

Removal mechanism of Al-bearing polysilicic acid from geothermal water by CTAB for the prevention of silica scaling

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In order to prevent the formation of silica scale during the geothermal power generation, removal of polysilicic acid from geothermal water by cationic surfactant at the laboratory was demonstrated. In addition, simultaneous aluminum removal was investigated based on our previous results; aluminum in geothermal water accelerates the formation of silica scale.

Stock solution of 500ppm Si was prepared and was diluted to be 400ppm Si at pH 8 for the sample solution. In addition, aluminum was added to be 5 ppm in the sample solution. To adjust the pH, HCl solution was used. When pH was fixed, the reaction time was considered to be zero. After silica polymerization was allowed for various reaction time, CTAB(cetyltrimethyl ammonium bromide) was added to be the concentrations of 10^{-3}M , 10^{-4}M , 10^{-5}M and 10^{-6}M , respectively. The aliquots of the sample solutions were taken and filtered by $0.45\ \mu\text{m}$ at adequate interval after addition of CTAB. Monosilicic acid and total silicic acid concentrations in the filtrate kept pH at 2 were determined by UV-1900 and ICP-AES 5300 (Perkin Elmer), respectively. The size of polysilicic acid in the filtrate from sample solutions were measured by Zetasizer-Nano.

Before addition of CTAB, the monosilicic acid concentration decreased with reaction time, while the total silicic acid concentration was kept for over the reaction time. The size of polysilicic acid increased with reaction time. Regarding to aluminum, its concentration decreased with decrease in monosilicic acid, indicating Si^{4+} in polysilicic acid was substituted by Al^{3+} . By addition of CTAB, the total silicic acid concentration also decreased with reaction time, suggesting that silica polymerization was accelerated due to electrostatic force between negatively charged Al-bearing polysilicic acid and CTA^+ . In contrast, the concentration behavior of monosilicic acid did not change at all, meaning CTAB only reacted with polysilicic acid. When 10^{-3}M and 10^{-4}M of CTAB was added, almost all polysilicic acid and aluminum were effectively removed from the solution. Those results clarify the possibility of prevention of silica scaling at geothermal power plants.