EXPERIENCE IN USING A TRANSPORTABLE ION EXCHANGE SYSTEM WITH RESIN SLUICING CAPABILITIES

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ABSTRACT

During the last several years, the cost of processing, transporting and disposing of radioactive wastes has risen rapidly to become a significant portion of the operating budgets of nuclear power stations. Transportable filtration ion exchange systems have helped restrain the cost of waste processing, but these systems have also been subject to increased costs. Recently a transportable system with resin sluicing capabilities has been installed and is operating at Florida Power Corporation's Crystal River Unit #3 station. The initial data indicate that savings to the station in processing their waste will be considerable.

The addition of resin sluicing capability to transportable systems adds a degree of complexity, which had to be considered in the system design and operating procedures, to ensure safety and minimize radiation exposure to operating personnel. As of February 15, 1984, the new system has processed over 400,000 gallons without problem, and operator exposure has been reduced significantly compared to the previous transportable system which used disposable vessels.

THE DEVELOPMENT OF TRANSPORTABLE SYSTEMS

Transportable ion exchange systems were originally developed to supplement or replace the waste evaporators originally installed in many power stations. Waste evaporators were typically unreliable with poor availability and required high man-rem exposures for maintenance. Transportable ion exchange offered a reliable, cost-effective alternative to evaporation/solidification.

The first-generation transportable ion exchange systems used a modified transport cask liner as an atmospheric vessel, in which the various resins were layered. These early systems suffered from occasional overflows of the contaminated wastewater and were relatively inefficient as compared to conventional ion exchange systems. Flow distribution was relatively poor, and the single vessel design resulted in disposal of significant volumes of inexhausted resins when leakage of activity was detected in the effluent. In addition, it was often difficult to load the vessels with the optimal ratio of cation to anion resin, particularly when waste stream chemistry fluctuated. As a result, one component of the resin mixture would often exhaust prematurely, and the vessel would have to be replaced despite the unused resin capacity.

Later systems using atmostpheric vessels employed more sophisticated level control systems and used two or more vessels in series. As an upstream vessel began to exhaust and leakage of radioactivity occurred, the downstream vessel would begin to load activity. In this way, resin capacity was more fully utilized and flow distribution became less critical to achieving maximum volumetric throughput. These systems, however, required relatively large amounts of floor space and specifying optimal ratios of cation to anion resin remained problematic.

Approximately five years ago, second-generation systems using disposable pressure vessels were introduced and have largely replaced atmospheric systems at power stations. These systems have provided improved flow distribution, loading of cation and anion resins in different vessels and series operation for maximum utilization of resin capacity. In addition, the potential for overflows was eliminated and much less space was required for system set-up.

Systems using disposable pressure vessels, however, have several disadvantages. The vessels are relatively expensive to dispose of and the volume of resin shipped for disposal was reduced relative to the large atmospheric vessels. Thus, a sluicable pressure vessel system, which combines the processing efficiency of pressure vessel systems with the transportation and disposal efficiency of large atmospheric vessels/liners, was developed.

COST COMPARISON

The overall cost of processing radioactive wastewater by transportable ion exchange is composed of the following cost components:

1. System rental
2. Labor
3. Resin
4. Disposal containers
5. Transportation
6. Disposal

Third-generation systems, using pressure vessels with resin sluicing capability, reduce the cost of items 4, 5, and 6; disposal containers, transportation and disposal. System rental is somewhat higher, however, due to the higher capital costs of the nondisposable ion exchange vessels and the additional controls required for sluicing operations.

Figure 1 illustrates the relative costs at a typical station for a system with resin sluicing capability versus a system using disposable vessels. As indicated in the figure, the major cost savings occur in the containers in which the exhausted resin is disposed. Expensive disposable pressure vessels are replaced with relatively inexpensive cask liners in the system with resin sluicing. The container cost, on a per cubic foot of resin basis, is reduced by 75% and overall processing costs are reduced by greater than 20%. Depending upon the distance from the disposal site and the purity of waste being processed, the savings could range from \$100,000 to \$250,000 a year.

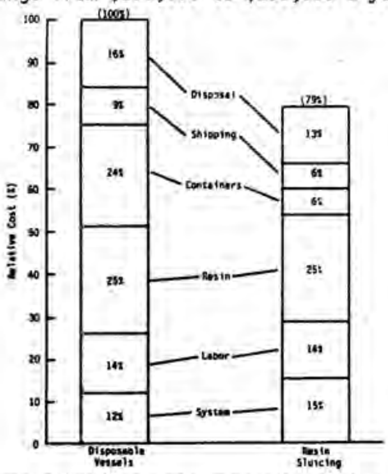

Fig. 1 Relative Cost of Processing Radwaste Water by Transportable Ion Exchange.

OPERATING EXPERIENCE

The experience of the first NUS transportable ion exchange system, installed at Florida Power Corporations' Crystal River Unit #3 has been excellent. Due to space restrictions at the power station, the configuration of the previous transportable system using disposable vessels resulted in a relatively high cost of operation. The new system with resin sluicing capability is expected to reduce overall processing costs by approximately 50%. Florida Power Corporation personnel are working with NUS to optimize the performance of the system.

In the two months since the system installation at the end of November 1983, over 400,000 gallons have been processed. Waste conductivity has ranged between 64 and 350 micromhos/cm with an average value of 140 micromhos/cm. The activity of the waste being processed has ranged between 2.6E-4 and 3.3E-2 microcuries/cc. System decontamination factors have been approximately 400 with the effluent activity typically 10^{-6} microcuries/cc to less than minimum detectable activity levels (MDA).

During this operating period, a total of 60 ft^3 of contaminated resin and filter media has been sluiced from the system. Radiation exposures to the technician have been decreased by use of the sluicable system. The technician no longer has to remove the vessels containing highly contaminated resins but remotely sluices the exhausted resins from the system. Exposure has decreased by 50% from greater than 30 millirem per week to approximately 15 millirem per week with the sluicable system. In addition, no plugging of radioactive resin or other abnormal occurrences which could result in excessive exposure have occurred during sluicing operations. This is directly attributable to the system design in which the contaminated resin is sluiced out in a dilute slurry to prevent plugging problems.

CONCLUSION

The use of resin sluicing with transportable ion exchange systems can reduce the overall cost of processing radioactive wastewater. The savings are achieved primarily by substituting cask liners for disposable pressure vessels as the disposal containers. Smaller savings are achieved in the transporation and disposal charges. Operating experience with the first transportable system in the United States with sluicing capability has proven the effectiveness of the system in decontamination performance and reducing radiation exposure to operating personnel.