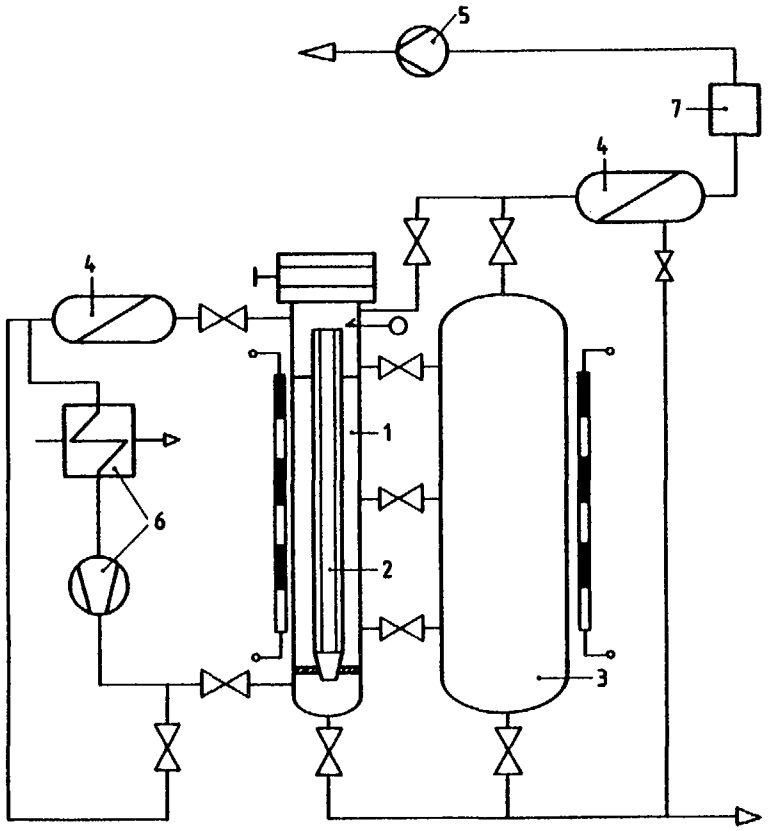

1 DISTILLATION VESSEL
2 FUEL ELEMENT
3 VACUUM TANK
4 SODIUM VAPOUR TRAP
5 VACUUM PUMP
6 COOLING SYSTEM
7 FISSION GAS MONITOR

FLOW DIAGRAM OF THE VACUUM DISTILLATION FACILITY FOR CORE COMPONENTS

FIG. 4

INTERATOM EXPERIENCE OF CLEANING SODIUM-WETTED COMPONENTS

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1. Introduction

INTERATOM has been concerned since 1967 with the development, testing, and application of methods to clean sodium-wetted components by moist nitrogen, vacuum distillation or alcohol.

The activities of INTERATOM in this area have been reported at the IAEA Specialists' Meeting on "Decontamination of Plant Components from Sodium and Radioactivity" in Dounreay, April 9 - 12, 1973 [1].

The three cleaning methods mentioned above are practised at present, too - with minor modifications - by INTERATOM and in the facilities of the SNR project.

This note summarizes the experiences of INTERATOM with methods of sodium removal since 1973.

2. Experience with Moist Nitrogen Cleaning

Cleaning of sodium-wetted components from INTERATOM test facilities is mostly performed by the moist nitrogen cleaning procedure which is also the reference method

for the SNR 300. The cleaning facilities of the SNR 300 and of INTERATOM have been described in detail elsewhere [1].

Particularly difficult is the removal of sodium from components having complicated geometries - e.g. blind holes, bend pipes, gaps etc. - where complete draining of sodium is not possible. In such circumstances, a layer of caustic soda is formed at the horizontal surfaces of the residual sodium which prevents complete chemical reaction.

An essential improvement in cleaning intricate components can be obtained by a special rotary plate (Fig. 1) developed by INTERATOM [2] which is installed in the cleaning tank. The components are fixed on the plate which, during the cleaning procedure, rotates at a speed of 2 r.p.m. Bellows valves, plugging meters, and small cold traps have been successfully cleaned by this method in a very short time (2.5 hrs.).

Cleaning of large components not suited for the rotary plate is performed in several steps: after the first step (no signal from the hydrogen monitor) the component is turned and cleaned in a second step; a third step follows, if required. Turning the component can produce sodium water reactions; therefore, special safety precautions are indispensible.

More than 100 cleaning processes have so far been performed in the INTERATOM moist nitrogen cleaning facility. Among the cleaned components are: two start-up cold traps of the KNK reactor, each with more than 50 kg of sodium, the prototype cold trap of the SNR 300 with a volume of 1.8 m^3, 20 cold traps and 15 sodium vapour traps, dissassembled absorber rods, vessels, pipings, and electro-magnetic pumps.

The process is carried out at temperatures below 110°C and with initial steam concentrations below 20 %, for safety reasons and to present corrosion damage. Cleaning a cold trap containing 30 to 50 kg of sodium requires approximately 50 hours.

3. Experience with Cleaning by Vacuum Distillation

3.1 General

Since 1971, INTERATOM has been carried out cleaning of sodium-wetted components by vacuum distillation. Cleaned were so far, almost exclusively, absorber rods and fuel-element dummies in connection with thermohydraulic and function tests.

3.2 Cleaning in the AKB Facility

Specially instrumented dummies of fuel and blanket elements as well as of absorber elements are tested in the INTERATOM Facility for Tests on Fast Breeder Core Components (AKB). After the test, adhering sodium has to be removed from the components for inspection.

Removal of sodium is performed in the test vessel itself, thus pollution of sodium adhering to the components and potential corrosion damage by sodium oxide and hydroxide during the distillation process can be avoided. Distillation is carried out at 580°C and 0.3 to 1.0 Torr; cleaning time approximately 10 hrs.

The whole series of the first and the second shut-down assemblies for the KNK reactor were cleaned successfully by this method. After cleaning, the surfaces were bright and free from sodium or sodium compounds. Unscrewing the

joints proved to be no problem, crevices, gaps, and screw threads were free from sodium and sodium oxide. After dissassembly, the parts were inspected, rinsed with demineralized water, dried,and re-assembled. Subsequently, the series were installed in the KNK reactor, and showed no failure during the total operation time of the KNK I.

The series of the KNK II shut-down assemblies and of SNR 300 shut-down assembly prototypes were successfully cleaned by the same method.

Likewise, sodium was removed very successfully by vacuum distillation from fuel elements after function tests (Table 1). The supporting elements used in the function tests were cleaned repeatedly and re-inserted in liquid sodium for a total of 10,000 hrs., without any damage.

3.3 Cleaning of Fuel Elements

A modified vacuum distillation procedure for cleaning spent fuel elements was developed by INTERATOM:

The fuel element is inserted in a small vessel which is gas cooled in the beginning. Then, the cooling is interrupted, and consequently, the temperature of the fuel element rises gradually by the decay heat. After a temperature of 550°C is reached, the vessel is suddenly evacuated to evaporate the sodium adhering to the fuel element. The gas cooling is switched on again as soon as the maximum allowable temperature is reached.

The first test results are very encouraging: a fuel element dummy could be successfully cleaned by this method in less than 30 minutes. Further results are reported in a separate paper at this meeting [3].

4. Experience with Cleaning by Alcohol

The alcohol cleaning procedure is applied only for small components at INTERATOM. The components to be cleaned are kept in an open tank filled with ethanol till the reaction is complete; they are then treated in an ultrasonic bath, rinsed with demineralized water, and dried in hot nitrogen.

Sodium sampling devices ("TNO harps") from INTERATOM test facilities are regularly cleaned by alcohol for the past seven years. The sodium receiver of this device is separated from the rinsing chamber by a bellows valve (Fig. 2). So far, the 15 existing sampling devices have been cleaned for a total of 300 times. After cleaning the unit is subjected to a helium leak test. Defective bellows are indicated by a higher leak rate, and have to be replaced. On the average, a valve has to be replaced after 30 cleaning procedures.

5. Characterization of Radioactive Surfaces

The behaviour of activated corrosion products and fission products in the SNR 300 primary system can be simulated in the SNR corrosion mockup loop operated by INTERATOM. Gamma-spectrometric measurements at the piping and removable samples allowed to determine the distribution of radionuclides in the loop and by-pass system.

Experimental results on the release and deposition rates of several radionuclides (e.g ^{54}Mn and ^{60}Co) are reported in a separate paper [4] at this meeting.

References

[1] H. Buchholz, W. Haubold:
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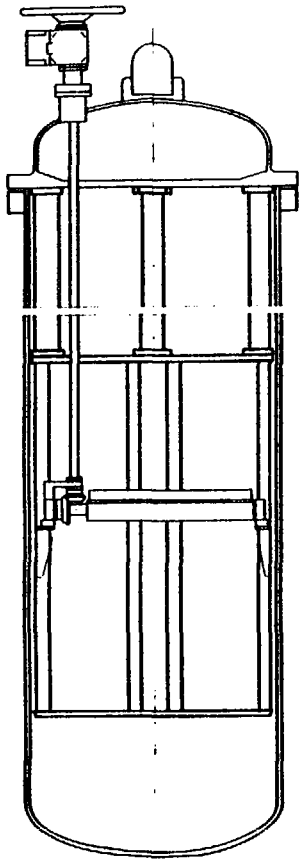
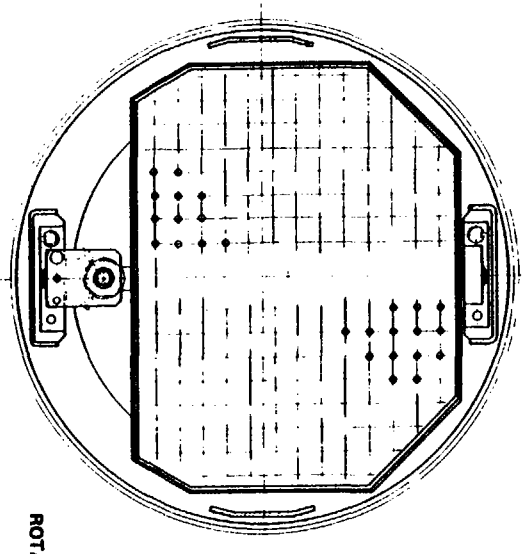
[3] E. Büscher, W. Haubold, W. Jansing, G. Kirchner:
Sodium Removal from Fuel Elements by Vacuum Distillation.
This meeting

[4] G. Menken, H. Holl:
Characterization and Experimental Aspects for Treatment of Radioactive Surfaces with Sodium Corrosion Mass Transfer Effects.
This meeting

Table 1: Cleaning of Core Components in the AKB Test Facility by Vacuum Distillation

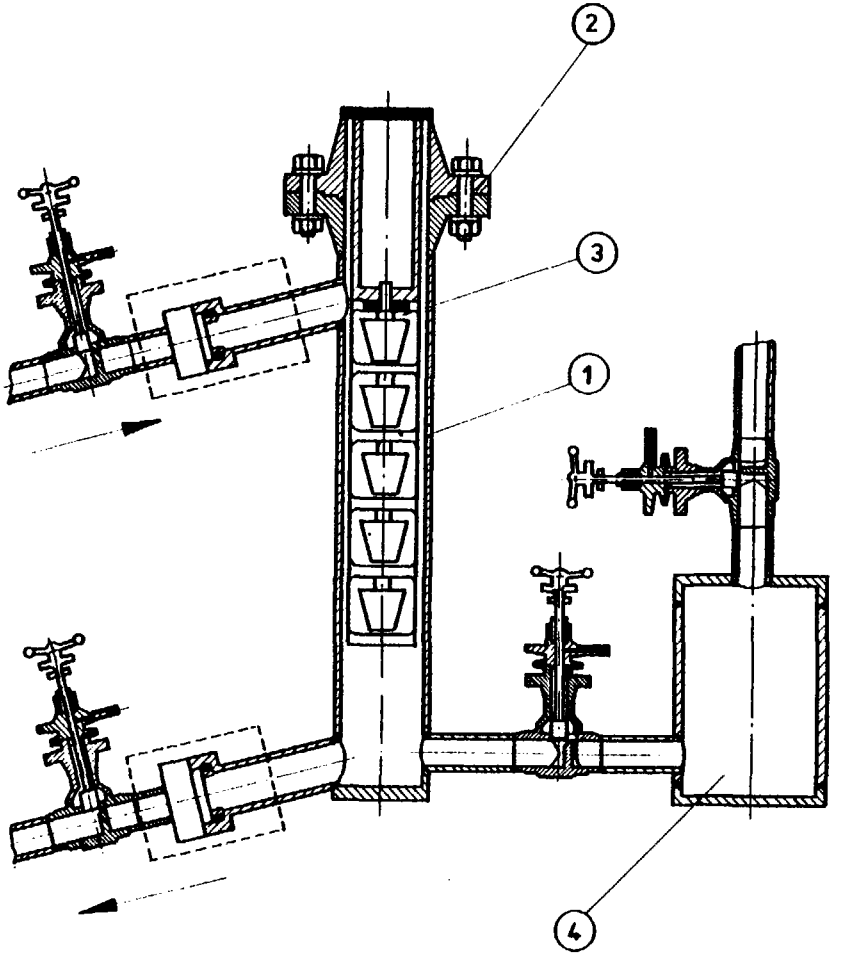
Date	Component	Distillation Temperature [°C]	Distillation Pressure [Torr]
29.3.72	2 Breeder Elements	650	3.2
20.7.72	Bundle of 7 Fuel Elements	650	3
14.11.72	UKAEA Fuel Element	550	3
15.1.73	Shut-down Assembly I	550	1.5
15.6.73	Shut-down Assembly II	580	3
15.6.73	UKAEA Fuel Element	580	1.5
18.10.74	Bundle of 7 Fuel Elements	580	1.5
11.4.75	Breeder Element Neptun	550	2.9
14.10.75	Bundle of 7 Fuel Elements	570	0.5
18.2.76	Breeder Element Uranus	580	0.3
10.9.76	Bundle of 7 Fuel Elements	580	0.4





ROTARY ASSEMBLING PLATE

Fig.: 1



SODIUM SAMPLING DEVICE

Fig.: 2