Monitoring silica precipitation using fiber optic sensors

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Only few sensors are known that measure the kinetics of mineral precipitation and crystal growth while operating at elevated temperature, pressure, and salinities. A novel attempt for this purpose is the use of fiber optic sensors that can operate at those harsh conditions and measure the attenuation of light sent through a glass fiber, based on the principle of refraction between the fiber and a medium coating it.

This correlation was already observed by Boerkamp et al. (2007), who found a relationship between the attenuation of the radiation guided within the fiber and the thickness of calcite precipitation (0.5 -6 µm) covering the fiber.

In our study, first, a systematic approach was undertaken to determine the parameters affecting the signal attenuation such as temperature, bending, and length of the sensing (decladded) fiber. Subsequently, silica precipitation experiments were conducted.

Silica is of special concern as an abundant mineral scale in geothermal environments, where high concentrations of dissolved silica often occur due to high fluid temperatures. However, silica precipitation upon cooling of oversaturated silica solutions is hardly predictable due to polymerization of monomeric silica molecules.

In our study, the process of silica polymerization and precipitation was monitored. For that purpose, an optical fiber was immersed in an oversaturated solution at controlled laboratory conditions. Over time (120 h), both monomeric and total silica (by a spectrophotometric method and ICP-OES, respectively) were analyzed. Simultaneously the transmission properties of the fiber optic sensor were measured.

Boerkamp, M., Lamb, D.W. and Lye, P.G., 2007. Using an intrinsic, exposed core, optical fiber sensor to quantify chemical scale formation. In Journal of Physics: Conference Series (Vol. 76, No. 1, p. 012016). IOP Publishing.