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SUMMARY OF ALL-UNION CONFERENCE ON THE APPLICATION OF RADIOACTIVE AND STABLE RADIOISOTOPES IN THE NATIONAL ECONOMY AND SCIENCE OF THE USSR--1957 (AEC-tr-2925 and AEC-tr-3093)

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INTRODUCTION

A total of 418 abstracts from this conference and the complete text of five plenary session papers, as well as 55 abstracts from an All-Union Conference on Radiation Chemistry held March 25 - April 2, 1957, have been made available in translation as AEC-Tr-2925. Almost all of these papers deal with the actual application of tracers or radiation in the national economy as contrasted with other conferences which emphasize reactor design experiments, or experiments in nuclear physics or chemistry. The papers presented were divided into three major sections as follows:

I. Isotope Production and High Intensity Gamma Systems
   - A. Isotope production--17
   - B. High intensity gamma systems--7

II. Technical Sciences and Industrial Uses of Isotopes
   - A. Metallurgy and metal working--64
   - B. Machine building, control of technological processes, construction of apparatus, methods and apparatus for the radiometry and dosimetry of nuclear radiations--66
   - C. Prospecting and development of useful minerals of heat technology and mechanics--49

III. Biology, Medicine and Agriculture
   - A. General meetings of the sections--10
   - B. Radiobiology--39
   - C. Medical radiology--58
   - D. Biochemistry and physiology--44
   - E. Applications of isotopes and radiation in animal rearing and fishery industry--24
   - F. Agrochemistry and soil science--40

This conference was much different from the Conference of the Academy of Science of the USSR on the Peaceful Uses of Atomic Energy held July 1-5, 1955 which grouped papers in the division of Chemical Science, Physics and Mathematics Technical Science and Biological Science. Papers in the first two groups were not pertinent here while the 18 papers given in the Technical Sciences section and 21 papers in the Biological Science Division compare with 179 and 215 papers respectively in this conference. Similarily this conference presents many more specific examples of uses of radiation and isotopes than were given at the Geneva Conference of 1955.

COMPARISON WITH THE UNITED STATES

Unfortunately it is futile to try to compare a conference of this sort with any conference held in this country, since no general conferences which include all areas of interest have been convened here. Instead certain segments of the nuclear field report in meetings of the American Nuclear Society, the Nuclear Division of the Institute of Chemical Engineers, the Hot Lab Conference, Health Physics Society, Society of Nuclear Medicine, etc., etc.

It is obvious from the abstracts of this meeting that it is fashionable in Russia to apply tracers to industrial problems. Because of this, some of the papers describe trivial procedures with little practical use but these should not obscure the many novel ideas and extensions of present techniques that are described here.

The potential industrial user of radioisotopes in the United States would have to search many different journals to find descriptions of such a spectrum of potentialities.

BREAKDOWN BY LOCATION

A startling fact emerges when the papers of sections I and II above, representing most of the industrial applications papers of the conference, are broken down as to author and location of author. These 203 papers have come from 104 different laboratories in the USSR. Only five laboratories supplied more than five papers. These included the Central Ferrous Metallurgical Research Institute with seventeen, the Central Committee for Use of Atomic Energy with ten, the Petroleum Institute of the Academy of Science with eight, Gubkin Petroleum Institute with seven, and the Academy of Medical Science with six. Two other locations supplied five papers and two others four papers. Ten locations supplied three papers, sixteen locations supplied two, and 69 locations presented only one paper.

It would be difficult to find a conference dealing with similar topics in this country that could count on one-third this number of sources for papers. Of course in the United States much reliance is placed on the National Laboratory system for leading the way in tracer applications, and this is reflected in the preponderance of papers from these laboratories in any scientific conference of this type.

In the Soviet Union tracers and radiation have found their way into a large number of areas including not only the iron and steel industry, but such widely diverse fields as the concrete, milk and silk industries, soil reclamation, river transport, and accident prevention. The widespread origin of these papers indicates a wholesale attempt by the country to seek applications in all fields of endeavor and also indicates the existence of a large number of facilities for handling and making use of these materials.

A breakdown of the separate conference on Radiation Chemistry shows a somewhat different trend in that 37 of the 55 papers were submitted by two laboratories, The Institute of Physical Chemistry of the Academy of Science and the Karpov Physical-Chemical Institute with 16 and 21 papers respectively. Four other units supplied two papers, while ten supplied only one. This undoubtedly is tied in with the need for elaborate radiation facilities in these studies and would seem to indicate that high level gamma irradiation facilities are not yet as wide spread in Russia as in this country.

The papers of section III on Biological Chemistry appear to show the same characteristics as section I and II with a great preponderance of locations supplying only one or at the most two papers.

SUMMARY OF PAPERS

Although isotope production was listed in a major heading of the conference, only two papers dealt with radioactive isotope production, one with a reactor and one with a 10 Mev deuteron cyclotron. Two other papers dealt with spectral analysis for high purity materials used in radioactive preparations, while a third paper appeared out of place in describing preparation of alpha, beta, and gamma counting sources of different tracers. Twelve papers dealt with problems of stable isotope separation including electromagnetic and diffusion methods.

Twenty-four papers dealt with different uses of tracers in the iron and steel industry. Sulfur and phosphorus were used quite generally in these studies of metals and slags in different processes, although some longer-lived isotopes such as calcium-45, chromium-51, iron-59, cobalt-60,

zirconium-95, cerium-141 and tantalum-182 were also used. An interesting discussion of the question of industrial hygiene and safety where some of these longer-lived isotopes are used in a plant is given in one of the papers.

Fifteen papers were presented on uses of gamma radiography and autoradiography in detecting flaws and for checking welds. Low energy gamma sources such as cesium-137, iridium-192, selenium-75 and thulium-170 are suggested for thinner pieces. The techniques of autoradiography have been used in a number of places to study crystalline states in the steel.

Uses of tracers in studying separations and purifications of non-ferrous metal systems are recorded in six papers. Thirteen other papers discuss experiments which study diffusion of metals with tracers in different solid systems, while seven more papers describe other types of tracer studies of physical properties of solids. Two papers were given on analysis in metallurgical work but the conference was slanted much more toward practical applications than towards this aspect. Several papers discussed radiation effects on metals such as germanium and the result of one neutron diffraction study is given.

Radiation and tracers have been applied in many varied industries and for many tasks. One of the most interesting was presented in a paper describing uses of radioactive isotopes in accident prevention. One familiar use of this type is that of neutralizing static with alpha and beta emitters. A second used strontium-90 sources on finger rings or wrist bands as emergency trips for hazardous machines.

Tracers have been used in the concrete industry for surface determination and corrosion studies, in metal working to determine the degree of degreasing and in foundry practice to study the cast formation processes

in molds. In the glass industry they trace the movement of glass in the wells of foundry ovens. In the milk industry the radiations have been used to furnish contact-free methods of measurement while in the mining industry tracers are used to study the flotation process and in an unrelated study blasting area.

In the petroleum industry transmission of samples is checked routinely by radiation while in the river transport and dredging field soil gauges determine the amount of silt per volume, as well as the particle size. In the silk industry radiation sources remove static charges and have been used to cultivate silk worm lines marked according to sex. Several uses of tracers in the textile industry are reported and a study of the mechanism of the basic processes in hot tinning are described.

Sixteen papers deal with the application of tracers in wear testing, tool studies and lubrication studies. These papers cover a spectrum between study of metal cutting processes to drive wear in coal machines and abrasion resistance of cemented steel.

Tracers have been used for studying the hydrodynamics of a liquid in a precipitating centrifuge and in the filtration of liquids through porous media. Eight papers describe gas measurements with gamma rays, particularly those adapted to high temperature measurements in boiling systems such as are involved in steam generators and turbines. Two papers describe leak detection with tracers while several others use tracers to study soil absorption and under-water hydrodynamics. Tracers have been used in soil reclamation and conservation, while radiation measurements have determined the liquid content of materials as widely divergent as concrete and foods.

Several papers describe the use of a radiation source and detector as a contactless spark-proof relay to open and close an electrical system. Several monitors and dosimeters are described and a few papers are devoted to specialized electronic measuring equipment.

Five articles discuss the problems of gamma-ray level gauges as adapted to automatic control of liquid flows and densitometer measurements. Five other papers describe the use of gamma-ray thickness gauges for such diverse materials as paper, hair, depth of fur in pelts, leather and film coatings. One paper describes backscattering measurement of concentration.

A large section of papers (27) deal with the problem of well logging. The use of (n,γ), (n,n) and (γ,γ) and (γ,n) reactions is discussed for many different determinations in many types of wells. Certain specialized electronic units to optimize this information available from logging are also described.

RADIATION CHEMISTRY (Separate Conference)*

Papers in this conference range from very elaborate studies of simple systems to general engineering studies of industrial systems. Some nine papers describe general radiation chemistry of simple systems, while six more papers describe the effects of ionizing radiation on inorganic solutions such as iron compounds, potassium permanganate, and uranium-IV Seven papers describe the effects of gamma radiation on electrode potentials of several systems and on the corrosion behavior of certain metals.

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* This section covering material from a separate conference appears also in AEC-tr-2925.

Six papers describe radiation chemical effects on proteins and biological systems while nine papers describe various effects of gamma radiation on hydrocarbons. Eleven papers report experiments involving plastics, resins, polymers, rubbers, etc., while five other papers describe effects of radiation on other organic systems including dyes.

Finally, there are eleven papers describing high intensity gamma-irradiation systems and their characteristics. It is interesting to note that most of these systems are in the range of 10 kilocuries or less.

BIOLOGY, MEDICINE, AGRICULTURE

Twenty-five different papers describe the application of tracer techniques to studies of agricultural crops, fertilizers and soils. Another thirteen papers describe tracer techniques in investigations of trees and shrubs. Tracers used with these experiments are primarily P-32, but some C-14, S-35, tritium and Ca-45 are also used.

Eight papers describe uses of high levels of gamma radiation in such varied applications as lengthening the storage time of potatoes, preservation of food, killing and the preservation of silk worm cocoons, etc. Two papers describe organoleptic tests of irradiated foodstuffs and wines.

Two papers describe tracer experiments in microbiology, while three others discuss studies of uses of tracer experiments in animal studies.

Twenty-four papers appeared in the field of plant biochemistry and physiology (including photosynthesis) while another twenty-one papers

describe biochemical and physiological experiments and techniques on animals. Some twelve papers were included in tracer techniques in medical radiology, while ten papers describe both internal and external therapeutic uses of radioisotopes in radiology.

Forty papers deal with the effects of radiation and radiation sickness in all types of animal systems, while the remaining forty papers are in the area of radiobiology.

ISOTOPE PRODUCTION

Much interesting information on development of isotope production in the USSR is included in a paper presented at the conference, but translated separately as AEC-tr-3093. Among other things it points out that in the USSR a neutron flux of 10^{12} to 10^{13} neutron/cm^2 sec is usually used for the production of isotopes. Similarily it indicates that production of barium-C-14 carbonate has increased from 2.2 curies in 1953 to 11.2 curies in 1956 and a planned 50 curies in 1957. Procedures have been developed to obtain cesium of 99.9% radiochemical purity and a specific activity of 6-7 curies per cc, while separation procedures for strontium-90, cerium-144, promethium-147 and europium-155 have also been developed.

Cobalt-60 production in 1954 amounted to 16,760 curies, in 1956 this rose to 64,000 curies, with a planned production of 300,000 curies in 1957. It is pointed out that a total of 18 compounds containing phosphorus-32 are being produced at present and that the total consumption of these compounds during the past five years amounted to 250 to 400 curies per year. At present a total of 88 different preparations containing

carbon-14 are produced. This might be compared with the 450 different carbon-14 labeled compounds available from twenty-one suppliers as listed in the April, 1957 Isotope Index. They list specifically 42 different compounds labeled with sulfur-35 versus 71 available through the Isotope Index. All in all they mention the availability of 284 types of compounds labeled with radioisotopes in 1957.

A total of 11,500 shipments of radioactive isotopes were made in 1954, 16,000 in 1955, and 23,500 in 1956. During the first quarter of 1957 a total of 8,974 shipments of radioisotopes were delivered to consumers, a considerable portion going to industrial enterprises and medical establishments. Mention also was made of exporting to China, Czechoslovakia, Poland, Hungary, Rumania, East Germany, Bulgaria, and other countries. Planning for 1958 provides for expanding output to include 360 compounds labeled with radioactive isotopes, the production of 60 new compounds containing stable isotopes, and production of 137 compounds containing radioactive C-14.

In terms of stable isotopes they report that 55 isotopes were supplied in 1955, 78 different isotopes in 1956 with a planned number of 136 isotopes and a total amount of 90,000 grams of stable isotopes to be supplied in 1957.

PLENARY SESSION PAPERS

A paper by V. N. Dakhnov describes the use of radioactive methods in prospecting and in developing useful minerals. A number of methods are described in detail. Eight charts and tracings are given and a total of twelve references to the Russian literature are included.

Shumilovsky and Melttser describe application of nuclear radiations to automation and technological process control in an interesting paper. They describe a number of interesting devices in different industries, but give the following illuminating statement: "It should be pointed out that even though the number of newly developed methods in this field and the new experimental techniques do not lag, and may even surpass those of foreign countries, the introduction and industrial acceptance of devices of this kind lie far behind that which is found abroad." At another point in their paper they mention, however, that at present more than 1000 instruments for gamma "defectoscopy" of materials are being used in the Soviet Union.

This paper gives examples of automatic control in the metallurgical, coal mining, petroleum,textile, paper, fur, tanning, dairy, refractory materials, gas, plastics, marine transportation and other industries. A number of instruments are pictured and diagrams given. Fifty-two references are included.

A. V. Lebedinsky presented a paper on the origins and symptoms of the action on living organisms of small radiation doses and concludes that even small radiation doses give measurable damage. He states: "All these considerations lead one to conclude that there is cause for alarm in the rising background. This concern has been increased by the view generally taken abroad that increase in the external gamma intensity is not dangerous. This view is opposed to experimental facts which direct attention to the potential hazards caused by the continuing rise in body activity due to uptake of strontium-90."

At another place in his paper he quotes, "While evaluating the experimental data we must point out that we now possess information which demonstrates that the sensitivity of organisms is enormously greater than was previously supposed. A number of studies show that the number of white blood cells may change at doses of 0.02 to 0.2 r per week. Lymphocyte anomalies are observed at single doses of 0.3 r. At dose rates of about 1 r per week the appearances of thrombocyte anomalies are observed. At somewhat lower dosages (~0.7 r per week) changes in a number of spermatazoids are found and at doses of 1 r spermatozonia are produced."

He closes his paper with the statement: "The present rise in the inherent levels of radioactivity, which threatens to become still greater in the future impels us to be extremely active in evaluating the situation. Knowing well that the causes of these changes are the continuous nuclear weapons tests, we must use all possible ways of combating the existing hazard. It seems to us that all scientific knowledge should impel scientists in all countries to support the humane demand of the Soviet Government that an international agreement on the cessation of further experimental explosions should be concluded." He supports his paper with twenty-three references to the Russian literature.

A. V. Kozlova authors a paper on the use of radioactive isotopes in clinical medicine which he starts off with the statement "Radioactive isotopes have been used for diagnostic and therapeutic purposes in the Soviet Union for not more than eight years," and goes on to explain the extent to which these methods are used today. He then spells out the policies of the Soviet Ministry of Health regarding use of both short-lived and long-lived isotopes and summarizes treatments of different types.

Klechkovsky read a paper on isotopes and radiation in agronomy which he supports with a list of 36 references and in which he summarizes much work being done at present in the Soviet Union.

SUMMARY

In summary then it appears that the Soviet Union has made great strides in the last five years in implementing a program of research into the application of isotopes in all phases of their economy. It also appears that a conference such as this one held in 1957 will further stimulate the use of isotopes in Russia by making available throughout the country results of recent work compiled from over 200 different laboratories, more than 100 of these being interested in strictly industrial applications.