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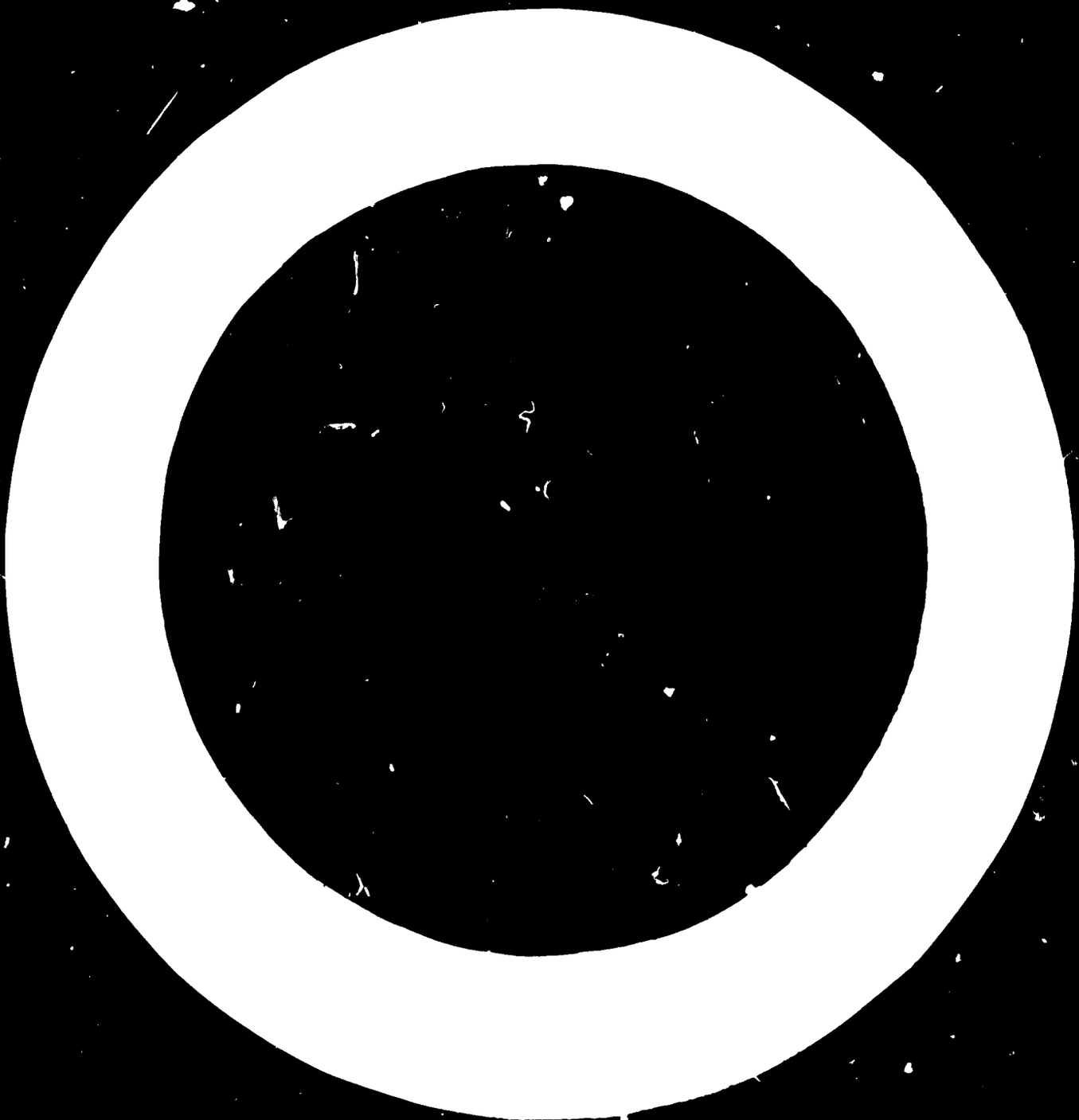
Background paper

INDUSTRIAL APPLICATIONS OF RADIOISOTOPES

Prepared for the Symposium

Presented by the International Atomic Energy Agency

Contents



Introduction

1. One of the chief missions of the International Atomic Energy Agency (IAEA) is to help Member States share fully in the peaceful benefits of atomic energy. The application of radioisotopes in industry is one such benefit which can and should be shared widely. This new family of radioisotope processes, instruments and techniques is gaining wide acceptance in industry by performing many tasks better and more economically than competitive methods.

2. No single application is as yet yielding large economic benefits on a national level. However, the number and diversity of applications are quite large and, collectively, the savings they afford industry are already appreciable in many nations and are growing rapidly.

3. This increasing acceptance of radio-active materials into the economic life of nations denotes an improvement in attitudes. Unwarranted fears are finally being dispelled in favour of a rational perspective, viz. that these materials can and should be put to use in industry.

4. The United Nations has repeatedly emphasized the need to apply all modern scientific techniques in industry and the importance of industrial expansion to developing countries. The best prospect of ensuring rapid progress in developing countries is by the wider and more intensive application of existing knowledge. The Industrial Applications Section of the IAEA directs its activities exclusively to this end.

I. PRINCIPLES OF INDUSTRIAL RADIOISOTOPE UTILIZATION

5. Radioisotopes are simply unstable forms of the same elements found in nature. They are created artificially by nuclear reactions in reactors, accelerators or some other similar device. Their utility stems from the fact that they all emit some form of nuclear radiation as they decay back to a natural state. Their wide range of application is derived from the variety in their radiations and their interaction with materials. With suitable adaption these radiations can be used to trace, to alter and to measure material in many ways.

6. The many industrial applications of radioisotopes can be conveniently grouped into three categories: radioisotopes trace materials; radiation alters materials, and radiation measures materials. A brief review of industrial radioisotope installations will demonstrate how these principles are being put to use.

Radioisotopes trace materials

7. Radioisotopes are routinely added to products for the purpose of tracing their reactions or movements; e.g., for following up the movement of oil, gas and water through underground reservoirs; for measuring transit rates and mixing efficiencies of chemicals in process streams; and for predetermining the course of effluent discharged into bays, estuaries and rivers. There is seldom any difficulty in finding a radio-active tracer which behaves exactly like the traced material because there is such a wide variety available. They also offer superior sensitivity and specificity; i.e. they can be detected and distinguished after great dilution, even through pipe walls.

8. Radio-active tracer applications can be of special value to new industry for studying and optimizing the efficiency of processes. A few thousand dollars worth of nuclear counting equipment suffices for many different applications of this type. The extent to which these techniques are being applied has been assessed by the Agency.(1)

Radiation alters materials

9. High-intensity radiation from sealed sources of radioisotopes is in routine use by modern industry:

(a) to destroy bacteria and insects in products;

(b) to produce chemical reactions and polimerize plastics;

(c) to produce power;

(d) to discharge static electricity from products; and

(e) to produce light.

10. The lethal effect of intense radiation on man is much better known than the beneficial use of this effect to kill bacteria and insects in products we use. For example, it is in use now to cold-sterilize medical instruments after they are sealed in germ-proof containers. It has also been in routine use for many years for disinfesting contaminated wool used in the manufacture of carpets. This should be of special interest to other nations where infestation of any product limits its export.

11. Intense gamma irradiation is also used commercially to produce certain chemicals such as ethyl bromide and to polymerize plastics such as polyethelene. A new wood plastic combination formed by radiation polymerization, which is now

being used in some countries for decorative purposes, may find use as a building material in semitropical areas in the form of bagasse-board/plastic combinations. It has proved to have very desirable moisture and insect resistance. The economic and social implications of the use of such a product in low-cost housing construction are considerable.

12. When radioisotopes are concentrated in gross quantities, the radiation which they emit can be used to generate heat and electricity. Power sources based on this phenomena are very long lived and highly reliable, which accounts for large national development efforts which have put them to use in space, undersea and in polar regions. As a consequence of these large national programmes, the cost and availability of these devices are now attractive for more mundane applications of interest to industry and developing nations, e.g. to power micro-wave relay stations and aircraft radar-beacons.

13. Radioisotope static eliminators are widely used, particularly in the textile industry. Self-sufficient light sources are used for safety emergency signs in mines, public buildings and aircraft. These sources, which are luminous phosphors excited by the low-energy radiation from gaseous radioisotopes, are relatively cheap and need no servicing.

Radiation measures materials

14. A whole family of radioisotope instruments is now used for measuring and controlling the properties of industrial products.(2) These instruments comprise the largest industrial use of radioisotopes today. Their benefits have been well demonstrated in some industries, but potential uses are still extensive, even in developed countries. An economic survey conducted by the Agency(3) showed that the tangible savings creditable to their use in 1964 were an appreciable portion of the total industrial output of the countries concerned.

15. Some intangible benefits of radiation measurement instruments are especially important to developing industry. Many of them improve quality control, an essential factor in new product acceptance. For example, the radioisotope thickness gauge is now standard equipment for maintaining uniform thickness of all types of sheet products - paper, rubber, metals, plastics, glass, plywood and others. The use of radioisotope gauges for product density control is also routine in many industries, such as petroleum refining, ore dressing, food

processing, cigarette manufacturing and cement production. These gauges make their measurement by sensing the amount of radiation which passes through the moving material from a small radioisotope source. The extent to which the radiation is absorbed by the material depends upon the thickness, density and composition of the material. Very high accuracy is obtained without contact with the product.

16. Measurements which are now routine for such instruments include:

(a) Elemental composition of ores and alloys;

(b) Thickness of sheet materials;

(c) Density of materials of constant thickness, such as liquids in a pipeline or tobacco in cigarettes;

(d) Bulk density of gross material, such as soil or rock strata;

(e) Coating and plating thickness, such as rubber on textiles or tin or steel;

(f) Level of materials in containers;

(g) Moisture content of soils and industrial products;

(h) Integrity of welds and castings;

(i) Other measurements such as pressure, flow rate, proximity or smoke detection.

These capabilities are too extensive to discuss in detail at this time; suffice it to point out that all major industries are utilizing one or more of them.

II. THE AGENCY'S PROGRAMME IN INDUSTRIAL APPLICATIONS OF RADIOISOTOPES

17. The Agency has an active programme to help Member States share this phase of nuclear technology. It is designed to coalesce industrial radioisotope technology and to transfer it to Member States upon request. Technology coalescence is accomplished chiefly through Agency-sponsored international symposia, consultant panels and study groups. The proceedings, bibliographies, guide books and standards which derive from these meetings are published and widely distributed.

18. Experience has proved that the transfer of radioisotope technology is best accomplished on a person-to-person basis. Accordingly, the mechanisms used for this purpose include special missions, national and regional experts and advisers, training courses, study tours, fellowships and scientist exchanges.

19. At the same time, the Agency offers an advisory service in industrial applications of radioisotopes to all Member States through which it is prepared to assist directly in problems of national or regional importance.

Technology coalescence

20. Industrial radioisotope technology is expanding rapidly. The pertinent technical literature, though extensive, is never current; nor does it cover all new radioisotope developments which are important to industry. More important, it seldom gives the critical analysis necessary to determine which new developments are significant and useful. Accordingly, the Agency often takes the lead in organizing international technical meetings to update, analyse, and evaluate segments of industrial radioisotope technology.

21. International symposia are used to publicize the latest developments in particular subject areas and stimulate contact and information exchange between scientists and industrial engineers. Past meetings have been of a general nature but future symposia will deal with specific subject areas.(4-11)

22. Panels or consultants' meetings are convened to discuss or give advice on special topics. Small groups of invited experts help to identify those developments which are ready and worth while for immediate industrial use and those in which further investigation is needed. A recent panel detailed those radio-active tracer applications which are in routine use and a consultants' meeting recommended terms and definitions relating to neutron moisture gauges. These definitions have already been accepted as standards by many member States.

23. Study groups are used to bring international experts and scientists together in a region to discuss particular problems. For example, a study group last year explored the international utility of radioisotope power generators.(12) Later this year another such group will meet in Bangkok to evaluate the industrial potential of the radiation process for polymerizing monimers in wood and bagasse board.

24. The technical literature covering the industrial uses of radioisotopes is so extensive today that it often discourages industrial engineers from searching it to find the best way to do a particular job. To help here, the Agency compiles bibliographies(13,14) and guide books on particular subjects. Agreement has been reached with many member States to use the Agency as the international exchange

centre for industrial radioisotope literature.[15] The mechanism for computor storage and recall of data is presently being organized in Vienna. This will minimize the literature searching required of thousands of scientists in all nations.

25. Finally, modest research contracts are available from the Agency to modify and demonstrate radioisotope instruments and techniques where necessary.

26. The circumstances of each requirement govern when and how these mechanism for coalescing technology are employed. Particular activities usually follow the recommendations of a panel or study group.

Technology transfer

27. As mentioned previously, industrial radioisotope technology is relatively easy to transfer on a person-to-person basis. The principles involved are fairly simple and the necessary equipment is modestly priced, readily available and easy to apply. Direct personal involvement is necessary to overcome inordinate fears of radio-activity on the part of both workers and managers. For this reason, Agency technical assistance is organized to help create self-sufficient national centres of industrial radioisotope technology which can then give direct assistance to interested industries. Sometimes this group is generated within an existing Atomic Energy Authority or industrial research institute; sometimes an independent organization takes shape. In any case, the necessary ingredient is always a few capable men who are interested in bringing the advantages of new technology to their nation. Once formed, these centres receive every possible technical assistance from the Agency until they are self-sustaining.

28. Technical assistance from the Agency takes various forms, depending on the industrial requirement involved. Special missions usually prepare the way for specific technical assistance projects. These are brief, well-planned, fact-finding visits to the requesting nation to determine how and where nuclear technology can best be employed. Such careful planning not only makes the follow-up assistance more effective, but it is necessary to facilitate advance procurement of equipment to carry out particular projects.

29. If one or more projects can be fairly well defined, the Agency usually arranges for experts with the specialized experience required to give the necessary assistance. Such experts are contracted for periods from three to

twelve months. In practice, care is taken that the engineers and scientists assigned to this duty have extensive experience so they can readily demonstrate where radioisotope techniques can solve additional problems.

30. Regional advisers are assigned for periods of at least six months to carry out a series of projects in countries in a region. Wherever possible, such regional assistance is organized and carried out in co-operation with the larger industrial development efforts of other recognized international organizations. Regional projects are active in Latin America and in the Far East at the present time.

31. Emphasis is also placed on giving direct in-plant experience in regional training courses. Participants are taken into different industrial plants where each carries out process measurements using radioisotopes. Such courses were held in Mexico City in 1966 and in Afghanistan in June 1967. The latter course, held jointly with the United Nations Educational, Scientific and Cultural Organization (UNESCO), emphasized the use of nuclear techniques for mineral exploration.

32. Another practical form of technical assistance is the study tour, in which a small group of industrialists and engineers are taken into operating plants and shown how radioisotopes are put to use. In 1966, fifteen countries interested in the industrial uses of radioisotopes sent specialists on an Agency-sponsored tour of the Soviet Union, France, Czechoslovakia and the United Kingdom. The detailed trip report prepared by the accompanying staff members extends this experience to all interested parties.(15)

33. Out-of-country fellowships and international scientist-exchange arrangements round out the Agency programme of person-to-person industrial isotope technology transfer. Every effort is made to co-ordinate the various assistance mechanisms so that they have maximum value. For example, regional advisers were assigned to portions of Latin America and the Far East soon after regional training courses were held in these areas.

III. CONCLUSIONS

34. The applications of radioisotope techniques are widespread in all advanced countries and their technical and economic advantages are adequately illustrated. The equipment necessary is relatively inexpensive and the economic benefits are high and are obtained immediately. The International Atomic Energy Agency recognizes this and, through the programme set out above, endeavours to encourage and promote industrial applications of radioisotopes to assist industrial development.

ANNEX

REFERENCES

1. Beswick, C.K., Routine industrial uses of radioisotope tracers, Radioisotope Tracers in Industry and Geophysics, IAEA, 21-38, Vienna (1967)

2. Clayton, C.G., Cameron, J.F., A review of the design and application of radioisotope instruments in industry, Radioisotope Instruments in Industry and Geophysics, IAEA, 1, 15-59, Vienna (1966)

3. International Atomic Energy Agency, Industrial Radioisotope Economics, Technical Reports Series No. 40, IAEA, Vienna (1965)

4. International Atomic Energy Agency, Large Radiation Sources in Industry, IAEA, Vienna (1960)

5. International Atomic Energy Agency, Radioisotopes in the Physical Sciences and Industry, IAEA, Vienna (1962)

6. International Atomic Energy Agency, Production and Use of Short-Lived Radioisotopes from Reactors, IAEA, Vienna (1963)

7. International Atomic Energy Agency, Industrial Use of Large Radiation Sources, IAEA, Vienna (1963)

8. International Atomic Energy Agency, Radiochemical Methods of Analysis, IAEA, Vienna (1965)

9. International Atomic Energy Agency, Radioisotope Instruments in Industry and Geophysics, IAEA, Vienna (1966)

10. International Atomic Energy Agency, Radioisotope Tracers in Industry and Geophysics, IAEA, Vienna (1967)

11. International Atomic Energy Agency - United Nations Educational, Scientific and Cultural Organization, Radioisotopes in the Physical Sciences and Industry, IAEA, Vienna (1962)

12. Report of a Study Group on Terrestrial Applications of Radioisotope Power Generators, IAEA, Vienna (1966)

13. Radioisotope Applications in Industry, IAEA, Vienna (1963)

14. Radioisotope Instruments in Industry and Geophysics, Bibliographical Series No. 20, IAEA, Vienna (1966)

15. Report of a Consultant's Meeting on Bibliographies on Industrial Applications of Radioisotopes, IAEA, Vienna (1966).

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