PROTECTION OF SILICA SCALE FORMATION IN THE GEOTHERMAL HOT WATER

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Introduction: In the hot water dominated geothermal areas, scale formation from supersaturated silica in the hot water frequently cause pluggings of pipes and vessels, and capacity of reinjection wells decreases. These cause difficulties in the normal operation of geothermal power plants, and increase the cost of geothermal power generation.

Specially, capacity decreasing of reinjection wells should be rapidly countermeasured because drilling wells take long periods and much money. According to recent reports, capacity decrease of reinjection wells are mainly caused with pluggings of penetrative underground layers by precipitation of silica in reinjection water. But capacity of reinjection wells are decreasing now in spite of various investigations formerly practiced, and so other new processes have been waited.

We have been researched and developed new silica removal process without capacity decreasing of reinjection wells. It is a process by coagulation and precipitation of silica in the hot water. This is adaptable to variations of plant operation and geothermal characteristics of wells, and cheaper than drilling new reinjection wells.

Experimental: Relations between total silica removal ratio and following items were researched with beaker test at the site.

Coagulant: Chlorides of Aℓ, Fe, Ca and Mg,
Assistant coagulant: Organic polymers
Temperature: Room temp. and 80°C, pH: 6 to 9
Total silica concentration: ∿800 ppm (polymerized silica 0 ∿ 50%)

Experimental apparatus made from plastics such as beakers and pipettes were used to protect contamination of silica precipitation on these surfaces. Dissolved silica (ionic silica) in the sample water was analyzed with molibdenum yellow method., total silica was analyzed with the same method after polymerized silica in the sample water had been dissolved with acid, and polymerized silica was obtained as a difference between total and dissolved silica.

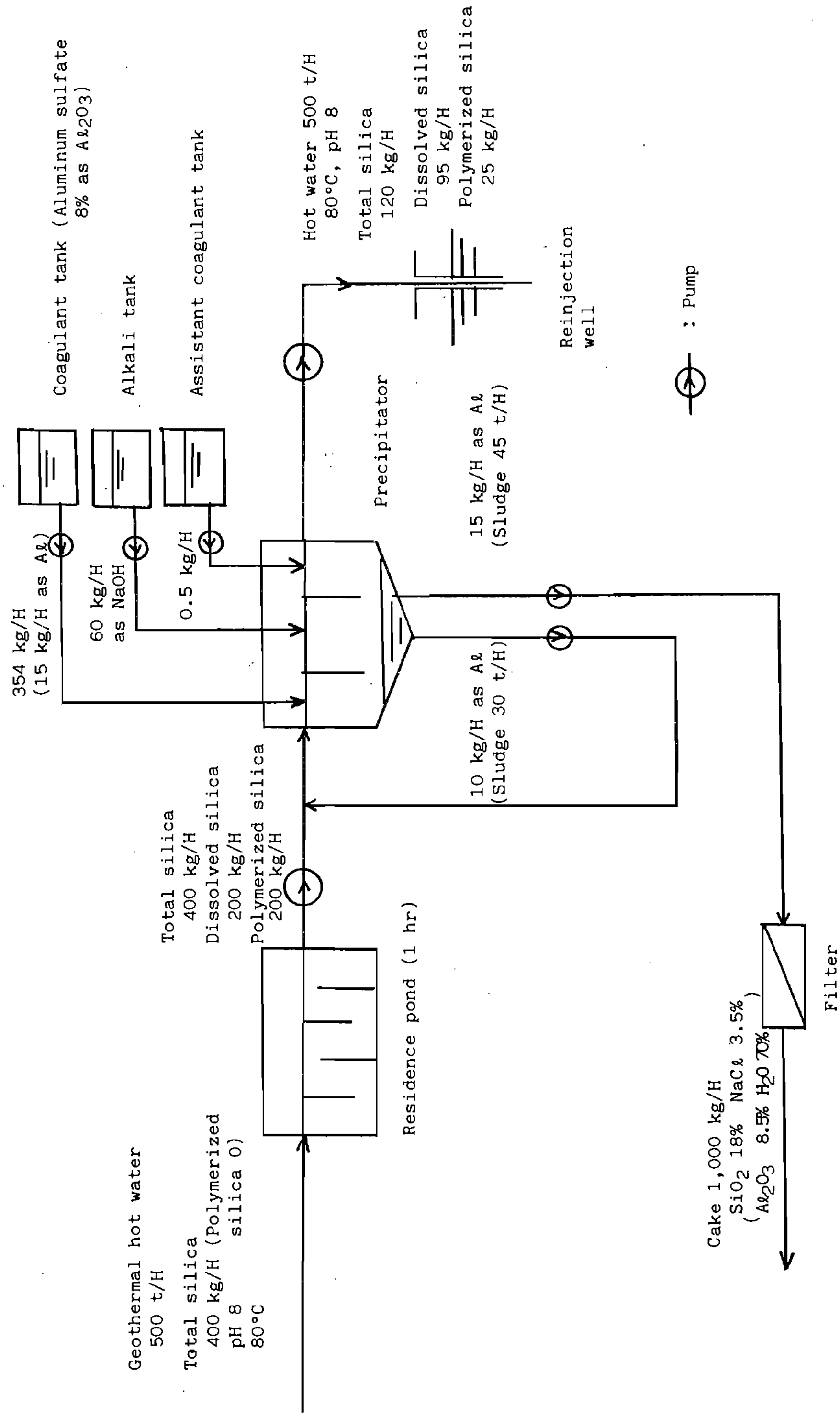
Results and Discussions: Following results were mainly obtained.

(1) Polymerizing rate of dissolved silica is maximum at the pH of 7 to 9.
(2) In the coagulation and precipitation process, polymerized silica is more removed than dissolved silica.
(3) Coaguiant of aluminum compound shows the highest silica removal ratio at the pH of around neutrality and 80°C.
(4) Among coagulants of organic polymers, cation organic polymers show the highest total silica removal ratio. Only 1 ppm of this assistant coagulant is added when aluminum compound is used as a coagulant.
(5) When coagulant of aluminum compound is added 30 to 50 ppm, further addition of 30 to 40% sludge at the bottom of precipitator reaches total silica removal ratio of 70 to 80%, which shows higher ratio of 20 to 30% comparing with no addition of sludge.
(6) Residence time of hot water in the precipitator takes about at least 1 hour judging from the sedimentation curve.

Conclusion: Based on the above test results, conception of our silica removal process in the geothermal hot water was shown as a following schematic diagram. Total silica concentration in the reinjected water decreases about 240 ppm which is equivalent to the saturated solubility of amorphous silica at 50°C. And so reinjection of water at 80°C causes no precipitation of silica in the penetrative underground layer.

Total costs of this process is counted as around two-hundred million yens per year including initial cost and running cost when depreciated within 15 years. Drilling of one reinjection well costs about two to four-hundred million yens in Japan and so costs of this new process is very attractive comparing other processes.

Further development themes are how to utilize the cake which is produced a few 10 tons per day, for example, as catalyzers, building materials and so on.



Schematic Diagram of Silica Removal Process in the Geothermal Water

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