DESIGN OF A MODULAR RADWASTE FACILITY

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ABSTRACT

This paper describes the design of a modular Radwaste volume reduction and solidification unit based on the AZTECH process developed and patented by the General Electric Company.

BACKGROUND

Several years ago, General Electric recognized the need for an improved encapsulation medium for low level radioactive waste. The desired characteristics of the improved media were: volume reduction capability, compatibility with all common waste forms, high availability, safety and ease of operation.

In response to the identified need, General Electric undertook the bench scale and pilot plant testing described in Ref. 1. This effort led to the selection of polyester as the preferred encapsulation medium. The polyester offered all the desired advantages plus superior leach resistance in comparison to the commonly used encapsulation media. Enhanced leach resistance was considered important as protection against the potential that Federal regulations will be made more stringent or that the new state and regional compacts will require enhanced properties for material accepted at the burial sites.

Subsequent to the process development activities, General Electric constructed a full scale demonstration plant and initiated a program to obtain USNRC approval of the AZTECH product and process under 10CFR61. The demonstration effort and the licensing effort are also described in Ref. 1.

Modular AZTECH

Once the process development was completed and the demonstration/licensing effort was well underway, attention was focused on the optimum configuration of the commercial unit.

A review of the current status of the waste processing situation was conducted, including discussion with Utility personnel which revealed the following facts:

1. Many currently installed radwaste systems were not performing properly
2. The currently installed systems represented a sizable capital investment.
3. The operators assigned to the operation of radwaste systems were generally the least experienced operators in the plant
4. Because of the problems experienced with the current systems, the Utilities were reluctant to invest in a new system unless it had a record of substantial successful operating experience

In light of the above facts, it was concluded that the production AZTECH unit should be configured to allow providing waste solidification as a service to utility customers. This finding led to the conclusion that the unit should be transportable and work was initiated on the design of a shop fabricated modular unit.

The decision to develop a modular unit had a second advantage in that it avoided the expense of extensive on-site construction with its attendant delays, expense and impact on plant operation. Thus it was concluded that the free standing modular design was the correct choice even for a permanent installation purchased by a utility.

A third advantage of modular construction is the full performance verification in the shop prior to shipment, thereby avoiding startup delays.

Design

Once the basic decision was made to provide a modular design, several other decision points were identified.

The first of the decisions was the capacity of the unit. It was decided that there should be one standard design for all applications. The use of a standard design is a natural complement to the modular concept because it avoids the high cost of repetitive engineering and allows optiminization of the design at a reasonable cost spread over several units. Given that there was a standard design, it had to be large enough to handle the majority of potential applications. It was therefore decided that the design basis should be a two unit plant. Ref. 2 was used to define the required capacity. Ref. 2 presents the results of a survey of several years of operating plant experience relative to the quantity and content of radwaste.

The design capacity of the unit was based on the worst case data presented in Ref. 2. The design basis was that the unit be able to process the design quantity of waste in 150 days per year. The selected capacity results in a unit that is larger than required for most applications. However there is not a strong effect of size on cost and the excess capacity lessens duty on equipment as *well as allowing* rapid recovery from unusual situations. Table I shows the design capacities used.

TABLE I

Design Capacities

Na_2SO_4 20% solutions	20,000 ft^3/yr
Bead or Powdered Resins	17,000 ft^3/yr
Boric Acid 10% solutions	10,000 ft^3/yr

Once the capacity was set, there were many decisions to be made relative to the configuration. The following paragraphs discuss the configuration and the reasons behind it. Discussion with utility personnel led to the conclusion that it was undesirable to require that feed be provided on demand. Accordingly, two holding tanks were made part of the design. The holding tanks were then given a second function, the decanting of solution from sludge feed. Resin feed is pumped to the tanks as a slurry. It is desirable to remove most of the water before charging to the AZTECH mixer-evaporator. The removal of excess water reduces the amount of energy and time required to process a batch of waste. The sludge is held in the tanks for approximately 8 hours while the sludge settles and clear water rises to the top. The tanks are equipped with a level measurement system for total level and for determining the level of the sludge/water interface. There is also a variable level suction system that allows pumping off the free water for return to the plant. The tanks are connected to a sample system that allows removal of sludge samples as required to determine properties and content. Since the settled sludge is thixotropic, and therefore does not flow well, the tanks are equipped with vibrators to aid the flow of the sludge to the progressive cavity pump that is used to transfer to the mixer-evaporator. Each of the two tanks has the capacity to support one batch operation.

Since the tanks are also used to hold solutions such as sodium sulfate, they are equipped with heating jackets to aid in keeping the solids in solution.

Discussion with utility personnel also indicated that process steam and air might not always be available to support the AZTECH process, therefore an electric boiler and an air compressor were added to the package.

Since the items discussed above may not be needed for some applications they are packaged in a separate module which can be deleted when not needed.

The process equipment module, which is the main AZTECH module, includes:

1. The mixer-evaporator, which is used for the azeotropic distillation of water, evaporation of vinyl toluene and mixing of the waste with the polyester.

2. The condenser which condenses the vapors from the evaporator

3. The vacuum pump which is a water ring pump and which produces the vacuum in the system

4. The decanter which separates the condensate into vinyl toluene and water

5. The condensate receiver and the vinyl toluene storage tank which collect the vinyl toluene and water from the decanter

6. The drum station which includes a turntable that positions the drums at the various stations for filling and inspection. This area includes equipment to confirm polymerization, measure cleanliness and provide the in-line mixer and catalyst injection system which mixes the catalyst with the discharged waste/polyester mixture. This area further includes the detector that obtains the data necessary to determine isotopic content.

7. The piping, pumps and valves necessary to complete the process system

8. Chemical addition equipment necessary to feed the vinyl toluene and polyester from the shipping drums to the process equipment.

The AZTECH process and equipment used in the demonstration plant is described in Ref. 1, however certain changes have been made in the modular design as discussed below.

The mixer evaporator has been changed to a flat bottom unit to provide less overall height to facilitate transport. The flat bottom unit also has more heat transfer surface and is more flexible in the batch size it can handle. The application of a flat bottom unit was demonstrated by testing in a vendor's test facility.

The equipment sizes were adjusted in accordance with the design basis discussed earlier in this paper.

The third module of AZTECH contains the control room, the offgas equipment and the HVAC. It also contains a small chemical test area used to test incoming chemicals, a safety shower and an eyewash station.

All modules have appropriate fire protection equipment, either a sprinkler system or, in the case of the control room, chemical fire extinguishers. It should be noted that the vinyl toluene and polyester do not present a large fire or explosion concern, having equal or less flamability than kerosene. As additional protection the mixer evaporator is equipped with a system to automatically inject nitrogen if the vacuum is lost at elevated temperatures.

The use of three modules are governed by the desire to meet two criteria; the need to move the equipment over highways or railways and the need to provide a design which includes adequate space for operation and maintenance. There is a strong temptation in designing modules to compress all the equipment into a very small space. In the design of modular AZTECH, a relatively roomy arrangement was maintained to allow for efficient operation and maintenance.

Another feature that was incorporated to accommodate ready maintenance is the positioning of equipment that requires maintenance. To the maximum extent possible, the equipment is located outside the shielding. Equipment that cannot be located outside the shield is located as close as possible to the shielding and may be accessed by appropriately located hatches. Also, the equipment is not all located in one shielded area but rather is arranged in four separate compartments. Table II shows the radiation design basis for the shielding. The shielding design is such that access for maintenance of equipment in one cell can be achieved with the equipment in adjacent cells full of waste. The shielding is fabricated of removable and permanent steel panels and contains viewing windows as necessary to allow visual access to the drum filling area. Television cameras also provide viewing capability for the drum station and inside the mixer-evaporator.

TABLE II

Radiation Design Basis

Control area - 1 mR per hour

Work area - 4 mR per hour

Dose in any compartment with adjacent compartment loaded - 25 mR per hour

Dose at fence - 0 .5 mR per hour

Dose at loading station - 4 mR per hour

The overall arrangement of the modules is shown on Figs. 1, 2 and 3.

Another unique aspect of the modular design is its control system. The system is run under fully automatic control. The "brain" of the control system is a process control computer that uses sequential ladder logic and has the capability to be readily reprogrammed to accept various process requirements.

The design of the modular AZTECH system has been completed and the first unit is in fabrication. The design is based on previously demonstrated operating principles and uses a fully demonstrated process. The criteria used in developing the design were selected to provide simple and trouble free operation and maintenance as well as safety.

REFERENCES

1. M.L. THOMPSON, G.P. Miller, et. al., "Aztech Systems and Testing," Waste Management '85, March 1985.

2. EPRI NP-3370 "Identification of Radwaste Sources and Reduction Techniques".

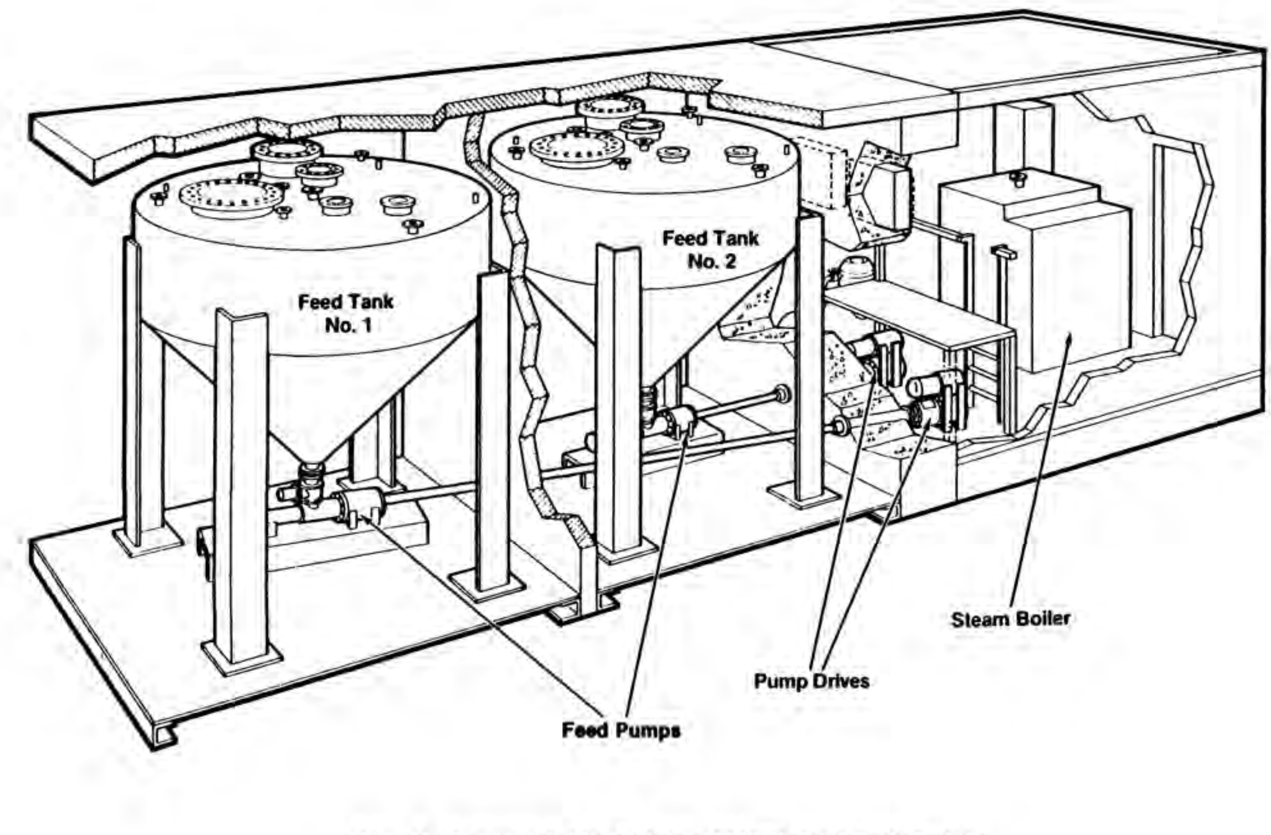

Fig. 1. Transportable Modular AZTECH Feed Tank Module

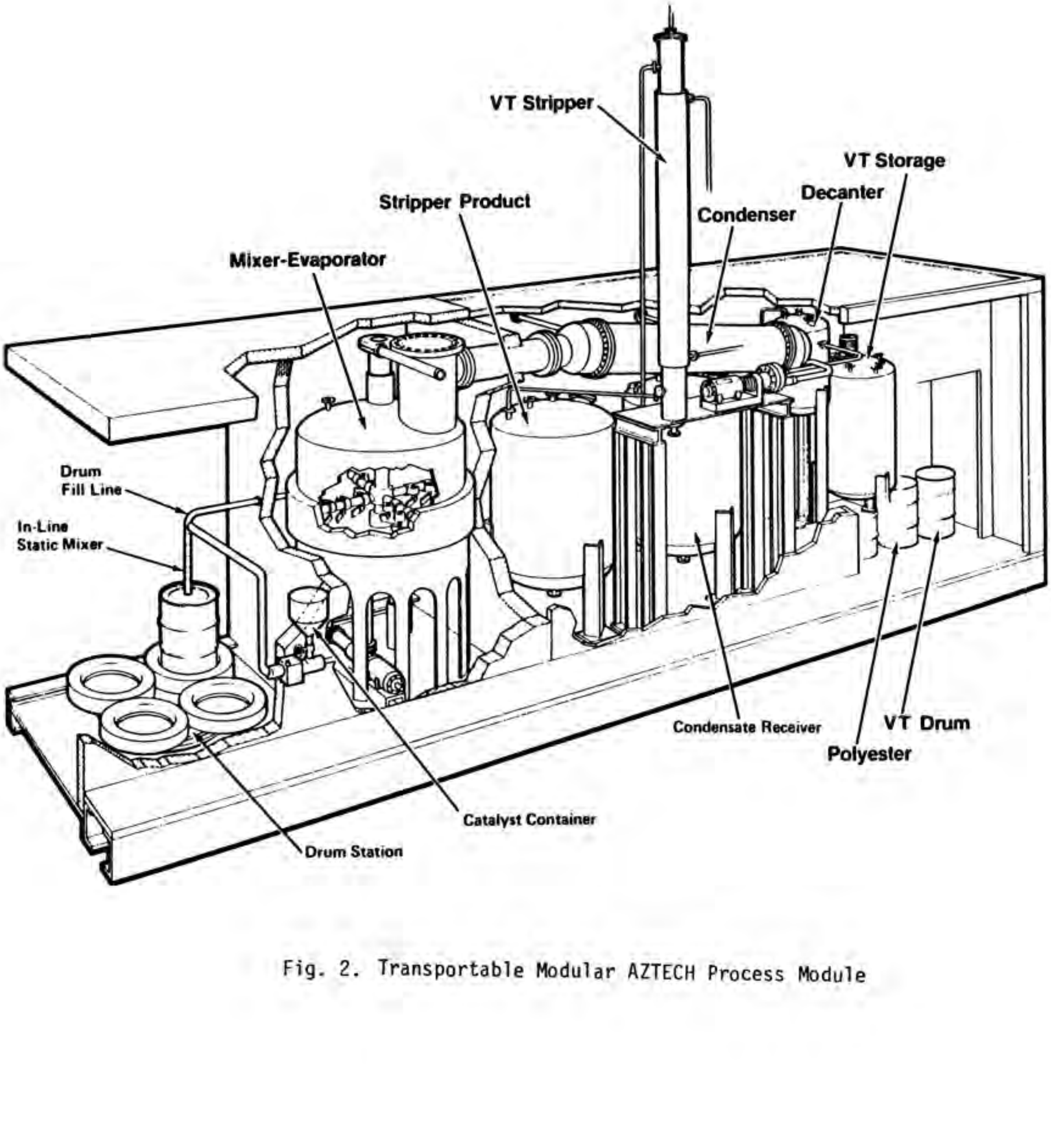

Fig. 2. Transportable Modular AZTECH Process Module

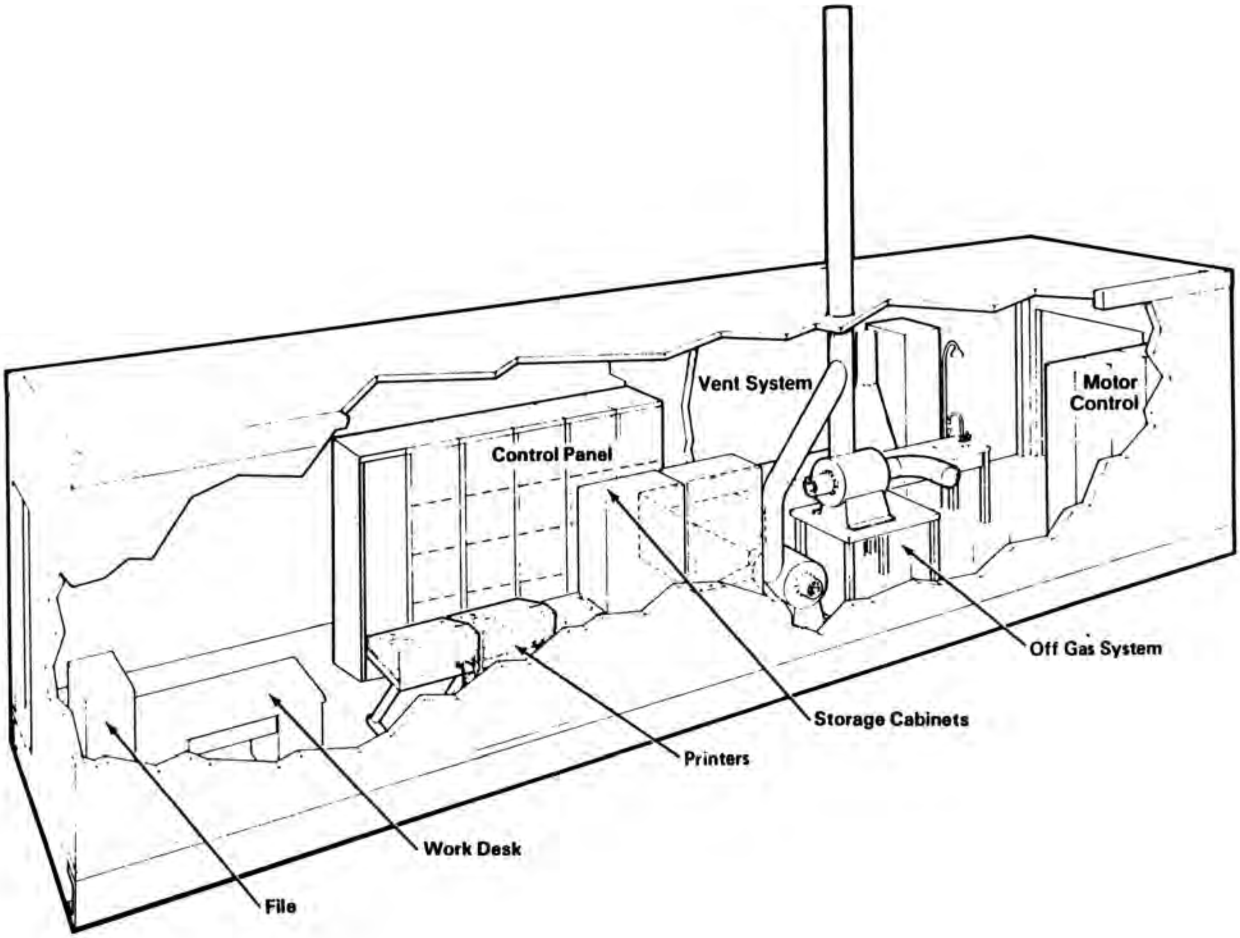

Fig. 3. Transportable Modular AZTECH Control Module