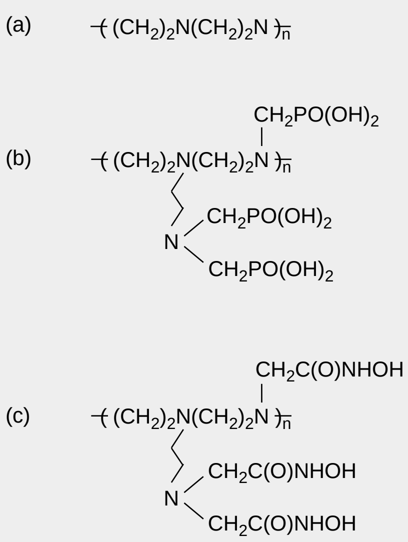

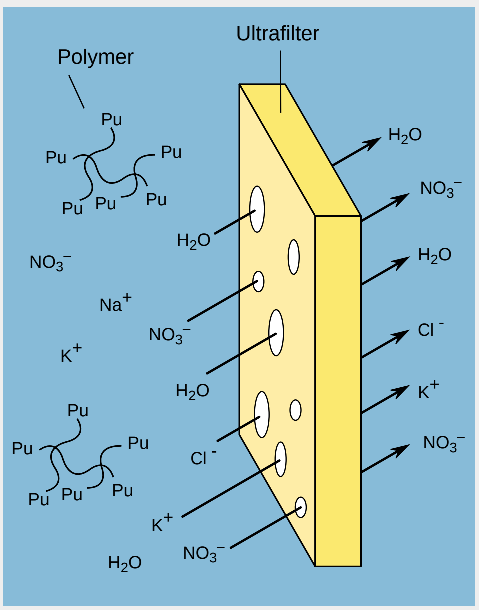

The Polymer Filtration™ process uses water-soluble polymers to separate and concentrate tiny amounts of actinides from the bulk of the solution. The structural formula of the polyethyleneimine polymer is shown in (a), while (b) and (c) show the polymer functionalized with three phosphonic acid groups and three hydroxamic acid groups, respectively. The diagram illustrates a water-soluble polymer with bound plutonium ions that is too large to pass through an ultrafiltration membrane. Water and small ions, driven by a modest pressure gradient of 10–50 psi, pass through the membrane.

Treatment of Liquid Wastes

Gordon D. Jarvinen, Geraldine M. Purdy, Barbara F. Smith, and Thomas C. Robinson

Polymer Filtration™ is a technology that can remove essentially all of the residual plutonium, americium, and other regulated metal ions from various liquid process and waste streams, including TA-55's liquid effluent.

The technology uses water-soluble polymers that selectively bind with target metal ions in aqueous solutions. Interactions between the metal ions and the binding groups on the polymer occurs homogeneously in solution. Reactions usually are faster compared to those that take place between ions and solid polymetric materials such as anion-exchange resins. In addition, water-soluble polymers can have much higher binding capacity for metal ions relative to the solid polymers because nearly all of the metal-binding groups are available in soluble polymers. (In the solid resins, some of the binding sites cannot contact the solution because they are "buried" in the solid structure.)

The water-soluble polymers have a sufficiently large molecular weight that they can be separated and concentrated from the bulk of the solution with an ultrafilter. (The ultrafiltration range is generally considered to include molecular weights from several thousand to several million daltons and particle sizes of about 2 to 1000 nanometers.) Water and the smaller unbound components of the solution pass freely through the ultrafiltration membrane (see figure). In the process, contaminants are highly concentrated in a small volume from a much larger bulk volume. The small volume of contaminiated solution containing the polymer/metal ion complexes can be solidified for disposal. Alternatively, the polymer can be recycled for further metal-ion recovery. When polymer recycle is required, the uncomplexed polymers are regenerated by changing the solution conditions to release the bound metal ions. A small volume of rinse water is used in another ultrafiltration step to recover the released metal ions in concentrated form for reuse or disposal.

In many of the liquid waste streams to be addressed, the target actinide ion is present in very low concentration relative to innocuous metal ions such as sodium, potassium, calcium, and magnesium. Phosphonic acid, acylpyrazolone, hydroxamic acid, and iminocarboxylic acid groups have a demonstrated affinity for higher-valence actinide ions relative to lower-valent metal ions. Therefore, our water-soluble polymers have employed these functional groups in our investigations. In testing to date, phosphonic acid derivatives have shown the best properties for removing plutonium and americium from process and waste solutions. The pilot-scale tests yield reductions in target metal-ion concentration of 10^4 to 10^6.

A Polymer Filtration™ unit will be installed in the new plutonium-238 Scrap Recovery glove-box line that will be operational in 2001. Demonstration runs also are underway to use Polymer Filtration™ to remove soluble actinides from aqueous chloride process streams at TA-55.

Polymer Filtration™ is a trademark of Polyionics Separation Technologies, Inc.