

Title: A discrete element model (DEM) for swelling behavior of clay

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Abstract:

Swelling of Shale-rocks create several problems [1] during underground drilling operations, such as stuck-pipe/drill-bit. However, swelling of shale-rocks can close the gaps between rock (wellbore) and casing –therefore no cementing is needed – which can save a lot of time and money and such a “natural” closing ensures “no-leakage” during further drilling and production phases. The field experience reveals that some shale-rocks are good candidate for swelling and some are not. It is believed that, amount of clay is the most important factor for shale-swelling. There are several other parameters that can influence the swelling behavior, such as- porosity, quartz contents, clay-cluster distribution, stress difference between field and drilling zone etc. Therefore, to plan a safe and efficient drilling through shale-rocks, we should understand the swelling mechanism of clay.

To investigate swelling of clay, we have introduced a discrete element model (DEM), based on Monte-Carlo technique. We define a probability of swelling for all the clay grains in the shale-rock sample that includes the effect of stress-difference, porosity, temperature etc. The time evolution of grain swelling results in bulk swelling behavior of the sample and the simulation result qualitatively matches [2] with the observations of shale/clay swelling experiments [3,4]. The Monte-Carlo based DEM code has been studied [5] for the entire parameter space by varying several important inputs like porosity, clay-quartz contents, stress difference, temperature etc. In addition, the mass-transport phenomenon has been implemented by considering clay grain movement through fractures (flow channels).

References

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