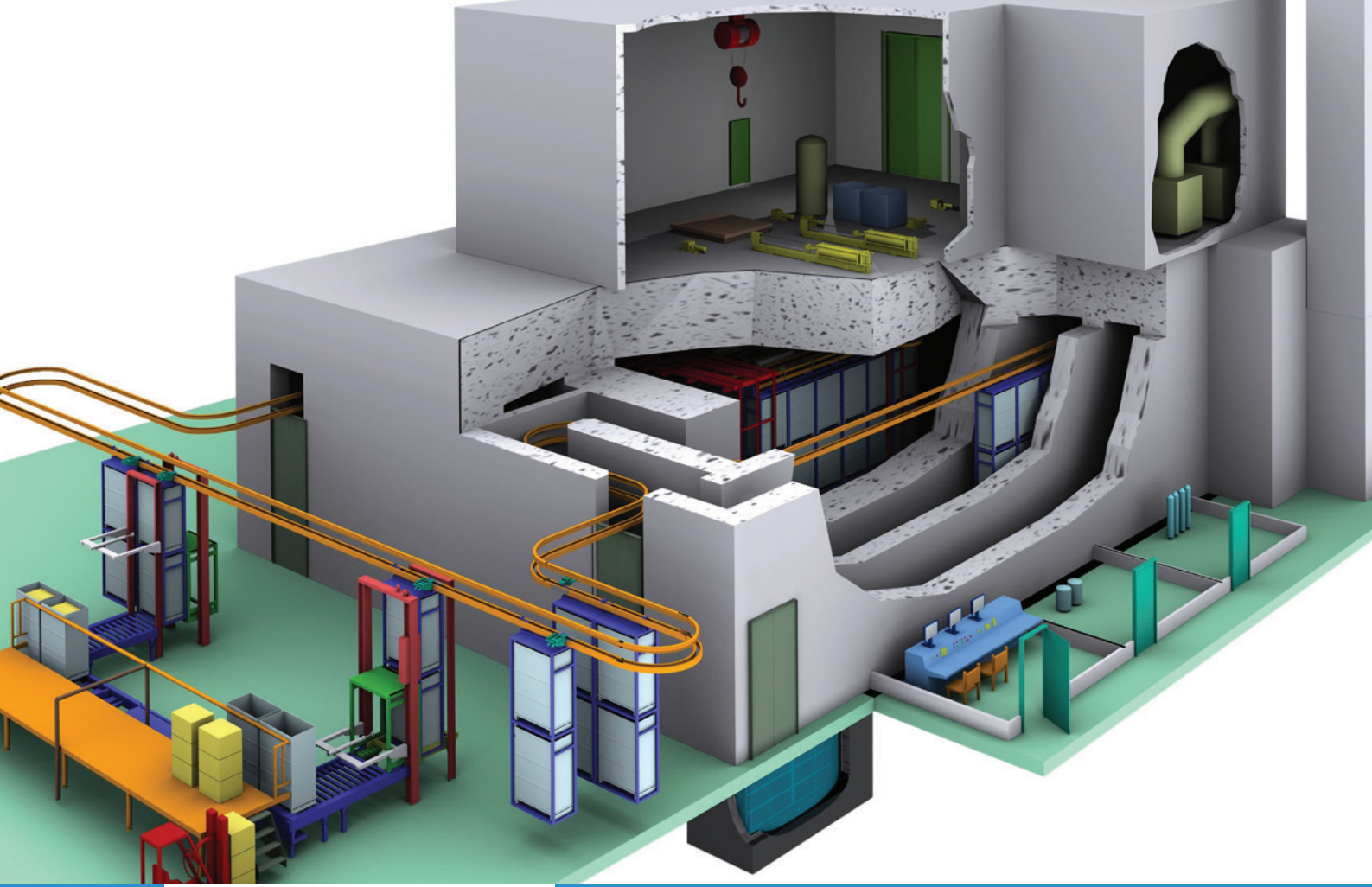

factsheet

Gamma Irradiation Technology using Cobalt-60

Gamma irradiation technology is used in a wide variety of industrial applications and uses Cobalt-60 as the source of ionizing radiation.

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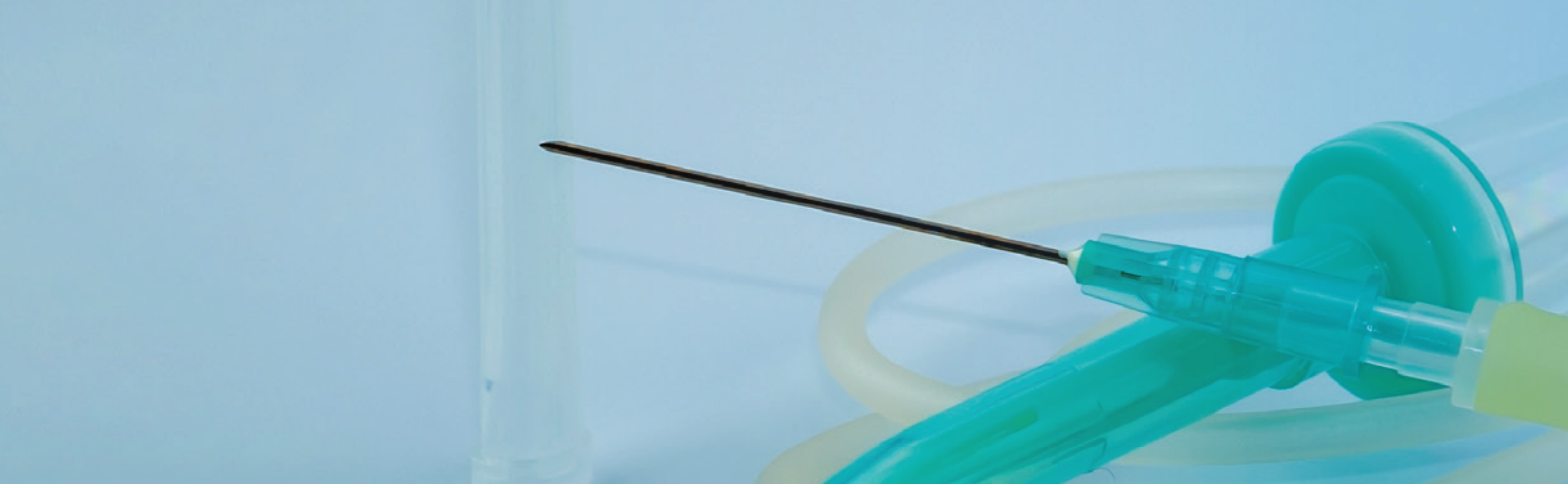

Gamma irradiation technology is used in a wide variety of industrial applications and is one of three radiation processing technologies, the others being electron beam and X-ray. Radiation processing is the application of ionizing radiation to products and materials for beneficial purposes. Gamma irradiation uses the man-made radioisotope Cobalt-60 as the source of ionizing gamma radiation.

Approximately 250 large-scale commercial gamma irradiators are in operation in about 50 countries. These irradiators process more than 400 million cubic feet of product annually*. Approximately half of this volume is medical products that require sterilisation by gamma irradiation. The other half consists of a wide range of products such as packaging material, pharmaceutical and cosmetic ingredients as well as food products. In each case processing is undertaken to reduce bacterial loads or to enhance performance of products and materials.

Cobalt-60

Cobalt-60 is produced by placing Cobalt-59, a naturally occurring metal, into a nuclear reactor where it absorbs neutrons and becomes radioactive Cobalt-60. The Cobalt-60 is removed from the nuclear reactor and transferred to a facility where it is encapsulated into stainless steel pencils. These pencils of Cobalt-60, usually called 'sources', are tested and certified to meet international design standards. The Cobalt-60 sources are installed into gamma irradiators where the products and material are processed by exposure to the gamma radiation emitted by the sources.

Image courtesy of STERIS AST

Cobalt-60 sources installed in a gamma irradiator. The sources are safely stored underwater. The radiation gives off a blue glow underwater, known as the Cherenkov Effect, caused by charged particles travelling faster than the speed that light normally travels through water.

Radiation processing

The product being processed in an irradiator must receive sufficient radiation dose to achieve the desired effect (e.g. sterilisation) but less than the dose that may damage the product (e.g. discolouring). The irradiation dose delivered is determined by: the amount of Cobalt-60 in the irradiator measured in the unit 'Curies'; the amount of time that the product stays exposed to the Cobalt-60 determined by the speed of the conveyor system; the distance between the source and the product; and the size and density of the package of product or material that is being treated. A post-irradiation control called dosimetry is used to ensure that product has received the correct dose of radiation.

Gamma radiation from Cobalt-60 has high penetrating capability (each time an atom of Cobalt-60 decays, two high energy photons [1.17MeV and 1.33MeV] are emitted). This makes gamma irradiation particularly suitable for treating large packages or pallets and higher density products.

*A Comparison of Gamma, E-beam, X-ray and Ethylene Oxide Technologies for the Industrial Sterilization of Medical Devices and Healthcare Products, International Irradiation Association, August 2017.

Gamma irradiators

There are several designs of gamma irradiator but they all include a number of common features:

- **Irradiation cell**: a concrete bunker which houses the Cobalt-60 and provides the necessary shielding to contain the ionizing radiation. The cell is where the product receives the radiation dose and is located inside a warehouse where non irradiated incoming product is segregated from irradiated products awaiting shipment.
- **Source rack**: a metal frame in which the Cobalt-60 sources are positioned. A hoist system lifts the rack into an elevated irradiation position and passively lowers into a storage position.
- **Conveyor system**: moves the product into the irradiation cell for treatment and then back out of the cell. Product can be treated as full pallets or as boxes within aluminium carriers depending on the irradiator design. When inside the cell, product is typically moved past the Cobalt-60 with pneumatics or another drive mechanism. Automatic or manual product handling stations are located at either end of the conveyor system for loading and unloading product on or off the conveyor.
- **Control system**: the flow of product through the irradiator and the various operations and systems of the irradiator are automatically managed and recorded by the control system. The control system is integrated with irradiator safety systems and can also be networked with warehouse, administration and reporting systems.
- **Safety and security systems**: there are multiple fail-safe systems and security features in place to ensure that personnel and public remain safe. The irradiation industry has an exemplary safety record.
- **Source storage**: when the Cobalt-60 is not being used for treating product, it is typically lowered into a pool of water directly under the irradiation cell for safe storage. The layer of water above the source rack provides shielding against the gamma radiation so that personnel can safely enter the cell to perform maintenance work on the irradiator.

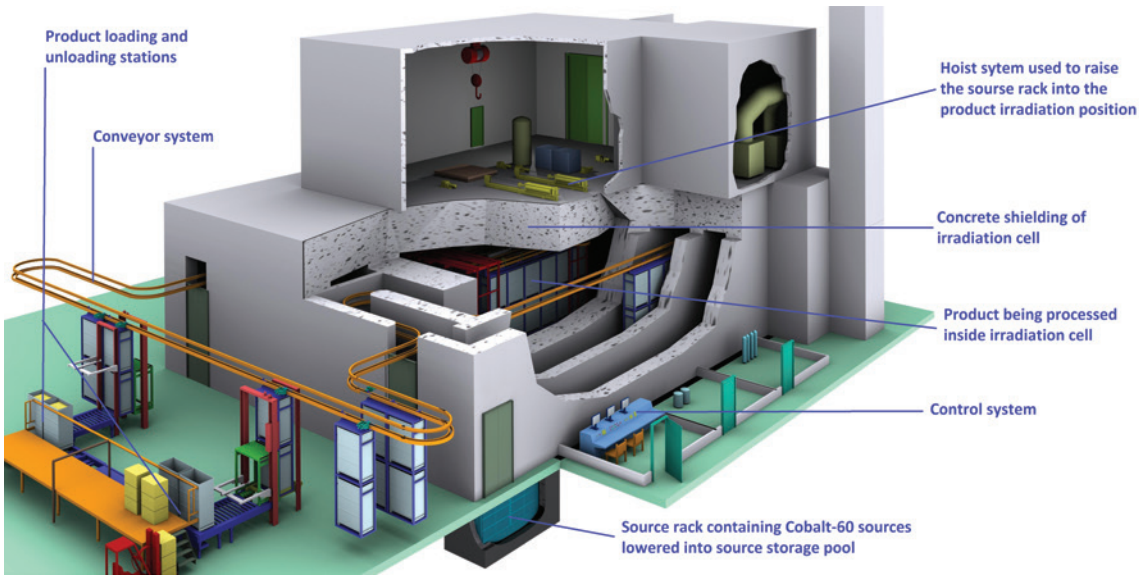

Image courtesy of SQHL Radiation Engineering Technology Co., Ltd.

There are a small number of other irradiator designs, such as those that utilise a dry source storage pit rather than a water pool. Small research or semi-commercial gamma irradiations may not have a conveyor system so batches of product are manually transferred into the irradiation cell. Small stand-alone irradiators are also utilized for low volume specialist applications.

Outlook

Gamma irradiation is a well-established and reliable technology that provides a critical sterilisation solution for a large proportion of medical device, wound care and other products. Demand for irradiation sterilisation will continue to grow with greater access to healthcare and an ageing population with extended life expectancy.

The gamma irradiation industry continues to meet the stringent safety and security regulations that govern the use of radioactive material whilst also meeting the high technical and quality standards that is demanded by suppliers and users of the technology. The industry will continue to evolve rather than be subject to radical and sudden change.