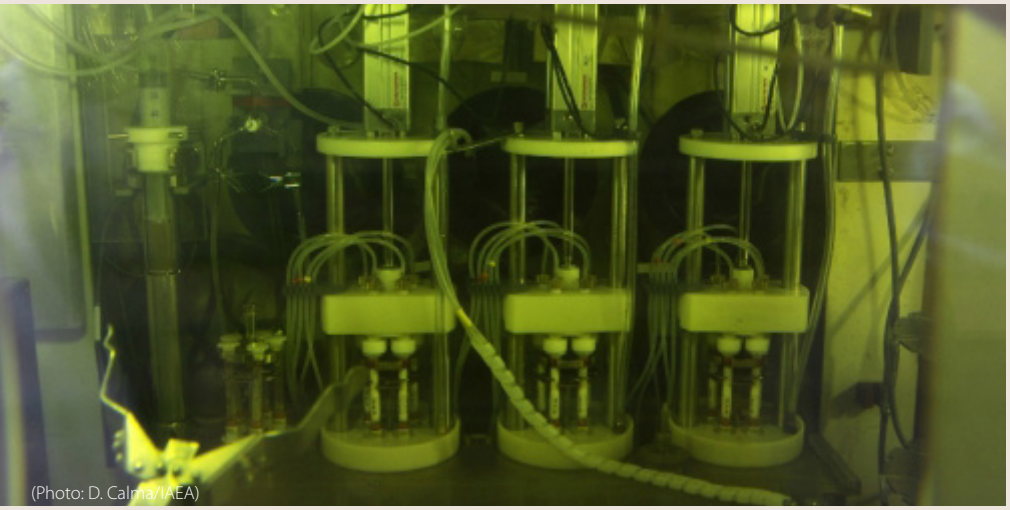
Alternative technology could boost production of Mo-99


(Photo: D. Calma/IAEA)

An alternative method for producing molybdenum-99 (Mo-99) could help to increase supply of this key isotope that is used to provide essential health care to millions of patients worldwide, revealed a paper published in the *Journal of Radioanalytical and Nuclear Chemistry* that was based on IAEA-supported research and co-authored by an IAEA expert.

As the major research reactors that supply Mo-99 age and cease production, the alternative method discussed in the paper offers a simplified way to diversify production and help ensure continued supplies of Mo-99 so that nuclear medicine services are not interrupted.

Troubles in the past

In 2009, reactors producing Mo-99 in Canada and the Netherlands were temporarily shut down for necessary repairs and maintenance. This caused major disruption in health care services worldwide, leading to cancelled medical scans and postponed operations, and in some cases requiring medical professionals to revert back to using old, less effective techniques. Although supply conditions have since improved, health officials and scientists have been looking into alternatives to address what the US National Academies of Sciences, Engineering and Medicine 2016 report, *Molybdenum-99 for Medical Imaging,* called 'supply vulnerabilities'.

"This disruption was really a wake-up call that something needed to be changed in how we are producing Mo-99," said Danas Ridikas, Research Reactor Specialist at the IAEA and co-author of the paper. "Diversification of how and where Mo-99 is produced, increased efficiency in the way the isotope is used, and devising a business model to recover production costs have all become essential to ensuring a continued, stable and economically viable supply of Mo-99."

Mo-99 is the parent isotope of technetium-99m (Tc-99m), the most widely used radionuclide for medical imaging. Because Tc-99m is unstable and decays quickly, its more stable parent isotope is produced and transported to hospitals.

With one research reactor in Canada ceasing production in October 2016, and another large producer in the Netherlands scheduled to go offline by 2024, finding alternative production methods is becoming increasingly critical, Ridikas explained. Producing Mo-99 by irradiating natural or enriched molybdenum is one of the lesser-used yet viable alternatives for fulfilling domestic needs, in particular for countries with research reactor facilities, he said.

Irradiating molybdenum

This technique, already in use in Chile, India, Kazakhstan, Peru, Russia and Uzbekistan, involves a simpler production process and generates less radioactive waste than the traditional method of producing Mo-99 through fission from uranium. It can also allow better use to be made of research reactors. Several countries, including Jordan, Mexico and Morocco, are considering implementing the technique.

While the new method shows potential, experts are still evaluating its efficiency. In December 2015, an IAEA workshop on the subject brought together experts from 15 research reactor facilities in 12 countries to explore the method and its feasibility. Experiments to irradiate natural molybdenum targets, carried out in several research reactors with IAEA support, clearly showed that when Mo-99 was obtained through irradiation there was less Mo-99 produced per gram of material irradiated than was the case with the fission method. However, the amount obtained should still be sufficient to meet local needs in several countries.

Although irradiating enriched molybdenum would yield a higher ratio of Mo-99, it would require a more expensive raw material, so using natural molybdenum, despite the lower yield, may be preferable, Ridikas explained. "The cost-effectiveness of irradiation and processing, compared to the fission method, still needs to be determined."

The lessons learned from the workshop and data on the approximate production capacities of the reactors formed the basis of a paper published by Ridikas and several other scientists in the *Journal of Radioanalytical and Nuclear Chemistry*. They also serve as a platform for continued research. A related workshop on irradiated target processing and preparation of technetium-99m generators, based on Mo-99 production by neutron capture, will be organized by the IAEA in 2017 in Kazakhstan.

— By Jeremy Li