A NEW, SMALL DRYING FACILITY FOR WET RADIOACTIVE WASTE AND LIQUIDS

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ABSTRACT

Due to the reason, that in Germany every Waste, that is foreseen to be stored in a final disposal facility or in a long time interim storage facility, it is necessary to treat a lot of waste using different drying technologies. In Germany two different drying facilities are in operation. The GNS Company prefers a vacuum – drying – technology and has built and designed PETRA – Drying - Facilities. In a lot of smaller locations, it is not possible to install such a facility because inside the working areas of that location, the available space to install the PETRA – Drying – Facility is too small. For that reason, GNS decided to design a new, small Drying – Facility using industrial standard components, applying the vacuum – drying – technology.
The new, small Drying – Facility for wet radioactive waste and liquids is presented in this paper. The results of some tests with a prototype facility are shown in chapter 4. The main components of that new facility are described in chapter 3.

INTRODUCTION

During the operation of nearly all Nuclear Facilities (Nuclear Power Station, Medicine Centers and Nuclear – Research – Centers) and in the phase of decommissioning, waste in any kind is produced. Usually the waste is packed in standard waste – containers and standard waste – drums. The containers and drums are normally manufactured in an industrial standard with some special requirements for nuclear applications. Normally the drums and containers are built using normal steel. Only for special waste – streams, stainless steel is used for the packaging.
To avoid the damage of the packaging in accordance to corrosion effects and to take account of the German rules for the storage of radioactive waste, all waste that is foreseen to be stored in a storage facility, has to be free of water. Because in Germany the Final Disposal Facility will not be in operation during the next 30 years, the rules for long time interim storage have special criteria for the treatment of waste that is packed in normal steel drums.
So nearly all waste – streams (mixed waste and wet waste) have to be dried and the result of the treatment is to be demonstrated. The state of engineering for the normal "Drying Facilities" that are in operation in German Nuclear Power Plants and Treatment Centers are using the vacuum – drying – process. The main components of those facilities are a condenser, a vacuum-pump and a cooling generator. The waste drums are placed in a heating chamber with max 8 drums per chamber in the GNS drying facility PETRA. For small amounts of waste to be treated, the PETRA drying facility is too big and the requested place to install the PETRA is not available at each location. So GNS decided to design a new drying facility using the same vacuum – drying – process with new simple mechanical equipment. The new drying facility is described in this paper.

DESCRIPTION OF THE NEW DRYING FACILITY

To take account that the space to install a drying facility in the different locations the main scope of design for the new facility was "as small as possible". The next scope in the exercise book was "as simple as possible" and "good maintenance"! Using the vacuum – drying – technology and the excellent experiences of the bigger vacuum drying facility PETRA, that is accepted by the German authorities and the German Experts (TÜV), GNS decided to build a prototype facility.

In Fig. 1 the flow – sheet of the new drying facility is shown.

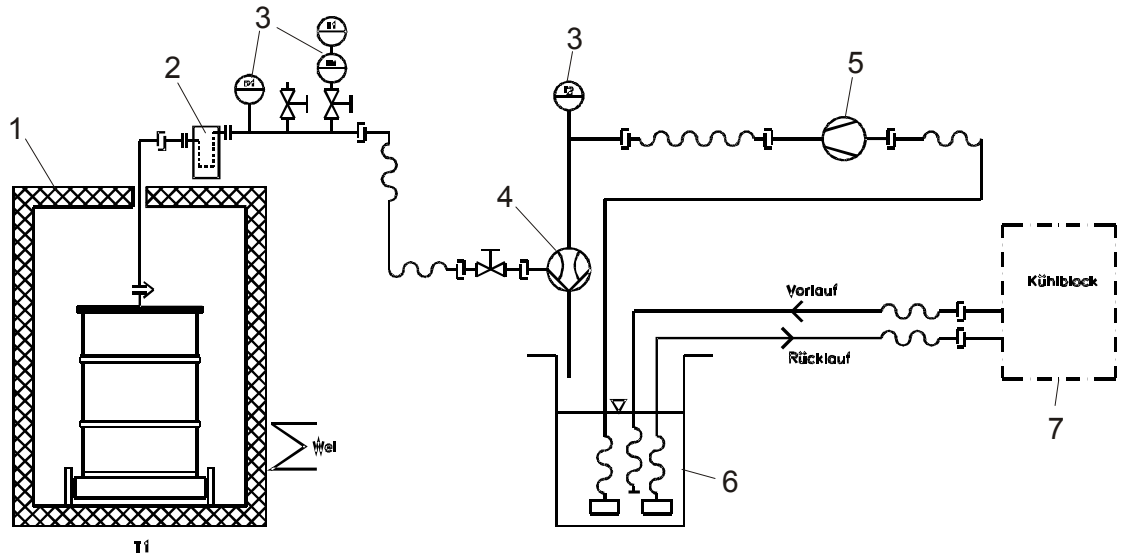


Fig. 1 Flow Sheet of the new Drying Facility

The main components in Fig. 1 are:

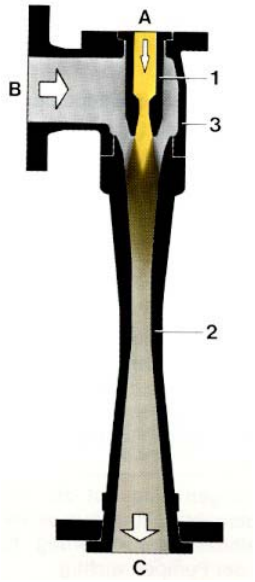
1 Heating Chamber for one 200 liter drum
2 Particle Filter
3 Measuring equipment for pressure, temperature and moisture
4 Water – Jet – Pump
5 High Pressure Water – Sucking – Pump (6bar)
6 Water Tank with thermal isolation
7 Cooling Station

The Heating Chamber is a closed system with a ventilation system and an electrical heating unit. Max 10kW heating energy is possible. In the tests the temperature inside the chamber was limited to 130°C.

The Particle Filter is installed to separate particles with a size greater then 100µm form the process – stream to protect the water – jet – pump.

The Measuring Equipment was installed to store the requested process – dates from the drying process in files on a standard – computer. The *Temperature* of the process – stream (moisture) and of the cooled water in the water – tank inside the connecting pipe in front of the water – jet – pump were measured with two Pt-100 thermometers.
The absolute *pressure* in the vacuum – system was measured using a standardized pressure monitor, useable in a range form 2000hPa to 1hPa.
To control the drying – process a *dew point measuring system* was installed. The dew point inside the process is the key – value to declare the waste inside the drum as dry in the meaning of the German rules for the final disposal of waste inside the final disposal facility.

The water – jet – pump (see Fig. 2) in that new drying facility is a standard water – jet – pump that is used in the chemical industry as a vacuum – pump to reach an total pressure down to 10 – 20 hPa (mbar). The reachable vacuum is only sloping to the temperature of the water inside the water – tank. Inside the water – jet – pump the moisture, that was taken from the waste inside the 200 liter drum in the heating chamber, condenses under nearly optimized conditions. So the water – jet – pump replaces the condenser and the vacuum – pump of the bigger PETRA Drying Facilities in one very small and simple component and makes the new facility so small.



High-Speed-Nozzle

Head

Diffuser

A: Water – Input
B: Steam – Input
C: Water and Steam Output

Fig. 2: Water – Jet – Pump

The High Pressure Water – Sucking – Pump is used to realize the requested pressure inside the water – jet – pump and to feed the cooled water permanent from the water – tank through the water – jet – pump. In the prototype facility a standard – industrial pump was used.

The Water Tank used in the prototype facility was a thermal isolated drum out of PE with a capacity of 100 liter. The tank was filled with 80 liters of water. The condensate from the drying – process is captured in the water – tank.

The water inside the water – tank was cooled using a Cooling Station in a industrial standard. Using the installed temperature – regulation, the temperature of the water was nearly exact 10°C.

DRYING TESTS WITH THE PROTOTYPE DRYING FACILITY AND RESULTS

To show that the new facility can also to be used for the drying of wet wastes, several tests were done with various materials with different amounts of water, which was filled in the 200 liter drums before the tests. The drums were connected to the water – jet – pump and the water inside the water – tank was cooled down to 10°C before the start of the drying process. In Fig. 3 the pressure inside the vacuum system is shown by drying a 200 liter drum filled with mixed waste and 1,0 liters of water per kilogram waste.

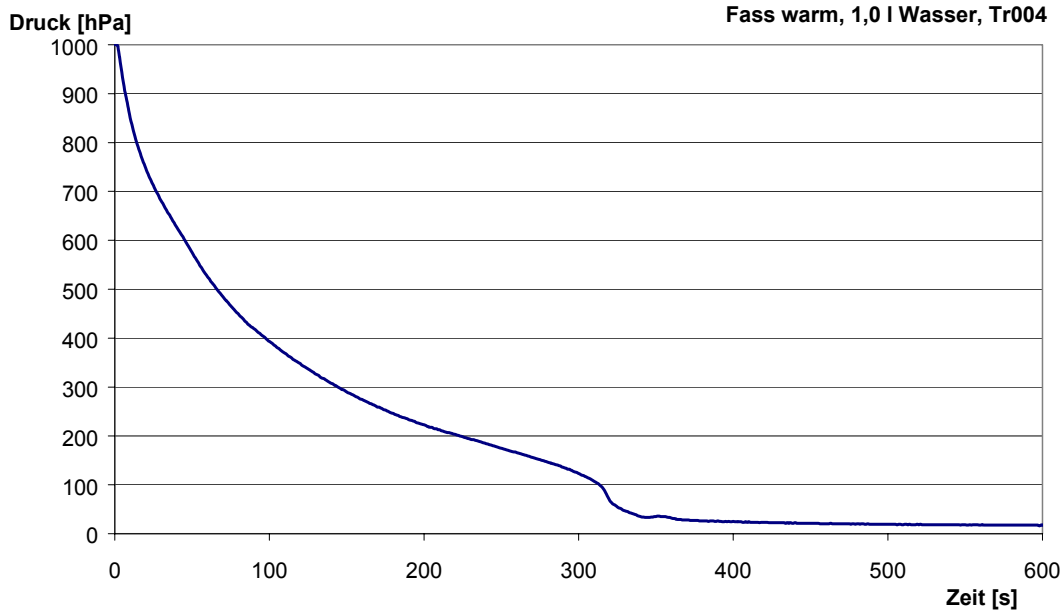


Fig. 3 Pressure During Drying a 200 Litre Drum with Wet Mixed Waste

Fig. 4 shows the complete drying process of the test with mixed waste with 1 liter water per kilogram waste inside the waste. The dew point temperature is shown in the graph 5. The pressure inside the vacuum system is shown in graph 1, the temperature of the water describes graph 2.

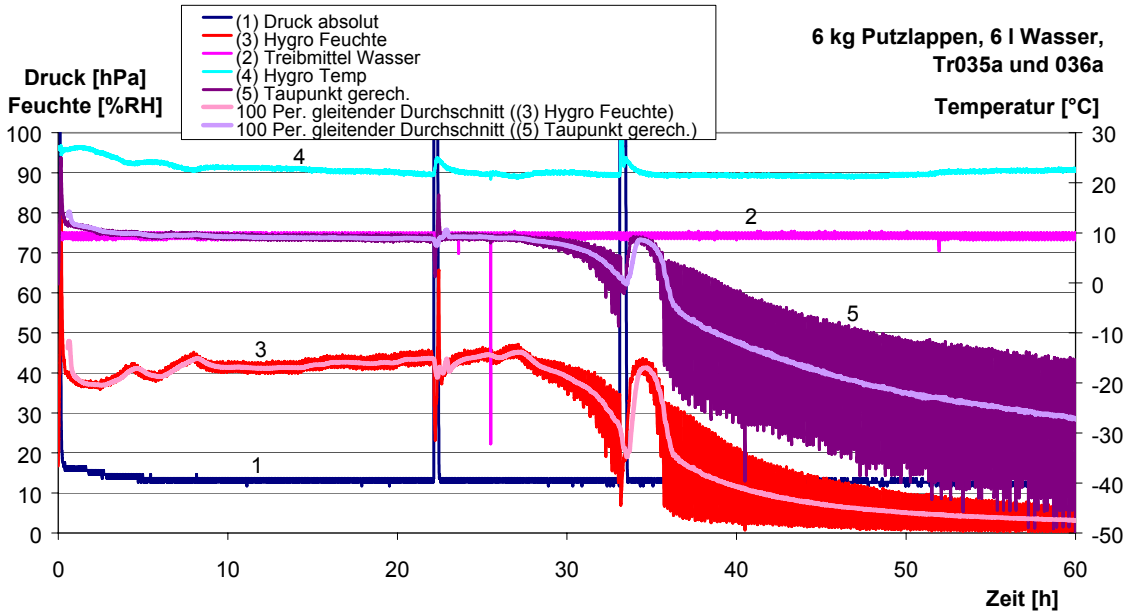


Fig. 4 Drying Process of a Test with Mixed Waste

CRITERIA FOR THE DRYING PROCESS

Usually the criteria to stop the drying process and to declare the waste inside the drums as dry in accordance to the regulations for the final disposal for the German final disposal facility is the amount of condensate per hour (less than 100ml/h each drum during a time of minimum 5 hours). This criteria is not being measured in the new drying facility because that small rise of water inside the water – tank is not be measured with "normal" measuring equipment. So GNS decided to take another criteria, that is also accepted by the German authority and the German experts for the declaration of waste under the rules of the regulatory for the final disposal facility. This criteria says, that the moisture inside the drum should not be higher than 80% of the moisture, measured in the environment of the facility at 25°C.
Using this criteria, you can declare the waste inside the drum as dry in accordance to the rules above, when the dew point temperature is less than 8,5°C. Tests after finishing the drying process of the mixed waste inside a 200 liter drum have shown, that the moisture inside the drum after cooling down to a temperature of 25°C was much more less than the measured 8,5°C. The test was done three times and the maximum humidity inside the drum under atmospherically conditions was always less than 20% (relative Humidity).

CONCLUSION

The tests of the prototype drying facility have shown, that it is possible to replace the components "Condenser, Vacuum Pump" and a lot of pipes with a water – jet – pump. The results of the drying tests with different materials have shown, that the new drying facility is even as fast than the other drying facilities that are installed in the NPP's in Germany.

That new small facility (requested space for the total installation: 4qm) can be installed at every location. In the prototype facility drying – rates of 1,5 to 2 liter per hour were reached.

Because of that advantages, the new facility is qualified to be installed in medicine centers and small research reactors or interim storage facilities where waste is stored for a long time to treat the drum before its delivery to the final disposal facility.

It is foreseen, to build an industrial standard drying facility for the mobile treatment - service of the GNS company.