Implementation of Treatment Systems for Low and Intermediate Radioactive Waste at Site Radwaste Treatment Facility (SRTF), PR China - 12556

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ABSTRACT

The AP1000 reactors being built in the People’s Republic of China require a waste treatment facility to process the low and intermediate radioactive waste produced by these nuclear power stations.

Westinghouse Electric Germany GmbH was successful in being awarded a contract as to the planning, delivery and commissioning of such a waste treatment facility. The Site Radwaste Treatment Facility (SRTF) is a waste treatment facility that can meet the AP1000 requirements and it will become operational in the near future.

The SRTF is situated at the location of Sanmen, People´s Republic of China, next to one of the AP1000 and is an adherent building to the AP1000 comprising different waste treatment processes for radioactive spent filter cartridges, ion-exchange resins and radioactive liquid and solid waste. The final product of the SRTF-treatment is a 200 l drum with cemented waste or grouted waste packages for storage in a local storage facility. The systems used in the SRTF are developed for these special requirements, based on experience from similar systems in the German nuclear industry. The main waste treatment systems in the SRTF are:

- Filter Cartridge Processing System (FCS)
- HVAC-Filter and Solid Waste Treatment Systems (HVS)
- Chemical Liquid Treatment Systems (CTS)
- Spent Resin Processing Systems (RES)
- Mobile Treatment System (MBS)

INTRODUCTION

Waste treatment systems as provided for the SRTF at Sanmen combine essential technical approaches to answer on final disposal requirements for low and intermediate radioactive waste. Efficient treatment concepts of different waste streams guarantee high Volume Reduction Factors on the waste packages. The processes guarantee products without any free liquids, standardized waste packages, immobilized waste forms, easy handling and storage. All systems work either automatically or remote controlled. The main treatment processes are described below.

FILTER CARTIDGE PROCESSING SYSTEM (FCS)

The FCS consists of a shielded cask, which is installed on a trailer (Fig.1). The trailer will be transferred between the AP1000 and the SRTF. The shielding container carries the 200 l drum containing the spent filter cartridges of the AP1000 units. The cask is provided with a special lid enabling simultaneous removal of the cask lid and the 200 l drum after transport to the SRTF. During the remote controlled removal, the lid will be positioned on a deposit station, the drum with the filter cartridges will be lifted on a roller conveyor. The 200 l drum will be transferred to the Grouting Station by means of roller conveyor and transport trolleys.

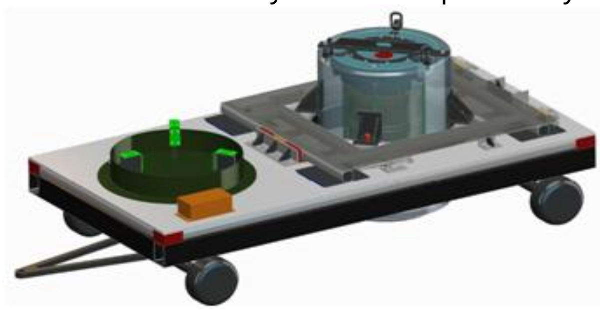

Fig.1. FCS: Trailer with shielding cask, mounted on movable platform

HVAC-FILTERS AND SOLID WASTE TREATMENT SYSTEM (HVS)

The HVS consists of a Sorting Box for solid waste (Fig.2), a 12-Drum-Dryer and a special compaction unit for HVAC-filters (Fig.3). All systems are connected to HEPA-filter units at the SRTF. One HEPA-filter unit is used for the treatment of discharged air with environmental condition, while the other one is used for discharged air of higher temperature and/or humidity.

Sorting Box

The Sorting Box is designed for four sorting stations entirely equipped with gloves and automatic controlled tablets with instruments for segmentation.
The operators sort the material manually by special sorting criteria like metallic waste, wood, plastic, glass and textile.

Fig.2. HVS: Sorting Box

As a first step, the incoming waste bags are opened by a bag opener, afterwards emptied on a conveyor belt and transported into the sorting box. The waste is sorted into 160 l drums which are designed for high pressure compaction. The 160 l drums are transported with transport trolleys to the 12-Drum-Dryer for drying.

HVAC-Filter Compaction

The HVAC Filter Compactor is used for the pre-compaction of HVAC-filters. The frames of the HVAC-filters are cracked and pressed in the form of the internal dimensions of the 160 l drums.
The compacted filter is pushed into the 160 l drum and is compacted by a hydraulic plunger afterwards.
In this way, two HVAC-filters can be pre-compacted into one 160 l drum and transferred to the Supercompactor hereafter.

Fig.3. HVS: HVAC-Filter Compactor

12-Drum-Dryer

Charges of twelve 160 l drums filled with sorted solid waste can be dried in the 12-Drum-Dryer. In the course of process, the residual moisture of the solid waste is evaporated. The humidity of the heating air is condensed by cooling it down and the condensed water is guided either to a tank for release or to the SRTF liquid waste treatment. In terms of a shut down criteria for the drying process, the condensate volume flow is measured.
After the drying process, the 160 l drums are transported out of the drying chamber by means of internal roller conveyor system onto a drum trolley. Other transport systems like roller conveyors or rail guided transport trolleys transport the dried solid waste to the Supercompactor. The system is designed with two operating units. To increase throughput, an extension with a third unit is possible.

TREATMENT OF LIQUID RADIOACTIVE WASTE (CTS)

The liquid radioactive waste consists mainly of samples kept from the chemical analysis of the reactor coolant system, decontamination waters and wash waters. The liquid radioactive waste arising from the AP1000 will be transported by a transport tank to the SRTF (Fig.4). At the SRTF, the liquid waste is collected and if necessary pre-treated for processing at the Evaporator. By means of the Evaporator the solid concentration of the liquid waste is increased. The distillate can be discharged while the concentrate is dried in an In-Drum-Dryer (Fig.5). As a product, a dried residual inside a 160 l drum is achieved and grouted in a 200 l drum.

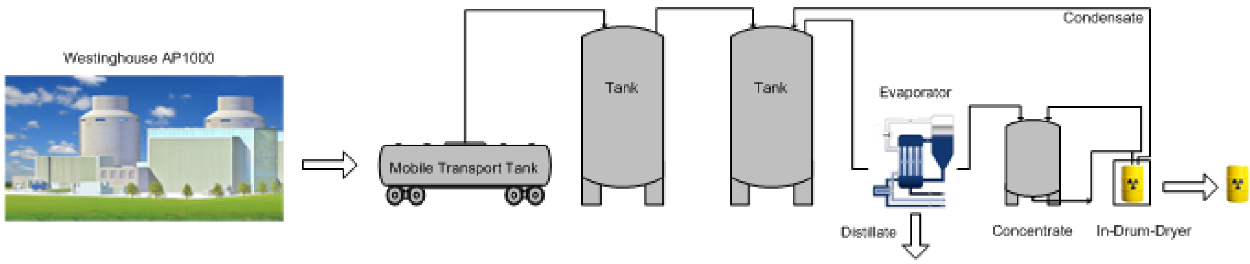

Fig.4. CTS: Treatment of Liquid Radioactive Waste in the SRTF

Evaporator

The Evaporator unit at SRTF is a vapor-compression-evaporator, which has a high capacity as well as high energy efficiency. The Evaporator processes in batches. During the concentration phase, the liquid waste is continuously sucked out of a receiver tank and the distillate is given to a distillate collection tank. At the end of the concentration phase the concentrate is discharged into a concentrate collection tank.

In-Drum-Dryer

If necessary, the concentrate from the evaporation will be chemically pre-treated and fed to the In-Drum-Dryer by a continuous circulation. The In-Drum-Dryer operation follows the principle of continuous dosing. Thereby, the filling level in the 160 l drum is kept constant by a level sensor. The drum is heated by hot air. This type of heating has the advantage that no hot-spots on the outer wall of the drum will occur.
At the end of the drying process, the content of the drum is solid and can be sampled with a sampling device. The 160 l drum is transferred via the Supercompactor and Overpack Optimizer to the Grouting System.

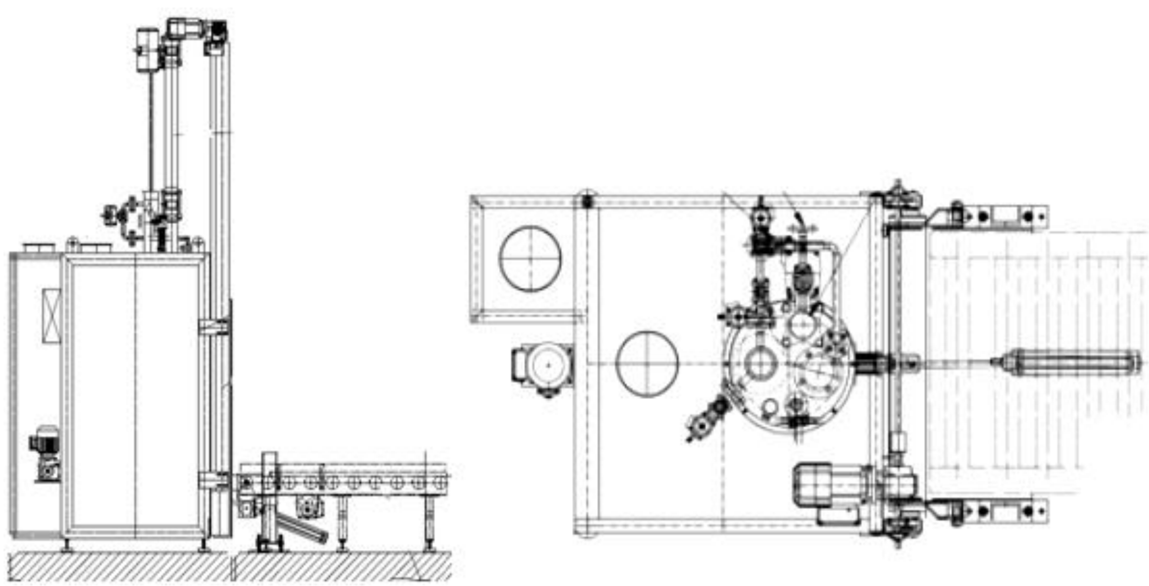

Fig.5. CTS: In-Drum-Dryer

CONDITIONING OF ION EXCHANGE RESIN, SUPERCOMPACTION, GROUTING AND CEMENTATION (RES)

The Spent Resin Processing System (RES) accomplishes many operational tasks besides the treatment of spent ion-exchange resins. Within the RES, the products of the interim treatment stages of all other systems were collected and transferred to additional processes assuring a further volume reduction and immobilization of the final product.
In particular the RES consists of reception systems like tanks and fill heads, a Conical Dryer, the Supercompactor, Grouting and Cementation Station as well as automatic Transport Units and finally the Radiation Monitoring Station for data tracking of the 200 l drum before entering the local storage.

Supercompaction

The 2000-t-Supercompactor (Fig.6) is the main system of the volume reducing concept of all SRTF systems. All 160 l drums are fed to the Supercompactor and are reduced to a fractional amount of their original size, depending on their content. These pellets are transported to a pellet storage area after determining specific data, e.g. height, weight, dose rate. To optimize the filling of the 200 l drums, the different pellets are sorted according to the mentioned sorting criteria.

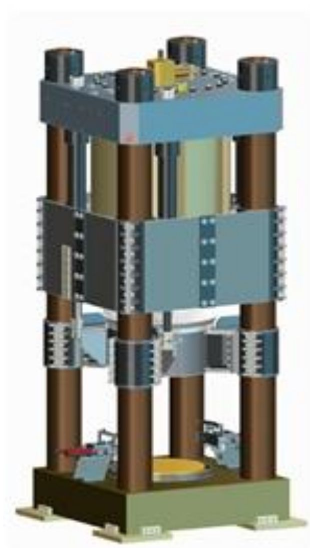

Fig.6. RES: 2000-t-Supercompactor

Conical Dryer

Spent ion-exchange resins (bead resins) from the nuclear islands are transported by a transport tank to the SRTF. The spent resin is buffered, pre-dosed and transferred to the Conical Dryer (Fig.7) gravimetrically.
To ensure a gentle drying of the spent resins, the drying process is performed under sub-atmospheric conditions. The heat is transferred from the conical dryer wall to the spent resins by means of a heating system. The resin is mixed by a stirrer to enhance the heat transfer. The hot resins are automatically filled into 160 l drums, which are capped automatically and transferred to the Supercompactor.

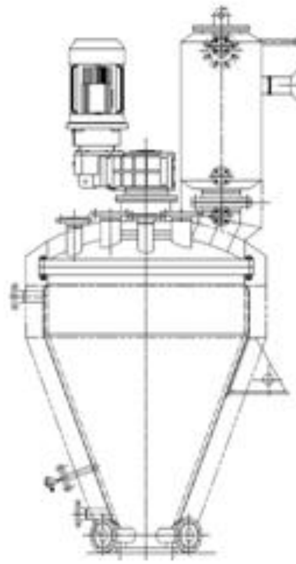

Fig.7. RES: Conical Dryer

Grouting and Cementation System

The Grouting and Cementation system performs the last process step at the SRTF. The content to be immobilized inside a 200 l drum is grouted with cement. The grouted 200 l drums are automatically capped. After curing, the 200 l drums are transferred to a drum inspection device where gamma spectroscopy and dose rate measurement are performed. Afterwards, the 200 l drums are stored in a local storage facility.

For special treatment of liquid radioactive waste, the cementation system (Fig.8) can be applied. For example, evaporator concentrate can be cemented. Therefore, the concentrate is mixed inside a 200 l drum with cement, thus immobilized.

Fig.8. RES: Cementation System

MOBILE TREATMENT SYSTEM (MBS)

If required, the Mobile Treatment System (MBS) (Fig.9) can be transported from the SRTF to the Radwaste Building of each AP1000 reactor on Sanmen site. Using different cleaning processes, such as filters, granular activated carbon, ion exchange resins and reverse osmosis, the MBS is able to treat various kinds of liquid waste, remotely controlled. The products permeate and retentate, are returned to the AP1000 for release and transferred to the SRTF for further treatment, respectively.

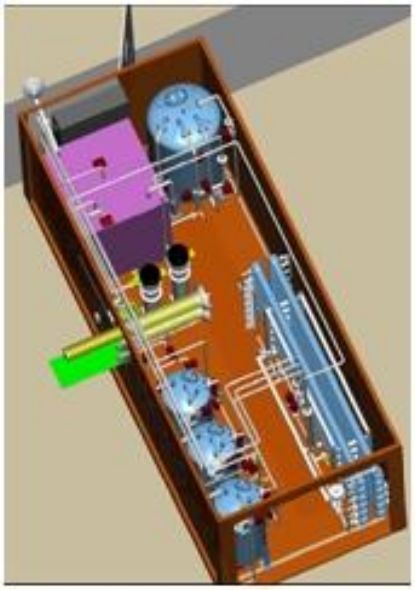

Fig. 9.MBS: Mobile Treatment System

PROJECT STATUS AND FUTURE PROJECT EXECUTION

The SRTF project is in the final steps of detail design, procurement and factory acceptance. Considering the project schedule and the construction progress of the building, a major part of the SRTF equipment is in the manufacturing phase. The first shipment of some heavy weight components and embedded parts took place in September 2011, shipment of all other equipment is scheduled for the first half of the year 2012.

Intense factory acceptance tests are performed at the respective factories for equipment supplied by Westinghouse. Further system integration tests will be done during installation and commissioning in China, when the numerous systems provided by the Customer are available. The integration of various systems being built in Germany and in China and the combined effort and smooth integration during installation and commissioning pose a remarkable challenge for all stakeholders involved in the design and construction of the SRTF.

The complexity of the SRTF in conjunction with its high level of automation can be seen as realization of established European radioactive waste processing concepts in Asia with trend-setting perspectives.