RADWASTE VOLUME REDUCTION AND SOLIDIFICATION BY GENERAL ELECTRIC

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Since 1978 General Electric has been actively engaged in developing a volume reduction and solidification system or treatment of radwaste generated in commercial nuclear power plants. The studies have been aimed at defining an integrated system that would be directly responsive to the rapid evolving needs of the industry for the volume reduction and solidification of low-level radwaste.

The resulting General Electric Volume Reduction System (GEVRS) is an integrated system based on two processes: the first uses azeotropic distillation technology and is called AZTECH, and the second is controlled-air incineration...called INCA. The AZTECH process serves to remove water from concentrated salt solutions, ion exchange resins and filter sludge slurries and then encapsulates the dried solids into a dense plastic product. The INCA unit serves to reduce combustible wastes to ashes suitable for encapsulation into the same plastic product produced by AZTECH.

The AZTECH process is shown schematically in Fig. 1. Water is removed from the concentrated salt solutions, ion exchange resins and filter sludge slurries by low-temperature distillation of the azeotrope formed between water and the monomer component of polyester. Azeotropic distillation has the characteristic of carrying overhead a fixed ratio of monomer and water vapors. Cooling the mixed vapors in the condenser produces two liquid phases that are immiscible and can be readily separated by decantation. By recycling the condensed monomer, the azeotropic distillation is continued until all water is removed from the system.

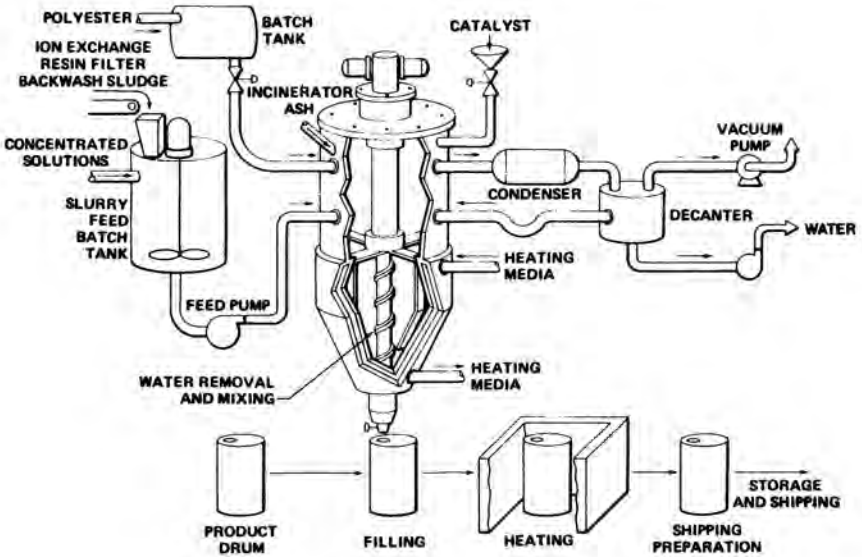
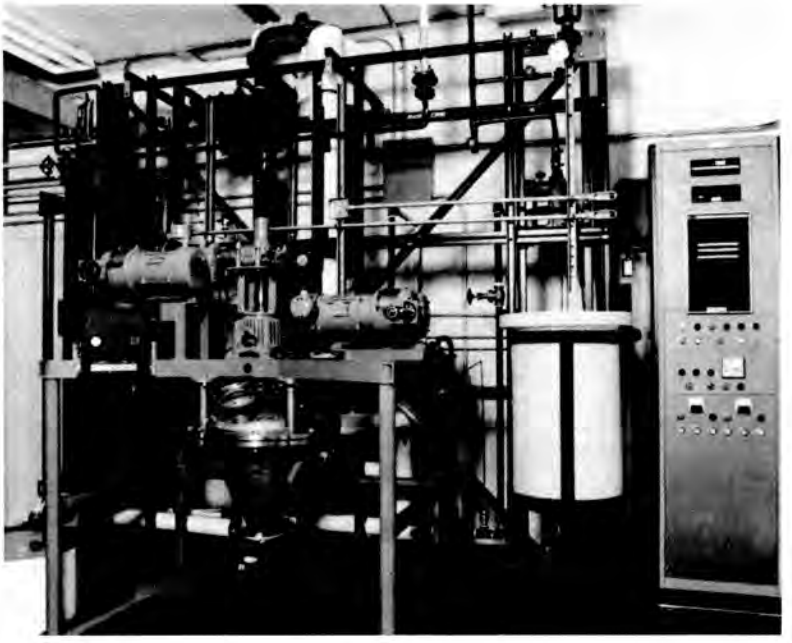


Fig. 1
AZTECH Radwaste Volume Reduction and Solidification System

The AZTECH process is operated in a batch mode with measured quantities of radwaste introduced into the mixer/evaporator vessel. A vacuum is established in the vessel, and hot water (140-160°F) is pumped through the jacket surrounding the vessel. The warmed liquid inside the vessel is stirred by the mixer blades. Liquid polyester containing monomer, inhibitors to prevent premature polymerization and other polyester components is fed into the vessel from the polyester feed tank. The constant-composition vapor is carried overhead, condensed and routed to the decanter. Monomer and water disengage in the decanter. The heavier water phase is routed to the radwaste system, and the monomer is recycled back to the mixing vessel. The azeotropic distillation cycle continues until a temperature increase in the vessel indicates that all the water has been removed. The residue in the vessel now consists of dried solids mixed and coated with the liquid polyester.

A catalyst is then added to the solids/polyester batch. The catalyst is specifically selected so that it will not promote polymerization at the water-removal operating temperature. The catalyst is mixed with the solids-polyester batch, and the mix is extruded into the waste product container. When filled the container is placed in a heating cabinet where the external surfaces are heated to approximately 180°F. Polymerization commences at this temperature and proceeds autocatalytically due to the heat of polymerization. The filled container is set aside until the reaction is complete, a process which takes about one hour. The container is then capped and transferred for storage and shipment. The resulting waste product is dense, hard, and has very low water permeability.

A pilot plant facility, which employs a 5-gallon stainless steel evaporator vessel, has been installed at GE's Vallecitos Nuclear Center to fully verify the technology and obtain engineering data for a full-scale prototype design. Design of a prototype-scale system will be completed in 1981 for installation at Vallecitos in 1982.



AZTECH Pilot Facility at G.E.'s
Vallecitos Nuclear Center in California

Verification testing at the AZTECH pilot facility has produced the following products using commercial grade chemicals.

FEED MATERIAL	VOLUME REDUCTION VS NON-SOLIDIFICATION	CEMENT
70W% Sodium Sulfate-30W% Polyester	5:1	7:1
40W% Powdered Ion Exchange Saturated with Sodium Sulfate-60W% Polyester	2:1	3:1
50W% Boric Acid-40W% Polyester	7:1	10:1
10W% Lubricating Oil-90W% Polyester		
50W% Ash-40% Polyester	1.5:1	2.2:1

The INCA process is shown schematically in Fig. 2. Combustible wastes such as contaminated paper, plastic, gloves, protective clothing and turbine oils are reduced to a solid ash by a controlled-air, two-stage combustion process. Air supplied to the primary combustion zone is limited in volume, yielding a "quiet" burning process with a minimum of particulates carried over to the off-gas treatment system. Final combustion is carried out in a secondary chamber.

The INCA equipment is operated continuously following collection of relatively large volumes of combustible materials. To prepare the feed materials, waste solids are sorted at the point of generation to eliminate significant quantities of non-combustible materials such as metals, glass and concrete. Combustibles are boxed and taken to a storage area. Prior to processing, waste packages are monitored by x-ray equipment for non-combustibles that have been missed in the pre-sort step. Suspect packages are returned for hand sorting.

Packaged wastes are introduced into the primary burn chamber of the incinerator through a charging chamber. A limited supply of air is introduced into the primary zone to control combustion at about 1500°F. Combustion gases and unburned products pass to the secondary burn chamber where additional air and fuel are added. Here, the combustion process is completed at temperatures in excess of 2000°F. The hot combustion gases from the incinerator are directed to an off-gas treatment system.

The off-gas system consists of a series of processes designed to cool the gases, remove the particulates and acidic HCl and SO_2 vapors. The principal equipment pieces are a quench tower, a high-energy venturi scrubber and a packed-column scrubber. A solution of potassium hydroxide is recycled through each equipment piece as the processing medium. At the end of the offgas system is a high-efficiency filter and a blower that maintains vacuum throughout the entire system.

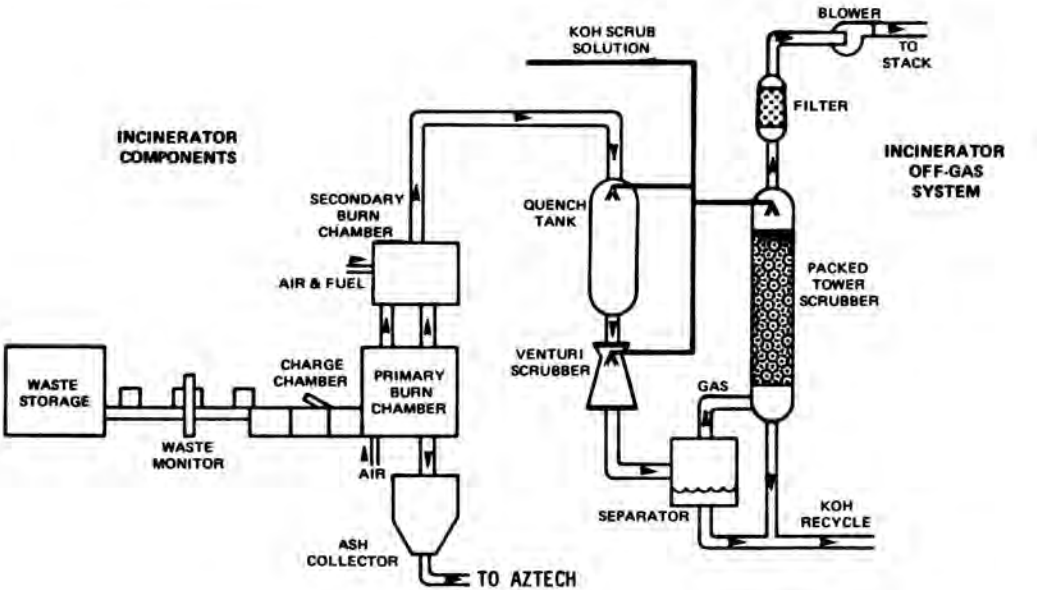


Fig. 2
INCA Incineration System

Ashes from the incinerator are cooled and accumulated prior to being air-veyed to the AZTECH system for solidification in plastic. The ash must be conditioned prior to encapsulation to remove metal or glass materials that could damage the AZTECH equipment.

The technical program for INCA is based on adapting the design of existing controlled-air incinerators for treating wastes contaminated with radioactive fission product and activation product materials. The major source of development data is the incinerator system being installed at the GE Fuel Manufacturing Plant in Wilmington, North Carolina. This system, is a large-scale, 600-pound-per-hour unit that will provide design proof-testing and production plant operational experience.

Operational testing with non-radioactive material was started in December 1981. Production plant operation with contaminated material will commence in early 1982.

The GEVRS offers a number of significant advantages in the treatment of radwaste generated in nuclear power plants. The system is responsive to the rapidly evolving needs of the industry in meeting escalating requirements in radwaste treatment and the increasing costs for radwaste shipment and disposal.

The AZTECH polyester solidification process produces a waste product that will meet anticipated regulatory requirements for a monolithic solid with high resistance to physical damage. The AZTECH azeotropic distillation process provides optimum, low-temperature volume reduction for hygroscopic salt concentrates equal to that for high-temperature thermal processes. The AZTECH volume reduction for ion exchange resins represents a practical balance between the economic limitations of directly solidifying wet slurries and the technical uncertainties of thermally destroying highly radioactive resins.

The INCA system provides very large volume reductions for bulk materials with high assurance of meeting regulatory standards for off-gas release.

Both the AZTECH and INCA systems are relatively simple in operation and flexible in application. The process simplicity of the AZTECH system is of particular value in facility requirements definition and plant operations and maintenance. The controlled-air process of INCA represents a proven system in commercial incinerator operation. The two processes can be applied as an integrated system to treat both the process and combustible wastes from a commercial power plant, or the AZTECH process can be installed as an independent unit.