Contribution ID: **985** Type: **Poster**

Chelation for filter regeneration: wave structures and process optimization

Wednesday, 16 May 2018 17:30 (15 minutes)

Treatment of water for human consumption often involves filtration through reactive porous media, such as activated carbon, or metal oxides. The sorption of contaminants inevitably leads to a depletion of available free sites and therefore a decrease in efficiency. A possible technique to regenerate filtration systems is the use of chelation agents. Such compounds, i.e. ethylenediaminetetraacetic acid (EDTA), readily form aqueous complexes with heavy metals. The introduction of a chelating agent into a filtration system thus forces the contaminant off the surface and into the mobile aqueous phase. Here we investigate the effect of chelation agents on the transport behavior of the chromium-iron oxide-proton-EDTA system through chromatographic theory. The analysis leads to a regime diagram in the phase plane illustrating the fundamental wave structures. A unique feature of this system is a Cr desorption shock which travels at the fluid velocity. This is in contrast to classic chromatographic theory, where shocks are brought about by sorption and are often retarded relative to the fluid velocity. The filter material can therefore be theoretically regenerated with one pore volume, a marked improvement from classic competitive sorption alone. We go on to optimize the filter regeneration process by engineering feed water composition (pH-EDTA) to minimize flush water volume and chelate mass usage.

References

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Session Classification: Poster 3

Track Classification: MS 1.11: Conservative and Reactive Transport of Charged Species in Permeable and Impermeable Porous Media