

Monitoring Imbibition and Estimating Residual Gas Saturation Using Low Field NMR

Minghua Ding* and Apostolos Kantzas

Department of Chemical and Petroleum Engineering and TIPM Laboratory
University of Calgary, 2500 University Drive N.W. Calgary, AB T2N 1N4
mding@ucalgary.ca

Abstract

Residual gas saturation is known to be a key factor to determine gas recovery from gas reservoirs with water influx. The influx of water controls all important recovery mechanisms in these gas reservoirs. Water imbibition has long been recognized as an important factor in recovering gas from water-wet, fractured gas reservoirs subjected to water flood and water drive.

In order to carefully study residual gas saturation due to water imbibition, both spontaneous and forced co-current imbibition tests were performed in a group of plugs from a Western-Canada sandstone reservoir and in Berea sandstone plugs. On-line NMR was used to monitor the in-situ gas saturation and the distribution of water in the pore space. Forced imbibition tests followed the spontaneous imbibition tests through a gradual increase of the water flow rate to evaluate the final residual gas saturation. The results indicate that the residual saturation depends not only on flow rates, but also on other parameters such as experimental time, reservoir properties, capillary number, etc.

In this study, we present experimental results of the different imbibition processes, along with the corresponding capillary number analysis and the definitive criteria for mobilization of residual gas during horizontal displacements. The potential applicability of such criteria in gas reservoirs is discussed.