Thermochemical Denitration of Sodium Nitrate Bearing Waste Stream

A voluminous liquid effluent (Low–level radioactive waste (LLW)) is generated as sodium nitrate solution (100 g $NaNO_3$/ l) in Nuclear Reprocessing Plants. This waste liquid stream poses disposal problem due to its high nitrate content as well as associated residual radioactivity. As per the Environment (Protection) Rules, 1986 implemented by Central Pollution Control Board (CPCB), the general standard for discharge of liquid nitrate effluent at marine coastal areas is 20 mg/ l. This entails huge water for disposal by conventional dilute and disperse technique. Cementation requires conditioning and nitrate will be in leachable form. When $NaNO_3$ is heated in air it melts without decomposition at 308^0C. Decomposition commences slowly at 600^0C and at 910^0C the reaction is completed with formation of sodium oxide. As the decomposition temperature is quite high, the disposal method will be exorbitant in addition to unstable operating conditions. The addition of a carbon–based reductant (e.g. sucrose) to a nitrate-containing feed stream into a thermal treatment system has been shown to achieve higher levels of denitration at lower temperatures and at a faster processing rate. This approach is sometimes referred to as Thermo–chemical Denitration or Sugar–additive Calcination. Carbon-based reductant eradicates formation of nitrogen oxides (NO_x). In thermal denitration process, sucrose added in nitrate stream and then the mixture is sprayed into a hot fluidized bed. The bed is maintained at the optimised temperature of 500 deg. C. In this process, sodium nitrate reacts with carbon of sucrose and forms sodium carbonate, nitrogen, carbon dioxide, and water. The radioactive impurities are trapped in the bed material of the fluidized-bed reactor. The dry powder collected from fluidized bed reactor, similar in consistency to washing soda is a non–hazardous chemical form and can be suitably disposed. The experimental investigations on thermal denitration of $NaNO_3$ solution have been carried out in an 80 NB laboratory scale fluidized bed reactor. 99.13% de-nitrification has been achieved in this process. The chemical analysis, XRD and material balance shows that $NaNO_3$ converts into Na_2CO_3 which is similar in consistency to washing soda is a non–hazardous radioactive waste form and can be accepted for burial[9]. Carbon based reductant also supresses the formation of NO_x.

The laboratory scale work was presented in 22nd meeting of the Nuclear Recycle Board Council. Since the activity profiles in the reactor and off-gas need to be tested with actual waste stream, it was decided to put up bench scale facility at NRB's site with AGM, INRPWMD as nodal officer. It was also decided to look into incorporation the similar facility in INRP on priority basis.

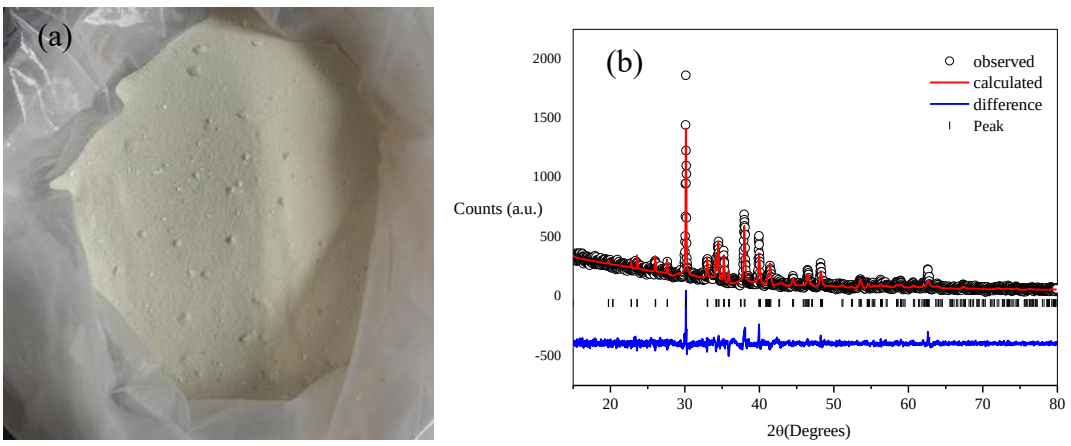

Figure 1: (a) Product Na_2CO_3 discharged from the reactor (b) XRD pattern confirms product to be Na_2CO_3