THE DOW SOLIDIFICATION PROCESS LICENSED TO AND PRACTICED BY PEC ENGINEERING, FRANCE

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ABSTRACT

Mobile Solidification Service is becoming increasingly attractive to nuclear power stations. A mobile unit using the Dow Solidification Process has been designed and is being built to meet the requirements of Electricite de France (EdF). Safety is given a high priority within the design features of the PEC mobile unit.

WHY A MOBILE SOLIDIFICATION SERVICE

Mobile Solidification Service is becoming increasingly attractive to nuclear power plants. The concept offers the desirable and economic solution to deal with the waste management requirements.

A number of reasons make the choice for a Mobile Solidification Service favorable.

a) the solidification system already in use at a particular site cannot fully satisfy the existing waste management requirements (i.e., processing throughput, quality and safety in waste handling).

b) The concept of a Mobile System allows the utilities to practice waste management, while no commitments for large equipment investment are needed. This is particularly desirable for utilities which are undecided as to what waste management scheme is best ("wait and see" policy).

c) With the technical and regulatory complexity involved in establishing a waste management concept, there is a growing desire to use a solidification service--no long term commitment and no capital involved.

WHY USE THE DOW SOLIDIFICATION PROCESS

A number of incentives can be listed for selecting the Dow Solidification Process:

a) The Dow Process for waste solidification is approved by:

- U.S. Nuclear Regulatory Commission
- Central Electricity Generating Board (C.E.G.B. in the U.K.)
- National Agency for waste management in France (ANDRA)

A great deal of industrial experience is available proving the practicality of the Dow Solidification System.

b) The Dow Waste Solidification has gained a reputation as one of the best available today. The quality of the monoliths obtained is high, both in physical and chemical integrity (leachability).

c) Provided the process control scheme is well designed, the Dow Waste Solidification Process can be practiced safely by properly trained personnel.

d) A cost analysis over the entire cost frame of waste management will readily show that the binder price is of limited impact.

e) The Dow binder system is applicable to a wide range of different low level radioactive wastes which are produced by various reactor types.

f) The process has shown to be suitable for the production of large size monoliths (such as 5 m^3 blocks).

THE MOBILE UNIT, A BRIEF DESCRIPTION

The design of the unit is tailored to the requirement as laid out by the Electricite de France (EdF).

A main feature is that the mobile unit can handle casks up to 1.1 m external diameter and 1.3 m height with corresponding liners of up to 5 m^3 size.

The mobile unit incorporates the following compartments:

- dewatering system
- mixing head (lost paddle system)
- quality control station
- loading/unloading position
- auxilliary components such as:

- polymer metering
- catalyst, promoter, extender metering
- ventilation (with absolute filter)
- control board

RADIOACTIVE PART

Dewatering System

The dewatering system dewaters ion exchange resins to 10% or below of free water (design allows for dewatering as low as 0.5%).

Ventilation System

The ventilate from the active area is passed through an absolute filter (to absorb radioactive traces) and is then blended with the ventilate from the nonradioactive area. The fan outlet is connected to the utility ventilation system.

NONRADIOACTIVE PART

Polymer Metering System

A piston metering pump and a flow meter are designed for proper metering of polymer supply. Due to the high polymer quantity to be handled per operating day, the polymer storage compartment is separated from the mobile unit. Flexible pipes are used for connection between storage and metering pump.

The flow-meter controls the timing on polymer flow giving signal to shut off the metering pump. In case of failure of the polymer flow meter or of the switch devices, the pump is stopped by a time counter (the time is set according to the pre-operational test-guidelines).

Metering System for Additives

The same metering concept as for the polymer is used. Storage of the additives is also outside the mobile unit using flexible transport tubing.

SAFETY CONSIDERATIONS OF THE MOBILE UNIT

Safety is given high priority within the design features of the PEC mobile unit. Three aspects are primarily focused on

- safety in equipment and process design
- product quality control
- safety in waste handling

Within this scope the following aspects can be mentioned:

a) All the quantities of polymer, waste, additives, etc., are metered accurately by means of weighing, not by the running-time of a volumetric pump.

b) The use of a micro-processor controls the compliance between computed and actual process parameters to prevent standard system errors.

c) Flow rates are adjusted automatically by a flow controller device controlled by flow-rate switches.

d) All the process parameters are monitored by two types of metering devices, one functioning as a backup safety device.

e) TV cameras allow for visual control during the process operation.

f) Within the overall process scheme, the product quality control will ensure that proper solidification occurs. The control implies monitoring of the temperature rise during curing and determination of the physical hardness of the set block. Additionally, a process control procedure (PCP) is laid out to establish the use of proper solidification procedure prior and during the solidification process.

g) With reference to safety from radiation exposure, the design features of the mobile unit insures that exposure to personnel involved with the operation, maintenance, and service inspection is at the very minimum.

The feeding screw is designed such that no solids will remain in the feeder.

All the driving mechanisms are located outside the shielding and are fitted with hand drive devices allowing manual emptying of the equipment in case of an emergency.

Mixing Head

A roller conveyor moves the container from the inlet position to the mixing position. A photo-cell stops the roller conveyor when the container reaches its position (accuracy $\pm$ 3 mm). A basket lifts the container up to engage the paddle (which is already placed in the container) into the drive shaft.

The mixing head is also equipped with a TV camera to view the paddle rotation and the waste level in the container.

A ventilation system including an absolute filter battery ensures that any releasing vapor is collected.

Quality Monitoring

At the quality assurance station the monolith undergoing curing is quality monitored by two principle features:

- An infra-red camera to monitor the temperature increase to ensure proper solidification.
- A special probe which will be lowered onto the top surface of the solidified block to assure proper hardness and the absence of free water pockets.

All monitored data is stored in a microprocessor for overall plant record control.

Upon assurance of proper product quality the container will be moved out of the mobile system. In case of deviations from the routine quality standards, the plant scheme allows for the necessary flexibility to examine and store faulty containers.

In/Outlet Positions

These sections consist of roller conveyors to move the containers from an inlet position to the mixing head and from the quality control station to the outlet position. Each roller conveyor section can be operated individually. The design feature allows for containers to be transported by lift truck or by crane.

Consequently, the equipment containing radioactive products such as ion exchange resins, evaporator concentrate, and sludges will be shielded by lead of 10 cm thickness to produce a contact dose rate of about 3 mRem/h/ci based on Co^{60}.

Thus, for evaporator concentrate with a specific activity of 6 μci/cc and a minimum volume of 35 liters, the operator dose rate will be in the order of 0.6 mRem/h.

For ion exchange resins, the radioactivity is usually high (~ 30 μci/cc). Based on the shielding rating which is applied, the radiation exposure amounts to 24 mRem/h, approximately.

To further minimize radiation exposure to personnel, the control board is separated from the processing plant and located remotely from the mixing station. TV monitoring systems will permit proper viewing of the operations.

The actual wall thickness of the mobile unit is designed with adequate safety margin to ensure minimum radiation exposure to personnel standing nearby during plant operation. At a distance of 6 ft the maximum dose rate is 2 mRem/h.

PILOT PLANT

A semi-industrial pilot unit has been constructed which can satisfy the need for necessary development work. Such a unit has been shown to be an asset for the study of detailed process parameters in the use of the Dow Waste Solidification Process.