Parallel simulation of the black-oil model using streamlines on non-orthogonal domains.

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Session where the abstract sould be considered: "Mathematical and numerical modeling of enhanced oil recovery"

Our preference for presentation is: oral.

In this work we present a parallel simulation of the black oil model on non-orthogonal domains by using the streamlines method [1]. We derive the governing equations of black oil applying the axiomatic formulation [2]. This model is subsequently modified to establish a pressure-saturation approach, which results in a loosely coupled system of three partial differential equations: one for the pressure and two for transport of water and gas saturations, containing terms of volatilized oil. The solution procedure is performed using an IMPES based method, where the oil pressure equation is solved first on a non-orthogonal grid; then we calculate the velocity field using the pressure previously calculated; this velocity field allows us to trace a set of streamlines; we transform the 3D transport equations to 1D equations valid on the streamlines, in such a way that the saturations are calculated along each streamline; the calculation on the streamlines are independent of each other, in such a way that this process can be executed in parallel. We developed a system to create meshes on irregular domains. Initially a 2D mesh is created solving an elliptic partial differential equation. Subsequently, the 3D mesh is obtained by extrusion over the base 2D grid and using a set of height-maps. The generation of 2D and 3D meshes are performed automatically, based on data provided, as the outer and inner boundaries and height-maps. The streamlines are calculated on the non-orthogonal mesh using the reformulation of King and Datta Gupta [3] and Jimenez et al. [4], with the Cordes Kinzelbach algorithm [5]. The finite volume method is used to obtain numerical models of the governing equations. We present several examples of application on non-orthogonal and heterogeneous domains.

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