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Pressure Transient Analysis in Partially Penetrating Infinite Conductivity Hydraulic Fractures in Naturally Fractured Reservoirs

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Although the effect of partial penetration of an infinite conductivity hydraulic fracture has been considered in a homogeneous reservoir, there is no study in similar problem in naturally fractured reservoirs. This paper presents the analysis of the solution to such problem in naturally fractured reservoirs. The method of analysis with or without type curve that enables us to evaluate the permeability in the three principal axes directions is also presented.

The solution to the mathematical model was obtained in Laplace domain with elliptical flow model. Several type curves were generated to study the pressure behavior. Both the early linear and pseudo-radial flow regimes are observed. The duration of the early linear flow regime is a function of the natural fractures storativity ratio, interporosity flow coefficient and the dimensionless hydraulic fracture's height. The effect of the dimensionless hydraulic fracture's height on the duration of the linear flow becomes negligible as its dimensionless height approaches unity. Therefore there is no single unique value of a dimensionless time for the end of the linear flow regime as in the case of homogeneous reservoir. Raghavan *et al* (1978) determined the end of the linear flow regime in fully penetrating hydraulic fractures in homogeneous reservoir to be 0.016. This value is based on the dimensionless pressure drop only. In this study, this value was found to be 0.01 and it was evaluated with pressure derivative curve which is more accurate.

Two simulated examples were used to validate the method of the analysis developed. The results obtained are in agreement with the input data.

Introduction

Hydraulic fracturing in the oil industry has contributed sizable reserves to the overall hydrocarbon reserves in the world. All the tight hydrocarbon reservoirs have to be fractured before they can be producible. These reservoirs are often produced with fully penetrating hydraulic fracture. A fully penetrating hydraulic fracture in a reservoir with water and hydrocarbon in contact will lead to an early or immediate water production. The only method of preventing unwanted fluid at the wellbore in a hydraulic fracture is to carry out partially penetrating hydraulic fracturing.

Anderson and Stahl (1967) have shown by actual measurement that hydraulic fracture may not penetrate the entire formation thickness even when it is intended to do so. According to Tinsley *et al* (1969), the entire height of the hydraulic fracture may not be producing in addition to partial penetration. Moreover, not all the fractured height is propped open by propants. The unpropped height may be healed and close completely. Therefore micro seismic and production logging tools are necessary to determine the effective height of the fracture.

Raghavan *et al* (1978) first presented the solution to a partially penetrating hydraulic fracture in a homogeneous reservoir. Their solution is based on the Green's function product solution technique presented by Gringarten and Ramey (1973). Several type curves for evaluation were presented without any example. Rodriguez *et al* (1984) presented type curve method of analysis for finite and infinite conductivity based on a numerical method for homogeneous isotropic system. They did not investigate the effect of vertical position on the wellbore pressure. The effect of the transition flow regime on the duration of the linear flow regime makes it necessary to study the behavior of transient flow in naturally fractured reservoirs. Moreover, the method employed by Raghavan and Rodriguez cannot be applied directly to naturally fractured reservoirs because of the transfer function. The problem has to be solved in Laplace domain before inversion to the real time domain. In this study, the elliptical flow model was applied to compute the dimensionless pressure of a partially penetrating hydraulic fracture at the wellbore. The effect of the vertical position of the fracture on the computed wellbore pressure was fully investigated.