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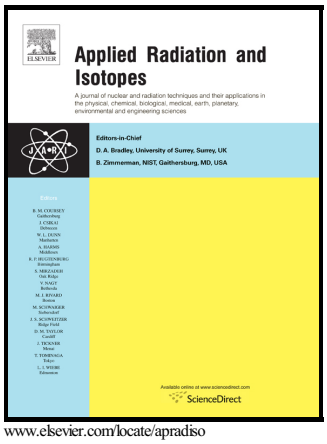

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Residence time distribution measurements in a pilot-scale poison tank using radiotracer technique

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Abstract: Various types of systems are used to control the reactivity and shutting down of a nuclear reactor during emergency and routine shutdown operations. Injection of boron solution (borated water) into the core of a reactor is one of the commonly used methods during emergency operation. A pilot-scale poison tank was designed and fabricated to simulate injection of boron poison into the core of a reactor along with coolant water. In order to design a full-scale poison tank, it was desired to characterize flow of liquid from the tank. Residence time distribution (RTD) measurement and analysis was adopted to characterize the flow dynamics. Radiotracer technique was applied to measure RTD of aqueous phase in the tank using Bromine-82 as a radiotracer. RTD measurements were carried out with two different modes of operation of the tank and at different flow rates. In Mode-1, the radiotracer was instantaneously injected at the inlet and monitored at the outlet, whereas in Mode-2, the tank was filled with radiotracer and its concentration was measured at the outlet. From the measured RTD curves, mean residence times (MRTs), dead volume and fraction of liquid pumped in with time were determined. The treated RTD curves were modeled using suitable mathematical models. An axial dispersion model with high degree of backmixing was found suitable to describe flow when operated in Mode-1, whereas a tanks-in-series model with backmixing was found suitable to describe flow of the poison in the tank when operated in Mode-2. The results were utilized to scale-up and design a full-scale poison tank for a nuclear reactor.

Keywords: Poison tank, Radiotracer, Bromine-82, Residence time distribution, Mean residence time, Dead volume, Axial dispersion model, Tank-in-series with backmixing model

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