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论文

内部磁场梯度引起的扩散对NMR岩石测量响应的影响

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摘要 低场NMR岩心分析能够刻度NMR测井响应，对于较为准确地预测储层的渗透率、束缚水体积等与产能密切相关的参数尤其重要.对来自南海东部油田的100%饱和盐水的砂岩岩心进行了变回波间隔的实验室NMR T 2测量，随着回波间隔的增大对实验观测到的两种不同的 T 2 分布的移动进行了理论上的分析和解释.随着回波间隔的增加， T 2谱向着长弛豫时间的移动可以用过优化NMR采集参数消除掉，而对另外一种由内部磁场梯度引起的移动即随着回波间隔增加 T 2谱向短弛豫时间的移动则复杂得多，至今为止也无法做到定量化内部磁场梯度的值，这种移动能够引起错误的NMR测井解释.因此理解内部磁场梯度对 T 2弛豫时间的影响是很有必要的.文中对由内部磁场梯度扩散引起的扩散弛豫对 T 2弛豫时间的影响进行了理论上的模拟计算，这有助于理解和解释岩石内部磁场梯度对NMR T 2弛豫时间的影响.最后结合压汞毛管压力曲线，解释了具体的岩心实验结果，并且计算了具体的岩心的内部磁场梯度值，计算出的内部磁场梯度值应该被视为内部磁场梯度的几何平均值.

关键词 内部磁场梯度的影响 两种不同的 T 2移动 实验室NMR测量 回波间隔

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Effects of diffusion due to internal gradients on NMR response in rocks

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Abstract Calibration of the NMR log response using low field lab NMR measurements of core samples is important for the accurate prediction of permeability and bulk volume of irreducible water related strongly to reservoir productivity. NMR CPMG T 2 measurements were performed on the sandstone cores from east oilfield, South China Sea, at multiple echo spacings at 100% brine saturated state. Two different shifts in the T 2 distributions with increasing echo spacing are found and the theoretical analysis and interpretation is given about the two different shifts. The shift of the T 2 peaks towards longer relaxation times can be eliminated by choosing short enough echo spacing. But the other shift of the T 2 peaks towards shorter relaxation times due to complicated internal field gradient can cause errors in the interpretation of the T 2 distributions and up to now there is no good way to quantify internal field gradients. Thus it is important to understand the effects of diffusion on T 2 relaxation times due to internal field gradients. The theoretical simulation results of the effects of diffusion-induced dephasing on the T 2 distribution due to magnetic field gradients are calculated, which is helpful to understand and explain the impacts of internal magnetic field gradients on NMR T 2 relaxation time. Finally, combined with mercury injection curves, the core measurement results are explainedand the internal magnetic field gradients of two cores are calculated, which should be regarded as geometric mean of internal field gradients distribution.

Key words

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