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Pre-Decisional

SRNS-N2000-2011-00039
RSM Tracking #: 10095

March 7, 2011

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Environmental Impact of Vacuum Salt Distillation

Ref: SRNL-STI-2010-00484, *Development and Deployment of Vacuum Salt Distillation at the Savannah River Site*, R.A. Pierce, D.C. Castigione, D.J. Pak, and T.B. Edwards

Background

Vacuum Salt Distillation (VSD) was recently integrated in the HB-Line Phase I process as a pretreatment to reduce/prevent dissolver and piping corrosion. The VSD process is being utilized to separate plutonium oxide from chloride salts which accelerate damage to expensive equipment during dissolution. Recent research has demonstrated that fluoride salts can also be removed, thus the potential exists to expand VSD utilization to convert excess non-Mixed Oxide compliant plutonium oxide (non-MOXable) materials into acceptable feed stocks for the MOX Fuel Fabrication Facility (MFFF). The fluoride removal capability requires an additional exchange reaction step which is accomplished through dry chemistry and results in by-products consistent with current VSD processing.

Distillation of chloride salts is a physical separation which occurs under low pressure and high temperature. Most chloride salts can be selectively distilled due to the large difference in vapor pressures that exists between plutonium oxide and chloride salts. Vaporized salts are condensed in an actively cooled section of the VSD vacuum chamber and are subsequently collected. The salt solids are treated as transuranic (TRU) waste under the currently approved Waste Acceptance Criteria (WAC). In addition to the salt waste stream, the only other by-products from the process are benign gases (mostly water vapor).

VSD has demonstrated that chloride salts can be removed from plutonium oxide to concentrations that not only enhance the dissolving capability by reducing the corrosion impact to equipment, but to also allow the plutonium oxide be considered acceptable as MOX feedstock. As indicated, fluoride salts may be similarly removed and increase the potential mass of plutonium oxide that can be converted to MFFF feedstock.

Environmental Considerations

The VSD process if employed to convert non-MOXable plutonium oxides to MOXable oxides is a net environmental improvement versus the current processes being considered. The plutonium oxides containing both chloride and fluoride salts are in the range of approximately 750 kg. The plutonium content represents the greatest mass relative to the salt content and dominates the potential environmental impact.

The current chemical processing disposition path that has been analyzed results in the entire plutonium mass ending up in the Defense Waste Processing Facility (DWPF) High Level Waste (HLW) glass. The chloride and fluoride salts are chemically separated in the Liquid Waste process and eventually are disposed in the Saltstone Low Level Waste (LLW) disposal unit. If VSD is utilized with this chemical processing pathway, then the only difference is the removed salts being added to the current secondary TRU waste stream in HB-Line. In addition, the reduction in failed equipment due to corrosion reduces the failed equipment contribution to TRU waste.

Another pathway for plutonium disposition is dry processing with eventual disposal as TRU waste. VSD would not be implemented for this disposition path; however, this disposition path establishes the baseline TRU waste volume. Dry processing of the 750 kg plutonium oxide to a waste form acceptable as TRU waste would result in ~5000 Pipe Overpack Component (POC) TRU 55-gallon waste drums, or 1000 m^3.

If VSD is utilized to convert the non-MOXable plutonium oxide containing chloride and fluoride salt to MOXable plutonium oxide, the 1000 m^3 of TRU waste would be avoided. The removed salts would be incorporated in the current secondary TRU waste generated in HB-Line and represent a slight volume increase (<< 2 m^3 of TRU waste).

Conclusion

The application of VSD results in a slight reduction to the environmental impact of the currently analyzed chemical processing pathway for dispositioning non-MOXable plutonium. The application of VSD to convert non-MOXable plutonium oxides to MOXable plutonium oxides as feedstock for MFFF does result in a significant waste reduction and therefore environmental impact.

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