A brief Discussion on a Regeneration and Decontamination Process for Radioactive Waste Resin

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1. Background

A View of China’s Nuclear Power Industry

Operational Status of Nuclear Power Plant Capacity:

- 58 units operating plant
- Over 61GWe

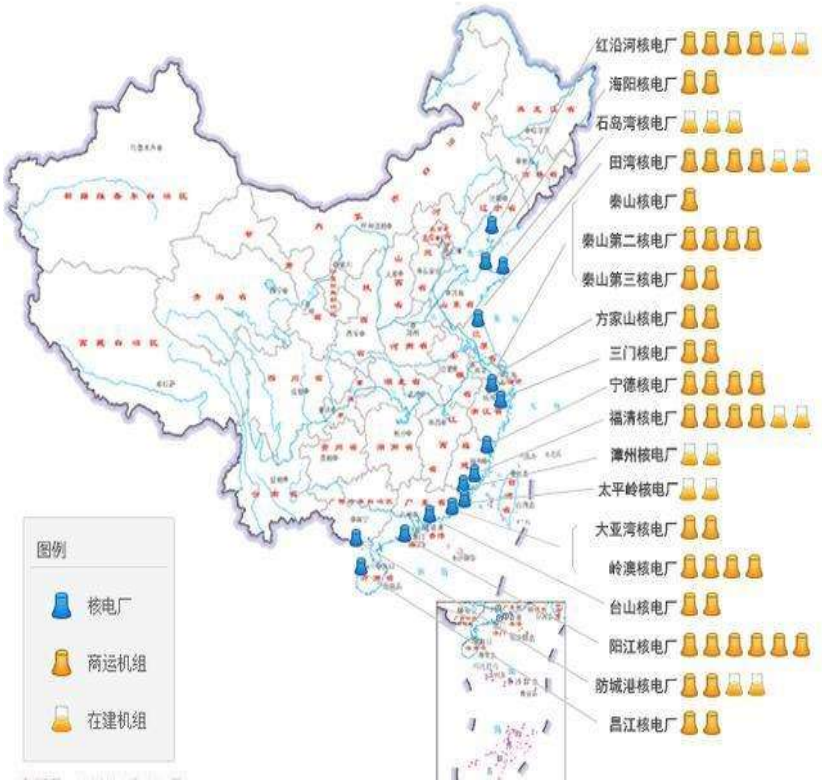
Installed capacity of nuclear power plants under construction

- 28 units under construction
- Over 33.6GWe

Distribution of Nuclear power plants

- Distributed along the east coast of the mainland of China
- Independently developed and operated by the four major power generation groups(CNNC,HUA NENG GROUP,CGN and SPIC)

Fig.1. the spread of NPP in China



1. Background

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the treatment problem of used radioactive ion exchange resins

◆ 1.produced volume of used resins of a typical 1GWe PWR anually

6-8m^3(Ion exchange resins are commonly used for the purification of the first loop coolant in the nuclear power plant)

◆ 2.Volume of cement curing treatment of used resins in a typical 1GWe PWR anually

15-21m^3(2-3times huger than the primitive resins),which amounts to about 1/3 of the annual output of solid waste from the nuclear power plant

◆ 3.lately applied treatment method of used radioactive resins waste

Technologies such as super compression and high integral container(HIC) dry storage are gradually applied in nuclear power plants.But the volume increase ratio of these two treatment methods is greater than 1,which is contrary to the principle of minimisation of the radioactive wastes.

2. Discovering problems

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New exploration of used radioactive resins treatment

number	name of the mathod	disadvantage
method 1	wet oxidation method	complicated process and high requirements on equipment
method 2	Supercritical water oxidation	complicated process and high requirements on equipment

Table.1. new exploration of used radioactive resins treatment

2. Discovering problems

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- **Radioactive metal ion forms in cationic resins**

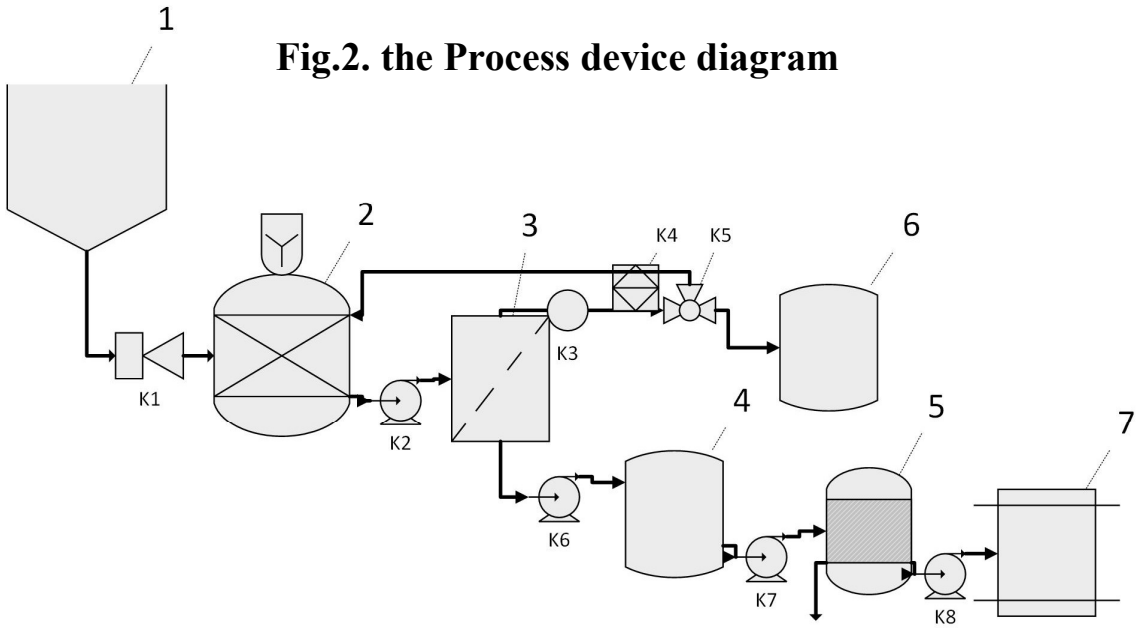
Except for a small number of metal ions contained in solid particles, most of the free ionic form is absorbed in the cationic exchange resins.

3. Solution to the problem

➢ the clearance way of the used radioactive resins

Main idea: With the help of the addition of sulphuric acid for elution,we can achieve the resin regeneration process,the adsorption of the radioactive metal ions from the resin can be restored to the free form into the elution residue,which means the radioactive used resins are radioactively decontaminated,or clean.

Fig.2. the Process device diagram



1 radioactive waste resin transfer device; 2 H_2SO_4 elution chamber; 3 resin elution residue separation room; 4 H_2SO_4 residual liquid neutralisation room; 5 waste liquid evaporation device; 6 decontamination room; 7 cement curing device; K1 resin injector; K2 transfer pump; K3 transfer pump; K4 radiation monitoring instrument; K5 three-way valve; K6 transfer pump; K7 transfer pump; K8 transfer pump

3. Solution to the problem

Process Flow Description

step1:The process flow is using the resin injector K1 to transfer the radioactive waste resin to the H_2SO_4 elution chamber (2) with agitator through the radioactive waste resin transfer device (1).

step2:after the radioactive waste resin is eluted by the full mixing of the H_2SO_4 solution, the waste resin and the sulphuric acid elution residue are transported to the resin elution residue separation room (3) through the transfer pump K2 to separate the solid and liquid.

step3:the separated waste resin passes through the transfer pump K3, and the radiation monitoring instrument K4 is set outside the pipeline to monitor the radiation level of the resin.

step4:when the waste resin reaches the level of decontamination, it is transported to the decontamination room (6) through the three-way valve K5 for temporary storage, and then it will be reused or disposed in a conventional way when the amount of the temporary storage is more than 2/3.

3. Solution to the problem

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Process Flow Description

step5:if the radioactivity level does not meet the requirements of the decontamination, the waste resin will return to the H_2SO_4 elution room (2) again; elution residual liquid which is seperated transports through the transfer pump K6 to the H_2SO_4 residual liquid neutralisation room (4) for acid and alkali neutralisation.

step6:neutralised residual liquid is sent to the waste liquid evaporation device (5) by the transfer pump K7 for evaporation and concentration.

step7:evaporative condensate is sent into the nuclear island liquid effluent emissions system, the concentrated liquid is sent to cement curing device (7) by transfer pump K8 for cement curing treatment.

3. Solution to the problem

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More details of the process

3 key devices

1.H_2SO_4 elution chamber

Two key elements are used in the H_2SO_4 elution chamber: the addition of a mechanical agitator(agitated for at lea-st 2 hours or more) and ensurance of the concentration of the sulphuric acid solution with a certain volume fraction (2-3 mol/L) .

2.Resin elution residue separation room

Adopts the method of filtering and intercepting to achieve the separation of waste resin and sulfuric acid elution solution.

3.H_2SO_4 residual liquid neutralisation chamber

the alkaline solution in the chamber used is NaOH（sodium hydroxide） solution, the concentration of which sh ould be such that the residual H_2SO_4 can be neutralised, and the pH after neutralisation is equal to 6-9.

Moreover,in order to reduce the cost of the peocess,we use nuclear power plant radioactive waste liquid evaporat-ion device to concentrate the neutralized waste liquid.

3. Solution to the problem

Superiority of the process

Great reduction of volume of the used radioactive resins waste

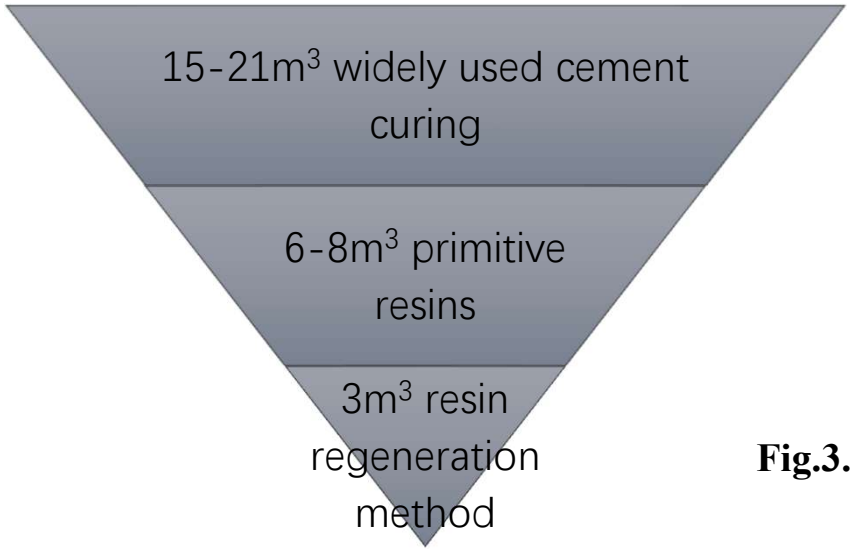

Fig.3. reduction of the volume of the waste resins

multi-purpose of the process

- the radioactive used resins was changed into common waste resin,which can avoid the problem of pollution of leaching of nuclides in the cement curing of the radioactive waste resin.
- the common waste resin can be further analyzed chemically to determine whether it meets the conditions for reuse,which can reduce the operational cost of the NPP.

4. Results and Discussion

Conclusion and Engineering Application

This process is analogous to the conventional resin regeneration technology, using the decontamination method of waste resin elution and regeneration of radionuclides, making it easy to reuse or dispose of ordinary waste resin, and curing the resulting concentrate liquid. The volume of radioactive waste resin is reduced, and the process does not require too much intervention by personnel, so this process has certain value for popularisation and application.

Q&A

Thanks you！

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