

The Peaceful Atom

July 2002

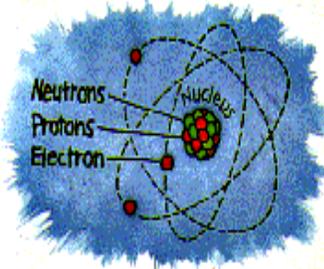
Fact Sheet 320-060

Division of Environmental Health
Office of Radiation Protection



(Taken directly from the Uranium Information Centre Ltd.)

The first power station to produce electricity by using heat from the splitting of uranium atoms began operating in the 1950s. Today most people are aware of the important contribution nuclear energy makes in providing 17% of the world's electricity, more than all electricity produced worldwide in 1960.



Not so well known are the many other ways the peaceful atom has slipped quietly into our lives, often unannounced and in many cases unappreciated.

Radioisotopes and radiation have many applications in agriculture, medicine, industry and research. They greatly improve the day-to-day quality of our lives.

WHAT IS A RADIOISOTOPE?

Isotopes are different forms of an atom of the same chemical element. They have identical chemical properties but a different relative atomic mass. While the number of protons is the same, the number of neutrons in the nucleus differs. Some isotopes are referred to as 'stable' and others as 'unstable' or 'radioactive'. It is the radioactive nature of these unstable isotopes, usually referred to as 'radioisotopes', which gives them so many applications in modern science and technology.

George de Hevesy



The first practical application of a radioisotope was made by George de Hevesy in 1911. At the time de Hevesy was a young Hungarian student working in Manchester with naturally radioactive materials. Not having much money he lived in modest accommodation and took his meals with his landlady. He began to suspect that some of the meals that appeared regularly might be made from leftovers from the preceding days or even weeks, but he could never be sure.

To try and confirm his suspicions de Hevesy put a small amount of radioactive material into the remains of a meal. Several days later when the same dish was served again he used a simple radiation detection instrument - a gold leaf electroscope - to check if the food was radioactive. It was, and de Hevesy's suspicions were confirmed.

History has forgotten the landlady, but George de Hevesy went on to win the Nobel Prize in 1943 and the Atoms for Peace award in 1959. Today scientists continue to find new and beneficial ways of using nuclear technology to improve our lives.

In our daily life we need food, water and good health. Isotopes play an important part in technologies that provide us with these basic needs.

FOOD AND AGRICULTURE

Development agencies and experts tell us that one billion people, (one out of every five of us), go to bed hungry every night and that tens of thousands die daily from hunger and hunger related causes. Radioisotopes and radiation used in food and agriculture are helping to reduce these tragic figures.

Fertilizers

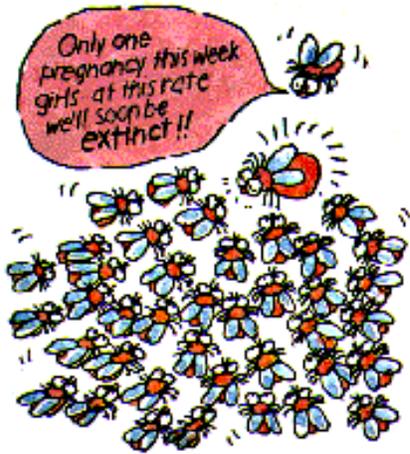
Fertilizers are expensive and if not properly used can damage the environment. Efficient use of fertilizers is therefore of concern to both developing and developed countries. It is important that as much of the fertilizer as possible finds its way into plants and that the minimum is lost to the environment. Fertilizers 'labeled' with a radioactive isotope, such as nitrogen-15 and phosphorus-32 provide a means of finding out how much is taken up by the plant and how much is lost.



Insect Control

Crop losses caused by insects may amount to more than 10% of the total harvest worldwide, - in some developing countries the figure can be as high as 30%. Stock losses due to tsetse in Africa and screwworm in Mexico have also been sizeable. Chemical insecticides have for many years been our main weapon in trying to reduce these losses, but they have not always been effective. Some insects have become resistant to the chemicals used and some insecticides leave poisonous residues on the crops. One solution has been the use of sterile insects.

The Sterile Insect Technique (SIT) consists of irradiating laboratory-reared male insects before hatching, to sterilize them. The sterilized males are then released in large numbers in the infested areas. When they mate with females, no offspring are produced. With repeated releases of sterilized males, the population of the insect pest in a given area is drastically reduced.



The biggest SIT operations so far have been conducted in Mexico against the Medfly (Mediterranean fruit fly) and the screwworm. In 1981 the Medfly operation was declared a complete success, and by 1991 the screwworm eradication had yielded some \$3 billion in benefits to the economy. The Mexican plants and equipment were then applied to infestations in Libya and

Central America. With the support of the UN Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA) and the Governments concerned, SIT programs are under way in several countries.

Increasing Genetic Variability

Ionizing radiation in plant breeding has been used for several decades to produce new genetic lines of sorghum, garlic, wheat, bananas, beans, avocado and peppers, all of which are more resistant to pests and more adaptable to harsh climatic conditions.

FOOD PRESERVATION



Some 25-30% of the food harvested is lost as a result of spoilage by microbes and pests. In a hungry world we cannot afford this. The reduction of spoilage due to infestation and contamination is of the utmost importance. This is especially so in countries which have hot and humid climates and where an extension of the shelf life of certain foods, even by a few days, is often enough to save them from spoiling before they can be consumed.

In all parts of the world there is growing use of irradiation technology to preserve food. In almost 40 countries health and safety authorities have approved irradiation of many kinds of food, ranging from spices, grains and grain products to fruit, vegetables and meat. On their trips into space, astronauts eat foods preserved by irradiation. Following three decades of testing, a worldwide standard was adopted in 1983 by a joint committee of the World Health Organization (WHO), FAO and IAEA.

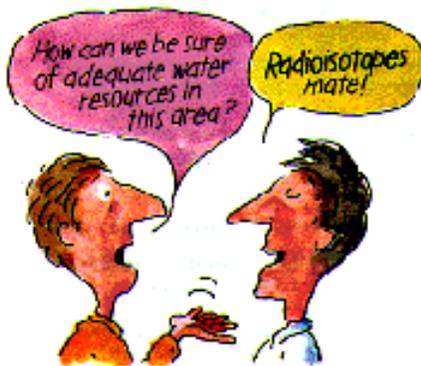
As well as reducing spoilage after harvesting, increased use of food irradiation is driven by concerns about food-borne diseases as well as growing international trade in foodstuffs which must meet stringent standards of quality.

It is important to understand that the irradiation of food does **not** make the food radioactive!

Radiation is also used to sterilize food packaging. In the Netherlands, for example, milk cartons are freed from bacteria by irradiation.

WATER RESOURCES

An adequate water supply is essential for life. Yet in many parts of the world water has always been scarce and in others it is becoming scarcer. Yet for any new development, whether agricultural, industrial or human settlement, a good renewable water supply is vital.



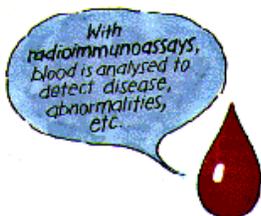
Isotopic techniques are often of great help to trace and measure the extent of underground water resources. Such techniques provide important analytical tools in the management of existing supplies of water and in the identification of new, renewable sources of water. They provide answers to questions about origin, age and distribution, the interconnections between ground and surface water and renewal systems. The results permit informed recommendations for the planning and management of the sustainable use of these water resources.

For surface waters they can give information about leakages through dams, the dynamics of lakes and reservoirs, flow rates and river discharge measurements and sedimentation rates. From Afghanistan to Zaire there are few countries, developed or developing, that have not used isotope techniques to investigate their water resources.

MEDICINE

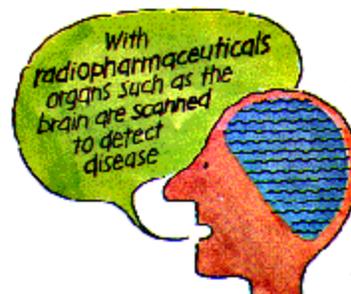
Many of us are aware of the wide use of radiation and radioisotopes in medicine particularly for diagnosis (identification) and therapy (treatment) of various medical conditions. Nuclear medicine mostly uses radioisotopes which emit gamma rays from within the body. It is estimated that about one out of every three hospital patients benefits in some way from the use of nuclear medicine.

Diagnosis



Radioisotopes are an essential part of diagnostic treatment. In combination with imaging devices and computers, they are also used to study the dynamic processes taking place in the various organs. The two most common nuclear medicine procedures are the detection of abnormalities in skeleton and in heart muscle.

In using radiopharmaceuticals for diagnosis, a radioactive dose is given to the patient and the activity in the organ can then be studied either as a two dimensional picture or, with a special technique called tomography, as a three dimensional picture.



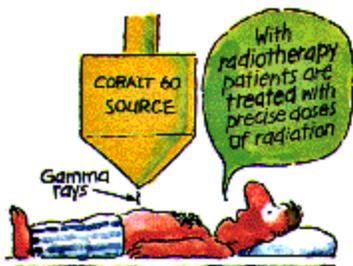
The most widely used diagnostic radioisotope is technetium-99m, with a half-life of six hours, and which gives a very low radiation dose. Such isotopes are ideal for tracing many bodily processes with the minimum of discomfort for the patient. They are widely used to indicate tumors and to study the heart, lungs, liver, kidneys, blood circulation and volume, and bone structure.

- ◆ Technetium generators, a lead pot enclosing a glass tube containing the radioisotope, are supplied to hospitals from the nuclear reactor where the isotopes are made. They contain molybdenum-99, with a half-life of 66 hours, which progressively decays to technetium-99. The Tc-99 is washed out of the lead pot by saline solution when it is required. After two weeks or less the generator is returned for recharging.

A major use of radioisotopes for diagnosis is in radio-immuno-assays for biochemical analysis. They can be used to measure very low concentrations of hormones, enzymes, hepatitis virus, some drugs and a range of other substances in a sample of the patient's blood. The patient never comes in contact with the radioisotopes used in the diagnostic tests. In the USA alone it is estimated that some 40 million such tests are carried out each year.

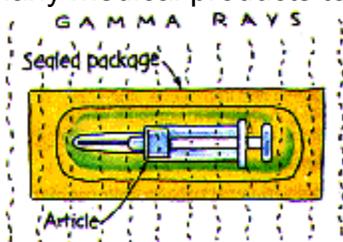
Therapy

The uses of radioisotopes in therapy are comparatively few, but important. Iridium-192 implants in the form of a wire are used to give precise doses to limited areas. Iodine-131 is used to treat the thyroid for cancer and other conditions. Some cancers are treated using gamma rays from an external cobalt-60 source, others using internal beta radiation. A new treatment uses samarium-153 complexed with organic phosphate to relieve the pain of secondary cancers lodged in bone.



Sterilization

Many medical products today are sterilized by gamma rays from a cobalt-60 source. This is a technique which generally is much cheaper and more effective than steam heat sterilization. The disposable syringe is an example of a product sterilized by gamma rays. Because it is a 'cold' process radiation it can be used to sterilize a range of heat-sensitive items such as powders, ointments and solutions and biological preparations such as bone, nerve, skin, etc, used in tissue grafts.



The benefit to humanity of sterilization by radiation is tremendous. It is safer and cheaper because it can be done after the item is packaged. The sterile shelf life of the item is then practically indefinite provided the package is not broken open. Apart from syringes, medical products sterilized by radiation include cotton wool, burn dressings, surgical gloves, heart valves, bandages, plastic and rubber sheets and surgical instruments.

SMOKE DETECTORS

One of the commonest uses of radioisotopes today is in household smoke detectors. These contain a small amount of americium-241 which is a decay product of plutonium-241 originating in nuclear reactors. The Am-241 emits alpha particles which ionize the air and allow a current between two electrodes. If smoke enters the detector it absorbs the alpha particles and interrupts the current, setting off the alarm.

SCIENCE AND INDUSTRY

Environmental Tracers

Radioisotopes also play an important role in detecting and analyzing pollutants, since even very small amounts of a radioisotope can easily be detected, and their decay means that no residues remain in the environment.

Nuclear techniques have been applied to a range of pollution problems including smog formation, sulphur dioxide contamination of the atmosphere, sewage dispersal from ocean outfalls and oil spillage.



Industrial Tracers

The ability to measure radioactivity in minute amounts has given radioisotopes a wide range of applications in industry as 'tracers'. By adding small amounts of radioactive substances to materials used in various processes it is possible to study the mixing and flow rates of a wide range of materials, including liquids, powders and gases and to locate leaks.

Tracers added to lubricating oils can help measure the rate of wear of engines and plant and equipment. Tracer techniques have been used in plant operations to check the performance of equipment and improve its efficiency, resulting in savings in energy and the better use of raw materials.

Instruments



Gauges containing radioactive sources are in wide use in all industries where levels of gases, liquids and solids must be checked. These gauges are most useful where heat, pressure or corrosive substances, such as molten glass or molten metal, make it impossible or difficult to use direct contact gauges.

Radioisotope thickness gauges are used in the making of continuous sheets of material including paper, plastic film, metal, etc, when it is desirable to avoid contact between the gauge and the material.

Density gauges are used where automatic control of a liquid, powder or solid is important, for example, in detergent manufacture. Tobacco companies are among the biggest users of radioisotope density gauges, which are used to check the amount of tobacco that is packed into each cigarette.

Radioisotope instruments have three great advantages:

- ◆ Measurements can be made without physical contact with the material or product being measured.
- ◆ Very little maintenance of the isotope source is necessary
- ◆ The cost/benefit ratio is excellent - many instruments pay for themselves within a few months through the savings they allow

Radiography

Radioisotopes, which emit gamma rays, can be used to check welds of new gas and oil pipeline systems, with the radioactive source being placed inside the pipe and the film outside the welds. This is more convenient than employing X-ray equipment.

Other forms of radiography (neutron radiography/ autoradiography), based on different principles, can be used to gauge the thickness and density of materials or locate components that are not visible by other means.

Power Sources

Some radioisotopes emit a lot of energy as they decay. Such energy can be harnessed for heart pacemakers and to power navigation beacons and satellites. The decay heat of plutonium-238 has powered many US space vehicles and enabled Voyager to send back pictures of distant planets. Pu-238 powered the Cassini space probe on its way to Saturn.

Dating

Analysis of radioisotopes is of vital importance in determining the age of rocks and other materials that are of interest to geologists, anthropologists and archaeologists.

From the moment we get up in the morning, until we go to sleep, we benefit unknowingly from many ingenious applications of radioisotopes and radiation. The water we wash with (origin, supply assurance), the textiles we wear (manufacture control gauging), the breakfast we eat (improved grains, water analysis), our transport to work (thickness gauges for checking steels and coatings on vehicles and assessing the effects of corrosion and wear on motor engines), the bridges we cross (neutron radiography), the paper we use (gauging, mixing during production processes), the drugs we take (analysis, perhaps radio-pharmaceuticals) not to mention medical tests (radioimmunoassay), or the environment, which radioisotope techniques help to keep clean (environmental analytical control), are all examples that we sometimes take for granted.

Source

Australia Uranium Association,

<http://world-nuclear.org/info/default.aspx?id=104&terms=the%20peaceful%20atom>

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