IPTC 11863

A Novel Method to Construct Capillary Pressure Curves by Using NMR Log Data and Its Application in Reservoir Evaluation

Liang Xiao and Yun-chao Yuan, Xi'an Shiyou University, China; Zhao-ming Chen, Shenzhen Branch of CNOOC, China

This paper was prepared for presentation at the International Petroleum Technology Conference held in Kuala Lumpur, Malaysia, 3–5 December 2008.

Abstract

By analyzing hundreds of capillary pressure curves, the controlling factors of shape and type of capillary pressure curves are found and a novel method is presented to construct capillary pressure curves by using reservoir permeability and a synthesized index. The accuracy of this new method is verified by mercury-injection experiments. Considering the limited quantity of capillary pressure data, a new method is developed to extract the Swanson parameter from the NMR T_2 distribution and estimate reservoir permeability. Integrating with NMR total porosity, reservoir capillary pressure curves can be constructed, which could be used to evaluate reservoir pore structure and calculate reservoir originality water saturation in the intervals with NMR log data. At last, the constructed NMR capillary pressure curve by this new method is used in well site to detect the change in reservoir pore structure and initial water saturation as a function of depth, comparision among the calculated result, core data and Archie water saturation, demonstrate the responsibility and accuracy.

Introduction

It is very important to understand reservoir pore structure information for geologists and field development workers in calculating field recoverable reserves and formulating appropriate development programs. So acquiring reservoir pore structure information of interested intervals is the target for policy-maker of field, but no way is available at present. With the appearance of NMR log technology, a new path is opened. From NMR T_2 distribution reservoir pore structure information can be gained directly (Xiao L. Z., 1998, Coates G. R. et al., 2000 and Xiao L. et al., 2007, Zhou C. C et al., 2007). With the development of research, more and more difficulties appear, and the major problem is the influence on the shape of NMR T_2 distribution when pore space is occupied by crude oil, especially light oil (Mao Z. Q. et al., 2007, Yakov et al., 1999, Looyestiji W.J., 2001), which affects the evaluation result for log analyst. Although many researchers (Xiao L., 2007, Yakov et al., 2001) propose that the shape of T_2 distribution should be calibrated to the condition of 100% water saturated and the calibrated methods are studied elementally, they are not sound. So the clue must be changed. These problems can be resolved by mercury-injection experiments, from which, mercury-injection capillary pressure curves can be obtained, then the distribution of pore throat radius will be extracted to evaluate the quality of reservoir pore structure, and by which, reservoir originality water saturation can also be calculated.

Problem

Another difficulty we are facing is that the test cost of mercury-injection experiment is high and mercury is poisonous, so the data of mercury-injection capillary pressure are fewer, even more the data are available only in the limited zones and can not be used to evaluate reservoir pore structure and calculate originality water saturation consecutively along the whole well. So many researchers (Liao M. G. et al., 2000，2002 and Zhong D. K., 1997) proposed their outcomes separately to obtain capillary pressure information from rock porosity and permeability. Their conceptions can be generalized that all capillary pressure curves are separated from 10% of mercury-injection saturation to 70% with 5% as a step width. So capillary pressure curves are divided into 14 equal portions, the relationships among mercury-injection pressure and porosity, permeability are constructed, by which, the reservoir capillary pressure curves can be constructed with the parameters of rock porosity and permeability, then they expanded these conceptions to reservoir conditions. These methods seem to be perfect, but if we