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Technology to harvest valuable metals from seawater: Nuclear analytical techniques for quantification of heavy metals

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The oceans are virtually limitless reservoir of dissolved uranium in a well-defined chemical environment. Various inorganic and organic adsorbents have so far been synthesized and evaluated at laboratory level using synthetic solutions with an objective for the recovery of uranium from seawater. With the development of radiation processing technology, special adsorbents are synthesized by Radiation Induced Grafting (RIG) of amidoxime groups in the form of leaflets, which provides efficient contact patterns with water body in the sea. Bench scale experiments were initiated to develop process technology. One of the major challenges is to ensure the quality assurance by accurate measurement of heavy metal ion concentrations from lean solutions. In order to address the key issues, Nuclear Analytical Techniques (NAT) are being developed. Nuclear analytical techniques are based on nuclear properties of the trace level isotopes and have high sensitivity and accuracy and are important tools for chemical analysis. Suitable nuclear radiations (ά, β, γ and n) are measured to estimate the concentration of radiation emitting isotope which in turn is used to determine the elemental concentration. In this paper, the application of nuclear analytical techniques is presented. Nuclear analytical techniques such as Neutron Activation Analysis (NAA) technique and Solid State Nuclear Track Detection (SSNTD) methods for analyzing the concentrations of heavy metal ions from lean solutions like seawater are presented. Nuclear analytical techniques are quite useful and effective in view of capability of multi-elemental analysis in a variety of samples and with good detection limits for a number of elements. Systematic optimization of preparation process for radiation grafted polymeric adsorbents was carried out with respect to dose, dose rate, duration and temperature to enhance grafting levels and the kinetics of heavy metal ions sorption. Uranium loading capacity on to these special adsorbents and effect of time and concentration of eluants for desorption of the same are other parameters of these studies. Both solid samples and eluted liquid samples have been analyzed by nuclear analytical techniques for establishing and standardization of procedures for analysis. Comparison of results, both by nuclear analytical techniques and non-nuclear techniques, are presented. The procedures and time required for analysis are standardized and comparison of results with non-nuclear analytical techniques is made. Elution efficiency of around 80% is achieved for the sorbents developed. Concentration factors of the order of 1000 times were observed w.r.to recovery of uranium from seawater. It is planned to analyze other elements also using these techniques in future.

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