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Solvent extraction process development for the preparation of nuclear grade gadolinium oxide for reactor application

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Gadolinium is an important rare earth element, which finds applications in reactors as a control rod material. Its nitrate form is used for dual purposes whereby it not only works efficiently for reactor control through moderator liquid poison addition system but also as a secondary shut down device in PHWR (Pressurized Heavy Water Reactor). Advantage of using gadolinium nitrate is, due to its high thermal neutron absorption cross section, quick burnout, greater solubility in the desirable pH range applicable to moderator. Indigenous source of gadolinium is monazite mineral where rare earths are obtained as by-product by selective leaching with dilute HCl. The concentration of gadolinium in the resulting chloride leach liquor is around 1.4%. Generally, this multi metal bearing solution is subjected for fractionation into three groups namely: Light rare earths (LRE): Ce, La, Pr and Nd), middle rare earths (MRE): Sm, Eu, Gd and heavy rare earths (HRE): Tb, Dy, Ho, Er, Y, Tm, Yb and Lu by solvent extraction technique employing D2EHPA (di-2ethyl hexyl phosphoric acid) or EHEHPA (2-ethylhexylphosphonic acid, mono-2 ethylhexyl ester). An integrated solvent extraction process to produce nuclear grade Gd2O3 (>99.5%) for its applications in pressurized heavy water reactor (PHWR) from a crude concentrate of rare earths containing ~70% Gd_2O_3 obtained as a by-product during the purification of samarium from MRE, has been developed and tested on bench-scale and continuous counter-current operations. The experimental conditions were optimized using computer simulation and validated by bench scale counter-current operations. Under optimized conditions of process parameters, continuous operations of mixer settler yielded kilogram quantity of nuclear pure Gd_2O_3 which was subsequently converted to gadolinium nitrate for PHWR application.

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