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Pore-scale Simulation Coupling Boundary Layer Effect And Media Deformation In Tight Formation

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Due to intense complexity and heterogeneity of pore and throat structure in tight formation, it's very difficult for representation. In addition, as there abounds in large numbers of micro-nano pores and throats, boundary layer and media deformation effect on pore scale flow cannot be ignored. Therfore, an accurately representative pore network flow model which couples boundary layer and media deformation effect is in great need.An irregular 3D random network model which can characterize porethroat size distribution and connection in tight formation is proposed. Based on the representative pore network model, a flow mathematical model which couples both boundary layer and media deformation effect at the same time is developed. In order to verify the simulation result, micro-tube experiment is carried out. After validation, factors influencing pore scale flow in tight formation are studied, such as boundary layer effect, media deformation effect and pore network model structure parameters. Results show that: it is boundary layer effect rather than media deformation that leads to non-linear flow in tight formation. And the more intense the boundary layer effect is, the more apparent the non-linear flow phenomenon will be. In contrast, media deformation effect just results in smaller velocity at the same displacement pressure gradient and the linear relationship between the velocity and displacement pressure gradient is unchanged. In addition, as for the existence of boundary layer effect, absolute permeability in tight formation is no longer a constant, it varies with the displacement pressure gradient, which is different from conventional reservoirs. Meanwhile, media deformation just brings out the overall decline of absolute permeability which does not change the trend of the permeability versus displacement pressure gradient.As coordination number in pore network model increases, connective paths grow larger, which eventually leads to the increase of absolute permeability. With the increase of aspect ratio, effective flow space is compressed, resulting in the decline of absolute permeability .

References

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