Recovery of oversaturated silica from Sumikawa geothermal brines with cationic polymer flocculants to prevent silica scale deposition

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The concentration of dissolved silica is increased in geothermal brine after vapor-brine separation and the solubility of silica is decreased with the temperature, so that dissolved silica in the brine becomes oversaturated. The oversaturated silica precipitates as amorphous silica and forms a silica scale. In particular, most of this scale contains aluminum to 10 wt% Al_2O_3 (Yokoyama et al., 1989, 2002; Ueda, 2002; Ikeda et al., 2015), and this scale has a solubility of approximately 150 mg/L lower than that of pure amorphous silica (Gallup, 1997a). This scale causes clogging of the ground piping, the reinjection well and the surrounding formation, which causes a decrease in the amount of reinjected brine.

Several beaker tests for the recovery of oversaturated silica in geothermal brines were performed with cationic precipitants to prevent silica scale deposition. The tests were conducted at the Sumikawa geothermal plants. The brine was mixed with cationic flocculants and the reaction was studied from the start of the experiment (NRT, no retention time) and for 15 minutes retention time (15RT) at 90 °C. The concentration of silica in the brine at Sumikawa was initially 1,150 mg/L and the final concentration after addition of the flocculants decreased linearly with increasing reagent concentration. When the reagent was added, the silica concentration at 15RT was 200 mg/L lower than at NRT. The total silica concentration almost reached the solubility limit (380 mg/L) of amorphous silica at 90 °C upon addition of 50 mg/L reagent. At Takigami, the silica concentration decreased by 100 and 150 mg/L from the initial brine at NRT and 15RT, respectively, upon addition of 50 mg/L reagent. These results indicate that the cationic flocculant reacts with polymeric silica rather than with monomeric silica and that 50 mg/L of the cationic flocculant is sufficient to reduce the silica concentration to the solubility of amorphous silica at 90 °C. With this treatment, the turbidity of the brine becomes lower than 10 mg/L. The sedimentation rates of precipitated silica in the brine by addition of the cationic flocculant were also measured. The rate at which the precipitate reacted with monomeric silica was faster than that with polymeric silica.