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Formation of Mg-Silicate Scales and Inhibition of Their Scale Formation at Injection Wells in Geothermal Power Plant

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Abstract : Scale precipitation causes a major issue for geothermal power plants because it reduces the production rate of geothermal energy. Each geothermal power plant's different chemical and physical conditions can cause the scale to precipitate under a particular set of fluid-rock interactions. Depending on the mineral, it is possible to have scale in the production well, steam separators, heat exchangers, reinjection wells, and everywhere in between. The scale consists mainly of smectite and trace amounts of chlorite, magnetite, quartz, hematite, dolomite, aragonite, and amorphous silica. The smectite scale is one of the difficult scales at injection wells in geothermal power plants. X-ray diffraction and chemical composition identify this smectite as Stevensite. The characteristics and the scale of each injection well line are different depending on the fluid chemistry. The smectite scale has been widely distributed in pipelines and surface plants. Mineral water equilibrium showed that the main factors controlling the saturation indices of smectite increased pH and dissolved Mg concentration due to the precipitate on the equipment surface. This study aims to characterize the scales and geothermal fluids collected from the Onuma geothermal power plant in Akita Prefecture, Japan. Field tests were conducted on October 30–November 3, 2021, at Onuma to determine the pH control methods for preventing magnesium silicate scaling, and as exemplified, the formation of magnesium silicate hydrates (M-S-H) with MgO to SiO2 ratios of 1.0 and pH values of 10 for one day has been studied at 25 °C. As a result, M-S-H scale formation could be suppressed, and stevensite formation could also be suppressed when we can decrease the pH of the fluid by less than 8.1, 7.4, and 8 (at 97 °C) in the fluid from O-3Rb and O-6Rb, O-10Rg, and O-12R, respectively. In this context, the scales and fluids collected from injection wells at a geothermal power plant in Japan were analyzed and characterized to understand the formation conditions of Mg-silicate scales with on-site synthesis experiments. From the results of the characterizations and on-site synthesis experiments, the inhibition method of their scale formation is discussed based on geochemical modeling in this study.

Keywords : magnesium silicate, scaling, inhibitor, geothermal power plant
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