SRNL Develops Activated Complex Theory (ACT) Durability Model for Radioactive Waste Glass

Savannah River National Laboratory has developed a new glass durability model that has the potential to allow those facilities that stabilize radioactive waste as a glass form to increase the "waste loading," or the amount of waste that can be incorporated into a quantity of glass. Glass durability models predict the durability of the final glass product from the composition of the melter feed.

In 2003, SRNL undertook a research project to develop a new linear and mechanistic high level radioactive glass durability model that would minimize and, if possible eliminate the need for analyzing every melter feed batch. The resulting model, called the Activated Complex Theory (ACT) model, is based on new theories about the role of activated surface complexes on glass durability. The ACT model is simpler than existing glass durability models and will provide a higher degree of accuracy than the existing models. It is based on simple atomic ratios that express the impacts of glass composition on durability by the conservation of the law of mass action.

Because it is based on elemental ratios of well analyzed sludges and glass formers, process control may be based on the weight ratios of these components, which would eliminate costly and time-consuming analysis of individual melter feed batches. In addition, it provides the technical basis for expanding the process control window, allowing a wider range in such attributes as: waste loading; the alkali content of the glass-formers; and the composition of the radioactive waste sludge. This will allow Purex-type and/or unwashed (high alkali) waste glasses to be processed. Processing of higher alkali (unwashed sludges) and/or the use of more alkali glass formers improves both the melt rate and throughput.

Like the durability model currently implemented in the Savannah River Site's Defense Waste Processing Facility, ACT will provide predictions of any waste glasses radionuclide release. These predictions can be used in the Performance Assessments being developed for the planned federal geological repository. These Performance Assessments assume that all glasses dissolve at an accelerated rate after thousands of years and this limits the compositional range of the waste glasses that must be produced. However, ACT has the ability to predict which glasses will undergo accelerated dissolution and which will not, thus increasing the range of glass compositions that can be processed.