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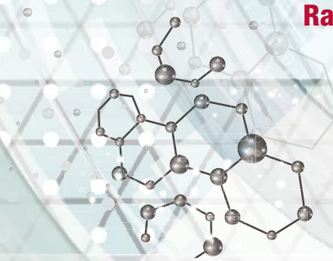
Materials Improved by Radiation

Radiation processing of polymers allows mass production of high quality goods: it is cost-effective, fast, precise and much cleaner than other conventional methods. This technology benefits various industries and ultimately millions of consumers.

Radiation processing is the large-scale use of ionizing radiation which has enough energy to remove tightly bound electrons from the orbit of an atom, creating reactive species which further react and improve the quality of the material. The energy involved is not enough for nuclear activation, therefore the products do not become radioactive.

Radiation technologies improve many products we use every day – from the planes we fly to the food we eat



Radiation technologies are used to form cross-links between polymer chains (radiation cross-linking).

This technology is applied in around 90% of materials used to build cars, airplanes and computers worldwide.

Radiation cross-linking makes wire and cable products stronger and more resistant to chemicals and fire, ensuring better safety.

These materials are used in many industries where improved resistance, optimum insulation, prolonged survival and high performance under harsh environmental conditions is crucial.

Radiation cross-linked shrink wraps prolong the freshness of food, for example.

Health and agriculture are just some of the many industries benefiting from radiation technologies

Cross-linked polymers reduce the healing time of wounds

Hydrogels are cross-linked polymers which are widely used in medicine. They absorb large amounts of water and when prepared by irradiation they get cross-linked as well as are made sterile. These polymers can accelerate wound healing. They are also used as beauty masks in the cosmetic industry.

Radiation processing of natural polymers improves plant growth

Cassava starch from edible root-cassava is a biodegradable material that is redesigned with radiation and used to make super water absorbents which then release their water slowly. The IAEA supports the adoption, manufacture and use of many non-toxic biodegradable polymers derived from plants and animals.

Radiation technologies are used to cut chains in natural polymers such as seaweed, sago, cassava starch and palm oil. Plants treated with such products grow faster and larger. Many countries are using these materials to improve their agriculture and to bring new products to the market.

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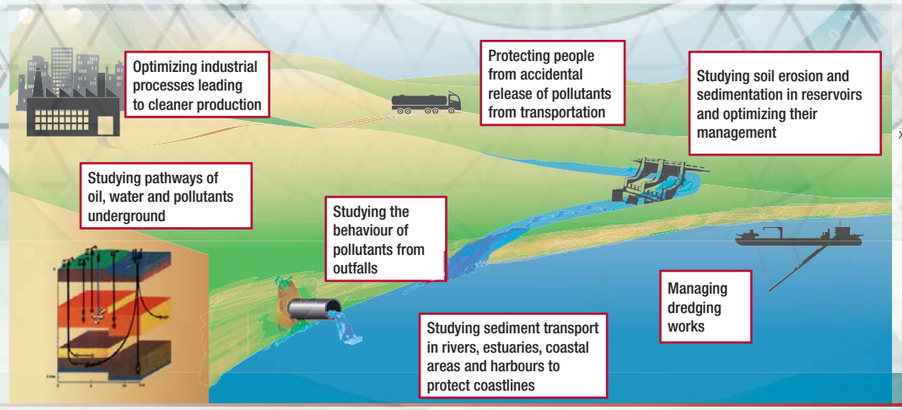
Radiation Technologies for Measurement

Radiotracers, nucleonic control systems and non-destructive testing are non-invasive technologies for measuring physical parameters in industrial production and environmental processes.

Radiation technologies are widely used in many industries because of their unique advantages such as high sensitivity, selectivity and accuracy. They can operate without actual physical contact with the analyzed material itself. These technologies work in extreme conditions where other methods cannot be used.

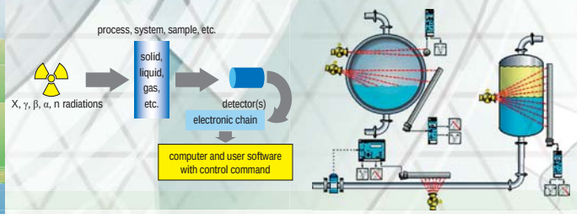
Radiotracers in industry and the environment

Radiotracers help to trace pathways of unseen phenomena in nature, for example pollutants in water. These technologies benefit industries and help identify the negative impacts of human activities.



Nucleonic control systems

Nucleonic control systems (NCS) or nucleonic gauges are widely used by industry to improve product and process quality, and save energy.



Measurement and analysis with NCS are based on the interaction between ionizing radiation and matter.

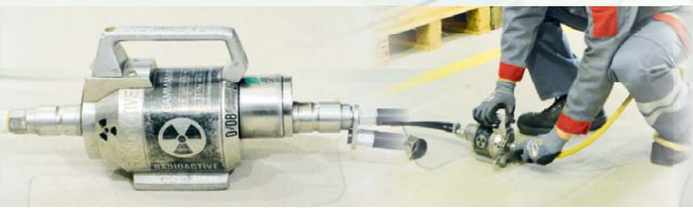
NCS are used in industry to measure and control process parameters such as thickness, density, level and composition.

NCS function in unique places, such as measuring the vertical profile of mud deposits in dams, harbour basins and navigation fairways.

Non-destructive testing (NDT): safety and quality first

How can you find out what is wrong inside an object without ripping it apart or destroying it? By using non-destructive testing.

NDT is a non-invasive technique that assesses the structural integrity of a material, component or structure without destroying its shape, size, chemical or physical properties.



There are two different radiation sources available for industrial use: X-ray and Gamma-ray.

There are several NDT technologies, such as radiographic testing, ultrasonic testing, visual testing and electromagnetic testing.

NDT is an essential quality-control technique that can save money, time and human lives.

Many industries benefit from NDT technologies, from transportation to oil and gas-exploration and civil engineering structures.

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Solutions for Pollution

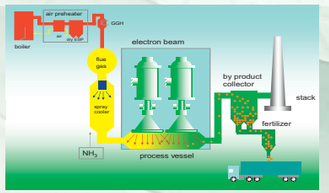
Radiation technologies are being deployed to treat and neutralize persistent industrial pollutants.

A breath of fresh air

Each day the world burns over 6 billion metric tons of coal, one of the most abundant fossil fuels. This emits pollutants like SO_2 and NO_x that get transformed into sulphuric and nitric acids in the atmosphere, causing environmental and economic losses.

Photo: UN photos/Flickr

Industry is searching for new ways to use coal more efficiently and reduce emissions. The IAEA helps Member States to convert fossil fuel emissions – also called flue gas – into high quality agricultural fertilizers with radiation technologies.



Scheme of the electron beam flue gas treatment (not to scale)

Electron beam treatment simultaneously removes SO_2 and NO_x in a single step process with no waste generation.

A demonstration facility which uses electron beam technology has been built with IAEA's support in Poland that efficiently removes 95% of SO_2 and 70% of NO_x from flue gas to meet European Union limits.

A drop of clean water

The wastewater from textile dyeing is highly contaminated with various chemicals, harmful to human health and the environment. In fact, 20% of global industrial water pollution comes from treatments in the textile dye industry.

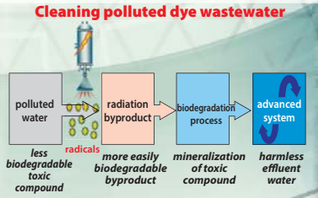
To colour textile, compounds with large, long and complex chains are added.

Wastewater from this industry can contain more than 70 complex chemicals which cannot be degraded easily.

Effective technologies are needed to treat such pollutants before they are discharged into the environment.

By collecting effluent and irradiating it with electron beams, scientists can fragment complex structures into smaller molecules which then can be treated and removed with normal biological processes.

Cleaning polluted dye wastewater



The IAEA-assisted facility at the Daegu Dye Industry Complex in South Korea successfully demonstrated this application with a treatment capacity of 10 000 m^3 wastewater per day.

Thanks to effective and reliable electron beam technology, stopping chemical dye waste from polluting rivers and waterways can be much easier in the future.

Photo: B. Kacinski/Flickr/CC BY 2.0

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Radiation Technologies Improve Health Care

Radiation can kill disease-causing germs and neutralize other harmful organisms.

Radiation technologies are commonly used to sanitize (clean or sterilize) equipment, thereby improving health care and ensuring the safety of patients.

Blood and implants are treated with radiation

Photo: dvortt/Flickr/CC BY 2.0

Irradiation of blood is a proven safe method to inhibit T-Lymphocyte proliferation and eliminate the risk of post-transfusion disease. This is possible because T-Lymphocytes are more radiosensitive than other blood components.

Preserved human connective tissue grafts such as bones and skin are indispensable in medical healthcare today. Tissue banks provide safe and effective allografts for their transplantation.

Sterilization with ionizing radiation inactivates microorganisms very efficiently and allows sterilization in a product's final wrapping.

Tissues to be implanted are sterilized with radiation to avoid transmission of viral infections such as HIV, hepatitis C and B viruses and bacterial infections.

Life-saving equipment sterilized with radiation

Radiation is a safe and cost-effective method for sterilizing single-use medical devices such as syringes and surgical gloves. A key advantage is that radiation allows already-packaged products to be sterilized. IAEA assists Member States to set up radiation facilities and provides guidelines for such applications.

Photo: Pete Lewis /UK Department for International Development/Flickr/CC BY 2.0

More than 40% of all single-use medical devices produced worldwide are sterilized with gamma irradiation.

More than 160 gamma irradiation plants around the world are operating to sterilize medical devices.

Around 12 million m^3 of medical devices are sterilized by radiation annually.

Effective vaccines through radiation

Vaccines made with bacteria killed by gamma radiation are more effective than those made using standard heat or chemical methods, as this allows them to retain their immunological properties better.

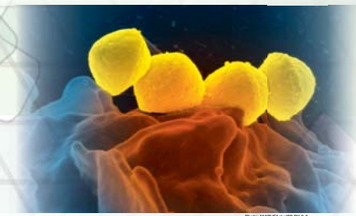

Photo: NIAID/Flickr/CC BY 2.0

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This opens the possibility of more efficient and safer vaccines in the future.