Gaseous Radiotracer Carrier Based on Hydroquinone Clathrate

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Radiotracers have been used widely in various industries such as the petrochemical, steel, and automobile industries. The selection of appropriate radioisotopes to be used as tracers is very important for confident results, and the selection procedure needs to consider physical and chemical characteristics of process fluids to be traced. In addition, their nature needs to be investigated to minimize the environmental impact of radiotracers during experiments. A gaseous tracer is produced by irradiating target elements with neutrons in a research nuclear reactor. For safety reasons, radioisotopes of a short half-life are preferred as tracers. Because it takes a considerable amount of time to transport radiotracers from a radioisotope production facility to a tracer investigation site, the gas target to neutron bombardment is usually pressurized in a quartz container The physical integrity of such a container needs to be guaranteed during neutron irradiation, but it is almost impossible to produce containers of identical physical strength. The reason for this is that a quartz ampoule is sealed by the melting of its inlet with a high temperature flame while gas is liquefied by liquid nitrogen at the bottom of the ampoule. This uncertainty with gas containers can make radioisotope production hazardous. As a substitute for the traditional quartz ampoule as a gas container, a clathrate compound was considered. It was prepared to hold Ar gas of up to several bars, and it was characterized to confirm its feasibility as a gas tracer carrier under various conditions. Gamma irradiation tests show the clathrate composite to be barely influenced by a radiation environment. X-ray diffraction, in-situ high-pressure synchrotron XRD, Raman spectroscopy, and NMR were used to characterize the synthesized clathrate samples quantitatively. In addition, the gravimetric method was used to study Ar release kinetics as a function of both the time and the temperature dependent phase stability of Ar-loaded clathrates. We plan to irradiate the synthesized clathrate samples with neutrons in a research reactor, and to quantify the radioactivity that is produced. Furthermore, an optimal design dedicated to handling radioactive gas will be drawn up for testing purposes.