MULTIPLE STAGE HYDRAULIC FRACTURING IN A NATURALLY FRACTURED RESERVOIR VIA XFEM

Gutierrez E. Renato*, Mejia S. E. Cristian†, Roehl Deane† and Romanel Celso †

* Institute TECGRAF and † Department of Civil and Environmental Engineering, Pontifical Catholic University of Rio de Janeiro, R. Marquês de São Vicente, 225 - Gávea, Rio de Janeiro - RJ, 22451-000, renatogu@tecgraf.puc-rio.br, crisms@tecgraf.puc-rio.br, deane@tecgraf.puc-rio.br, romanel@puc-rio.br, https://www.tecgraf.puc-rio.br/

ABSTRACT

The future of oil and gas industry depends on understanding and predicting well performance during hydraulic fracturing operations. The development of methods that guide operators in locating, drilling and pressurizing wells is essential to make the fracking process more effective. Recently, hydraulic fracturing operations use different stimulation schemes where multiple hydraulic fractures are initiated along adjacent horizontal wells and multi-stage fracturing is performed. Schemes such as simultaneous [1], sequential [2], modified zipper-frac [3] and Texas two-step [4] hydraulic fracturing are used. Modified zipper-frac involves fractures from two lateral wells situated in a staggered pattern whereas in Texas two-step after fluid injection into the first interval, by moving towards the heel, a second interval is stimulated, then a third interval is stimulated between the two previously fractured intervals. The stress shadowing owed to the presence of multiple induced and natural fractures can affect fracture geometry: length, aperture, height, and propagation direction. Therefore, the design of multiple hydraulic fracturing treatments should consider fracture interaction. This paper focuses on a performance comparison between the four schemes when hydraulic fracture spacing and intersection angle between induced and natural fractures are varied. In this study, the eXtended Finite Element Method (XFEM) was implemented in a fully coupled hydro-mechanical framework to simulate the initiation and propagation of multiple fractures along arbitrary, solution-dependent paths. The stress shadowing effects on hydraulic fractures in a naturally fractured reservoir are investigated for each scheme. Different fracture spacing will lead to different stress conditions, which can prevent/enhance secondary hydraulic fractures. Texas two-step compared with conventional simultaneous fracturing reduces the effective fracture spacing (FS) in a horizontal wellbore and results in more-efficient completions. Additionally, exists risk of connecting adjacent wellbores if opposing fractures become very close. Moreover, increasing fracture complexity stimulates larger drainage areas due to intersection with natural fractures.

REFERENCES

[1] X. Chen, Y. Li, J. Zhao, W. Xu, and D. Fu, “Numerical investigation for simultaneous growth of hydraulic fractures in multiple horizontal wells,” *J. Nat. Gas Sci. Eng.*, vol. 51, no. November 2017, pp. 44–52, 2018.

[2] C. Liu *et al.*, “Optimal spacing of sequential and simultaneous fracturing in horizontal well,” *J. Nat. Gas Sci. Eng.*, vol. 29, pp. 329–336, 2016.

[3] B. Sobhaniaragh, J. Trevelyan, W. J. Mansur, and F. C. Peters, “Numerical simulation of MZF design with non-planar hydraulic fracturing from multi-lateral horizontal wells,” *J. Nat. Gas Sci. Eng.*, vol. 46, pp. 93–107, 2017.

[4] B. Sobhaniaragh, W. J. Mansur, and F. C. Peters, “The role of stress interference in hydraulic fracturing of horizontal wells,” *Int. J. Rock Mech. Min. Sci.*, vol. 106, no. April, pp. 153–164, 2018.