COMMISSIONING OF THE TIHANGE 2 (PWR) VOLUME REDUCTION AND SOLIDIFICATION SYSTEM

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ABSTRACT

The Tihange 2 VR and solidification system combines the full dehydration of the residues and the encapsulation of the dried product into cement. Testing of the system was first performed away from the power plant site, i.e. : in laboratories, with a pilot scale unit and in factories (full size, actual components). The on-site checking and testing program comprises six working phases : pretesting checks, prestart-up checks, operation of single components or sub-assemblies, sub-assemblies operation with simulated wastes, complete system operation with simulated waste and, finally the commissioning test. At the beginning of 1983, the program has reached the 5th phase stage.

Preamble

The TIHANGE 2 Power Station in Belgium, provided with a 900 MWe PWR, was recently connected to the grid and most of the plant systems are now operating industrially.

At the end of 1977, during its construction, it was decided to install a radwaste volume reduction unit in addition to the solidification installation initially envisaged, and to adapt the system design accordingly.

This new radwaste VR and solidification unit (so-called TDS system) can achieve both full dehydration of the residues and encapsulation of the dried product into cement. The design and construction are based on a specific BELGATOM development the study of which initiated in 1975, on the basis of previous work performed from 1969 onwards. A demonstration unit with a 50 l/h processing capacity has been in regular operation since 1979 at the Mol nuclear research center (Belgium).

TDS System Description

Figure 1 gives a simplified flow diagram of the Tihange 2 unit. It is mainly composed of :

- a storage of the incoming radwaste allowing the segregation of four different types of waste, namely :
  1. Evaporator bottoms
  2. Flocculates
  3. Magnetic sludges
  4. Ion exchange resins
- a chemical pretreatment for the waste of types 1 and 2
- a total dehydration of the pretreated liquids
- a buffer storage of the dried residues
- an encapsulation batch mixer, which can embed as well dried residues as slurries (i.e. without VR in operation) into a cement matrix
- a drum filling station, followed by a matrix setting position and a concrete plug pouring station.
- a remote drum transportation carriage.

The system also comprises several ancillaries, mainly :

- a vapor and off-gas treatment
- a condensate collection and return line
- a matrix preparation sub-assembly
- flushing and decontamination circuits.

One of the major design difficulties was due to the limited available space and unfavorable arrangement of the building which was setteld prior to the decision to add a VR unit.

As such, the Tihange 2 - TDS system has an evaporation capacity in the 150 l/h range and is the first industrial size installation of this new design to be put into service.

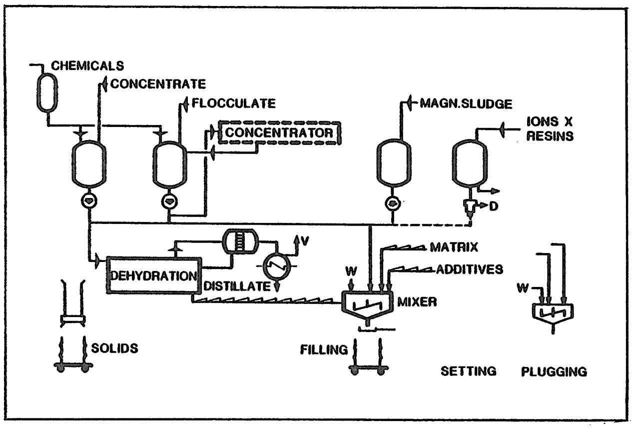

Fig.1 : Simplified Flow Diagram of Tihange 2 VR & Solidication System.

At the time this paper was written, the operational testing of the TDS system had just been initiated. The test results will be reported during the first semester 1983.

The following paragraphs are devoted to a description of the off site tests already carried out and of the on-site checking and testing program as presently organized.

Off-Site Testing Program

An extensive "off site" testing program was considered necessary because of :

1° the system novelty

2° the achievable schedule for the on-site work which was allowing but a late test period and a short running time for the components and circuits once erected.

The aims of this off site testing were mainly :

- to experimentally determine the process parameters
- to check the components operational behaviour in practice
- to trace as much as possible the potential troubles or incidents
- to determine, at an early stage, the required adaptations or improvements
- to provide the data and information needed for the procedures writing.

The program included :

- laboratory scale experiments in order to screen the problems and define the most promising ranges for the process parameters
- pilot scale verification and confirmation tests carried out with industrial type components, aimed at demonstrating the adequacy of the design lay-out and equipment chosen
- full size demonstration tests performed e.g. with the Tihange 2 components themselves in order to determine the operability and performances of the latter, together with the possible size effect on the process parameters.

This led finally to the set-up of the system prior to its on-site erection and start-up.

The pilot scale tests were mainly carried out with the above mentioned non-radioactive demonstration unit using simulated waste solutions.

Regarding the full size demonstration tests, the major functions of the process were also checked using, as far as was feasible, the actual components manufactured for the Tihange 2 unit.

- dehydration sub-assembly : 200 h operations with simulated waste solutions under nominal service conditions
- dried product conveyor : transfer operation with the actual dried product
- encapsulation mixer : production of several 200 l drums, efficiency of inner flushing device
- sampling method for embedded residues : properties correlation with the full size solidified product
- pretreatment tank stirrer : efficiency, long term behaviour, restarting after drive failure.

Through the above work, some potential troubles were pinpointed and the corresponding adaptations made before erection. In general, it confirmed the operability of the components and the required compression strength property i.e. better than 150 kg/cm^2, for the full size solidified product.

On-Site Checking & Testing Program

The "on-site" checking and testing program, leading to the commissioning of the whole VR & Solidification System, is subdivided into 6 working phases which are briefly outlined below. Each checking or testing step is dealt with in a particular procedure which details and records all predetermined actions and expected results.

The whole program is submitted to the QA requirements as mentioned in the position paper ETSB 11.1.

Phase 0 : Pretesting Checks.

The aim of this phase is to ascertain that all the works have been fully and adequately completed and that the QC requirements have also been thoroughly fulfilled prior to initiation of the next phase.

- Completion of the works :
  - mechanical equipment :
    component erection, circuits assembly, supporting, drives and remote actuators,...etc...
  - electrical + I & C equipment :
    primary elements, cabling, boards and boxes, control cabinets, instrumentation, heat tracing,... etc...
  - utilities and miscellaneous (lagging, viewing devices, handling, special tooling,...)
- Circuit flushing and cleaning
- Final hydro-testing of all vessels, circuits, parts...submitted to pressure
- Availability of utilities.

Finally, pretesting QC results are checked for completeness and acceptance as specified in the program.

Phase 1 : Prestart-up Checks.

During this phase, a thorough verification, item by item, of all system components is carried out, in order to establish whether they are ready for operation and capable of performing the expected functions.

The "checking" actions are grouped as follows:

- Instrumentation and control :
  wiring, power supplies, channels functionning, calibration, interlocks and safeties, signaling,...
- Heat tracing :
  isolation, functioning, preliminary setting, temperature distribution,...
- Valving :
  tightness, operation, position indicators, interlocks, remote actuation,...
- Motorized components :
  pumps, conveyors, stirrers, actuators, carriage,...
- Static components :
  tanks, silos, heat exchangers, filters,...
- Special equipment :
  evaporators, dryer, hopper, mixers, drip pan, shielding,...

Corresponding QC results are recorded in the reference procedure and filed.

Phase 2 : Operation of single components or sub-assemblies.

Phase 1 being completed, it is then possible to start-up and operate each single component during a given time in order to establish its nominal performances and behaviour and to adjust the preliminary settings.

From then, components are said to be ready for operation in combination with others, i.e. for testing of "simple sub-assembly functions" and determination of the reference "operational measurement values" for such a sub-assembly. For instance :

- Demineralized water circulation :
  filling, recirculation, transfer, metering
- Dehydration nominal performance with demineralized water :
  evaporator 1 and 2, dryer
- Blank operation of encapsulation sub-assembly :
  mixers functions, flushing devices, drip collection, conveyors, operation sequence
- Handlings operation with dummy parts :
  filter cartridges, drums, carriage, positioning, remote actuators
- Preoperation of the matrix preparation subassembly :
  silos filling, product transfer and metering, ...
- Special tooling.

QC reports are then confirmed and initialled for approval.

<u>Phase 3</u> : Operation of sub-assemblies with simulated wastes.

This testing phase is the most important one, since it demonstrates the full operational capability of one sub-assembly after the other. This is carried out with reference simulated incoming waste solutions or slurries, starting from the inlet of the system, proceeding down towards the evacuation position of the filled drums. The reference simulated liquid wastes are : borates and several flocculates.

During this phase, particular attention is also paid to the :

. checking and possible correction of all presettings
. pre-final trimming of the components
. recording of the measured values for further reference
. verification of the final solidified product properties and expected D.F.

so as to establish the "nominal status" of the system prior to its semi-industrial start-up.

The normal testing sequence of the sub-assemblies is the following :

step 1 : Pretreatment
step 2 : Waste transfer and metering
step 3 : Waste encapsulation and filling of drums
step 4 : Drum handling and plugging
step 5 : Flushing and decontamination.

The "dehydration" step can be tested either separately or between steps 1 and 2.

At the end of this period, all operating procedures are validated for the next phase.

<u>Phase 4</u> : Complete system operation with simulated wastes.

In fact, phase 4 constitues the final rehearsal for the full system operation, prior to the formal commissioning test. During this phase, all test steps are performed without interruption, using the above validated operating basis.

During phase 4, it is still possible to carry out some limited trimming of the components.

Satisfactory completion of the present phase means that :

- the whole system is ready for industrial operation
- the operating procedures and parameters are confirmed for application throughout the final non-radioactive demonstration of the system.

The program is then concluded by the last testing phase, i.e. the "Commissioning test", leading to the delivery of the "active operation permit".

<u>Concluding Considerations</u>

At the beginning of 1983, the program had progressed to the Phase 4 level except for the dehydration sub-assembly. A few tenths of drum had already been produced from evaporator bottoms containing mainly sodium borates. Drilling of samples in the solidified mass had also been performed and the compression strength test yielded values quite above the specification, i.e. 150 kg/cm^2.

At this stage of the on-site testing program, it is worthwhile mentioning some general considerations which should never be underestimated.

. Sound and rational waste management starts upstream of the waste collection system.

. The true nature and content of the actual waste solutions must whenever possible be simulated in view of an effective demonstration, since different solution contents mean different operational behaviours.

. The ideal program sequence cannot always be applied ; therefore, full recording and checking of the operations and results as executed, will avoid potential oversight.

. Enough spare testing time must be foreseen in the program schedule in order to cope easily with additional trimmings or testings. Furthermore, when acceptable from the time and cost standpoints, long demonstration runs may reveal potential weak points, which otherwise would show up later, when processing radioactive wastes.

. As far as is feasible, provisional devices should be precluded ; indeed, the system may then temporarily and significantly be different with respect to its final state, and such devices are sometime the cause of irrelevant problems.

. From testing phase 2 onwards, utilities must already be fully operable and reliable.

. Other contractor's works, which may spoil the system pre-established status, should be watched over.

Upon completion of the TDS system commissioning, a general testing report will be issued and presented to the licensing authorities.