Contribution ID: **993**

Type: **Oral Presentation**

Particle-laden fluid flow in fractures: particle transport, deposition and clogging

Monday, 22 May 2023 17:15 (15 minutes)

Fluid flow through fractured rock masses determines groundwater resource utilization, contaminant transport and remediation, resource recovery (oil and gas, geothermal), and energy waste storage (CO2 geological storage). While the matrix determines storativity in most cases, fractures with high transmissivity control fluid flow. Fluid flow through fractures may be accompanied by particle transport, including detached native fines or injected proppants and lost circulation materials. Small-scale experiments fail to capture the radial-dependent inertial effects and particle clogging patterns that can emerge away from injection or extraction wellbores.

This research explores divergent particle-laden fluid flow through large-scale fractures. We designed and built a large-scale parallel-plate setup (diameter=900 mm) to mimic fractures with different surface topographies and apertures. The device is instrumented with multi-physics sensors, while the transparent plates facilitate real-time visualization and particle-tracking. We explore particles with different sizes, shapes and specific gravities (including quasi-buoyant and dense particles).

Experimental results, numerical simulations and energy-based analytical solutions highlight the development of an annular zone with negative pressure away from the central injection point (previously reported in very few publications in other fields). Annular depressurization is more apparent as the fluid flow rate increases, i.e., at high Reynolds numbers, and it is anticipated under field conditions during drilling (particularly while traversing high aperture fractures) or when imposing high fluid injection rates.

Quasi-buoyant particles follow the fluid streamlines. However, local changes in the fluid velocity field during radial flow can enhance particle retardation, which changes the local particle concentration and enhances the probability of clogging. Dense particles transported along horizontal fractures settle to form an annular “dune”during divergent radial flow. Experimental and numerical results show the interplay between particle concentration, fracture aperture and injection flow rate on the dune topology and its radial distance to the injection port. Particle deposition patterns and the resulting dune topology become more complex in fractures with rough surfaces or shear-induced anisotropic transmissivity. Analytical and numerical studies investigate the relative role of the various parameters involved.

Participation

In-Person

References

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

Saudi Arabia

Acceptance of the Terms & Conditions

Click here to agree

Energy Transition Focused Abstracts

Primary authors: HAFEZ, Ahmed (KAUST); LIU, Qi (KAUST); FINKBEINER, Thomas (Kaust); SANTAMARINA, J. Carlos (Georgia Tech)

Presenter: HAFEZ, Ahmed (KAUST)

Session Classification: MS03

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media