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A Semi-Analytical Model for Characterizing the Transient Flow Behavior of Reoriented Refractures Considering the Interference from the Initial Fractures

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In order to improve the field productivity, the industries can create new fractured wells to reduce the interval between the initial fractures. However, the production from the initial fractured wells can induce stress reorientation in the vicinity of the fractures. As such, a refracturing treatment in the stress reorientation region can lead to a reoriented refracture which has a more or less azimuth with respect to the initial fracture. This azimuth can even be 90 degrees if the stress reorientation is sufficiently large. Tiltmeter data monitored in the Lost Hills field and the Codell formation justify that the reoriented refractures can be frequently observed after the refracturing treatment. In addition to the refracture's length, refracture's conductivity and the in-situ conditions, there are two more factors, the reorientation azimuth and the interference from the initial fracture, can exert significant influence on the transient flow behavior of the reoriented refractures. In such case, the conventional analytical/semi-analytical models which neglect these two factors are no longer applicable to characterize the transient flow behavior from such a refracture.

In this work, we develop a novel semi-analytical model to characterize the transient flow behavior of a reoriented refracture considering the interference from the initial fractures. In this model, the fractures are explicitly represented with discretized segments. We apply finite difference approximation to the initial fractures and refractures, respectively, to simulate the transient flow in the fracture system. Additionally, the fluid flow in the matrix system can be characterized by Green function and Newman product principle. Based on the continuity of flux and pressure, we couple the fracture flow equations with the matrix flow equations to construct a semi-analytical model. Hereafter, we validate the proposed model against a commercial numerical simulator.

With the aid of the proposed model, we distinguish the flow regimes of a reoriented refracture on the dimensionless pressure derivative plot. These flow regimes include wellbore after flow, bilinear flow, formation linear flow, early pseudoradial flow and late pseudoradial flow. During the early pseudoradial flow period, the dimensionless pressure derivative plot is asymptotic to y = 0.5 on the log-log plot, whereas during the late pseudoradial flow period, the dimensionless pressure derivative is asymptotic to a value that is a function of the production rates of the initial fracture and the refracture. In addition, we carry out a thorough investigation about the influences of fracture conductivity, reorientation azimuth, position of the refracture, and production rate of the initial fracture, on the pressure response of a reoriented refracture. The interference from the initial fracture is studied at constant-production-rate constraint and constant-bottomhole-pressure constraint, respectively.

This proposed model can be applied to the real field cases in three different ways: first, one can use this proposed model to obtain the properties of the refracture by matching the historical production data; second, the performance of a refracture can be evaluated before the refracturing treatment in order to optimize the refracturing treatment; and third, one can use this proposed model to predict the production of a reoriented refracture once the properties of the refracture are known.

References

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