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The effects of sand bridge structures on gas and water relative permeability evolution during the continuous sand migration process in hydrate-bearing porous media

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Natural gas hydrate is a type of potential clean energy resource with vast reserves concentrated in the permafrost and submarine deposits as a solid phase. During the hydrate exploitation process, the hydrate transforms from a solid phase to the gas and water phases and flows in the porous media. Particle movement occurs in the pore space due to the hydrate phase transition, leading to the variation of gas and water flow.
In this study, Micro X-Ray Computed Tomography (CT) and a pore network model (PNM) were adopted to study gas and water flow during a continuous sand migration process in hydrate-bearing porous media. First, the continuous hydrate dissociation experiment was conducted in the hydrate-bearing sample with an optimal median grain size ratio (6.5) under conditions of a thermal-stimulated process. Then, four groups of CT images were obtained and used to visualize the 3D pore network. Next, pore space parameters are calculated after image processing. After that, gas and water flow were analyzed by the PNM.
Results showed that in the early stage, the increase of pore space connectivity expansion caused by hydrate dissociation was the main factor in gas-water flow increment. With the continuous hydrate dissociation, the sharp increase of tiny pore and throat numbers caused by sand bridge structures were the main factors leading to the decrease of both gas and water relative permeability. At the final stage, sand migration and gas and water flow were mainly influenced by the occurrence of stable sand bridge structures. Moreover, gas and water relative permeabilities at the same water saturation were larger than that in the initial stage. And the extension of the pore space caused by hydrate dissociation was in charge of this result. Sand bridge structure in controlling gas and water relative permeabilities in this study can be considered as a micro mechanism reference in considering both sand production and fluid flow ability in hydrate-bearing porous media under the process of hydrate dissociation.

Participation

In-Person

References

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