Numerical simulation of simultaneous multiple fractures initiation in unconventional reservoirs through injection control of horizontal well

Chuang Liu[a], Fang Shi[a], DeTang Lu[a], HengAn Wu[a,*], Han Wang[a] and He Liu[b,*]

[a] CAS Key Laboratory of Mechanical Behavior and Design of Materials, Department of Modern Mechanics, University of Science and Technology of China, Hefei, 230027, Anhui, P. R. China

b PetroChina Research Institute of Petroleum Exploration & Development, Beijing, 100083, P. R. China

*Corresponding authors, Email: wuha@ustc.edu.cn, liuhe@petrochina.com.cn

Simultaneous fracturing stimulations of horizontal well have been wildly used in unconventional reservoirs as effective tools for promoting productivity. The propagation of hydraulic fractures is driven by high fluid pressure. However, due to the stress shadow effects, fracture lengths and widths of some perforation clusters may be restricted. We present a numerical model to simulate nonplanar fractures simultaneous propagation in porous media based on the extended finite element method (XFEM). The volume of hydraulic fluid flowing into each fracture is dynamically calculated in this model. Sensitivity studies of formation parameters on fractures geometry of simultaneous fracturing are presented. In-situ stress contrast is found to be the main factor controlling the fractures propagation. The propagation of interior fracture will be restricted or compressed to be closed in the vicinity of the horizontal well. The influence of injection rate, perforation diameter and perforation numbers on fractures geometry is studied. Strategies to optimize fractures geometry are presented through injection control of each fracture. The presented method can be used in horizontal well design to achieve reasonable fractures geometry.

Keywords: simultaneous fracturing, XFEM, horizontal well, fracture geometry, perforation friction