Sciences USSR, G. M. Turpayev, and D. Ye. Ryvkina.

Extensive possibilities exist of using the isotope method in the investigation of the nutrition and metabolism of farm animals. Specifically, the rate of blood circulation, the blood volume, and the characteristics of phosphorus metabolism in highly productive milk cows were determined with the aid of this method (Prof. A. A. Kudryavtsev).

Investigation with the aid of radioactive carbon of the metabolism of yeast and lactic acid bacteria made it possible to develop an improved technology of fermentation with a significantly shorter cycle of production (Prof I. Ya. Veselov).

A great number of papers dealt with the use of the tracer atom method for the investigation of the vital activities of the plant organism, particularly the process of photosynthesis. The rapid resynthesis and replacement of the constitutional proteins of plants has been experimentally proven (Prof S. V. Turchin), the important role of chloroplasts in the biochemical functioning of the plant cells clarified (M. N. Sisakyan), the fact that the assimilation of carbon dioxide in the process of photosynthesis begins with addition of carbon dioxide to the iron of the molecule of the acceptor demonstrated, and the assumption that phosphoroglyceric acid is originally formed refuted (Ye. R. Boychenko, Doctor of Biological Sciences, and N. I. Zakharova). The effect of ecological and physiological conditions and of the species of plants on the composition of the organic substances formed in the process of photosynthesis has been clarified (O. V. Zalenskiy). For instance, it has been established that photosynthesis which occurs in fruits of the poppy regulates the gas regime of the fruits and assures their normal development, although the nutrition of seeds takes place principally by utilizing assimilated products that originate in the leaves (V. E. Pontovich).

The application of radioactive isotopes opens up new experimental possibilities of investigating the very fine processes which take place during the fertilization of plants. For all practical purposes, these processes have not been investigated to any appreciable extent as yet. Taking as examples corn, wheat, and tobacco, the significance of repeated pollination for the physiological processes taking place in developing seeds has been shown and in some cases the significance of this type of pollination for increasing the vitality of the progeny obtained from the resulting seeds has been demonstrated (I. M. Polyakov, Corresponding Member Academy of Sciences Ukrainian SSR).



The papers that had been presented were subjected to a discussion. Those who participated in the discussion gave a critical evaluation of the data cited by the authors of the paper, particularly when questions connected with the practical application of radiation in industry and agriculture were involved. This testifies to the great amount of interest which Soviet scientists evince in the rapid and successful solution of the problems connected with the extensive use in the people's economy of the new and powerful means which are capable of advancing it.

It understandable that the program of the session has reflected only some directions along which the work of Soviet biologists proceeds as far as the problem of the application of ionizing radiation and the use of the method of tracer atoms is concerned. The fact that reports were made by representatives of the academies of sciences of union republics and workers from branch institutes testify to the fact that extensive research in this field is being conducted in the USSR.

The following foreign scientists participated in the session: Prof Su Yu-ku (People's Republic of China), Sokhey, Pal Rudrendra Kumar, Shirsat, Ganapati, and Khanolkar (India), Shagdar (Active Member of the Committee of Sciences, Mongolian People's Republic), and Gerrit Avgustin Sivabessi (Indonesia).

In an address concluding this session, Academician V. A. Engel'gardt emphasized that the gratifying fact of the presence at the session of foreign scientists transforms this session into a preview of more extensive international scientific gatherings where problems connected with the utilization of the newly discovered forces will be discussed from the standpoint of their use for the benefit of humanity.

At the session of the Department of Technical Sciences the following foreign visitors participated: Professor Macke (Dresden Technological Institute), Professor Szulin and Dr Niewodniczanski (Polish Academy of Sciences), the metallurgists Ts'en Sen (People's Republic of China), Sin San-kuk (Democratic People's Republic of Korea), Dr Barwich (Academy of Sciences at Berlin), and Prof Mao Kkha (Burma).

The session was opened with a number of reports dealing with problems of the application of radioactive isotopes in metallurgy. The data presented demonstrated the extensive possibilities of the investigation of metallurgical processes and of the physics of metals with the aid of the method of radioactive isotopes. The possibilities of studying the effect of refractories in contaminating steel with nonmetalic inclusions were discussed (E. M. Samarin, Corresponding Member of the Academy of Sciences USSR, and Ye. S. Kalinnikov). In a report by E. I. Osipov, results obtained by means of the tracer-atom method in the investigations of processes of mixing in the hearths of open-hearth furnaces were discussed.

By using the radioactive isotope of calcium and applying the radiographic method S. M. Gnuchev investigated the effect of the method of pouring on the structure of steel ingots. It could be seen from the radiograms shown by the author of the report that when either bottom pouring or top pouring is used the lower part of the ingot is contaminated to the greatest extent. Contamination is increased when bottom pouring with supplementary addition of hot metal is applied. The kinetics of the desulfurization of cast iron were also investigated with the aid of tracer atoms (L. A. Shvartsman, O. V. Travin).

In a report by A. A. Zhukovitskiy it has been shown that application of radioactive isotopes for the investigation of evaporation and for the determination of the coefficient of diffusion of metals has made it possible to develop a number of original methods for the study of processes taking place in metals and alloys. These methods are already in use at the scientific research institutions of the USSR. As Academician T. N. Gudtsov mentioned in a brief introduction, the application of radioactive isotopes makes it possible to measure at relatively low temperatures the vapor pressure of metals which have a very low vapor tension.

At the Institute of Metallurgy, Academy of Sciences USSR, several devices have been developed for this purpose. The equipment that has been developed makes it possible to determine the quantity of condensed active metal. If the ratio between radioactive and nonradioactive metals in the sample is known, and the temperature, duration of the experiment, and the function of the distribution of the molecular beam in space are also known quantities, it is easy to calculate the rate of evaporation or vapor pressure of the metal under investigation. With the use of this method, the heats of sublimation of iron, cobalt, zinc, and other pure metals were determined.

In the investigation of the vapor pressure of metals which enter into the composition of alloys, it is best to use methods that are based on the principle of isotope exchange between the sample containing the radioactive isotope of the metal under investigation and a sample which does not contain the radioactive isotope. Using the method of isotope exchange, the vapor pressure of iron in its alloys with chromium and with a number of other metals was investigated (A. N. Nesmeyanov, N. V. Lebedev, D. I. Lozgachev, and E. G. Chudinov). In a report by M. A. Starikovich, Corresponding Member of the Academy of Sciences USSR, the results of an investigation by the method of radioactive isotopes of the carrying over [entrainment] of salts with steam and of the hydrodynamics of two-phase liquids were discussed.

Academician G. V. Kurdyumov called attention to very important results which were obtained in the measurement of coefficients of diffusion and self-diffusion [homogeneous diffusion] with the application of radioactive isotopes. Data of this type cannot be obtained by ordinary methods.

A number of reports dealt with the application of isotopes and rays emitted by radioactive substances in machine construction; particularly in the control of the wearing out of machine parts and of cutting tools and in the measurement of the thickness of metal products. The data contained in these reports demonstrate that the methods in question, which have been developed in the USSR and are being extensively used there, make it possible to determine with precision which is much greater than that obtained hitherto the processes of wear at different velocities, pressures, and temperatures, and also to observe the action of different lubricating oils, fuels, and additives to oils and fuels. The experimental data which have been accumulated make it possible even at this point to give recommendations to industrial enterprises in regard to the application of rapid methods for the determination of the effects on wear of lubricating oils and of various anticorrosion additives (Yu. S. Zaslavskiy).

An important application of radioactive isotopes is in investigations dealing with the wear of cutting tools. The existing methods of measuring the wear of tools are not sufficiently precise and require a great deal of work. In a report given by Ye. P. Nadeinskaya results of the application of radioactive

isotopes in the development of a rapid method for measuring the wear resistance of cutting tools have been described. Equipment designed especially for this purpose makes it possible to determine directly the rate of wear by measuring the radioactivity of the products of wear.

The value of the new method consists also in the circumstance that the quantitative and qualitative analysis of the wear to which tools are subjected can be carried out during the process of cutting itself. The new method makes it possible to determine the optimum rate of cutting which results in the least amount of wear.

At present, USSR enterprises active in various branches of industry use gamma rays for the control of a number of technological processes of metal working. In a report by I. G. Fakidov, the application of the ionization method in the gamma-ray defectoscopy of metal products having a great thickness was discussed.

The application of rays emitted by radioactive substances in the control of the thickness of rolled steel and of metal coatings was also subjected to discussion (B. I. Verkhovskiy, A. N. Makarov). V. A. Yanushkevskiy presented data on the industrial application of isotopes in the marking of rolled steel.

Academician V. I. Dikushin pointed out the great significance of work dealing with the application of radioactive isotopes and expressed confidence that further improvement of methods based on their use will lead to a wide application of the techniques in question in various branches of the people's economy.

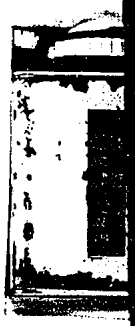
Radioactive isotopes and rays emitted by radioactive substances are also being applied practically in the prospecting for useful minerals. This type of application was discussed in a report by V. N. Dokhnov.

In a number of reports, the application of radioactive isotopes in the petroleum industry was discussed. Information was given on the use of neutron radiation for the investigation of wells with the purpose of distinguishing between petroleum-bearing strata and water-bearing strata (E. I. Kholin, N. K. Kukharenko, U. S. Shimelivich). In a report by B. G. Yerozolimskiy and E. F. Bespalov, the use of scintillation counters in radiometric equipment was subjected to discussion.

In summarizing the results of the discussion of this group of reports, Prof L. F. Vereshchagin remarked that during the past 5 years the volume of work done in the field under consideration has considerably grown. This testifies to the extensive introduction of methods involving the use of radioactivity into practical prospecting for petroleum and natural gas deposits.

However, much remains to be done in this field. For instance, one must test and introduce with a greater degree of confidence methods of this type into the prospecting for other useful minerals, i.e., those yielding boron, manganese, mercury, tungsten, and cadmium.

The application of radioactivity in the construction of instruments and the actual introduction already at this stage of instruments [control appliances] of this type into practical use at industrial plants indicate the extensive possibilities of using atomic energy in the automatization of technological processes at USSR industrial enterprises.



At the conclusion of the session, Vereshchagin said: "We are proud of being the participants at the first session of the Academy of Sciences USSR in history which deals with the peaceful utilization of atomic energy. We note with a feeling of profound satisfaction that, due to the efforts of our scientists and engineers, the results of manifold scientific investigations in the field of the peaceful utilization of atomic energy have found application in many branches of industry."

During the time of the session a demonstration of industrial models of USSR radiometric, dosimetric, and counter devices and instruments and also of equipment which operates with the utilization of rays emitted by radioactive substances was organized for the participants at the session. At present, several types of equipment for the measurement of the activity of radioactive substances and of the intensity of radiation emitted by them are being produced. This equipment is also used for controlling the contamination with radioactive substances of buildings in which work with them is conducted. Specifically, the participants at the session were shown an improved counter installation of the B-2 type which is distinguished by portability, realiability, and convenience in use and also by the increased assortment of counter tubes which form a part of the equipment. Also demonstrated was a scintillation attachment for the device of the B type and a new type of portable laboratory radiometer for the measurement of the contamination of clothing, hands, and working surfaces with preparations that emit alpha or beta radiation. This radiometer makes it possible to carry out measurements in a range extending from single impulses to 100,000 impulses per minute. Special arrangements are provided for the automatic compensation of the gamma-radiation backround in the measurement of beta-activity and for automatic signalization indicating that the permissible level of radiation has been exceeded.

The participants at the session familiarized themselves with new types of dosimetric equipment widely used in the practical work of medical institutions and scientific research institutes. This included new models of individual dosimeters of the DK - 0,2 type.

Great interest was elicited by an assortment of manual tools for work with radioactive substances at a distance. This assortment included various types of handles for the holding and carrying of dishes weighing up to one kg and containing radioactive solutions. Special pipettes, automatic pipettes, micropumps, etc., were also shown.

Attention was also attracted by radiometers of the "Sevan" type, which are designed for use in field investigations involving radioactive isotopes and particularly for investigations of the assimilation of phosphorus fertilizers by plants depending on the method of introduction and time of introduction of the fertilizer.

Various types of appliances which operate with the use of radioactive isotopes were subjected to detailed inspection. Among them was the device GUP-Co-0,5 for industrial gamma-ray defectoscopy to be applied in tests carried out at plant laboratories or plant production departments. This device is equipped with special protective sheaths. Several types of portable ampules for testing by the method of gamma-transmission were also shown. These ampules are designed for the control of the quality of welded seams of pipes and of steam conduits and also for the circular inspection by the method of gamma-ray transmission of annular seams in pipes having a diameter of 150-550 mm, as well as for the inspection of sheets which have a thickness equivalent to 30-40 mm of steel sheeting.

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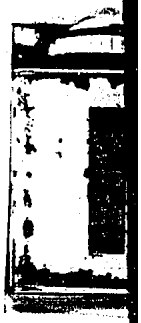

Several types of level indicators which work on the principle of radioactivity and are to be used in various branches of industry were demonstrated. One of them was a level indicator for universal industrial use, which makes it possible to carry out continuous measurements at a distance. This device records and controls the level without penetration into the object subjected to measurement or control or contact with the medium the level of which is being measured. By means of this indicator the level can be measured in tanks, autoclaves, pipe conduits, etc.

With the aid of this device, one may control the level of liquids, the boundary between two phases, and also the nominal level of boiling and bubbling liquids within a range of values up to 500 mm. The absolute error of measurements comprises ± 1 mm.

Devices for the recording and automatic control of the level of liquid metal which are based on radioactive ray transmission through a vessel containing the metal have also been shown. Other examples of the equipment demonstrated are a device for the measurement at a distance of the level of liquid chlorine or of some other liquid packed in cylinders (in this application the system source-receiver is displaced together with the level of the liquid and the error in the measurement is no higher than 10 mm) and a device for the continuous measurement, recording, and control of the density of various liquids at a distance by a method which is based on the principle of the absorption of radiation emitted by radioactive substances (in this application the range of measurements is 0.5 - 2.5 grams per cubic centimeter and the limit of error is ± 2%). Also shown was a gamma-ray sludge meter which is used at present for the control of the operation of suction dredges. The operation of this device is based on the measurement of the intensity of radiation emitted by a radioactive substance after it has passed through the sludge (the range of measurement in this case is 1.0 - 1.4 grams per cubic centimeter when the diameter of the suction dredge is 500-800 mm). Other equipment shown comprised a device for continuous measurement at a distance of the thickness of cold-rolled sheets which is based on the recording of radiation transmitted through the material (the ranges of measurement as applied to a steel band are 3-150 microns and 50 microns - 1 mm, with a limit of error amounting to ± 1.5%) and a device for the measurement of the thickness of coatings which is based on the measurement of the intensity of reflected gamma radiation (the range of measurement as applied to a tin coating on sheet iron is 0.10 microns with a limit of error comprising ± 2.5%).

The participants at the session also familiarized themselves with other industrial models of equipment that has been applied in various branches of industry.

For instance, increasingly extensive application is given to a device for measurement at a distance and recording of the pressure of rarefied gases and vapors. The range of measurement obtained with this device is indicated by the fact that it has a linear scale corresponding to pressures from 0.01 mm to 10 mm of mercury. Being provided with this scale, the device in question can be used for measuring air pressure or the pressure of water vapor at temperatures from 20 - 150°C. In order to obtain the desired values, the recorded values must be multiplied by appropriate correction factors. The error in measurements with a device of this type amounts to ± 2.5%.

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Of great interest for the industry is a portable counter of objects which operates on the principle of radioactivity. Particularly promising is the application of this device in the counting of objects on conveyers with a changeable rate of movement. The device counts up to 120 objects per minute and may operate under conditions where a high humidity is encountered.

The extensive range of radioactive isotopes which are available and the high level of development of modern electronics make it possible to design devices for the control and measurement of the most diverse technological factors. These devices are an additional proof of the immense possibilities which the application of radioactive substances and of the radiation emitted by them opens up to instrument engineering and consequently to science and production.

The demonstration of samples of radiometric, dosimetric, and counter devices organized by the Academy of Sciences USSR represented not only an important adjunct to the work of the session but also a clear illustration of the persistent efforts which Soviet scientists and technologists apply to the task of harnessing for the benefit of humanity the new natural forces which have recently become available for exploitation.

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