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Salt Production from Produced Water Containing NORM in Oil Industry: Risk Assessment and NORM Waste Management

The present study has determined the radiation risks generated from using oil produced water containing naturally occurring radioactive materials (NORM) to produce sodium chloride by evaporation and crystallization processes. The study showed that radium (the main nuclide) is precipitated and concentrated in the evaporation ponds and is not expected to be present in other phases of the project as crystallizers or in the salt as the final product of the production process. The concentration of precipitated radium-226 during evaporation process has been calculated with the assumption of 5000 m³ daily flooding water in the evaporation ponds and the concentration of radium-226 in the water is about 17 Bq l⁻¹. The expected activity concentration in evaporation ponds sediment was found to be 91 Bq g⁻¹, which is much higher than the international limit to be non-radioactive hazardous waste (1 Bq g⁻¹), and the generated annual NORM waste was found to be 3.4×10⁵ kg.

RESRAD 7.0 software has been used to assess the radiation dose to operators at the evaporation ponds in the project. Assuming activity concentrations of the deposited materials at the evaporation ponds are 91 Bq g⁻¹ and 1820 Bq g⁻¹ for the first year and after 20 years of operation, respectively, the assessment showed that any member of the evaporation ponds operators would not receive annual doses in excess of the internationally recommended limit of 1 mSv per year. The major contributor to the dose will be from external radiation. In addition, the internal dose is also predicted using the same parameters and found to be negligible and this due to the fact that most radon with daughters stay in water and most radon emitted to the air is dispersed. Therefore, the radiation risks associated with project activities during normal operation are rather small. However, considerations should be given to the dose to be received by the handling operators of the deposited materials; the assessment results showed that the doses for workers handling one drum at distance 0 cm and height of 55 (forklift driver) is 0.0014 mSv/hr and the operator will receive 2.8 mSv per year (2000 working hrs.). Finally, the risks associated with the project is rather small during operation, but the generated waste deposited at the bottom of evaporation ponds and the disposal of such waste should be considered in the cost benefit calculations and the plan of such projects.

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