Plant Decontamination as a Precondition of the Remote Dismantling Concept of the Karlsruhe Vitrification Plant VEK – 12206

Joachim Dux, Joachim Fleisch, Bernhard Latzko, Norbert Rohleder

WAK Rückbau- und Entsorgungs- GmbH, P.O.Box 12 63,
76339 Eggenstein-Leopoldshafen, Germany

ABSTRACT

Vitrification of the high-active liquid waste concentrates (HAWC) was a major milestone in the WAK decommissioning project (StiWAK). From September 2009 to June 2010, about 56 m³ of HAWC were vitrified at the Karlsruhe vitrification facility (VEK) and filled into 123 canisters. HAWC vitrification was followed by an extensive rinsing and shutdown program, in the course of which both the VEK process installations and the facilities for the storage and evaporation of high-active fission product solutions (LAVA) are prepared specifically for dismantling. Finally the rinsing programme leads to an overall reduction of the remaining contamination in the installations by a factor of approx. 5 - 10. The amount of liquids arisen from this program has been vitrified and another 17 canisters have been filled. In total, 140 canisters were packed into 5 CASTOR casks that were already transported to the Zwischenlager Nord (interim store North) of EWN GmbH (ZLN) in the mid of February 2011. The melter of the VEK was already shut down in the late November 2010.

BOUNDARY CONDITIONS IN THE EMPTIED HAWC STORAGE TANKS

At LAVA, the HAWC was stored in two tanks with a volume of 75 m³ each. The HAWC in homogenized concentration was distributed equally between both tanks. During vitrification operation, one of these two tanks was emptied first before the HAWC from the second tank was transferred from LAVA to VEK. Using the transfer systems available, every tank was emptied down to a remaining volume of about 400 l. After the tanks had been emptied, the dose rates inside were measured via the sampling systems using BeO dosimeters (see Fig. 1) in order to determine the remaining activity inventory. At the bottom of the tanks, dose rates reached up to 600 Gy/h. Calculation at known nuclide composition yielded a total activity of about 5x1015 Bq.

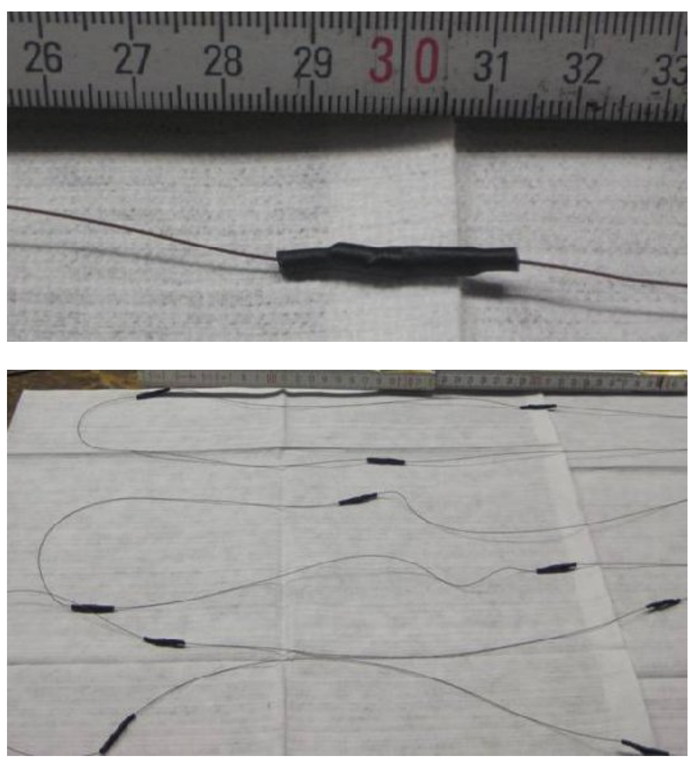

Fig. 1. Assembling of BeO dosimeters

It was largely demonstrated that dried HAWC residues are responsible for these remaining activities and that amounts of solid deposits worth mentioning do not exist in the tanks.

Based on these values and the VEK operation characteristics, an optimum rinsing and shut-down program was developed for the storage areas at LAVA and VEK, which started immediately upon the completion of HAWC vitrification.

LAVA AND VEK PLANT DECONTAMINATION MEASURES

The rinsing and shutdown program for LAVA and VEK covers all HAWC-containing process installations as well as the systems and facilities for offgas treatment at VEK. Particular attention is paid to the storage tanks at LAVA, the melter, and the wet offgas cleaning system of VEK.

An overview of the system components affected is given by the flowchart in Fig. 2.

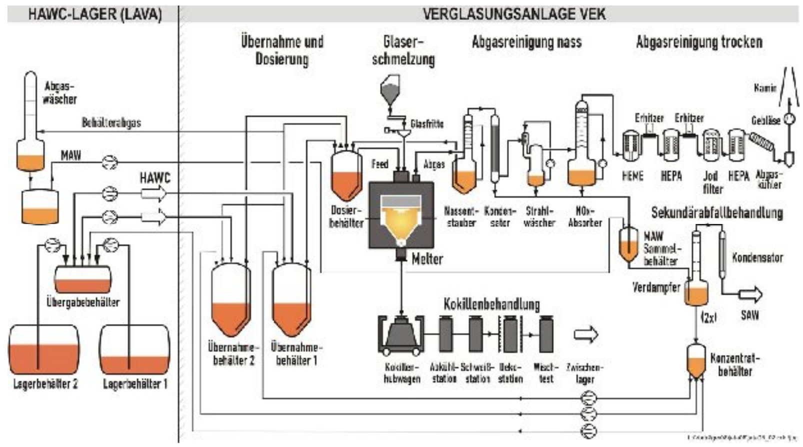

Fig. 2. Flowchart of the VEK with the LAVA storage tanks

After the first rinsing tests in the first HAWC storage tank (210 B 03, s. section 2), 0.5 m³ of rinsing solution were filled into the tank twice via the pulsators, in which dried HAWC residues had been suspected. Using the existing transfer systems (steam jet), this rinsing solution was discharged into the second HAWC storage tank (210 B 02). In this way, the dose rate in tank 210 B 03 was reduced by about 15%.

In the next step, 2.2 m³ of rinsing solution were filled into tank 210 B 03 via various components of LAVA (offgas condenser, separator, pulsators) together with 2.8 m³ from a reservoir (210 B 06). Thus, a cleaning effect was achieved in the individual components. With the filling volume of about 5 m³, the pulsators of storage tank 210 B 03 could be operated efficiently again and deposits possibly existing on the tank floor were resuspended. Then, the complete rinsing liquid was transferred to storage tank 210 B 02 using the steam jet. Subsequent dose rate measurement in the tank by means of the BeO dosimeters confirmed a reduction by more than 70%.
This decontamination step was repeated with about 6 m³ rinsing solution, by means of which the original dose rate was reduced by another 10%.

At last, 1 m³ rinsing solution was filled into the storage tank via the pulsators and 4 m³ via the reservoir 210 B 06. After mixing the rinsing solution by the pulsators, the tank was emptied via the existing steam jet into the storage tank 210 B 02 and the remaining amounts were discharged via the sampling lines. Final dose rate measurement yielded a value of 118 Gy/h 61 mm above the tank floor and a value of 18 Gy/h at a height of 961 mm, which corresponds to about 20% of the initial dose rate. The dose rate profiles of the two storage tanks are shown in Fig. 3.

No further tank decontamination measures were taken, as no decisive decontamination effect was to be expected.
In analogy, the rinsing program was accomplished in the HAWC storage tank 210 B 02. The rinsing solutions from tank 210 B 03 were used for this purpose. The tank was filled via various systems and components again (offgas condenser, separator, etc.) and via the pulsators in order to reach a decontamination effect.
In the beginning, the dose rate measurements accompanying the rinsing program of the second storage tank yielded values of 23 Gy/h. In the end, values of 21 Gy/h were measured at a height of 1000 mm above the tank floor (dose rate measurement at a lower point of this tank was technically impossible). Before the first measurements in the tank, the rinsing solutions from the first HAWC-tank were filled into the tank and were discharged. This led to a lower initial dose rate.

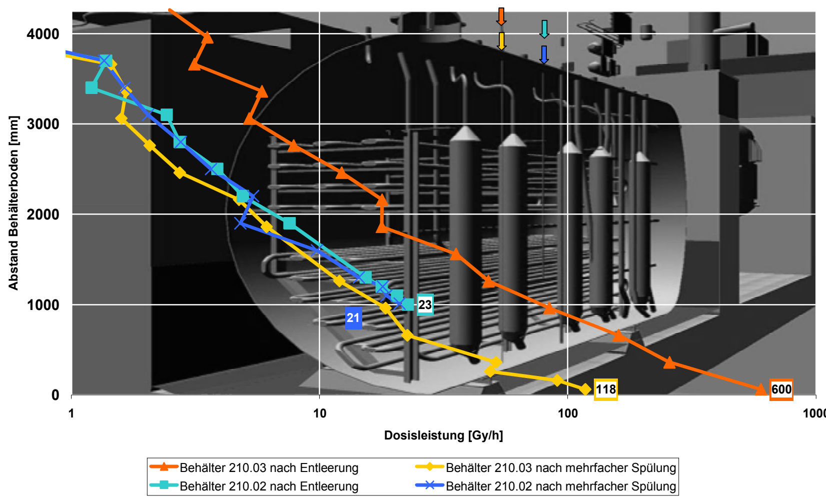

Fig. 3. Dose rate profiles in the HAWC storage tanks prior and after rinsing

Rinsing and decontamination in the VEK covered all components and process installations that had contained HAWC during operation. For this purpose, the rinsing solutions from the HAWC storage tanks of LAVA were used and then vitrified. While vitrifying the rinsing solutions, the solids accumulated in the offgas pipe of the melter (s. Fig. 4) could be mechanically removed and immobilized in the molten glass for a second time. The last batch of the melter was filled completely into the last canister in a single process, which resulted in a maximum activity reduction.

The process-related liquids remaining at VEK are presently being concentrated by the VEK evaporator system and collected in one tank. There, the about 3 m³ of remaining liquids will be dried within a few months. At the beginning of dismantling, the plant will be completely empty and dry.

To determine the current radiological situation of VEK after operation, an extensive dose rate measurement program is being executed at the moment. It will also serve as a basis for planning remote dismantling of the VEK process installations.

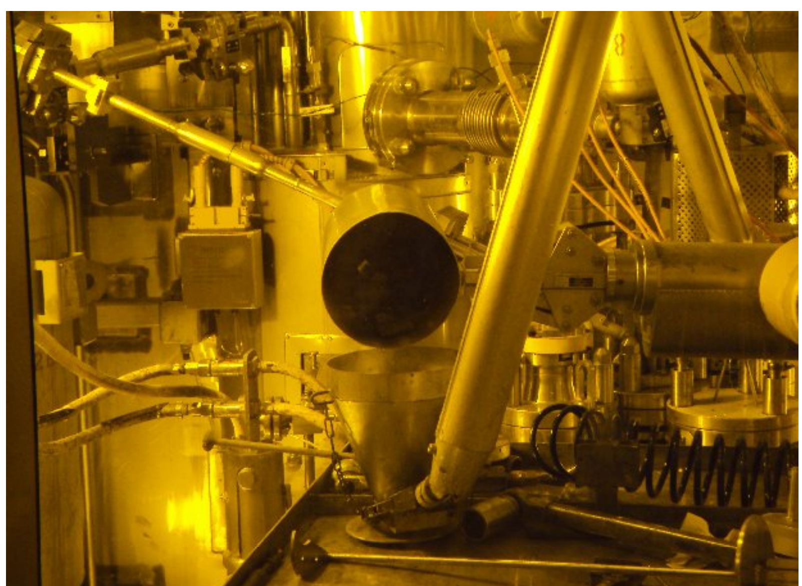

Fig. 4. Vitrification of solids from the offgas pipe of the VEK-melter

Upon completion of the rinsing and shutdown program at VEK (in May 2011), all VEK installations will be irreversibly taken out of operation under the already licensed step 4 of the technical and administrative deregulation after vitrification. Thus, the necessary prerequisites for dismantling the plant will be generated. VEK dismantling is presently being planned.

BOUNDARY CONDITIONS FOR VEK DISMANTLING

According to the current WAK decommissioning concept, it is envisaged to disassemble the VEK in two separate steps and to subject the building structures to release measurement. In the first step, the highly contaminated facilities of the VEK will be dismantled remotely. These are the facilities in the transfer cell with the former HAWC-containing pipelines and tanks, the facilities of the melter cell with the melter and some components of the offgas cleaning system, and the cell areas, where the offgas cleaning systems and the filter systems are located. This will require extensive reconstruction work and new installations. Concept planning for this dismantling area is available, drafting of the application documents based on the radiological status of the plant after operation has started. According to current planning, plant dismantling and release measurement of the building structure will have been completed by 2020.

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