FROM EVAPORATORS TO ION EXCHANGE: EXPERIENCE AT FOUR PWRS

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ABSTRACT

The use of evaporators to process PWR radwaste water is wide spread. Recent technical as well as economic forces have driven a growing number of utilities to consider switching to ion exchange. This paper summarizes the experience of four PWRs that made the switch from evaporators to sluicable demineralization systems for low-level radwaste water treatment. In addition to increasing water processing rates and eliminating overall down-time due to evaporator maintenance, the demin system reduced personnel exposure by 80-93% and reduced total burial volume by 75-95%. Cost reductions directly attributable to the switchover ranged from 33 to 77% of evaporator processing costs.

PLANT AND EVAPORATOR PERFORMANCE

Plant A has two reactors with a total generating capacity of just over 2000 MW(e). The two units went commercial in the 1975 to 1980 period. During the year immediately prior to the switchover the plants processed, by evaporation, a total of 2 millon gallons of low-level waste water. Evaporator bottoms were cement solidified requiring 51 liners with a total burial volume of 8670 cu. ft. The plant reported that the evaporation effort alone required one full time operator with an additional full time technician for maintenance and support.

Plant B is a single unit with a generating capacity of about 500 MW(e). This unit went on-line in the early 1970's and produced about 4000 cu. ft. of solidified evaporator bottoms during the outage year just prior to conversion to ion-exchange. Although demin processing initiated at the tail end of the 1987 outage the plant stored 90% of the total outage water in anticipation of more efficient processing by ion-exchange. Due to the lower waste water volume, this plant's evaporator manpower requirements were about one-half of Plant A's.

With a total generating capacity of about 700 MW(e) Plant C went commercial in the early 1970's and processed 2.1 millon gallons of waste water during the last year of evaporator use. Bottoms were cement solidified in 80 cu. ft. liners. The total number of liners generated was 100. This particular evaporator had an average processing rate of 6-7 gallons per minute. The very large water volume and low processing rate required around-the-clock manpower for both operation and support. These factors explain the high exposure experienced by evaporator operators and maintenance support personnel. A total exposure of 20 man-Rem was recorded for this plant's last year of evaporator operation.

The single reactor unit at Plant D has a generating capacity of a little over 800 MW(e). This plant went commercial in the early 1970's. Just prior to switching to ion-exchange the plant processed 1.6 millon gallons in a year and generated 14,000 gallons of evaporator concentrates. That year's burial volume totaled 3400 cu. ft. The processing rate was limited to a maximum of 4 gpm. Personnel exposure was 7.5 man-Rem.

ION-EXCHANGE SYSTEM PERFORMANCE

During 1986 we replaced the evaporator operation at Plants A and D. The following year demin systems were installed in the remaining two plants. Plant engineering support was made prior to equipment arrival. Actual installation of the system in the plants required support from plant maintenance, security, health physics and radwaste personnel. At those plants where the support was immediately available, installation time totaled one and one-half days. At each plant a shielded and portable 5-vessel ion-exchange system was installed. The sluicable system processes waste water at a rate of 50 gallons per minute using either commercially available conventional ion-exchange resins or proprietary ion-selective media.

Because the demin system has no moving parts, it is essentially a passive system requiring no maintenance and subsequently has no down-time. It operates with a single technician on-call 24 hours a day. Due to the higher processing rates processing frequently requires much less than 40 hours per week. This substantial reduction in manpower is not reflected in plant data (including cost reduction) since the demin system has, by plant policy, been used to free the evaporator operator and maintenance personnel for other tasks rather than to replace them.

In addition to faster processing times and a lower manpower requirement, the system substantially reduced personnel exposure, total burial volume, and dramatically cut waste water processing costs at each plant. The following tables summarize these results for each plant. For comparative purposes the personnel exposure data has been normalized to 1 millon gallons.

SUMMARY

Based only on minimizing personnel exposure the ALARA consideration and maximizing volume reduction, the switch to ion-exchange for these four power plants was well justified (Table I-II). Although the U. S. NRC emphasizes volume reduction, regulation does not yet require

it. The real driving force for demin substitution of evaporator processing is illustrated in Table III. Substantial cost reduction for rad-waste processing is a major pay-off of the switchover.

TABLE I

Personnel Exposure.

PLANT	Man-rem to Process 1 Million Gallons Evaporator	Demin	% Reduction
A	> 7.3	0.8	89%
B	no data	1.3	—
C	7.5	0.5	93%
D	6.2	1.2	80%

TABLE II

Volume Reduction.

PLANT	Solidified Evaporator Bottoms Cu. Ft.	Demin Media Cu. Ft.	Burial Volume % Reduction[1]
A	8670	461	95%
B	4000	41	96%
C	8000	215	97%
D	3400	162	94%

(1) Calculation based on number of HICs.

TABLE III

Processing Costs.

PLANT	% Cost Reduction[2]
A	77%
B	33%
C	70%
D	44%

(2) Calculations based on costs for solidification, transportation and burial.