7.4 **Modeling of mechanical interactions of proppant and hydraulic fractures for in-situ oil shale retorting**

Hai Huang, Zhijie Xu, Thomas Wood, Carl Palmer, Earl Mattson

Idaho National Laboratory, Idaho Falls, ID, United States

Several in-situ oil shale retorting strategies require creation of either vertical or horizontal hydraulic fractures and injection of proppant to facilitate the flow of generated hydrocarbon fluid. An important issue is to reliably model the mechanical interactions between proppants and hydraulic fractures during heating and to quantify/predict the degree of proppant embedment into the shale matrix and associated reduction in fracture aperture under both thermal stress and confining stress (i.e. overburden). An extended 2D discrete element model (DEM) that incorporates the effect of plastic deformation of oil shale was developed and applied to the problem of modeling proppant-fracture mechanical interactions. The softening of the shale rock due to retorting and the development of localized plasticity zones near the surface of fracture walls was shown to be critical to the degree of proppant embedment and fracture closure. The 2D DEM model was carefully calibrated to realistic shale and proppant mechanical properties. Sensitivity studies were performed to systematically investigate the effects of mechanical properties of oil shale and proppants, proppant size, fracture closing stress, on the degree of proppant embedment into the shale formation and reduction of fracture aperture. The proppant size (diameter) has a significant effect on fracture closure. Greater average embedment and fracture closure were observed for the 20/40 proppant than for the smallest proppant (40/70) used in the sensitivity studies. These results suggest that the DEM model that includes plastic oil shale deformation is an effective predictive tool to quantify proppant embedment and the associated fracture aperture reduction under high temperature/stress environments representative of some proposed in-situ oil shale retorting strategies.