Effects of pH on SAGD Boiler Blow-Down and Spectro-Fluorescence Analysis

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The SAGD boiler blow-down (BBD) water contains high concentration of dissolved organic matter (DOM), total dissolved solids (TDS), and dissolved silica. The pH of BBD is highly alkaline (above 11), but prior to disposal, the pH of the BBD is typically reduced. This can cause silica-DOM co-precipitation, with several associated problems, such as fouling of filters, equipment, and clogging of disposal wells. The silica-DOM co-precipitation caused by variation of pH, as well as the chemical signature of the precipitated DOM is investigated in this study. We systematically acidified the BBD water to different terminal pH values, determined the extent of precipitation, and studied the nature of the precipitate and supernatant using characterization techniques for water soluble organic matter. In particular, we used fluorescence excitation emission matrix (EEM) spectroscopy to obtain a fingerprint of the soluble and insoluble organic matter. Spectro-fluorescence analyses of the supernatants obtained at different pHs show a reduction in intensity of hydrophobic acid fluorophores with decrease in pH. The specific UV absorbance at 254 nm ($SUVA_{254}$) of the supernatant predicts that the humic-like hydrophobic fractions precipitate at acidic pH. Furthermore, we extracted the acid precipitated organic matter (after acidification to pH 2) into methanol, re-dissolved the dried acid extractable organic matter in water, and studied its precipitation behavior with pH variation. It was evident that this organic fraction precipitates on its own even in absence of silica. From these studies we elucidate the mechanisms of co-precipitation of silica and organic matter with pH changes. In highly alkaline solutions, silica exists as dissolved silicate. The organic matter also remains highly solubilized. As the pH is reduced, silica aggregation occurs by polycondensation. Furthermore, the organic acid salts present in BBD forms free acid, which become insoluble in aqueous media and precipitate. Presence of silica in BBD provides additional sites for these organic materials to precipitate. The interactions between siliceous and organic components result in more aggressive co-precipitation of silica and DOM.