SOLIDIFICATION OF

CHEMICAL DECONTAMINATION RESIN

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ABSTRACT

The chemical decontamination of Boiling Water (BWR) recirculation piping and Pressurized Water Reactor (PWR) steam generator channel heads involves the use of various proprietary chemical solutions. These chemicals must be evaluated in accordance with waste disposal site licenses and regulatory criteria regarding the disposal of chemicals and chelating agents. The chemicals are commonly adsorbed on bead resins and the existing criteria for resin processing are identified and discussed. Solidification of resins is the processing method recommended to meet burial site criteria and allow expeditious processing.

INTRODUCTION

Over the past few years several methods and associated systems have been perfected and used for the decontamination of PWR steam generator channel heads and BWR recirculation piping. A method which can be used for both channel head and recirculation piping is chemical decontamination. Basically, chemical decontamination is performed by pumping dilute chemical solutions through the components to be decontaminated. Reducing, oxidizing and flushing solutions are used in various sequences and at various concentrations to achieve the desired results. The sequences and concentrations are customized to meet the goals of the particular decontamination effort, taking into consideration, among other things, coupon test results, outage schedules, potential decontamination factors and regulatory approvals. Figure 1 shows a typical chemical decontamination system flow diagram.

One apparently common feature of chemical decontamination systems (e.g., Westinghouse, London Nuclear) is the use of bead resin beds to collect the removed radioactive species and to remove the chemicals used for the decontamination process. In this way, the system waste volumes are minimized and the large volumes of water required for making the solutions are returned to the plant as clean water.

Resins are selected to be specific for the process being conducted. For example, during the radioactivity removal cycle, a resin that cleans the chemical solution of the removed radioactive particles only is used, which allows the solution to pass through the bed essentially undiluted. Because different, specific resins must be used during various parts of the process, resin beds must either be emptied and replenished with different resins, or several separate resin beds must be used. In either case, the resins are

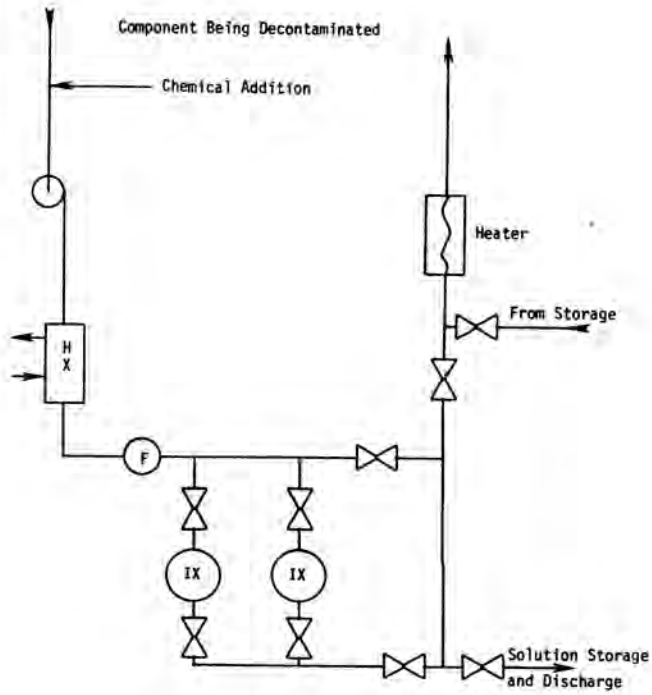

Fig. 1. Typical Chemical Decontamination System

discharged as radioactive waste, and they must be processed to allow disposal as such. Resin transfer can be done by slurrying the bed to a disposable liner. Figures 2 and 3 show typical flow diagrams for transferring resins. The liner type to be used is dependent upon the type of process to be used to place the resins in an acceptable form for burial. Westinghouse Hittman Nuclear Incor-

porated (Hittman) has used it's standard HN-100 and HN-200 steel solidification liners for this purpose in the past.

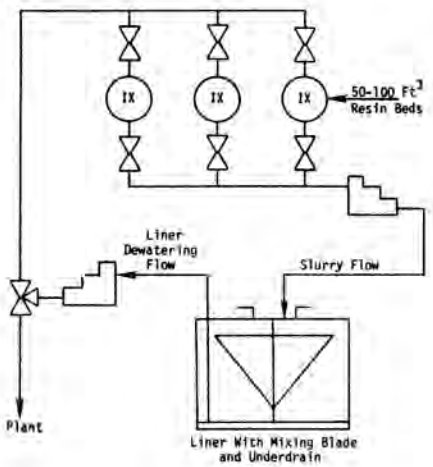

Fig. 2. Flow Diagram for Discharging Resin Beds at End of Decontamination

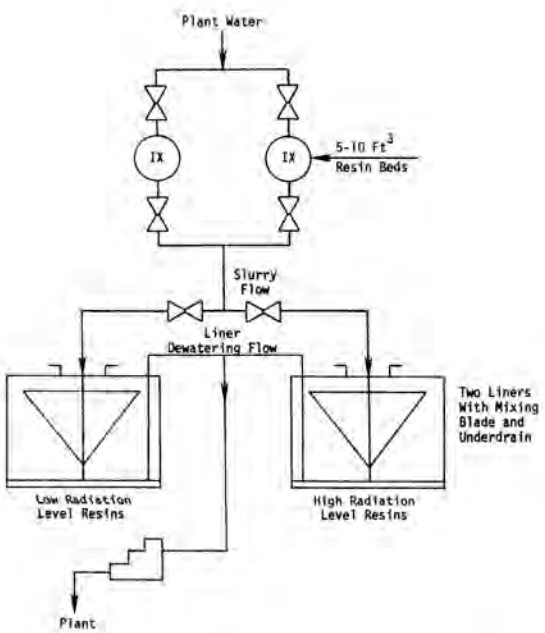

Fig. 3. Flow Diagram for Discharging Resin Beds After Single Decontamination Cycle

One type of resin will contain most of the activity removed in the decontamination process, while the other resins will contain the chemicals and a small amount of activity. The amount of resins generated is directly proportional to the "strengths" (i.e., concentrations) number of passes made and volumes of the chemical solutions.[1] Since the component to be decontaminated must be completely filled to reach all of the surfaces, the solution volumes required are fixed for the given component.

PROCESSING RESINS FOR DISPOSAL

The bead resins generated in the decontamination process will contain chemicals that are fairly common (e.g., EDTA, citric acid, potassium permanganate), but the exact formulas used are proprietary to the vendor providing the decontamination services. The amount of chemicals used, and therefore potentially retained on a particular resin bed, is usually several hundred pounds per solution.

Because of the large amounts and different types of chemicals used, the disposal of these resins presents two unique problems. First, if the chemicals used are hazardous or toxic, an evaluation must be performed to show that the wastes are acceptable at the disposal site. Second, if any of the chemicals are chelating agents, the processing method must place these agents in a form that meets specific burial site license and regulatory restrictions.

Chemical Hazards

The three operating U.S. waste burial site licenses contain similar restrictions on chemicals disposal as follows:

- Richland, WA - State of Washington license number WN-1019-2 amendment number 16, Condition 22: Restriction on, "toxic chemicals (including pathogenic or infectious materials)".
- Barnwell, SC - State of South Carolina lincese number 097, amendment number 36, Condition 48: Restriction on, "toxic chemicals".
- Beatty, NV - State of Nevada license number 13-11-0043-02, Condition 15: Restriction on, "waste having hazardous properties".

The restriction in each license requires that an evaluation be performed to determine whether:

- Richland, WA - Condition 22: "The chemical hazard exceeds the radiological hazard".
- Barnwell, SC - Condition 48: "The chemical hazard exceeds the radiological hazard".
- Beatty, NV - Condition 15: "Safe long term burial can be effected".

The burden is upon the generator to provide evaluation information, and upon the burial site licensee to make the specific determinations and

maintain records. If the radiological hazard does not outweigh the chemical hazard, specific regulatory approval is required for disposal.

Although there are no specific evaluation guidelines in the licenses or site operating manuals, a good starting point in an evaluation is to determine if the chemicals are regulated wastes under the U. S. Environmental Protection Agency (EPA) administered Resource Conservation and Recovery Act (RCRA) regulations in 40 CFR 260-265 and 122-124.

These regulations require that the generators of chemical wastes determine if the waste is hazardous according to five criteria:

- o Ignitability (by test)
- o Corrosivity (by test)
- o Reactivity (by test)
- o E.P. Toxicity (by test)
- o Specific listing of the chemical in one of several classification tables (generally, the listed chemicals are toxic).

For the Richland, WA and Barnwell, SC burial sites it appears that toxicity criteria only would apply, while for the Beatty, NV burial site all of the criteria would apply.

Once a determination has been made that the chemical is an RCRA hazardous (i.e., toxic) waste, the determination or evaluation required by the regulations can be performed. The radiological hazards are generally well known, e.g., Maximum Permissable Concentrations (MPC's) in 10 CFR 20 Appendix B, Exempt Amounts of Activity in 10 CFR 20 Appendix C, and radiation exposure rate information can be used in the determination.

The chemical hazards are usually less well known and reference sources such as the Merck Index can be used to obtain information. Also the EPA can be contacted for assistance.

If the chemical waste is not an RCRA hazardous (i.e., toxic) waste, it can be assumed that the waste would not be regulated for disposal but for the radioactivity and no information need be supplied to the burial site licensee.

Chelating Agents

Wastes containing more than 0.1% by weight chelating agents must be identified in accordance with 10 CFR 20.311(b), and the weight percentage must be estimated. In addition, each burial site license contains specific requirements for the disposal of these wastes as follows:

- o Richland, WA - Condition 34: If these agents are greater than 1% by package volume the wastes must be segregated and isolated from other wastes with ten feet of soil.
- o Barnwell, SC - Condition 46: If these agents are greater than 8% by weight they may not be received. Wastes between 0.1% and 8% must be solidified in an approved media (e.g., cement) and segregated from Class B and C wastes by ten feet. (Note: weight percents must be based on pre-solidification concentrations).
- o Beatty, NV - Condition 24-1.f: Weight percent of agent must be specified excluding packaging weight.

  Condition 24-11: Wastes containing more than 1% by weight chelating agent must be segregated from all wastes by ten feet of dirt.

The waste generator must have enough information from the decontamination vendor to determine which resins may be subject to these restrictions. The segregation criteria could increase total burial costs for the waste.

Processing Methods

Except for the Beatty, NV site, bead resins are acceptable when fully dewatered (essentially no free water) and if the long lived activity (half-life greater than five years) concentration is less than one microcurie/cc. The Beatty disposal site license, number 13-11-043-02, amendment 7, condition 24.7f requires that all resins be solidified.

Otherwise, resins must be solidified with an approved media or placed in a high integrity container (HIC) and dewatered. Note that the Barnwell, SC burial site license requires chelating agent containing waste to be solidified which would obviate the need for a HIC. Also note that the Barnwell, SC and Richland, WA burial sites only accept HIC's approved by the respective state licensing authorities. High integrity containers are usually temperature restricted so that resin slurried into them for dewatering must be below the limiting temperature. An additional concern for HIC's is that no incompatible chemicals can be put into the container, so a verification of chemical contents and restrictions must be made for a particular HIC.

Because of the various operational restrictions for HIC's, it is probably more efficient to dewater or solidify these bead resins in steel liners.

10 CFR 61 Considerations

The contamination on steam generator channel heads and BWR recirculation piping is mostly Co-60 and Co-58. All wastes will generally be Class A in accordance with 10 CFR 61.55(a)(4).

Therefore, according to these regulations, the wastes need only meet the 10 CFR 61.56(a) requirements and need not be "stabilized". One of the 10 CFR 61.56(a) requirements, (a)(8), is that non-radiological hazardous material be treated to reduce the hazard to the maximum extent practicable. Again, RCRA hazardous waste chemicals must be considered and evaluated.

The Barnwell, SC burial site license, number 097, amendment 38, condition 33 requires that waste having an activity concentration greater than one microcurie/cc of isotopes with half lives greater than five years meet the Class B and Class C stability criteria implemented by 10 CFR 61.56(b) and defined in the U.S. Nuclear Regulatory Commission (NRC) Technical Position on Waste Form, May 1983. Process control plans for solidification in this

case must be capable of meeting this criteria for these higher activity wastes.

The Case for Solidification

Based on the foregoing requirements, it can be seen that solidification of chemical decontamination bead resins offers several advantages that should be considered when planning for a decontamination:

- Solidification allows the widest choice of burial sites, since it provides a universally acceptable product.
- Solidification allows a wide selection of disposable steel liners which allow the transfer of thermally hot waste.
- Solidification reduces the concentration of activity in the liner and also reduces radiation exposure rates associated with the transportation and disposal of the resins.
- Solidification obviates the need for HIC's and eliminates questions of chemical or thermal incompatibility.
- Solidification probably would reduce the hazards which may exist for chemical hazardous or toxic waste.

Since the decontamination and subsequent waste processing are done during an extended plant outage, the following should also make solidification attractive:

- Solidification will eliminate the possibility of a HIC dewatering failure due to changes in waste composition, which may impact on schedules and ultimate costs since reprocessing might be necessary.
- Dewatering bead resins to meet burial criteria (essentially no free water) is a time consuming process, generally taking from 12-24 hours after resin transfer. Solidification can be accomplished in about four hours or less.

CONCLUSION

An important part of planning for chemical decontamination is the waste processing and disposal aspects of the campaign. This pre-planning should include the chemical characteristics of the various decontamination solutions and a review of burial site and regulatory requirements. Solidification of waste bead resins is recommended to allow the widest choice of burial sites and to expedite processing so that the total decontamination may be carried out in a timely manner.

REFERENCES

[1] R. DiSALVO, "Steam Generator Decontamination Waste: Factors Affecting Process System Selection", ANS Transactions 44, p. 159, San Francisco, CA (1983).