Three-dimensional numerical modeling of hydraulic fracturing: Investigation of the influence of time, injection rate and fluid viscosity

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Engkish Extended Abstract

Summary

According to the results, as the injection duration and the pumping rate increase, the fracture length increases and the maximum length created is about 22 meters by applying a fluid with a viscosity of one centipoise during 5 minutes injection time and the rate of 35 barrels per minute or similarly by the same fluid with 18 minutes injection time and the rate of 10 barrels per minute.

Introduction

Hydraulic fracturing if properly implemented can be one of the least costly ways to increase the maximum production of the reservoir. Due to the complexity of the hydraulic fracturing process, various modeling has been performed to find the closest predictions of the actual fracture characteristics. Linear elastic fracture mechanics (LEFM), adhesion zone method, and plastic criteria can be used to evaluate the fracture onset time and its expansion in rock.

Methodology and Approaches

To investigate the effect of injection duration on fracture growth, fluid was injected into the well with a viscosity of 1 cp and an injection rate of 0- 10 barrels per minute for periods of 5, 8, 10, 12, 15, and 18 minutes. This injection is made by drilling a well in the middle part of the reservoir. In the first 5 seconds, the injection rate increases linearly from zero to 0.07 barrels per minute and remains constant until the end of injection time. This distribution of injection rate over time is chosen to avoid sudden pressure. As the injection begins, the fluid pressure within the fracture increases, and as the fracture pressure is reached, fracture occurs.

Results and Conclusions

The purpose of designing hydraulic fracturing operations is to make some predictions to optimize these operations. There are five important factors to design for a hydraulic fracture: the length, height, and fracture opening that the propane holds, the fracture initiation pressure, and the fracture orientation. Four of these critical parameters are derived from hydraulic fracture modeling, so modeling provides 80% of the required solutions.

The main input parameters for modeling hydraulic fractures are surface stresses, pore pressure, Young's modulus, Poisson's coefficient, porosity, permeability, angle of friction, and rock adhesion, and parameters related to rock fracture mechanics such as fracture energy, toughness, and components. As the injection duration and pumping rate increase, the fracture length increases, and the maximum length created for a fluid with a viscosity of one centipede at an injection of 5 min at 35 barrels per minute or 18 min at 10 barrels, is about 3 meters high while its maximum height is about 70 meters. Also, the maximum fracture opening in its opening is about 1 mm. Fluid viscosity affects the fracture width more than its length and also increases with the fracture width viscosity.