Petroleum Research

Petroleum Research 2019 (June-July), Vol. 29, No. 105, 30-31

DOI: 10.22078/pr.2018.2937.2374

The Laboratory Study of Cementing Effect of Natural Fracture on Hydraulic Fracture Propagation in Unconventional Oil and Gas Reservoirs

Ali Naghi Dehghan

Department of Mining Engineering, Faculty of Engineering, Science and Research Branch, Islamic Azad University, Tehran, Iran

a.dehghan@srbiau.ac.ir

DOI: 10.22078/pr.2018.3353.2539

Received: July/07/2018 Accepted: December/09/2018

INTRODUCTION

Hydraulic fracturing is a highly efficient technique for simulating tight oil and gas naturally fractured reservoirs. Moreover, it is used to measure in situ stress and is an indispensable tool for design in rock engineering and geophysical research. Hydraulic fracturing involves pressurizing a well or borehole to induce a tensile fracture which generally runs perpendicular to the lowest principle compressive stress. The amount is determined by calculating the breakdown pressure by measuring the critical borehole pressure required to induce fracture. Breakdown pressure is dependent on the in situ stress and the mechanical characteristics of the rock. In addition, factors affecting fracture propagation and fracture geometry include the state of the stress, injection rate, fracture fluid, Young's modulus, fracture toughness of the rocks (tensile strength), initial pore pressure, leak-off coefficient, relative bed thickness of the formation, and specimen size. In many regions, the orientation of current in-situ stresses has not changed from the time of the formation of the natural fractures. Consequently, the hydraulic fracture is likely to be subparallel to the fractures with which it interacts. In other regions, the natural fractures are a result of a totally different stress regime than the present day, so the natural fractures may be oblique or orthogonal to the hydraulic fracture path. The properties of fracture cements are distinct from those for intact rock. Depending on the cement material (and fracture) properties, the pre-existing fractures may act as a weak path or a barrier for further crack propagation [1,2]. This forms a competition between sealed pre-existing cracks and the intact matrix for fracturing. [1-3].

EXPERIMENTAL SET UP AND TEST PROCEDURE

The laboratory tests on the synthetic rock specimens were conducted using a hydraulic fracturing test system. Test specimen is placed between two thick, transparent plates of 25 mm thickness. In addition, the specimen is a 152 mm by 152 mm cast sheet of 5.1 mm thickness with a 3.2 mm diameter hole in the center. Fracturing fluid is injected in the center of the specimen to initiate and propagate a fracture. The far-field stress is applied via pneumatic jacks on two parallel sides of the specimen to give a preferential direction for fracture propagation. Thin, flexible layers of polymer-based clear adhesive are used on top and bottom of the specimen to prevent fluid leakage. Fracture growth in the experiments is recorded using a high resolution digital camera. The monitored field of view is approximately 51 mm by 25 mm with the long side being parallel to the applied far-field stress. Moreover, an oblique natural fracture with 25 mm length and variable thickness is cast around 20 mm away from the injection port.

RESULTS AND DISCUSSION

Here a total of four fracturing tests are presented. The specimens in the first three tests had hard natural fractures, and the specimen in the fourth test had a soft natural fracture. Changing the distance between the injection port and the cemented natural fracture can yield a different fracture trajectory under the same conditions. The induced hydraulic fracture is more likely to cross a natural fracture which is placed at relatively larger distances. Hard natural fractures act as barriers or obstacles to hydraulic fracture propagation. The induced hydraulic fracture tends to cross thin, hard natural fractures and to be diverted by thicker natural fractures with the same natural fracture filling material. The strength of natural fracture filling material relative to the host rock influences the fracture propagation outcome. Hydraulic fractures are more likely to cross weaker natural fractures and to be diverted by stronger natural fractures with the same natural fracture geometry. Moreover, the breakdown pressure of test specimens with soft natural fractures is lower than the breakdown pressure of specimens with hard natural fractures.

CONCLUSIONS

Laboratory experiments are conducted in this study to examine the behavior of an induced hydraulic fracture as it approaches a cemented natural fracture. Finally, the results provide a novel evidence of the impact of natural fracture filling materials on the outcome of hydraulic fracture propagation at its interaction with natural fractures.

REFERENCES

[1]. Dehghan A. N., Goshtasbi K., Ahangari K., Jin Y. and Bahmani A., *“3D Numerical modeling of the propagation of hydraulic fracture at its intersection with natural (Pre-existing) fracture,”* Rock Mechanics and Rock Engineering, Vol. 50, pp. 367-386, 2017.

[2]. Gale J. F. W, Laubach S. E., Olson J. E., Eichhubl P. and Fall A., *“Natural fractures in shale: a review and new observations*,*”* AAPG Bulletin, Vol. 98, No. 11, pp. 2165-2216, 2014.

[3]. Anderson T. L., *“Fracture mechanics fundamentals and applications*,*”* third edition. CRC Press, Taylor & Francis Group, 2005.