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Numerical Method for Productivity Prediction of Water-Producing Gas Well with Complex 3D Fractures: Case Study of Xujiahe Gas Well in Sichuan Basin

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Abstract : Unconventional resources have gradually become the main direction for oil and gas exploration and development. However, the productivity of gas wells, the level of water production, and the seepage law in tight fractured gas reservoirs are very different. These are the reasons why production prediction is so difficult. Firstly, a three-dimensional multi-scale fracture and multiphase mathematical model based on an embedded discrete fracture model (EDFM) is established. And the material balance method is used to calculate the water body multiple according to the production performance characteristics of water-producing gas well. This will help construct a 'virtual water body'. Based on these, this paper presents a numerical simulation process that can adapt to different production modes of gas wells. The research results show that fractures have a double-sided effect. The positive side is that it can increase the initial production capacity, but the negative side is that it can connect to the water body, which will lead to the gas production drop and the water production rise both rapidly, showing a 'scissor-like' characteristic. It is worth noting that fractures with different angles have different abilities to connect with the water body. The higher the angle of gas well development, the earlier the water maybe break through. When the reservoir is a single layer, there may be a stable production period without water before the fractures connect with the water body. Once connected, a 'scissors shape' will appear. If the reservoir has multiple layers, the gas and water will produce at the same time. The above gas-water relationship can be matched with the gas well production date of the Xujiahe gas reservoir in the Sichuan Basin. This method is used to predict the productivity of a well with hydraulic fractures in this gas reservoir, and the prediction results are in agreement with on-site production data by more than 90%. It shows that this research idea has great potential in the productivity prediction of water-producing gas wells. Early prediction results are of great significance to guide the design of development plans.

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