CONDENSATE TREATMENT IN BWR CIRCUITS BY FILTER DEMINERALIZER UNITS USING POWDERED ION EXCHANGE RESIN AT MEDIUM AND HIGH TEMPERATURE

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Abstract

Considering the radiation build-up in some BWR reactors, we make a correlation between this phenomenon and the condensate purification system applied and the point of its utilization into the circuits.
The application temperature of such a plant seems to have a very important role on the equilibria of metals contained in the reactor water and on the oxide composition.
The efficiency of the condensate polishing system and the corrosion control are the most interesting objectives to achieve and to maintain, to control and regulate the physical and chemical process in the feedwater and in the reactor water.
Up to date the technology owns major knowledge and a consistent know how on using chemical products in order to increase the condensate polishing system efficiency.
It is also considered a typical parallel case of a conventional power station and a secondary system of BWR units.

Our Companies have been involving for some years and for different reasons in the utilization of condensate purification system in Nuclear Power Stations (specifically BWR and PWR units).

Our continuous presence in different plants and in different situations, and also the examination of the obtained results has shown us that the application of the powdered resins filtration technology should be much better know and much more appreciated.
Much effort is spent on the limitation of activity build-up and the occupational exposure and also to reduce the corrosion and the position on fuel roads.

In this sense the condensate purification plants using powdered ion exchange resins as precoat material, has assumed a considerable importance for the feedwater purity characteristics.
Expecially referring to our experience on swedish BWR plants, we can without any doubt say that the limited radioactive build-up observed in these circuits must be correlated to quite a peculiar application of technology of filter demineralizer condensate purification sistems which are applied at a higher temperature in respect to other applications around the world.
In Sweden, the temperature of application of filter demineralizing plant using ion exchange powdered resin ranges from 65 to 93°C.
The lowest value of shut down radiation levels on reactor water clean up systems pipes has been observed in Oskarshamn 1 that has the higher application temperature of the condensate purification system (93°C).
The peculiarity, from our point of view is absolutely exceptional and unfortunately not enough is known and appreciated of powdered resins application at high temperature (90 - 95°C) and that it presents the following positive aspects:
1) At such a temperature in a thermal cycle it is possible to treat parts of heater drains which usually contain high levels of iron oxides.
2) At such a temperature the anion resin, constituing about 30% of the total precoat material, maintain part of its exchange capacity also after 15 working days.

120 3) The effectiveness on filtering suspended matters at this temperature is still high and particularly higher than those of granular resin which cannot be used at this temperature.

With the same quantity of influent suspended substances, we suppone 20 - 30 ppb of total iron, we can consider an outlet value in the best conditions of 2 - 3 ppb for condensate purification equipped with deep bed plant and 0,3 ppb for a condensate purification system equipped with powdered resin plant.

4) With a lower water viscosity at 90 - 95° it is possible to obtain on the filter demineralizers, run length of 3 - 4 weeks without noting increasing of differential pressure across the filter.

With the same crud load conditions but at a lower temperature (30°C) the higher water viscosity negatively influences the differential pressure across the filter and for this reason it is possible to have a much shorter run length in the order of 8 - 10 days with heavy repercussion on the radwaste costs.

5) At such a temperature a powdered resin precoat becomes a special type of chemical reactor.

Every type of oxide is retained on it.

If iron copper leaves the precoat layer to pass into the treated water, their form is in the majority a complexed form that is not able to carry any Co 59 into the reactor water.

These complexed forms are easily retained on the reactor water clean up system (filter demineralizers and/or deep beds).

Deep studies are going on to understand the stability of the complexed forms of the reactor water conditions.

At 90 - 95°C of temperature application anion resin release some amines (3 - 4 ppb) continuously in the feedwater.

The amine effect on the oxide already present in the reactor is very similar to that described by Dr. Sturla in his studies on the application of powdered resins at high temperature in conventional boilers (1).

Pratically the released amine from the anion resin is increasing the ratio $\frac{Fe^{++}}{Fe^{+++}}$ and taking copper into the solution.

As an ultimate effect we obtained a slow and continuous cleaning of the reactor.

The attached figure (1) is a symptomatic exemplification of the phenomenon that happened on a powdered resin layer applied in a conventional circuit (pH 9.1) at 133°C.

At this temperature some magnetite is solubilized.

At neutral conditions and lower temperature we can expect a similar configurations for the reaction between Fe^{++} and Cu^{+}.

The purification of condensate in full flow precoat filter with powdered ion exchange resin in different BWR circuits has permitted us to obtain very low limits of iron and copper in the reactor feedwater and consequently a very low transportation rate of Co 59.

With a titanium condenser and no deep beds in service, after having optimized the precoating sequence and the products to be used on the filter demineralizers, we have now the possibility to maintain in the feedwater a normal limit of 0,3 ppb of total iron and 0,1 of copper.

We are now trying to introduce on these plants the continuous use of bodyfeed system in order to increase the run length of the filter demineralizer decreasing the total operating cost.

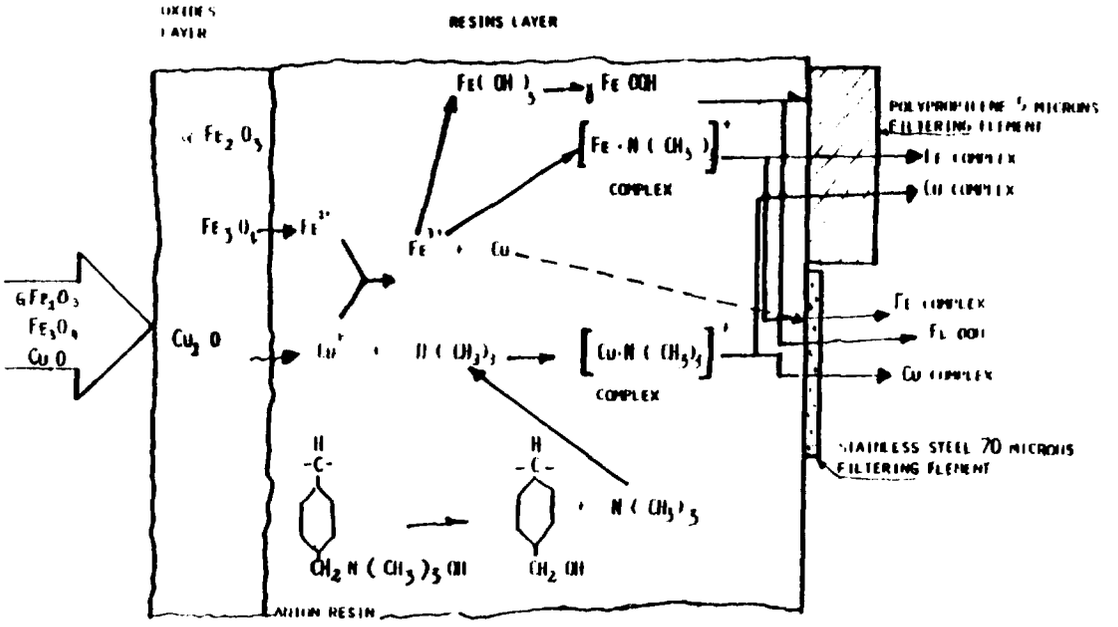
Our experience on condensate treatment in PWR secondary circuits is still too limited.

We have experienced this application at Ringhals 4 a swedish PWR unit. The cleaning efficiency of the filter demineralizers is very high and it permit us to get a very good water chemistry in a very short space of time, during the start-up period.

But the application at a low temperature (20 - 25°C) and the high ammonia content (pH 9.5) into the circuits, are heavy limitations to the possibility of application of powdered resins.

We would like to have in the future the possibility to change the current phylosophy increasing for example the temperature of application of the condensate purification system as already done in BWR circuits.

The italian experience of the high temperature application of powdered ion exchange resins in conventional once through boilers has convinced us that the new approach on the utilization of this product could carry interesting results in solving problems like erosion-corrosion and "denting".



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(1) " High pressure boilers feed water problems deposition on orifice valves". By P. Sturla.
American Power Conference - Chicago, 21 - 24 April 1975.