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On-line and off-line EMIS for production of medical and industrial radionuclide and radiotracer generators

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Abstract

Radionuclides are extensively used in the medical field both for diagnostic (tracer) and therapeutic purposes. The requirements concerning half-life vary from a few seconds to a few days, and the desired radiation properties range from simple low-energy gamma emitters and positron emitters for diagnostic purposes to beta, auger electron and alpha emitters for therapy.

Industrial use includes both beta and gamma emitters mainly for tracing purposes. Half-lives and radiation characteristics may be different from those of the medical nuclides: Some applications require half-lives of months to years (extended reservoir examinations) while other applications can only utilize short-lived radiotracers with half-lives of minutes to hours (industrial process monitoring). Further in industrial applications, higher-energy gamma radiation (> 1 MeV) as well as multi-gamma emission is useful, especially in process monitoring.

Some of the interesting radionuclides can be produced in reactors and small-size particle accelerators in low-energy fission, simple absorption, transfer or knock-on reactions while others will require high-energy fission, spallation and fragmentation reactions. To extend the region of use outside the immediate surrounding of such production facilities (due to half-life limitations), the application of radionuclide and radiotracer generators based on a long-lived mother and a shorter-lived daughter is now in extensive development. The short-lived radiotracer can thereby be produced on site and on demand.

Both the medical and industrial application area require high radiochemical purity. One of the best ways to avoid cumbersome work-up and purification procedures is to make use of EMIS after (or during) irradiation of a suitable target material. In the best cases, isotopically pure products may be collected for direct labelling of various defined chemical or biochemical compounds.

This presentation will describe mother-daughter nuclear relationships of interest to these two application areas. Additionally, examples are given on how these may be produced in an affordable way by selecting a proper target material and involving EMIS in the process. Furthermore, examples are sketched of some possible generator types and systems and how they may be operated.

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