LIQUID RADWASTE PROCESSING, OPERATIONAL EXPERIENCE

UTILIZING DURATEK MOBILE PROCESS SYSTEM (MPS)

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ABSTRACT

The use of Duratek's Mobile Process System (MPS) employing sluiceable pressure vessels and improved operational techniques generates operational efficiencies including volume reduction (VR), reduced personnel labor and exposure and higher flowrates for cleanup of liquid radwaste streams in an operating nuclear power plant (Salem Generating Station).

Significant additional VR is achievable based on laboratory and on-site experience utilizing Durasil™ 70. Under high conductivity, actual waste stream conditions, this proprietary media has demonstrated through-puts of a magnitude 15 times higher than organic cation resin. A long term problem, cobalt species removal, is mitigated by this media.

BACKGROUND

Public Service Electric and Gas' Salem Nuclear Generating Station consists of twin 1100 MW PWR Westinghouse units. The liquid radwaste system collects liquids from floor drains, sample points, laundries, labs, primary and auxiliary equipment drains, containment and other miscellaneous source points.

The two primary sources of water are the DI Water and Service Water. Quality of the two supplies varies greatly. The Service Water is mechanically filtered brackish Delaware Bay water with high sodium and conductivity characteristics. The DI Water is high quality, demineralized water.

The waste collection system provides minimal opportunities for segregation of water incursions based on water quality. The resulting high conductivity water tempers the usual high efficiency of demineralization with ordinary organic exchangers.

The previous liquid radwaste treatment system was a single pass, 110 cubic foot atmospheric liner without mechanical or carbon filtration. Process rate ranged from 10-15 GPM.

SYSTEM DESCRIPTION

In May 1984, Duratek was chosen to provide a full service contract for cradle to grave treatment of the liquid radwaste stream at Salem. The contract called for provision of the processing system, shielding, resins, filters, HICs, transport cask and personnel. Duratek's Mobile Process System (MPS) was installed and commenced operations on July 1, 1984.

Duratek's Mobile Process System consists of a booster pump, and a mechanical filtration unit followed by five processing vessels containing various filtration and exchange medias. Piping, valving and instrumentation to monitor processing and control vessel logic are mounted on the linear, 2" steel clad, lead shielding surrounding the tank farm. The modular shielding is designed for an adaptive, custom installation.

Manual and fail-safe valving controls sluicing of depleted media to volumetrically efficient steel liners or High Integrity Containers (HICs) for dewatering and disposal. System design basis was concerned with volume reduction, improved resin utilization and ALARA.

Increased Media Through-put

Volume reduction, a direct function of media through-put, is attained in the Duratek MPS by aggressive prefiltration, both mechanical and carbon, cascade logic and resin deployment based on nuclide content of the waste stream.

Removal of bed fouling suspended solids is achieved with a mechanical filter using a single 5 micron, inside loading, pleated paper, element. The large filtration area of this type filter, combined with excellent water quality due to a comprehensive sludge control program administered by PSE&G, has allowed a through-put of greater than 350K gallons per element.

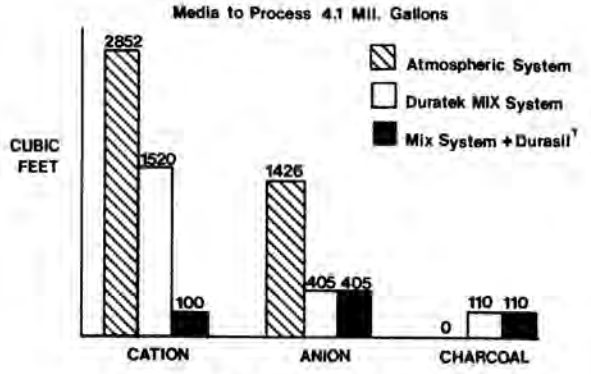
Organics, including oils, are removed by the activated carbon bed in the first pressure vessel. To prevent early bed masking, useful life is extended by selection of a relatively large mesh (20-40) activated carbon.

Since most filtration takes place in the top 6-8" of the carbon bed, additional through-put is obtained by "layering". Layering is achieved by processing an arbitrary volume of water before loading additional carbon layers. The several filtration zones established increases both filtration and through-put for each vessel loading. Depending on water quality, pressure vessel systems routinely achieve through-puts of 5-10K gal/C.F. The MPS, at PSE&G, has averaged 32K gal/C.F. of activated carbon.

To fully utilize exchange sites (10-30% of total) remaining after initial isotopic breakthrough, ion exchange vessels are placed in a cascade logic with the exhausted bed being followed by a freshly charged vessel. Table I illustrates the resulting reduction of depleted media needed to process a yearly volume of 4.1 million gallons.

TABLE I

Media Depletion



1 Projections based on on-site testing.

Additionally, this cascade logic provides protection of downstream beds against fouling and masking. Through a 54 vessel loading history, no bed has been removed as a result of a pressure drop.

To assure flow contact with all resin media, each bed is air sparged as it approaches depletion. The criteria used to determine need for sparging is two consecutive DFs of less than 1. This fluffing should only be done for a newly depleted bed. Older beds should not be disturbed to prevent dislocation of filtered material.

The Salem station has experienced an excellent fuel integrity history. The resulting lack of iodine concentrations allows limited use of anion resin except for removal of CrO^4 whose effluent is subject to the MDA limit of less than 0.22 PPM. Approximately 23% of the water volume requires anion treatment.

Historic organic anion to cation depletion ratio at this facility had been 1:1.5 prior to introduction of the MPS. Judicious anion usuage, possible with individually selectable pressure vessels, has improved system through-put for anion resin from 2700 gal/C.F. to 10,124 gal/C.F. The resulting 1:3.75 depletion ratio generates a 75% reduction in anion depletion.

Volume Reduction

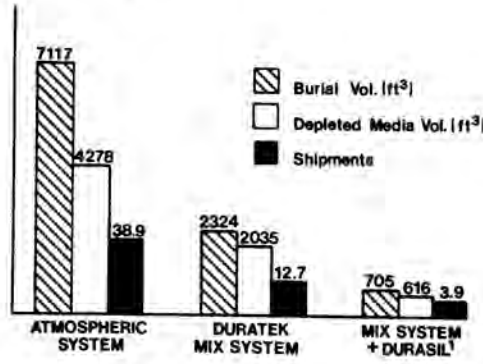
Volume projections shown in Table I and Table II are based on actual 1982 media utilization rates for an atmospheric system and actual results for The MPS +Durasil™70 data is based on laboratory and on-site testing. Water quality is assumed to be similar for all processing periods, though some degradation may have occurred due to plant age and additional maintenance.

For comparative purposes, burial is assumed to be in a HIC with internal/burial volume of 160/183 C.F., respectively.

The resulting VR with organic exchangers and filter media is shown in Table II. On a yearly basis, this represents a total materials savings for all media types of 2243 C.F. or (2035/4278) 52.4%. The resultant VR for burial (7119/2324) is 3.06. Total systems VR is represented in Table III.

TABLE II

System Comparison



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Higher Processing Rates

Excellent flow characteristic of a pressure vessel system vs. atmospheric liners allows processing rates up to 50 GPM. This equates to 1.66 gallon per cubic foot of media, well below the 2-3 gallons per cubic foot of media recommended for proper residence time.

Proper media retention element design enhances uniform flow characteristic throughout a wide flow-rate range. Problems of peaking and leakage associated with the inverted cone flow profile of larger process vessels is avoided. The resulting increased dynamic water/exchanger contact provides improved exchanger utilization. Additionally, increased flowrates enhances response time to water inventory build-up.

Labor/Exposure Reduction

The higher processing rate and reduced media volume available with a pressurized, sluiceable system generates significant savings in both labor and the total man-rem incurred in treatment of the liquid radwaste.

Assuming an 8 hour processing period, the MPS system, at its actual flowrate of 47 GPM, will process 22,560 gallons. The previous atmospheric system could process 7,200 gallons at 15 GPM during the same time period. Effectively, a single operator is able to process water equivalent to the

output of three operators with the slower atomospheric system.

Actual plant experience verifies this. A single operator, assigned to liquid radwaste treatment, has replaced what was a 2-4 man effort.

On a yearly basis, the projected labor savings and companion exposure reduction resulting from high flowrates and greater system VRs are graphically illustrated in Table III.

TABLE III

Operational Comparisons

	Atmos. System	Duratek MPS	MPS + Durasil™ 70
Total System VR*	76.8	235.2	775.4
Operator Man-Yrs.	3.0	1.2	1.0
Support Man-Yrs.	2.0	1.0	.5
Man-Rem	7.2	3.1	2.5

* Note: System VR is based on 4.1 million gallons (546,667 C.F.) being zero VR.

PROCESSING WITH DURASIL™

The Engineering Group performed an exhaustive safety evalution of the Durasil™ 70 material including toxicity, radiological stability, gas generation, flammability, explosivity, handling procedures, processing techniques, dewatering and burial acceptability. A post introduction tracking/evaluation program was also established.

The burial of a limited quantity of test materials took place February 25th. Durasil™ will be utilized in processing of liquid wastes in the future.

Projections, based on on-site and laboratory testing, indicates a potential through-put improvement with Durasil™ 70 of a magnitude of 15 over cation exchangers contained in an atmospheric liner. Burial VR factor, for the MPS and MPS +Durasil™ 70 System, compared to the atmospheric system, is 3 and 10, respectively. Since anion and charcoal use remains constant, the final VR of 10 for the MPS +Durasil™ 70 is somewhat less than the through-put gain of 15.

Some exposure reduction is expected with the use of Durasil™. Though the Durasil™ 70 media attains a higher rad level (1-10R) than organic resin because of increased through-put, system shielding and design, together with a numerical reuction of HICs and shipments to be handled, should mitigate resultant exposure.

Since an operator assignment of less than 1 is not possible, labor savings generated by Durasil™ use will accumulate from clerical, security and Rad Protection manpower saved due to fewer vessel movements, cask loadings and shipments.

Higher quality effluent may also be expected due to improved cobalt removal with Durasil 70 in the high sodium, high conductivity environment encountered in the Salem liquid radwaste stream.