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Threshold pressure for the capillary with irregular cross section

Wednesday, 2 June 2021 09:00 (1 hour)

Threshold pressure (or capillary entry pressure) is the minimum pressure difference required for the non-wetting fluid to penetrate a capillary filled with a wetting fluid. It is well known that this capillary pressure for the circular capillary can be calculated by Young-Laplace equation. While for capillaries with irregular sections, the MS-P method, which was originally proposed by Mayer and Stowe (1965) and further developed by Princen (1969a, 1969b, 1970), has been widely used to analytically estimate the threshold pressure. However, the equations derivated from MS-P method are very complicated and unconcise.

In this work, we derivate a concise and accurate predictor of the threshold pressure in irregular capillaries using the Reduced Similar Geometry (RSG) method (Mason and Morrow,1991), which is a special case of the MS-P method. The main idea of the RSG method is to remove the central portion of cross section occupied by the non-wetting phase and construct a reduced cross section shape similar to the original. First, we extend the RSG method to tangential polygons. Then we simplify the threshold pressure equation into a concise form by introduce a completeness factor. This factor indicates the completeness of the inscribed circle in the reduced shape and is decided by the shape factor and wetting conditions. Further, we generalize this concise equation to capillaries with arbitrary cross sections by changing the completeness factor. The short explanation is for the proposed equation is that the threshold radius is the weighted harmonic mean of the maximum inner circle radius and area equivalent radius (the square root of the ratio of area to π). This study can help understand the capillary behavior better and provide a fast tool to predict the threshold pressure in irregular capillaries.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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