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Investigation of the Effect of Thermal Stresses on Hydraulic Fracturing in Geothermal Reservoirs

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Geothermal energy has been widely proposed as a potential green energy resource to replace traditional fossil fuels. The most ubiquitous form of geothermal energy is found in hot dry rocks which are usually composed of granite (or other types of volcanic rocks) with very low permeability and are developed as enhanced geothermal systems (EGS). Hydraulic fracturing is a powerful technology to increase the permeability, enhance the water –rock contact and maximize the economic potential of EGS.

Due to the high cost associated with hydraulic fracturing operations, it is important to build reliable tools for predicting how the formation will respond to water injection. Numerical modeling of hydraulic fractures is an important method for studying fracture parameters such as length, width and fluid leak-off. In enhanced geothermal systems, the typical temperature difference between the reservoir and the injected fluid can range from $200^{\circ}C$ to $300^{\circ}C$. As a result, the injected fluid rapidly cools down the near wellbore area and the resulting thermal contraction generates thermal tensile stress. This stress reduces fracture breakdown and extension pressure. Increase in injectivity near injection wells resulting from thermal contraction has been reported by researchers [1, 2] at the beginning of the injection process.

Hydraulic fracturing is widely used for improving permeability in hydrocarbon reservoirs [3], hazardous solid waste disposal [4, 5], for leaching processes and fault reactivation in mining [6], and soil and groundwater remediation [7] as well. The studies have shown that even for such non-geothermal applications, cryogenic effects help to reduce the water consumption, formation damage, and the environmental impact of water-based fracturing [8].

Modeling of thermal stresses in hydraulic fracturing requires coupling of hydro-thermal physics with fracture mechanics. In this study, a more accessible method than developing a complex finite element code for this purpose has been proposed. Hydraulic fracturing was modelled by creating a three-dimensional model using Abaqus software, and thermal effects were incorporated using heat-sink boundary conditions. The results were validated against analytical and experimental studies. Investigation of the influence of thermal properties of rock and the hydraulic fracturing design parameters, on fracture geometry and pressure showed that the temperature difference between rock and injected fluid, thermal expansion coefficient of rock, and thermal conductivity of rock are the most significant factors in defining hydraulic fractures'geometry and fracking pressure in geothermal reservoirs. In general, hydraulic fractures exhibit greater opening and less extension under thermal stresses compared to non-thermal fracturing processes.

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References

[1] V.-d. Stefansson, "Geothermal reinjection experience," Geothermics, vol. 26, no. 1, pp. 99-139, 1997. [2] E. Kaya, S. j. Zarrouk and M. J. O'Sullivan, "Reinjection in geothermal fields: A review of worldwide experience," Renewable and sustainable energy reviews, vol. 15, no. 1, pp. 47-68, 2011. [3] Y. Cheng and Y. Zhang, "Hydraulic Fracturing Experiment Investigation for the Application of Geothermal Energy Extraction," ACS Omega, vol. 5, no. 15, pp. 8667-8686. [4] L. Kuhar, P.Breuer, D. Robinson and A. McFarlane, "Making Hard Rock In Situ Recovery a Reality," in THIRD INTERNATIONAL FUTURE MINING CONFERENCE, Sidney, 2015. [5] L. Murdoch and W. W. Slack, "Forms of hydraulic fractures in shallow fine-grained formations," Journal of Geotechnical and Geoenvironmental Engineering, vol. 128, no. 6, pp. 479-487, 2002. [6] L. Wang, B. Yao, M. Cha, N. B. Algahtani, T. W. Patterson, T. J. Kneafsey, J. L. Miskimins, X. Yin and Y.-S. Wu, "Waterless fracturing technologies for unconventional reservoirs - opportunities for liquid nitrogen," Journal of Natural Gas Science and Engineering, vol. 35, no. Part A, pp. 160-174, 2016. [7] M. A. Grant, J. Clearwater, J. Quinao, P. F. Bixley and M. L. Brun, "THERMAL STIMULATION OF GEOTHERMAL WELLS: A REVIEW OF FIELD DATA," in Thirty-Eight Workshop on Geothermal Reservoir Engineering, Stanford, 2013. [8] B. Hainey, R. Keck, M. Smith, K. Lynch and J. Barth, "On-site fracturing disposal of oilfield-waste solids in Wilmington field, California," SPE Production and Facilities, vol. 14, no. 2, pp. 88-93, 1999.

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