

Pressure-dependent contact angle of coal

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Introduction

The occurrence of a gas-water two-phase region can significantly affect gas flow rate due to interfacial tension that exists on the gas-water interface.

The contact angle of water on the coal surface is one of the critical factors that controls interfacial tension. This in turn, affects capillary pressure and the evolution of relative permeability curves.

Previous work indicates that the contact angle of water on solid surface is pressure dependent. However, few studies have directly quantified the change of coal contact angles with respect to decreasing reservoir pressures with gas depletion and its impact on coal seam gas production.

In this work, a high-pressure chamber (maximum 16 MPa) with four observation windows was used to measure contact angles of water to coals under different pressures (Figure 1). Three coal samples from different seams were measured. Five different pressures were used in this work, starting from 10 MPa with a decrement of 2 MPa (Figure 2).

Experimental setup

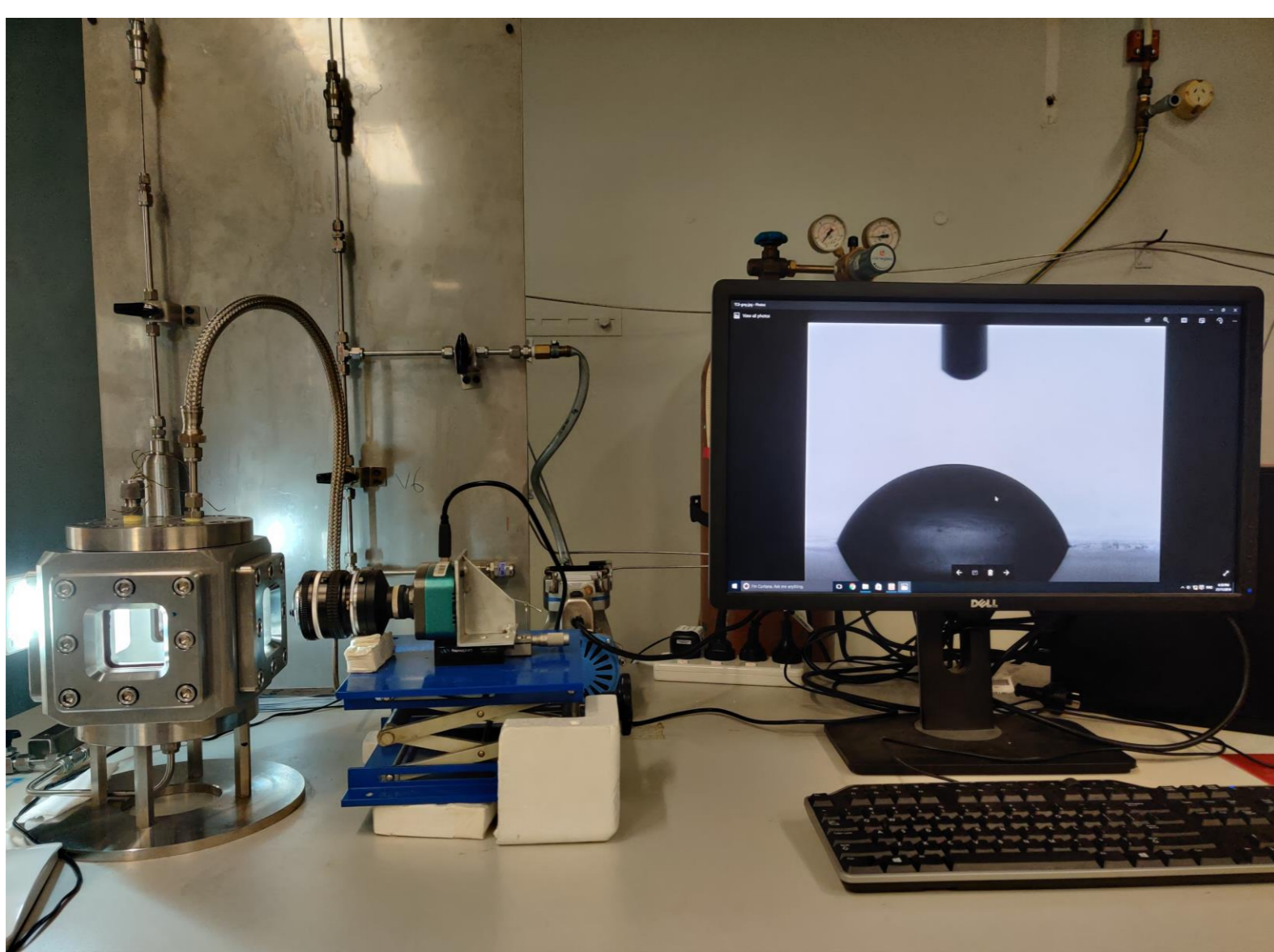
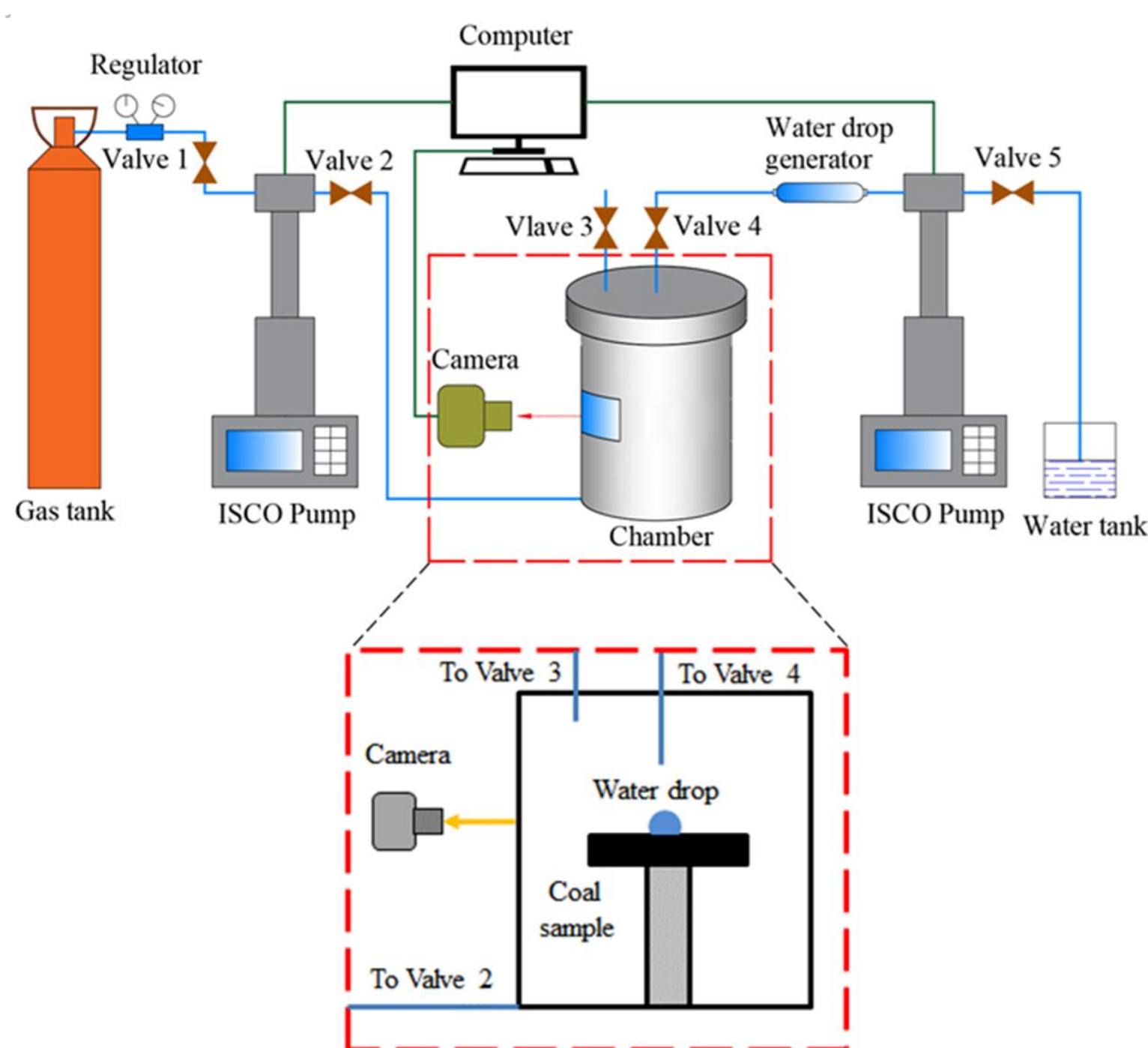


Figure 1: Experimental apparatus for high pressure contact angle measurement

Results

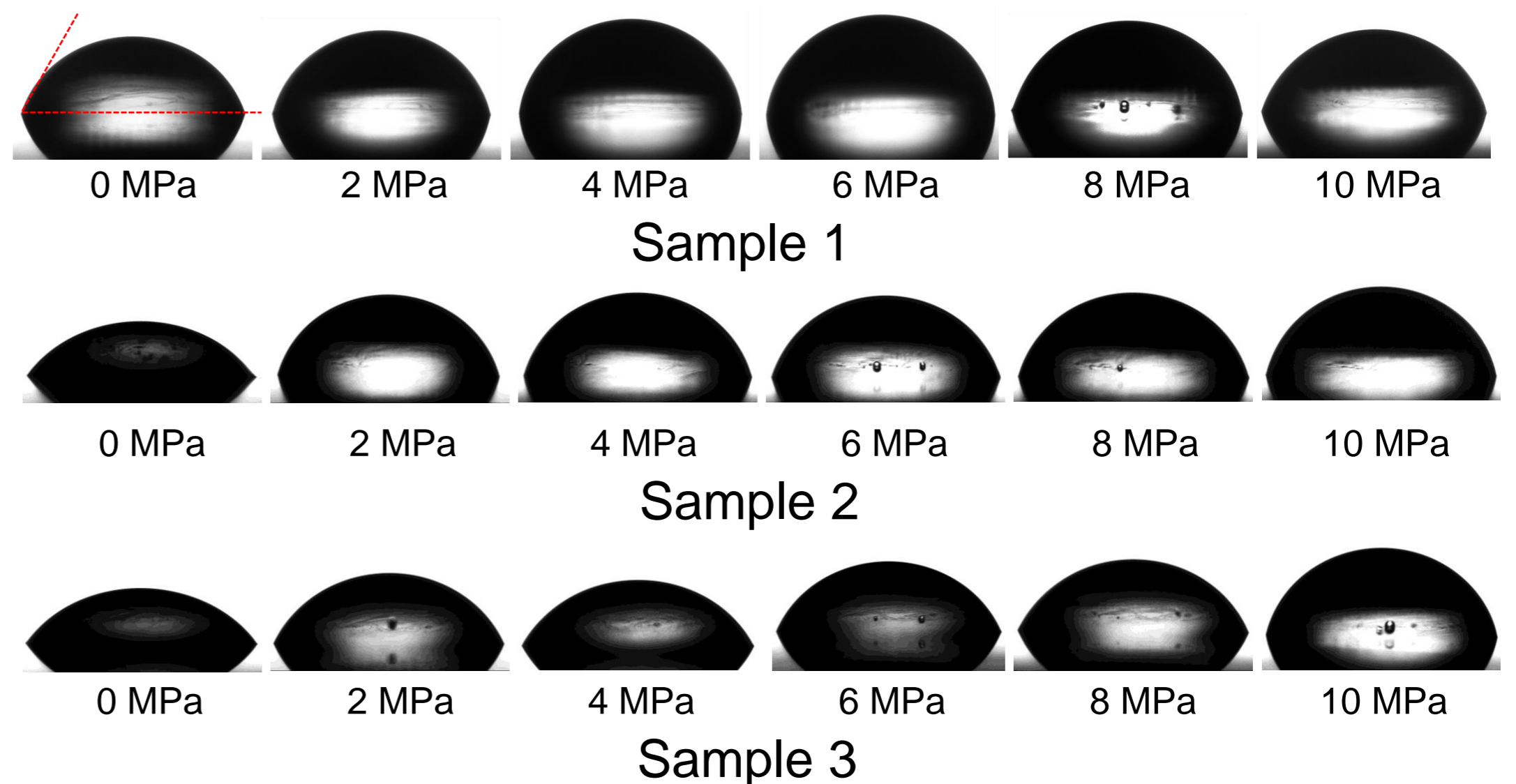


Figure 2: Evolution of contact angle with gas pressure

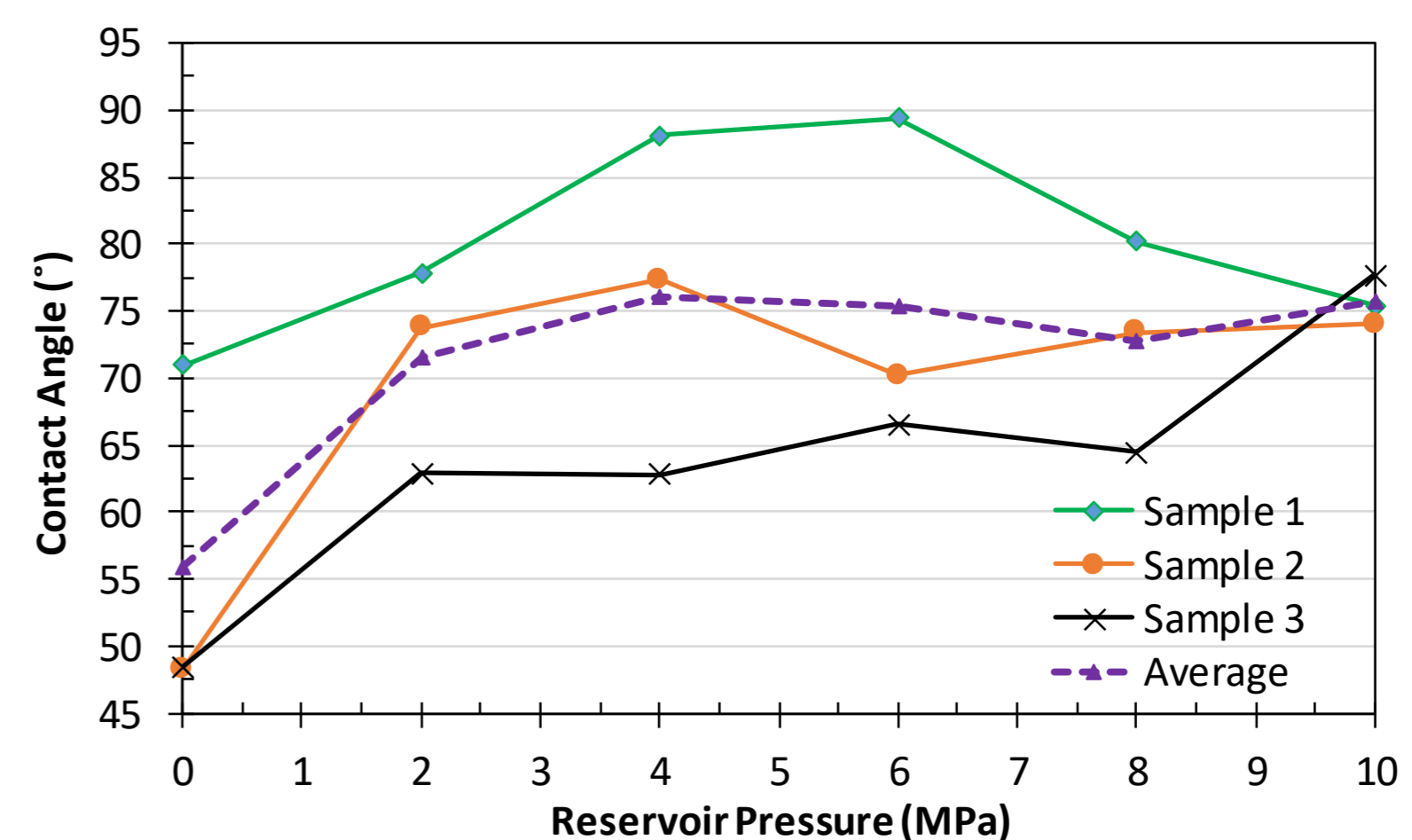


Figure 3: Plot of contact angle versus pressure

Results show the trend varies from sample to sample, depending on its surface chemistry (Figure 3). For instance, for sample 1, the angle θ rises with pressure up to 6 MPa and then decreases gradually, while for sample 3, the angle θ shows an increasing trend.

The mean contact angle roughly drops with gas depletion, indicating that coal becomes more hydrophilic with depletion. This could result in an increase in capillary pressure and thus reduction in gas relative permeability values.

Future work

The mathematical relationship between contact angle and pressure needs to be further analysed. Its impact on gas trapping, well productivity, and ultimate gas recovery rate needs to be addressed in detail.

Acknowledgements

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References

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