THROUGH-TUBING CASING DEFORMATION AND TUBING ECCENTRICITY IMAGE TOOL FOR WELL INTEGRITY MONITORING AND PLUG-ABANDONMENT

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Abstract:

Casing deformation and tubing eccentricity is a concern in the oil and gas industry for safety and operational reasons. Casing deformation or tubing eccentricity originates from various sources such as well completion, corrosion, formation swelling, collapse, salt dome creep, etc. It is important to implement a well-integrity surveillance program covering all of the casing and tubing strings for the full well life-cycle from initial completion to abandonment. However, there has been no effective logging method to evaluate though-tubing the condition of the casing string for deformation and eccentricity.

This paper describes a new Deformation-and Eccentricity (DEC) tool which is based on electromagnetic technology and designed to measure casing deformation and tubing eccentricity while logging inside completion tubing. The DEC tool generates a unique compressed-and-focused magnetic field which provides increased Signal-to-Noise Ratio (SNR) and employs an array of magnetic sensors to measure the magnetic flux density distributions azimuthally around the tool. The tool's compressed-and-focused magnetic field is designed to (1) saturate the magnetic flux of the tubing and (2) inject more magnetic flux into the first casing behind the tubing, (3) to increase signal measurement sensitivity and SNR. The sensor matrix measures flux density changes which correspond to variations in distance between tubing and casing. The high resolution azimuthal magnetic sensor matrix delivers high accuracy measurements, which are used to image the flux density changes. A finite element based forward modeling and an optimized Gaussian Processes Regression method has been developed to process the raw logging data. DEC has a built-in orientation measurement based on gyro and accelerometers that are used to align the deformation and eccentricity images and index curves, as well as the tubing thickness image. The tool specifications as 1% of eccentricity ratio and 5% of deformation ratio accuracy in the range of casing OD up to 13-3/8".

DEC technology provides an advanced answer product for through-tubing casing deformation and eccentricity measurements in downhole well-integrity and plugabandonment applications. When combined with other well-integrity measurements such as multi-finger caliper and multi-pipe thickness log tool a complete well integrity evaluation can be achieved throughout the life cycle of a well. For example, significant casing deformation can often indicate the potentially damaged cement behind the casing. Other applications for the technology include tubing clamp location for fiber-optics cables and control lines, and the orientation of multistring tubing completions, etc.

Performances of the tool have been validated through research simulations, lab tests, and field trials. The paper includes a field case study of a deviated gas production well with tubing buckling and casing micro-dogleg.

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Bio:

QinShan Yang serves as a Senior Advisor at GOWell. Dr. Yang has more than eighteen years of experience in the industry. He has worked in various positions for Schlumberger, CNPC, UT Austin, and now at GOWell. Currently, he is the leader and advisor in the field of well integrity, Acoustic/EM tool physics, and DAS/DTS projects. He has published more than twenty technical papers and holds twelve patents. Dr. Yang received Ph.D. degree from the Chinese Academy of Science and his postdoctoral study on the formation evaluation and unconventional reservoir from The University of Texas at Austin. Dr. Yang is an active SPWLA, SPE, and SEG member and involved in volunteering activities.