EXPERIENCE IN WASTE DRYING

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ABSTRACT

Ion exchange resins, filter media and sludges are currently either dewatered or solidified for stabilization, prior to disposal at a low level waste facility. Nuclear Packaging developed the Resin Drying System and placed it into commercial service to provide a system which meets the regulatory requirements for free standing water with a relatively short process duration, requiring no chemical or material addition and utilizing more volume efficient containers than were previously available.

The Resin Drying System has proven to be a very cost effective, efficient and secure means of processing low level radioactive waste for many utilities in the United States.

INTRODUCTION

Since the state of South Carolina first imposed restrictions on liquids being buried, there has been a progression of methodologies for maximizing the volume of waste disposed and minimizing it's free liquid content. These systems have ranged from solidification systems, to dewatering systems to the present day drying system which allows high volume utilization as well as meeting the ever more restrictive liquid minimization criteria.

One such system is the Nuclear Packaging drying system. Since its origin over two years ago, this system has been demonstrated to sharply reduce personnel exposure, to be highly reliable, and to be adaptable to many different types of waste.

Presently, there are some eleven units at various plants processing over 2000 cubic feet of waste a month. These units are processing bead resin, glass based resin, powdered resin, activated carbon, and sludges such as tank bottoms and zeolites. These systems are unique in that they allow the waste material to be qualified prior to processing and to be processed in very short time frames to a verifiable end point with semi-remote equipment. This minimizes personnel exposure and still allows the waste to be processed without incident or uncertainty of ever having exceeded the allowable free liquid levels. In fact, the systems have proven so effective that less than one half the regulatory levels of allowable liquid can be guaranteed.

The efficiency of this process, for which patent protection is being sought, is demonstrated in the very short process time and the container filling efficiencies obtained with the system. For most wastes, the total process can be accomplished in one shift or less. Additionally, the process allows more than the burial volume of the container of waste, as measured by the plant, to be disposed of in the container.

This paper describes the experience of the operation of these systems over the past two years in over 12 different plants.

SYSTEM DESCRIPTION

The NuPac Resin Drying System is a portable or permanent in-plant system containing all necessary equipment and controls for free water removal from ion-exchange resin and filter media. It consists of a dewatering fillhead, piping skid, blower skid, chiller and control system. Figure 1 illustrates a typical equipment arrangement. Components are skid mounted allowing flexibility for locating the equipment in the radwaste processing area.

The container is filled through valve WS-1, allowing control of waste flow into the container from the Resin Drying System control panel. A flow diagram has been included as Fig. 2 for reference. The dewater pump is cycled on and off to maintain the proper water level in the container during the filling operation. In the case of powdered resin, the valve to each individual filter bank is opened as that level is covered. Once the container has been filled, the waste transfer lines are flushed and the dewatering cycle is intiated.

The dewatering cycle consists of removing the bulk water from the resin bed using the dewater pump. The dewater pump is run until suction is lost at the outlet distributor in the case of bead resin. With powdered resin, the filter banks are isolated individually as suction is lost, from the top down.

With the bulk water removed, the drying cycle can be initiated. The valves to the outlet distributor or filter banks are opened and the dewater pump, chiller and blower energized. Air is circulated in a closed loop from the blower to the container and back again. The air leaving the container enters the entrainment separator where it is de-humidified and any entrained water is separated. The dewater pump is used to maintain the proper water level in the separator tank.

The air is heated as it passes through the blower, resulting in hot, very dry air being discharged into the container. This air collects moisture through evaporative drying as it passes through the resin bed.

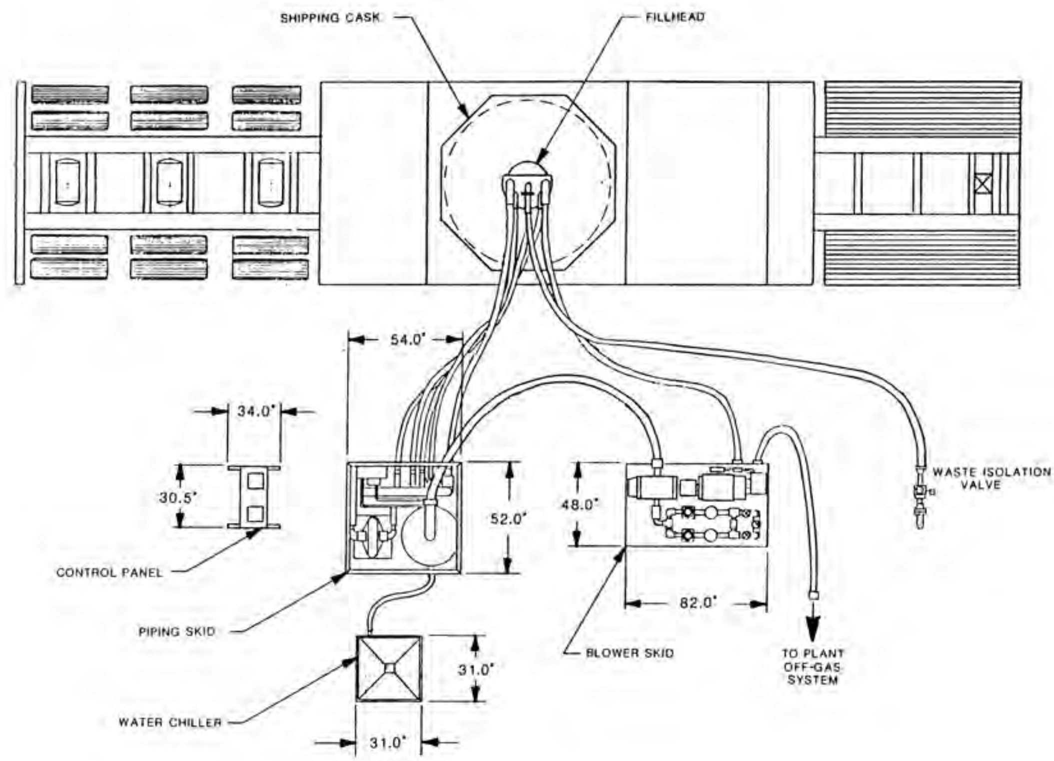

Fig. 1. Equipment Arrangement.

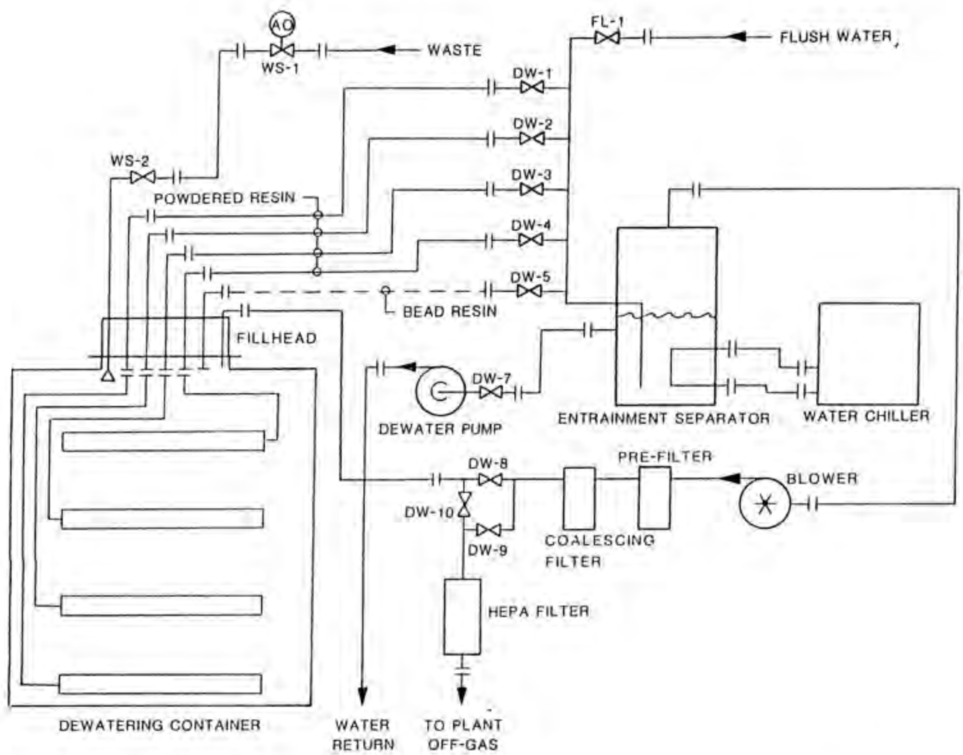

Fig. 2. Pacific Nuclear Systems Resin Drying System Piping Diagram.

After a few hours operation the container can be refilled to take advantage of the volume reduction effected by the system. This volume reduction is due to increased packing efficiency because of the high vacuum level developed by the blower. Essentilly, the waste particles are forced into tight contact with each other allowing up to 15% more waste to be loaded into the container.

The endpoint for the drying process is based on a direct measurement of the dryness of the resin bed (relative humidity of the air leaving the container) and the temperature of the resin bed. Relative humidity represents the ability of the resin to absorb water and the resin bed temperature represents the heat available to drive a condensation cycle and therefore the amount of water to be absorbed. Having developed this relationship for the various resin categories uniquely allows NuPac to establish the point at which the resin bed is dry enough that free water will not be generated as the container cools during handling, shipment and burial. This condensation cycle, uncovered in our qualification testing program, drove NuPac to a drying type system and is largely the reason that dewatered containers arrive at burial sites with excessive free water.

BACKGROUND

The driving factor behind the use of dewatering is economics. The waste does not have to go through volume expansion associated with solidification. Additionally, the dewatering process requires less floor space than do solidification systems and does not use chemicals which may be dusty, corrosive and hazardous.

Prior to the free liquid limitations imposed by the State of South Carolina in 1980, dewatering containers were thin gauge carbon steel vessels with some filter cartridges unscientifically placed at the bottom. In response to this new criteria testing programs were implemented based on using "representative" waste media. That is to say, the equipment design and operating procedures were based on empirical data. The ability to dewater bead resin, for example, in a qualification testing program was used to qualify the system to process bead resin at a nuclear power plant. The fallacy here is that the range of physical, chemical and thermal properties was not addressed. There is no mechanism in place to establish that the resin to be processed at the power plant does not deviate significantly from the resin used in the qualification testing program. As a result, some of the containers dewatered using these systems have shown up at burial sites with excessive free water.

A fundamentally different approach was taken to qualifying the Resin Drying System. A computer model was generated initially in order to address the many fluid flow and thermodyanamic factors involved. This model was then refined and confirmed through testing. As a result, it is uniquely possible to predict system performance based on the characteristics of the waste which will be processed. Prior to processing, each waste stream is characterized to ensure that it falls within the operating range of the system and to establish the appropriate process endpoint. If necessary, special internals are designed or the operating procedure is revised based on the results of the characterization.

SITE OPERATING EXPERIENCE

The first Resin Drying System was placed into commercial operation in January of 1985, following nine months of testing and development. Ten more units have since been placed into operation and another five units are slated to go into operation later this year. The resin drying system has been found to be a very cost effective method of handling ion exchange resins and filter media.

Approximately 100 dewatering operations have been conducted at nuclear power plants to date. Containers have varied in size from 142 cu ft to 210 cu ft. The volume of resin processed to date (12/31/86) is approximately as follows:

Bead Resin	10,000 cu ft
Powdered Resin	6,500 cu ft

Puncture tests are performed on some of the containers arriving at the Barnwell site, by the State of South Carolina, as a check on excessive free liquid. No containers processed with the Resin Drying System have ever been found to have excessive free liquid.

Testing has been conducted at several utilities to establish the actual volume of waste which is transferred into a dewatering container using our system. In testing conducted at WPPSS Nuclear Plant No. 2, four liners of powdered resin were processed to determine the actual volume that is processed into a NuPac CS-190 liner. Level readings were taken on the waste tank before and after waste transfers, and the resin content calculated based upon tank inventories of backwashed beds and records of the number of resin volume removed from the tank on each transfer was recorded as discharged into the processing liner. It was determined that 180 cu. ft. of resin was transferred into each of the four liners when a four hour resin drying cycle was performed after the initial fill, followed by a second fill cycle to the container high level alarm point. The usable internal volume of the NuPac CS-190 container is 158 cu ft, indicating that a volume reduction of 14% was achieved using the drying system. It is interesting to note that 180 cu ft of waste was processed into a container having a burial volume of only 170 cu ft. Due to the high vacuum level maintained by the blower during the drying operation, the packing efficiency is increased significantly resulting in a lower volume of resin than as received from the supplier even including the dirt and sludge which is trapped by the resin during service.

Testing has also been conducted by Arkansas Nuclear One to establish the volume of bead resin which is loaded into a disposal container using our system. In this testing, ANO filled 55 gallon drums with 7 cubic feet each of decanted bead resin and counted the number of drums loaded into the container. The container was loaded to the high level set point (3" of freeboard) dewatered, dried for four hours, and refilled. Using this technique, ANO was able to load the dewatering container with 28 drums, or 196 cu ft. The internal volume of this container is 177 cu ft, resulting in a volume reduction of over 10%. This test was then conducted a second time in order to substantiate the results.

The Resin Drying System has a significant economic advantage over either conventional dewatering systems or solidification systems. Figure 3 presents a typical cost comparison between these options. It is based on a utility which generates 12,000 cu ft of powdered resin per year, transporting to Barnwell from a distance of 1500 miles. This results in a cost savings of $200,000 dollars over dewatering and a savings of $850,000 over solidification.

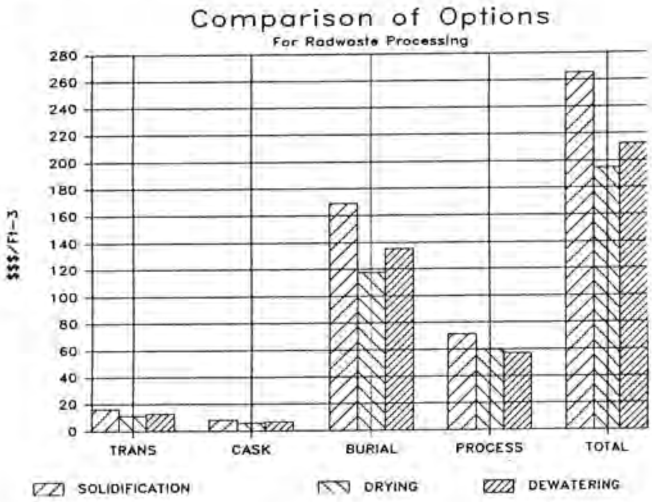

Fig. 3. Comparison of Options.

SUMMARY

The NuPac Resin Drying System has been in commercial operation for better than two years, having processed over 15,000 cu ft of waste at twelve utilities. In this period of time it has proven to be a very reliable and cost effective method of handling ion exchange resins and filter sludges.

This system is unique in that it addressed the full range of physical and chemical characteristics of the waste stream, applying a positive endpoint to the process based on the dryness of the resin bed. For this reason, no container processed with this system has ever been found to have excessive free water.

In addition, the volume reduction associated with this system coupled with reductions in operator exposure provide a significant economic advantage over other options a utility may have for processing resins and sludges.