A new rate gyroscopic wellbore survey system achieves the accuracy and operational flexibility needed for today's complex drilling challenges

Abstract
This paper describes a new wellbore survey system based on inertial guidance aerospace technology which has been designed for today's more complex operations such as extended-reach and horizontal drilling. The system performs a survey as the tool moves continuously through a wellbore, and probes can be pumped down through drillpipe to inclination angles in excess of horizontal. In addition, a unique quality assurance technique and control procedures quantify and optimize system performance in the field.

Development and operation of the system is described along with laboratory test results. Field test runs are compared with other survey systems and, finally, a commercial run in Canada is analyzed. In conclusion, results indicate that the system meets its specification for a high degree of precision, quality assurance techniques have been validated, and survey speed and operational flexibility have been enhanced.

Introduction
During the 1970's and 1980's, numerous companies in the energy industry defined a need for new wellbore survey technology to be adapted from modern aerospace guidance systems. Conventional surveying methods, magnetic and free-gyro based technology, had limitations in accuracy and quality assurance which had become unacceptable in many. Relief-well drilling, larger offshore platform development and simultaneous drilling and production called for a substantial increase in quantifiable accuracy; increasingly complex reservoir development and smaller geological targets also required more precise surveying techniques. By 1984 at least five new systems had been designed or had become available for oil industry applications. They ranged in diameter to 10 5/8-inches and in length to 40 feet. All had in common the deployment of rate gyroscopes and accelerometers in various configurations based on aerospace techniques. To varying degrees, these systems achieved the goals as defined during that period. Quantifiable lateral accuracy was increased substantially - to a range of 0.1 to 0.3 percent of hole depth.

Today, while the overall goal of inertial guidance rate gyroscopic surveying remains essentially the same - high quantifiable accuracy - drilling operations and economics have changed dramatically, producing many new challenges for the survey industry:
- Advances in seismic, drilling and completion technology have improved the economic feasibility of more difficult drilling operations such as extended-reach and horizontal drilling.
- Difficult drilling objectives have strained the limits of conventional survey technology, the accuracy of which can degrade with depth, direction and inclination.
- Drilling assemblies have become smaller in many operations, requiring greater directional control and smaller survey instrumentation.

While magnetic survey technology has improved and has opportunities for achieving an acceptable degree of precision, numerous and difficult variables for error exist which are difficult to model consistently, e.g. variations in the earth's magnetic field strength and dip angle, abnormalities in non-magnetic drill collars, drillstring magnetization, geomagnetic interference, magnetic storms and crustal anomalies.

Rate gyroscopic instruments as described in this paper, not subject to the adverse affects of the magnetic field, measure earth rate of rotation, gravity and sensor behavior to compute wellbore position. As in aerospace, they offer a means of quantifying a high level of accuracy, with fewer variables for error.
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BP needed to drill a well through a difficult section of formation well known to cause tool-damaging vibration. When drilling vertical, horizontal, or extended reach wells, obtaining accurate measurements of inclination and azimuth is a fundamental requirement. For these measurements, Sperry Drilling services offers three types of MWD directional sensors and the Evader® MWD gyro service. Wellbore Drill String Continuous Survey Directional Survey Angular Rate Sensor. These keywords were added by machine and not by the authors. This process is experimental and the keywords may be updated as the learning algorithm improves. Original Russian Text © Ya. I. Binder, T.V. Paderina, V.G. Rozentsvein, 2009, published in Giroskopiya i Navigatsiya, 2009, No. 1, pp. 52–63. Noy, K.A. and Leonard, J.G., A New Rate Gyroscopic Wellbore Survey System Achieves the Accuracy and Operational Flexibility Needed for Today’s Complex Drilling Challenges (Proc. SPE/IADC 37664 Drilling Conference), Amsterdam, Netherlands, 1997, pp. 773–783. Google Scholar. Efficient, accurate and reliable navigation and positioning, in all environmental and operational conditions, is a key requirement for modern offshore operations. Protracted MTBF and service life, scalability and flexibility, interchangeability and life-cycle cost reductions through commonalities, low maintenance and obsolescence management are prevailing criteria applicable for satisfying customer’s life of field operations. track characteristics of INS with the precision of a seabed deployed acoustic array this complete solution can scale from a single observation vehicle operating in a limited area with only one reference transponder to full field operations with multiple vessels and vehicles all being managed remotely using Canopus topside software.