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Technetium-99m: From Nuclear Medicine Applications to Fine Sediment Transport Studies

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Technetium ^{99m}Tc is, nowadays, the most applied radioisotope in nuclear medicine, whose use began in the mid-1960s. Features such as emission of γ-radiation of low energy (140 keV) with very good imaging properties, half-life $\tau_{1/2} = 6.02$ h, and production via relatively long-lived generators, facilitating their supply and use in locations far from manufacturing sites, were instrumental for the widespread use of the radionuclide.

However, in the aquatic environment, heavy metals and many organic compounds are usually associated with the fine sediment phase (silt, clay, or mud). The fate of these contaminants will be associated with the dynamic behaviour of suspended or bottom sediments in polluted streams. The study of suspended sediment behaviour is central to many environmental studies. Of special interest is the study of individual discharges of contaminants associated with suspended sediments, the short-term dispersion of contaminated material dredged from harbours and reservoirs when dumped into water bodies and the behaviour of natural sediment in suspension in bays, estuaries or reservoirs. Tracking for few hours of the contaminated suspended sediments introduced into streams or in the coastal area by individual discharges could allow the quantitative in situ determination of the advection, dispersion, dilution and sedimentation rates, parameters important for the calibration and validation of hydrodynamic models that comprise both the solid and liquid phases.

Radioactive tracers, in appropriate chemical form, are used to label fine sediment by chemical sorption, and some (such as ^{198}Au and ^{51}Cr) have been employed to study the dynamics of fine sediment in suspension. But these tracers have to be produced in nuclear reactor each time they are used and require heavy shielding due to the dense flux of high-energy γ-radiation they emit, which hampers their use in remote areas.

Given the favourable characteristics of ^{99m}Tc, the feasibility of its use for labelling mud, through the chemical reduction of the TcO_4^- eluted from Mo/Tc generators, was studied in laboratory with regard to the following aspects: 1) labelling yield as function of different factors (type and amount of reductant; effect of pH; sediment concentration; contact time; labelling stability); and 2) hydrodynamic behaviour of labelled and non-labelled sediment, through sedimentation tests. The laboratory tests were successful and this new use of the ^{99m}Tc allowed already interesting

results obtained in various applications: Montevideo Bay (Uruguay), Pampulha Hydrographic Basin (Brazil), Orinoco River (Venezuela), environmental impact due to the fine sediment originated from bottom discharge of small hydroelectric power plant (Brazil), etc.

The work performed in some field applications used second week generators obtained, at no cost, from Nuclear Medicine laboratories. The reason is that the ^{99m}Tc detector for environmental applications is placed into the water, in 4π geometry and for medical applications it is situated externally to the patient. So, the necessary activity concentrations for environmental use (Bq/mℓ in water) are much lower (10^{-7}) than in nuclear medicine utilization (Bq/mℓ in blood).

Country/Organization invited to participate

Brazil

Primary author: Mr VIANNA BANDEIRA, Jefferson (National Nuclear Energy Commission (CNEN-CDTN), Brazil)

Co-author: Mr HANNAS SALIM, Lecio (National Nuclear Energy Commission (CNEN-CDTN), Brazil)

Presenter: Mr VIANNA BANDEIRA, Jefferson (National Nuclear Energy Commission (CNEN-CDTN), Brazil)

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