PERFORMANCE OF DURASIL™ 70 MEDIA

SALEM NUCLEAR GENERATING STATION

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ABSTRACT

The use of Duratek's EVR™ (Enhanced Volume Reduction) Demineralization System employing sluiceable pressure vessels and improved operational techniques has generated operational efficiencies including volume reduction (VR), reduced personnel labor and exposure, higher flowrates and improved decontamination factors (DF) for cleanup of liquid radwaste streams at the Salem Nuclear Generating Station.

Further significant VR improvements have been achieved utilizing Duratek's Durasil™ D-70 process media. This proprietary media has demonstrated the ability to process the high conductivity wastestreams found at the Salem facility. Earlier lab and on-site testing projections of throughputs of a magnitude 15 times higher than organic resin have been confirmed. A long-term problem, cobalt species removal in a high sodium environment, has been 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 miscellanous source points.

The two primary sources of water are 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 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 which operated in the 10-15 GPM range. This was replaced by a pressure vessel system initially using organic resin with the subsequent introduction of the Durasil™ media in March 1985.

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 Enhanced Volume Reduction System (EVR™) was installed and commenced operations on July 1, 1984.

Duratek's EVR™ system consists of a booster pump, and a mechanical filtration unit followed by five processing vessels containing various filtration and exchange media. 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 depeleted 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.

The operating logics for use with organic resins and Durasil™ media are shown in Fig. 1 and 2.

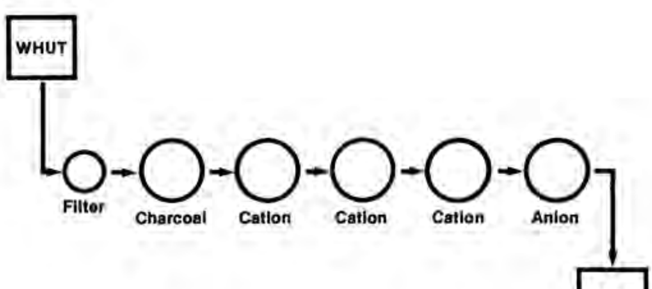

Fig. 1 Organic Logic

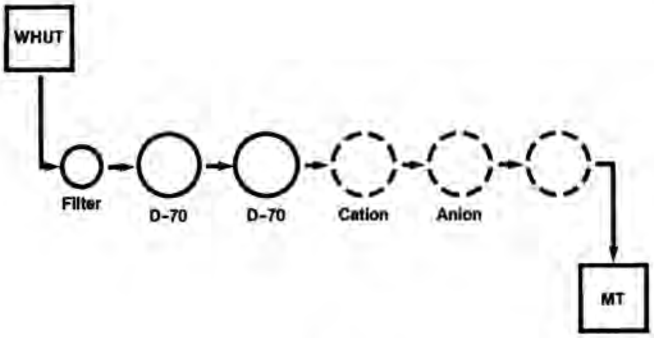

Fig 2. Durasil™ Media Logic

INCREASED MEDIA THROUGHPUT

Volume reduction, a direct function of media throughput, is attained in the Duratek EVR™ system by aggressive prefiltration, both mechanical and carbon, cascade logic and resin deployment based on nuclide content of the wastestream.

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 throughput of greater than 350K gallons per element.

During the period when organic resins were used, organics, including oils, were removed by the activated carbon bed in the first pressure vessel. To prevent early bed masking, useful life was extended by selection of a relatively large mesh (20-40) activated carbon.

The introduction of the carbon-based Durasil™ D-70 media has entirely eliminated the need for activated carbon as a filtration/oil absorbant since the depleted D-70, as it is moved forward in the process logic, serves this purpose. The media has shown no tendency to slough-off or leach activity from the depleted media when it is advanced in the logic chain.

To fully utilize exchange site (10-30% of total) remaining after initial isotopic breakthru, ion exchange vessels are placed in a cascade logic with the exhausted bed being followed by a freshly-charged vessel.

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 which is subject to the MDA limit of less than 0.22 PPM. Approximately 23% of the water volume require anion treatment.

DURASIL™ INTRODUCTION

Durasil™ D-70 was certified for use at the Salem facility after an exhaustive safety evaluation by the Engineering Group. Specific characteristics of interest were toxicity, radiological stability, gas generation, flammability, explosivity, stability, handling procedures, processing techniques, dewatering and burial acceptability. In all cases, the media was found to meet or exceed the applicable requirements or regulations.

Introduction of the D-70 media occurred in March 1985. A program was instituted to characterize the radwaste stream for tracking of chemistry variables and their effect on throughputs. To date, no waste-stream constituent has any apparent effect on the DF or total throughput of the Durasil™ media.

Since this was the first use of this media at the Salem site, a stepped conversion program was followed. Vessels loaded with organic resin were available if needed for supplementary processing.

DURASIL™ PROCESSING CONSIDERATIONS

Mechanical prefiltration of the radwaste stream is important for efficient use of the D-70 product. Because of the long vessel run times, even minor particulate levels in the wastestream can accumulate causing observable pressure drops across the lead bed. The previously mentioned cascade logic provides protection for downstream beds against fouling and masking.

To assure flow contact with all media, this media, like organic resins, benefits from occasional air spargings. Care should be exercised to avoid sparging of the lead vessel to preclude dislodging of accumulated particulate matter. No significant activity pertubations of the vessels effluent have been detected as a result of this sparging procedure.

Single vessels of cation and anion resin have been retained for specialized processing. Since the D-70 media is designed principally for cobalt removal, organic cation resin is employed for cesium removal. The presence of cesium is an indicator of primary water input. This water has a relatively low conductivity and can be segregated, making organic resin usage feasible. Review and introduction of a cesium specific Durasil™ product is planned for the future. Anion resin is used on a demand basis for chromate removal.

VOLUME REDUCTION

The improvements in throughputs are shown in Fig. 3. Figures 4-6 give the details of material usage based on a normalized annual flow of 4.1 million gallons.

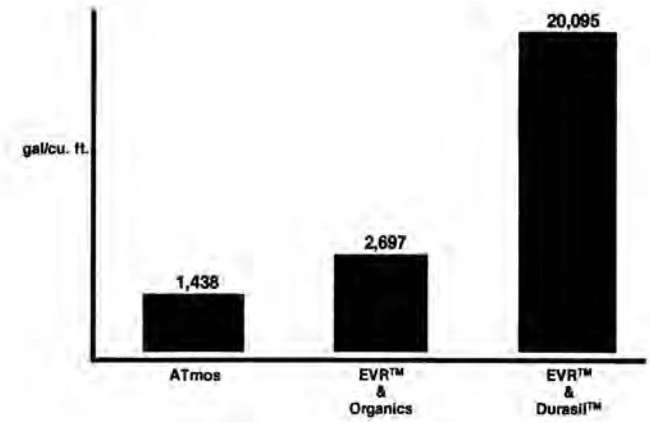

Fig. 3 Average Throughput

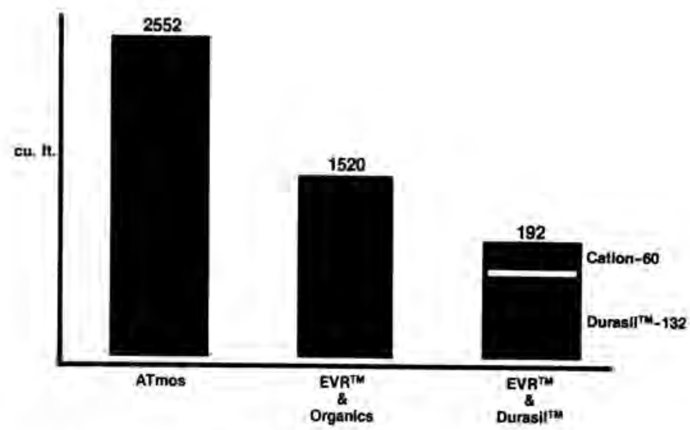

Fig. 4 Cation Use

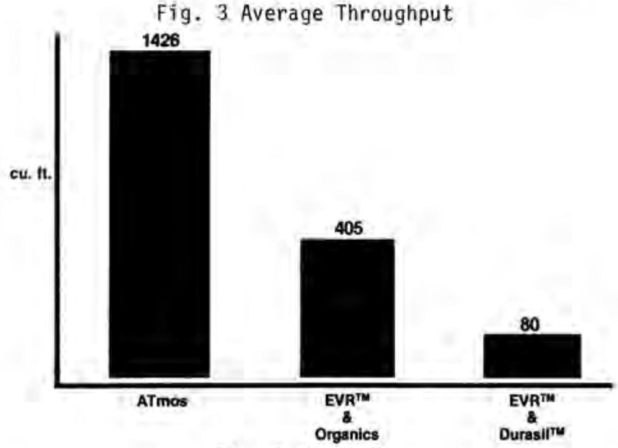

Fig. 5 Anion Use

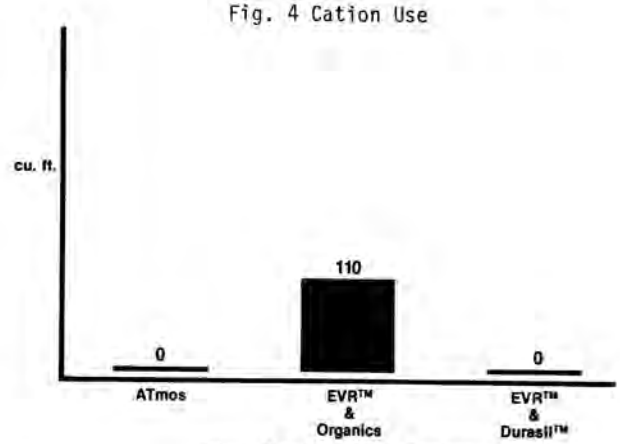

Fig. 6 Activated Carbon

The three bars represent first, the atmospheric system, second, the EVR™ system using organic resin, and third, the EVR™ system using Durasil™ media. Water quality is assumed to be similar for all processing periods.

Burial volumes and annual shipments, based on use of a HIC with internal/burial volume of 160/183 cubic feet, respectively, are compared in Figs. 7 & 8.

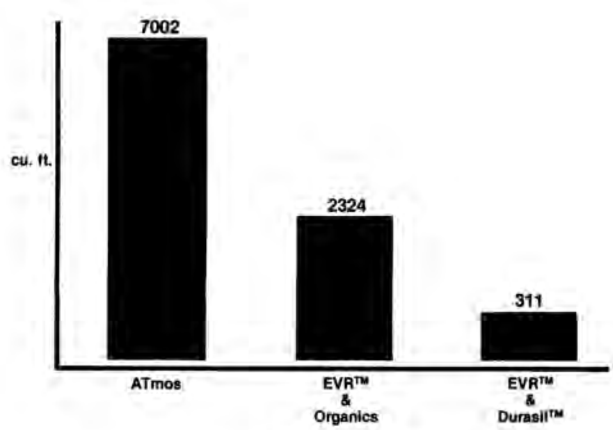

Fig. 7 Burial Volume

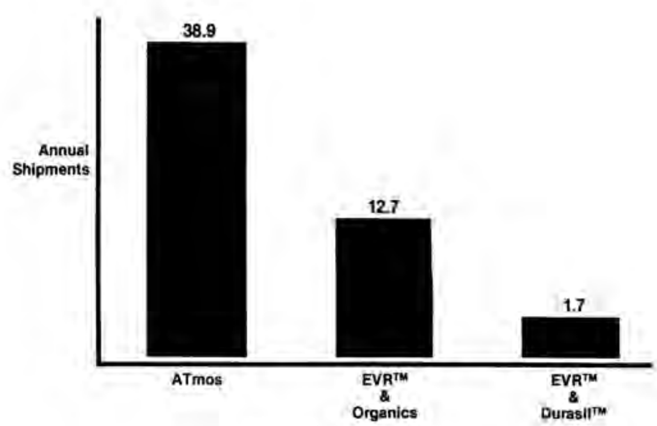

Fig. 8 Shipments

It is readily apparent from the figures that the EVR™ and Durasil™ combination results in substantial reductions (a factor 22.5) in material usage and burial volume over the atmospheric system. Total system VRs are compared in Table I.

TABLE I

Comparative Support and Exposure

	Atoms. System	EVR™ Organics	EVR™ Durasil™
Total System VR*	76.8	235.2	1,758
Operator Man-Yrs.	3.0	1.2	1.0
Support Man-Yrs.	2.0	1.0	0.5
Man-Rem	7.2	3.1	2.5

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

HIGHER PROCESSING RATES

The excellent flow characteristics of a pressure vessel system vs. atmospheric liners allow 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 characteristics throughout a wide flowrate 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 enhance response time to water inventory buildup.

LABOR/EXPOSURE REDUCTION

The higher processing rate and reduced media volumes achievable 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 EVR™ 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 atmospheric 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 I.

Some exposure reduction has been experienced with the use of Durasil™ media. Though the Durasil™ 70 media attains a higher rad level (1-10 R) than organic resin, system shielding and design, together with a numerical reduction of HICs and shipments to be handled has reduced exposure for both site and contractor personnel as shown in Table I. Manpower requirements are also cut substantially.

COBALT RELEASE

The performance of the Durasil™ media for Co removal is compared with that of organic resins in Table II. As can be seen in Table II, the Co release is decreased by a factor 5 for Co-60 and 13 for Co-58. All DFs are computed for media in the EVR™ system.

TABLE II

Co Release

	Durasil 70	Organic Resin
Conductivity	1626	787
Ave DF Co-60	42	8
Ave DF Co-58	78	6

SUMMARY

The introduction of a sluiceable pressure vessel system and use of Durasil™ media for processing of the liquid radwaste stream at Public Service Electric and Gas' Salem Nuclear Generating Station has resulted in significant reductions of burial volume, shipments and labor input while improving cobalt removal and the quality of the system effluent.