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Nuclear magnetic resonance as a method of fluid mobility detection in porous media

Sergey Zhakov (1) and Valentin Loskutov (2,3)

(1) Institute of Metal Physics, The Ural Branch of Russian Academy of Science, Ekaterinburg, 18, S.Kovalevskaya Str., 620990, Russia (zhakov@imp.uran.ru), (2) Baker Hughes, Russian Science Center, Kutateladze 4A, Novosibirsk, 630128, Russia (val_losk@rambler.ru), (3) Mary State University, Yoskar-Ola, Lenin sq.1, Russia

The nuclear magnetic resonance (NMR) method is widely used for studying the structure of porous media and processes taking place in such media. This method permits to determine porosity and pore-size distributions, which have direct practical application in various areas.
The problem of porous media permeability determination is connected directly with extraction of hydrocarbons from pays and water from aquiferous layers. But it is impossible to measure directly amount of fluid past through the fixes cross section for determination of bed permeability. So various indirect approaches are used to find correlation of permeability value with porosity and pore size distribution which can be determined directly using NMR relaxometry. In contrast to porosity, permeability is dynamic characteristic of porous media so it may be measured correctly only in conditions of moving fluid.
Natural porous medium has branched pore structure, so a chaotic component of fluid velocity will occur even for constant mean filtration fluid velocity. In the presence of magnetic field gradient this chaotic fluid velocity will produce additional spin dephasing and decrease of relaxation time [1].
Direct detecting of fluid movement in porous core samples through the Carr-Purcell-Meiboom-Gill (CPMG) pulse sequence has been demonstrated and theoretical model and analysis was given. Experiments were made on a set of sandstone samples (Berea, Bentheimer, Castle Gate, Leopard) and with synthetic high-perm samples made of abrasive material. The experiments show that the NMR spin echo measurements permit to fix mean fluid velocity mm/sec. The experiments and the theoretical model show that for low fluid velocities the mean relaxation rate is proportional to fluid velocity . The results may serve as the basis for determination of mobility of liquids in porous media and permeability.

1. P.T.Callaghan. Principles of Nuclear Magnetic Resonance Microscopy. 1991, Oxford University Press.