

Multi-coils Design of Downhole NMR Azimuthal Imaging Probe

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Introduction

During last decades, wireline NMR downhole tools and logging while drilling (LWD) NMR downhole tools were widely welcomed and applied in oil industry and the hardware was continued updating. However, the single coil configured in the probe combined with gradient magnetic field is only able to achieve radial profile imaging but not azimuthal imaging. In order to understand formation better, inhomogeneity for example, azimuthal imaging will provide more comprehensive data and visualized map around borehole. Recently, some progress about azimuthal imaging had been made [1,2].

Content

In this paper, we design and implement a multi-coils structure configured in the probe combined with quadrupolar magnet [3] to achieve azimuthal imaging. The electromagnetic simulation was done with the help of commercial software ANSYS HFSS by using FEM. The magnet assembly is consisted of four bread-shaped magnets combined with additional small hexangular magnets to produce enough strength and high homogeneity of static field along with circumferential direction at deeper DOI. This multi-coil is consisted of four saddle-shaped surface coil elements which are equally positioned at four different directions. Capacitive networks are used to eliminate the mutual effects and enhance the performance of the multi-coils.

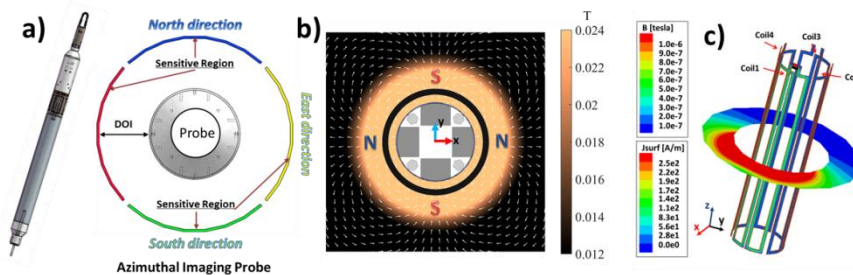


Fig. 1: a) is the illustration of azimuthal imaging probe; b) is the quadrupolar static field map; c) is the configuration of multi-coils and RF field map for one coil.

Results and Conclusion

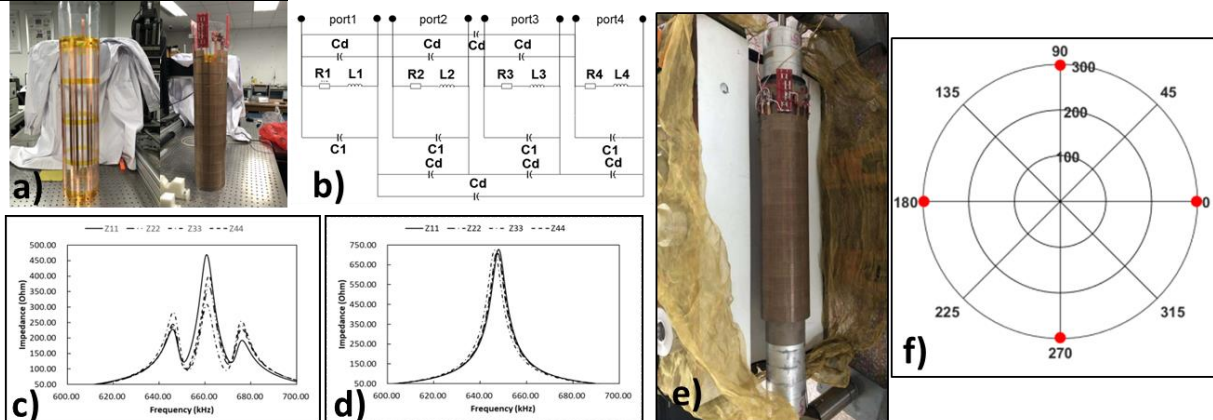


Fig. 2: The manufactured multi-coils and azimuthal measurement result. a) is the multi-coils; b) is the scheme of capacitive decoupling for multi-coils; c) is the coupling result of multi-coils; d) is the decoupling result of multi-coils; e) the illustration of test for multi-coils, the probe is put in a water tank which is splitted into four sections; f) azimuthal measurement result, the solution is copper sulfate solution with the same concentration, and T_2 value is 298 ms corresponding to red dots. The circle lines are representing the isoline of T_2 , polar coordinate is representing the azimuthal degree.

This probe can achieve azimuthal imaging measurement by using quadrupolar magnet and multi-coils array. However, this work is still faced with technical problems to be solved, such as the data post-processing and development of design of probe.

References: [1] W.Liu, Micro. Meso. Mater., vol. 269, pp. 97–102, 2018.

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[3] S.H. Luo, Magn. Reson. Imaging.. vol. 56. pp. 168-173, 2019.