Hydraulic fracturing is a necessary tool to access the unconventional oil and gas reserves (such as shale and coal seam gas) needed to meet short-to-medium term global energy demand. It has been widely used as a panacea to improve the production of a well without a complete understanding of the physical mechanisms occurring.

Proppant transport through a fracture is known as a key factor governing the efficacy of a treatment. Greater understanding of how this occurs during an operation may enable optimisation of fracturing treatments.

Conventional modelling techniques inaccurately treat proppant as a continuous property of the fluid. This approach loses physical details of the collisions occurring in the system.

This study uses a combined approach to resolve thermal suspension behaviour. The particles are modelled using the discrete element method (DEM). Particle motion is determined through numerical integration of Newton’s second law.

\[ m \ddot{x} = F_{\text{Drag}} + F_{\text{Contact}} \]

The hydrodynamics of the simulation are resolved through the lattice Boltzmann method (LBM). In this approach, distribution populations \( f_i \) are transmitted and relaxed upon a Cartesian grid of nodal locations. Macroscopic fluid properties are found as a function of these populations.

\[ f_i(x, t + \Delta t) = f_i(x, t) - \frac{1}{\tau_f} \left[ f_i(x, t) - f_i^{eq}(x, t) \right] + \frac{1}{4\Delta x^2} G \cdot c_i \]

A second, \( g_i \), population captures all thermal behaviours.

\[ \sum_i f_i = \rho \quad \sum_i f_i c_i = \rho u \quad \sum_i g_i = T \]

Appropriate conjugate heat transfer between the proppant and the surrounding fluid has been achieved using extra forcing terms in the relaxation of the thermal population.

The longer settling times in the thermal cases indicate that understanding this behaviour could improve proppant transport and help design better fracturing treatments.

This model is currently able to capture changing thermal interactions within a particle suspension. Incorporating the change in physical properties of the fluid phase with temperature will capture the complex behaviour of fracturing fluids used in industry.