

Author's Reply to Discussion of Valid Capillary Pressure Data at Low Wetting-Phase Saturation

J.C. Melrose, SPE, Stanford U.

I thank Saidi for his interest in my paper. It appears that Saidi and I have basically different concepts of the fundamental physical principles that determine the capillary pressure curve in the range of low saturations. My conception of these principles is presented in various published papers that I have written over the past 25 years. A list of these papers, which include extensive references to the relevant physics and physical chemistry literature, is available upon request. Consequently, my reply to Saidi will be confined to the following brief summary.

My views and those of Saidi differ in three important respects. First, we differ as to the range of applicability of the Young-Laplace equation. In my view, Saidi incorrectly restricts this range. Thus, he appears to believe that pendular saturations are not governed by the Young-Laplace equation.

Second, the estimate of the thickness of an aqueous wetting film that Saidi adopts is too large by a factor of at least 10. Among physical chemists, the 1932 work of Deryagin, which Saidi cites, has long since been discredited and forgotten. The subsequent work of Deryagin, cited by Saidi, is likewise either outdated or, at least, misleading. For example, the disjoining-pressure concept is now acknowledged to be nothing but a partial substitute for the concept of chemical potential change.

Third, Saidi's discussion completely ignores one of the fundamental physical principles applicable to the problem at hand. According to this principle, the change in the chemical potential of the water component, as the capillary pressure changes from zero to some higher value, is exactly the same in both liquid and vapor phases.¹ It then follows from an integration of the Gibbs-Duhem equation for the liquid phase that the chemical potential change and the capillary pressure are not independent variables. They are instead equivalent variables, either of which determines the state of the system. It is precisely because of this equivalence that the water-vapor-desorption (WVD) method can be used to measure capillary pressures. Saidi does not refer to the WVD data reported in my papers. Neither does he refer to any of the relevant physics and physical chemistry literature, as cited in these and other recent papers.

Reference

1. Melrose, J.C.: "Use of Water-Vapor Desorption Data in the Determination of Capillary Pressures at Low Water Saturations," *SPE* (Aug. 1988) 913-18.

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