Caustic Recycling Pilot Unit to Separate Sodium from LLW at Hanford Site

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As part of the DOE sponsored Advanced Remediation Technologies initiative, a scheme was developed to combine Continuous Sludge Leaching (CSL), Near-Tank Cesium Removal (NTCR), and Caustic Recycling Unit (CRU) using the Ceramatec technology, into a single system known as the Pilot Near-Tank Treatment System (PNTTS). The Cesium (Cs) decontaminated effluent from NTCR process will be sent to the caustic recycle process for recovery of the caustic which will be reused in another cycle of caustic leaching in the CSL process.

Such an integrated mobile technology demonstration will give DOE the options to insert this process for sodium management at various sites in Hanford, and will minimize the addition of further sodium into the waste tanks. This allows for recycling of the caustic used to remove aluminum during sludge washing as a pretreatment step in the vitrification of radioactive waste which will decrease the LLW waste volume by as much as 39%.

The CRU pilot process was designed to recycle sodium in the form of pure sodium hydroxide. The basis for the design of the ¼th scale pilot caustic recycling unit was to demonstrate the efficient operation of a larger scale system to recycle caustic from the NTCR effluent stream. The CRU unit was designed to process 0.28 liter/minute of NTCR effluent, and generate 10M concentration of "usable" sodium hydroxide. The proposed process operates at 40ºC to provide additional aluminum solubility and then recover the sodium hydroxide to the point where the Aluminum is saturated at 40ºC. A system was developed to safely separate and vent the gases generated during operation of the CRU with the production of 10M sodium hydroxide. Caustic was produced at a rate between 1.9 to 9.3 kg/hr.

The CRU was located inside an ISO container to allow for moving the unit close to tank locations to process the LLW stream. Actual tests with the NTCR effluent simulant from PARSONS process was tested with the CRU. The modular CRU is easily scalable as a standalone system for caustic recycling, or for NTTS integration or for use as In-Tank Treatment System to process sodium bearing waste to meet LLW processing needs at the HANFORD site. The standalone pilot operation of the CRU to recycle sodium from NTCR effluent places the technology demonstration at TRL level 6.

Multiple operations were performed with CRU to process up to 500 gallons of NTCR effluent and demonstrate an efficient separation of sodium up to 70 % without solids precipitation while producing 10M caustic. Batch mode operation was conducted to study the chemistry variation effect, establish the processing rate and optimize the process operating conditions to recycle caustic from NTCR effluent. The performance of

CRU was monitored by tracking the density parameter to control the concentration of caustic produced.

Different levels of sodium were separated in tests from the effluent at a fixed operating current density and temperature. Cell operating voltage remained stable during of the unit operation which demonstrates steady operation to separate sodium from the NTCR effluent. The sodium transfer current efficiency was measured in testing based on the concentration of caustic produced. Measurements showed the current efficiency of 99.8% for sodium transfer from the NTCR effluent to make sodium hydroxide.

The sodium and hydroxide content of the anolyte (feed) and catholyte (product) were measured before and after each batch test. In two separate batch tests, samples were taken at different levels of sodium separation and analyzed to determine the stability of the NTCR effluent after sodium separation. The stability characteristics and changes in physical and chemical properties of the NTCR effluent chemistry after separation of sodium hydroxide as a function of storage time were evaluated. The parameters such as level of precipitated alumina, total alkalinity, analysis of Al, Na, K, Cs, Fe, OH, nitrate, nitrite, total dissolved and undissolved solids, viscosity, density, and other parameters of the NTCR effluent were analyzed. Changes in rheology and properties of NTCR stream to support downstream handling of the effluent after sodium separation was the basis for the analysis. The analysis shows that the NTCR effluent is stable without formation of alumina precipitation after 70% of sodium was separated from the effluent.