METHOD AND EQUIPMENT FOR TREATING WASTE WATER RESULTING FROM THE TECHNOLOGICAL TESTING PROCESSES OF NPP EQUIPMENT

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ABSTRACT

Modern methods and technologies coupled together with advanced equipment for treating residual substances resulted from technological processes are mandatory measures for all industrial facilities.
The correct management of the used working agents and of the all wastes resulted from the different technological process (preparation, use, collection, neutralization, discharge) is intended to reduce up to removal of their potential negative impact on the environment.
The high pressure and temperature testing stands from INR intended for functional testing of nuclear components (fuel bundles, fuelling machines, etc.) were included in these measures since the use of oils, demineralized water chemically treated, greases, etc.
This paper is focused on the method and equipment used at INR Pitesti in the chemical treatment of demineralized waters, as well as the equipment for collecting, neutralizing and discharging them after use.

Key words: demineralised water, environment management, waste waters

Introduction

The development, into an accelerated rhythm, of the industry, demographic explosion followed by the urbanization, destruction of some large forest area, degradation of some great rivers, release in the atmosphere of huge amount of foul gases, determined, in the last dozens of years, a significant disturbance of the environment.
Lack of the flop-out measures, until deletion, of the itemized causes, will determine an irreversible disturbance of the environment balance, with inestimable consequences, on long and average term.

At this stage of the human civilization, we still assist at situation as the safety regulations and laws of the environment are flagrant broken, as the technical – economic interests are coming first to the detriment of „pure life conditions" [1].

RATEN-INR Pitești is developing the complex research, design, fabrication, control and functional testing activities of the equipment for the nuclear area, operation of the nuclear plant and the equipment and material testing, activities that can result in waste with a possible impact on environment – at small scale.

The Out of Reactor Testing Department (TAR) from RATEN - Institute for Nuclear Research, has as endowment a series of installations to control and functional testing of NPP equipment for CANDU 600 type reactors.

The testing installations are operating at high pressure and temperature conditions, using as working agents: oils, demineralised chemically treated water, vaseline, etc.

Application of some modern methods and technologies, doubling by using of some efficient equipment for treating waste resulted from technological processes in installations are mandatory measures for the RATEN - INR Pitesti, also.

Because of the Environment Management is one of the major priority, and the environment performance has an increased meaning for all interested internal and external parties, the Board of Institute decided development and implementation of an Environment Management System, according to the SR EN ISO 14001/2005 requests. Complying with these requests will result in decreasing, until deletion, of the negative impact of the waste on the environment.

The preparation installation of water as working agent for testing rigs

The NPP components testing rigs (nuclear fuel, Fuelling Machines, etc.), represent an installations and equipment assembly capable to provide operation parameters (pressures, temperatures, flow rates) similar to those from reactor. The testing rigs are using demineralized, outgassed and chemically treated water as working agent, and complying with the testing request with: pH of 9.5 -10.5; a maximum conductivity of 30 µS/cm; the Oxygen remised in water = max. 200 ppb; content of un-dissolved solid slurry = max.0.2 mg/l [3].

The water preparation is carried out in the Water Preparation Station of the Out of Reactor Department (Fig 1).

To obtain the physical-chemical parameters of water (pH, Oxygen concentration, particulates, etc.) the substances used are:

- Lithium hydroxide;
- Hydrazine.

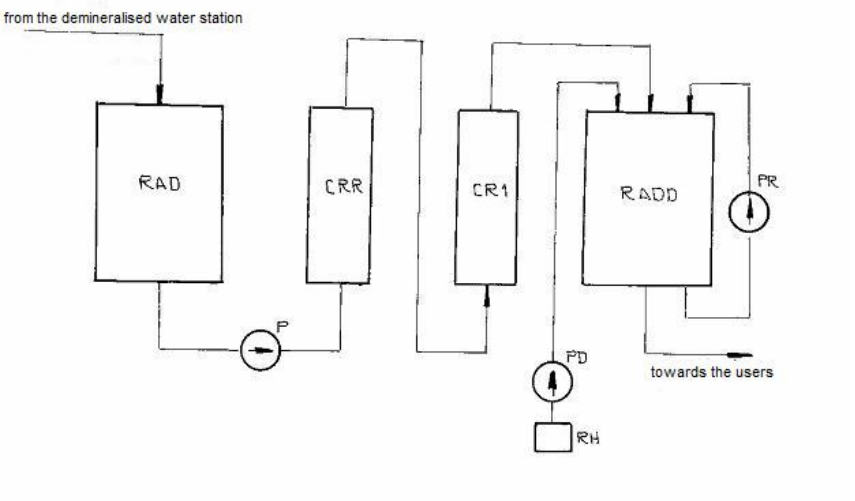

Fig. 1 *The outgassed and chemically treated demineralised System*

Where:
RAD - Demineralised water tank;
P - Pump;
CRR - Oxidation-reduction column;
CRI - Ion- exchange resin column;
RADD - Demineralised and outgassed water tank;
PD - Metering pump;
PR - Recirculating pump;
RH - Hydrazine collector.

Before chemical treatment, the water passing through complex ion-exchange filters. Then, complying with the procedure instructions, the water – poisonous substance mixture is carried out to obtain the specified parameters.

The thermo-hydraulic circuits of the Out of Reactor testing stands are closed, with round circulation, carrying-out a continuous transfer between water treatment station and thermo-hydraulic loops during testing, the water coming back through the return pipeline to the RADD [4].

After use, the industrial effluents are resulted. These are collected in the headers placed close by the testing installation. There are taking place the treating process in order to its neutralizations (pH < 8.5, hydrazine = 0). In each stage of the technological process, the water samples are taken off and Analysis Bulletins are issued.

Thus, the water is analysed for the following conditions:
- at the acceptance time;
- after treating in special vessels from outgassed station;
- during testing process, at time period well-established;
- before and after neutralization, in the collecting headers.

Fig.2. *The water treatment station – partial view*

After neutralization, the water is circulated to the INR Water- purification Plant, where the new Analysis Bulletins are issued after water is checked-out. The neutral water is finally discharged into environment, without any detrimental impact on it [2].

The component parts of the waste waters collecting and neutralization plant

The effluents resulted from water supply system of the Out of Reactor Department testing rigs contain Lithium hydride with concentration appropriate to a pH of 10.3 ± 0.2 and Hydrazine.

The Safety Regulations specific for the effluents discharge resulted from technological process impose a series of quality requests for the water following discharging to environment. From this point of view, the residual water from testing rigs exploitation have to comply with a Hydrazine concentration according to Standards and a pH between ranges 6.5 – 8.5. Because of this reason, these waters have to be chemically treated in order to complete Hydrazine deletion and to bring the pH between acceptance limits.

For the residual waters treating resulted in the technological NPP components testing process, have been required fabrication of a taking-over and circulating system to their collecting into drainage basin.

The components of the collecting and neutralization plant have been placed close by the testing rigs.

Have carried out:

- Two collecting and treating drainage basins for residual water;
- Separation of the meteoric water and industrial lines;
- Lines and component parts for effluents.

Fig.2. *The air discharge and effluents discharge/collecting pipes from testing rigs – partial view*

Have also provided the required equipment for barbotage, to decant and circulate the water to the INR Water-purification Plant [2].

The water treating method having hydrazine content

The chosen method is consisting in Hydrazine oxidation using an iodine solution into a slightly alkaline or neutral agent, at the room temperature. In this condition, are taking place the following chemical reactions:

$$2I_2 + N_2H_4 \rightarrow 4HI + N_2$$

$$HI + LiOH \rightarrow LiI + H_2O$$

The materials required for neutralization process are:

- The iodine solution of 0.5 N;
- Reacting substances and laboratory equipment for Hydrazine proportioning and the pH measuring.

The plant is operating as follows:

- The water is removed from installation into the treating tank, by gravity circulation through the pipelines;
- After about 15 minutes of bubbling the sample (1 l) is taken off to determine the Hydrazine content and the pH.
- After analysing the sample in the laboratory, is determined the iodine solution volume required to destruction the Hydrazine, taking into account the water volume being treated.
- Is bubbling with compressed air, adding, under stirring, the specified iodine solution volume.
- The stirring is going on during 30 minutes.
- The stirring stops, is taking off the sample for pH determination.
- In case of the solution pH decreased to the values less than 6, is adding under stirring, Sodium hydrate solution 1M, bringing the pH into range of 7.5 – 8.5.
- The stirring stops and is taken off sample for Hydrazine content determination.
- In case of the complete Hydrazine destruction did not took place, the above operations are iterating, adding an iodine solution volume established until getting the desired pH [5].

The water volumes balance-sheet from technological processes of NPP components testing

The amount of demineralized and chemically treated water volume supplied in the thermo-hydraulic circuits before starting a technological process, have to be equal to total of volumes collecting as effluents in the tanks, after testing process.

At the preparation stages of the testing installation and during tests, are necessary the water controlled discharges, for air discharge thermo hydraulic pipelines.

At the same time appear the losses due to leakiness, also. These are not significant quantitative. The building floor where the testing equipment are installed is all concrete and shows geometries (slopes, angles of surfaces) allowing the entire their collection.

In this case, the relation between the water volumes is as follows:

(1) $\Sigma v_i = \Sigma v_c$

where: Σv_i = total of the inlet water volumes;

Σv_c = total of the water volumes from collecting tanks after testing process.

$\Sigma v_c = V_P + V_{leak}$

where: V_P = the water volume used in the technological process;

V_{leak} = the water volume resulted after air discharge pipelines plus the loss volume due to leakiness.

After measurements, if the relation (1) is complying with there, is not uncontrolled loss of the residual water.

Conclusions

- The discharging, admission and transfer pipelines, of the residual waters as well as the collecting tank of them provide the tightness required through entire thermo hydraulic circuit lay-out, thus deleting the water loss;
- The new collecting system of the waste waters existing in the Out of Reactor Department provided and still does the entire collection of them.

- The solution chosen for the residual water treating / neutralization is simple and efficient;
- The impact over environment, in this case, is vanishing.

References

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