Industrial Applications of Radioisotopes in India

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I INTRODUCTION

Production of radioisotopes in India started way back in 1956 with commissioning of 1 MW research reactor named as APSARA. The production capability was augmented in 1963 when 40 MW CIRUS reactor attained its full rated capacity. During the early seventies, a strong need was felt for building another research reactor with higher neutron flux to meet the growing demand of radioisotopes. This led to the setting up of a 100 MW reactor named as DHRUVA. Therefore, the radioisotopeproduction capability was augmented by many folds with commissioning of DHURVA reactor in 1985. Subsequently, the CIRUS reactor, refurbished in 2003, was shutdown on December 31, 2010 after 50 years of successful operation.Today, with the operation of DHRUVA reactor, India is one of the leading producers and suppliers of various radioisotope products..

The applications of radioisotopes and radiation technology in industry, healthcare and agriculture form an important part of India's programme of using nuclear technology for societal benefits. As a consequence of an early realization of importance of radioisotopes and radiation technology, India today has a fairly advanced base for applications of radioisotopes and radiation technology in medicine, industry and agriculture. Board of Radiation and Isotope Technology (BRIT), Department of Atomic Energy (DAE) supplies radioisotopes and radiation equipment to the various users in the country and abroad, and along with the Bhabha Atomic Research Centre (BARC), Mumbai offers professional services to meet the country's demand in various fields of applications. The Bhabha Atomic Research Centre, Mumbai also undertakes R&D programmes for advanced applications. The radioisotope applications in industry are divided into following two categories:

(a) Radiotracer applications
(b) Sealed source applications

Some of the applications are briefly discussed below.

II RADIOTRACER APPLICATIONS

The idea of using tracers for troubleshooting and to investigate flow behavior in chemical process equipment has always attracted attention of engineers and scientists. In radiotracer applications, the radioactive material in a suitable physo-chemical form similar to that of the process material is injected into the system at the inlet and its passage is monitored along the system at strategically selected locations using radiation detectors. The presence of tracer or tracer concentration obtained as a function of time at detection location(s) is plotted and information about occurrence of malfunctions, if any and hydrodynamic behavior of the process equipment are drawn. The commonly carried out radiotracer applications in industry in India of include:

(a) leak detection in buried pipeline and industrial systems

(b) mixing/blending time measurements in batch type systems

(c) flow rate measurements in pipe lines and open channels

(d) residence time distribution measurement and analysis in continuous flow systems

(e) sediment transport investigations in ports

(f) effluent dispersion studies in water bodies

(g) wear and corrosion rate measurements

(h) radioactive particle tracking technique for flow visualization

(i) radiotracer applications in oil fields

Since early sixties, BARC, Mumbai has made pioneering contribution to the development and promotion of radiotracer technology in India and Asia Pacific region for troubleshooting and process optimization in industry. Isotope Production and Applications Division (IP&AD), BARC alone has carried out over 350 field-scale radiotracer investigations to benefit the Indian industry during last four decades.In addition to this, large steel and oil industries have their own tracer groups for in-house applications.BARC is recognized as a centre of excellence for tracer technology in industry in the region of Asia and the Pacific and provided strong support to the RCA/UNDP projects on industrial applications of isotopes and radiation technology since 1982.

III SEALED SOURCE APPLICATION

In sealed source applications, radiation source is encapsulated in a metal capsule and never directly come in contact with either process material or equipment. The penetrating radiation from the radiation source capsule are directed at the desired location in the equipment under investigation or material of interest and the intensity of transmitted or scattered radiation intensity is measured and analyze to draw information about content of the system or physical properties of the material. The sealed source applications in industry can be further divided into following four categories.

(a) Non-destructive testing*(Radiography and Tomography)*
(b) Radiometry/Gamma scanning
(c) Nucleonic control systems
(d) Radiation processing

BARC and BRIT, Mumbai have played a pivotal role in promoting the use of gamma emitting sealed sources for NDT applications in India. Radiography is extensively used as a mandatory requirement in manufacturing of pressure vessels, turbines, space vehicles, aircrafts, ships, bridges, offshore rigs and platforms, transport pipelines and a host of other industrial areas. There has been a phenomenal growth in the number of radiography testing installation in India during last 3 decades. Today, there are over 2800 radiography cameras, 500 industrial X-ray machine and 800 radiography sites in about 500 institutions. Isotope radiography exposure devices housing ^{192}Ir and ^{60}Co sources and with lead shielding are produced in India and are marketed by the Board of Radiation and Isotope Technology (BRIT). Training courses are regularly organized for various cadres of radiography personnel; operators to managers (RT-1 to RT-3). Nearly 10,000 people have so far been trained and licensed to practice isotope radiography technique.

One of the recent developments in the field of NDT in BARC is the building of a industrial computed tomography (ICT) imaging system for cross-sectional examination (3-dimensional) of various objects like reactor fuel assemblies and solid propellants in rocket motors. The first ICT system in BARC was developed using a 7 Ci (260 Gbq) ^{137}Cs source and a NaI (Tl) scintillation detector. The system has been upgraded with an X-ray source and an array of cadmium tungstate detectors.

Gamma scanning is a non-invasive technique used frequently for troubleshooting of industrial process columns. This technique is also employed for debottlenecking studies of processes involving multiphase systems. The technique is so effective that even for predictive maintenance of column hardware, it is frequently used. Basically this technique uses absorption of gamma ray emitting from radioisotopes by process fluids consisting of vapour and liquid. The technique is gradually being used to solve more and more complex problems like misdistribution in packed bed, entrainment from tray columns etc. The international scenario, this technique is exploited on a routine basis and offered as specialized service. Gamma scanning technique has also emerged as a reliable research tool to generate valuable performance data.

Another application of sealed source applications is the Nucleonic Gauging. Indian industry has been using nucleonic gauges for over 4 decades. It is estimated that there are now more than 10,000 nucleonic control systems in about 1850 installations. These include level gauges, well logging systems, thickness gauges, density and moisture gauges, beta scopes and others. The main manufacturer of NCS in India is the Electronics Corporation of India Limited, Hyderabad.

High intensity gamma radiation can impart beneficial changes in materials exposed to it. The source of the high energy gamma radiation is usually either radioactive cobalt-60 produced in nuclear reactors or high energy electron beams from industrial electron accelerator. India produces Cobalt-60 in its research reactors as well as in the nuclear power reactors. Over the years, BARC has developed technology for fabrication of high intensity sources and fro design construction and operation of gamma irradiators for a variety of applications. Some of the common applications of gamma radiation processing include sterilization of medical products, sewage sludge hygienization and vulcanization of natural rubber latex. The radiation processing applications using electron accelerator includecross-linking of wire and cables, coloration of gems and semi-precious stones, degradation of Teflon scrap for use in lubricants etc.

IV CONCLUSIONS

India has fairly advanced infrastructure/facilities and good expertise for applications of radioisotopes in industry. The Bhabha Atomic Research Centre and the Board of Radiation and Isotope Technology have developed the necessary know-how and expertise in the areas of industrial applications of radioisotopes technology. Indian industry has been immenselybenefitted from the application of radioisotope technology. The level of application,

though growing, is still not commensurate with the level of technology development for a country of India's size and economy. With the present trend towards liberalization of economy and the increased awareness of the potential of radioisotope technology in industry, one can safely look forward to increased applications.

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