Modeling geometry of planar hydraulic fractures using the Planar 3D ILSA model

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In modern hydraulic fracturing simulators, a transition to modeling of fracture opening within the Planar3D approach is observed. Unlike classical models (PKN, KGD), this approach makes no a priori assumptions about the characteristic relation of crack length and height. In Planar3D model all directions of fracture propagation are equivalent in terms of applied failure criteria, viscosity and filtration properties. Therefore, the Planar3D model provides a more accurate prediction of fracture growth.

To solve the elasticity problem, the displacement discontinuity method is used [1]. The use of this approach makes it possible to significantly accelerate the algorithm, since the initial three-dimensional elasticity problem is reduced to one integral relation between the fluid pressure and the fracture width.

Tracking the moving fracture front is one of the significant problems in the modeling of a planar fracture. In the linear elasticity fracture mechanics, stresses have a singularity at the fracture tip, the resolution of which requires the refinement of the computational mesh and its rearrangement as the fracture front propagates. In order to avoid the associated computational costs, as well as to improve the accuracy of calculations, the ILSA algorithm [2] is used. This algorithm is based on the use of the three-process tip asymptotic solution at the fracture tip, which connects the fracture width in the inner points with the distance to the fracture front and thus allows someone to determine the position of the fracture front on a relatively coarse and uniform mesh.

Another difficulty is that a reservoir has many layers with different geological stresses. The final shape of the fracture essentially depends on stress jumps at the boundaries of this layers. Thus for correct calculation of the fracture front location, this fact must be taken into account. The presence of layers with different confining stresses or a stop of pumping can cause partial or complete closure of the fracture. To obtain the correct result in this case the contact problem is solved, which allows one to compute the value of the contact force and provides a correct calculation of the fluid flows inside the fracture.

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References

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