

Straight to the Point

Orlando Ramirez

Precision matters, that's why more and more drilling contractors are interested in dispelling the myths between North seeking Gyroscopes and MEMS survey instruments

Increasingly as time goes on, MEMS is showing its weaknesses in providing accurate drilling results, while north-seeking gyros continue to outshine the competition

Technicians are impressed by the repeatable accuracy and reliability of north-seeking gyro technology

With millions of dollars on the line, even the smallest mistake can cost precious time and money. In the drilling industry mistakes cost more than money; they can result in significant damage to a company's reputation or the environment. Most drilling contractors rely on a downhole survey instrument to make sure their drilling is as accurate as possible, but the million dollar question for drilling contractors is which downhole measurement tool is the most accurate for all round drill hole surveying applications? The two most common measurement tools currently used by drilling contractors are North-seeking gyroscopes and Micro-Electro-Mechanical Systems (MEMS), and there's a debate going on as to which one is more precise.

HITTING THE TARGET —SURVEY NAVIGATION SYSTEMS

Technically, a gyroscope is a device that can measure angular velocity. While North Seeking Gyro systems measure angular velocity, companies manufacturing MEMS devices are marketing that same

ability, when in fact the two systems rely on different measurement tools. The MEMS gyroscope is not a rotating structure but a vibrating one. Miniaturized devices built on this principle can be used as a relatively inexpensive type of attitude indicator but is less accurate in determining the positioning in a borehole. The physical principle is very simple: a vibrating object tends to keep vibrating in the same plane as its support is rotated. It is therefore much simpler and cheaper than a conventional rotating mass gyroscope but 100 times less accurate. This type of device is also known as a Coriolis vibratory gyro because as the plane of oscillation is rotated, the response detected by the transducer results from the coriolis term in its equations of motion ("Coriolis force").

Using the MEMS system, every new borehole will have a starting azimuth along with X, Y and Z coordinates which are entered into the software and the system follows the well path using these coordinates as a reference point. The MEMS detects change in direction from the start position, but due to low sensitivity of the sensor, the accuracy required for borehole industry standards is difficult to obtain in most borehole profiles. A MEMS gyroscope is common in air bags and places where high angular velocities are involved, but in places where small angular velocities are required MEMS do not perform as well.

With a North Seeking Gyro, the system does not need to know a starting azimuth or reference point because it is designed to find true north, not magnetic north which can shift its geographical position over time. All the tool requires is the latitude of the drill location. Each and every individual survey point measured by a North Seeking Gyro is independent and directly seeks true north with gyro compassing technology.

ACCURACY

How do the differences of the two systems affect their accuracy? Theoretically, a MEMS system should not be able to accurately predict the path

of the drill using its reference points due to the poor bias stability, and the deeper a hole is drilled, the greater the risk of error increases. The accuracy of a MEMS system depends on the construction and design of each type of system. Currently, measuring angles using a typical MEMS over a period of time is not possible by integrating the angular rate, due to the bias errors which would cause drift. In addition, a MEMS survey instrument contains a magnetometer, which means the system could be influenced by magnetic interference when trying to locate true north or the starting azimuth reference. The reality is most of the tools advertised in today's market contain a magnetic sensor because they rely on finding magnetic north, and all data is only related to their starting position.

A North Seeking Gyro measures the angular velocity of the earth's rotation with a two-axis spinning mass sensor that feels the earth spin axis. This provides a more accurate and direct method of measurement that is typically one hundred times more sensitive than a MEMS system. This accuracy is not affected by the depth of the hole and there is no drift in accuracy over time. Because a North Seeking Gyro is not affected by magnetic interference, it can be run inside casing, drill pipe and magnetically distributed ground. As a result the generated survey data is considered more reliable and accurate than the data generated by a MEMS.

During a recent drill program conducted by Major Drilling America technicians an NQ core hole was surveyed using a north-seeking gyro in memory mode to a depth of 1,300 meters—inclination was 7.38 degrees and azimuth was 212.06. Following the initial survey, the hole was deepened and, two and a half months later, the company was called out to survey the hole again. When the data was retrieved, the tie-on inclination was 7.38 degrees and azimuth was 212.16. Technicians couldn't believe such repeatable accuracy.

DRIFT IN ACCURACY OVER TIME

Many MEMS manufacturers claim to use a gyro in their instrument; however a quick look at the specifications of a MEMS sensor and one can see that the gyro does not have any function during operations. MEMS relies solely on their magnetometers and accelerometers. Over time, the accuracy of these instruments drifts causing further deviation from their intended target. With north seeking gyro's, the initial measurements will remain accurate despite of the depth, and there will be no drift in accuracy over time.

In an economy where companies are increasingly measured by the return on investment, the

equipment they use must be the most reliable, rugged and accurate on the market.

Frank Westcott, the president of Colorado based company, Native Navigation agrees. "When you work in an environment such as the Piceance Basin where precision is critical, you need a reliable tool for accuracy and not one affected by magnetic interference. The north-seeking gyro tracer has worked perfectly 100 percent of the time," he says.

International Directional Services, a directional drilling and borehole survey services company has tested many survey instruments, both magnetic and non-magnetic over the years. General Manger Greg Taylor says the company experience with repeatability and accuracy of the North Seeking Gyro has been excellent. Similarly positive feedback has been reported by mining companies in Ontario, Canada's Sudbury Nickel basin, from Goldcorp's Red lake gold camp, and from petroleum companies in Tunisia, and from offshore oil and gas fields of eastern Italy.

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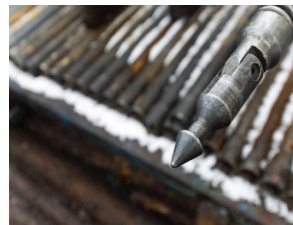
At present, based on the proven technology, track record and results, North Seeking Gyros outshine MEMS for accuracy. The superior accuracy of

North Seeking Gyros is also backed-up by field comparison data and field operator's experiences. The small cost saved on a less expensive product is by far outweighed by long term losses created because of a decrease in productivity when a mine, gas field or oil reservoir does not extract its maximum potential.

As more companies are discovering, MEMS technologies are drifting far behind North Seeking Gyro systems; North Seeking Gyro's are, and will continue to grow stronger, as the number one choice with a majority of end users. The risks of a MEMS gyro has already been established in the oilfields with some petroleum companies only allowing North Seeking Gyro's onsite for surveying contracts and that's likely to become more common in the near future.

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The North Seeking Gyroscopic Inclinometer does not require field calibration



NORTH SEEKING GYRO	MEMS SURVEY INSTRUMENT
Direct method of measurement	Indirect method of measurement
Accurately surveys in deep holes and highly deviated holes	Due to low sensitivity does not accurately measure deviated holes
Random Drift 0.01°/hr to 0.05°/hr	N/A (Non available)
Does not need a starting point	Requires a starting point
Free of magnetic interference	Has magnetic interference as a result of a magnetometer built into the system
High sensitivity 0.1°/h	Low sensitivity

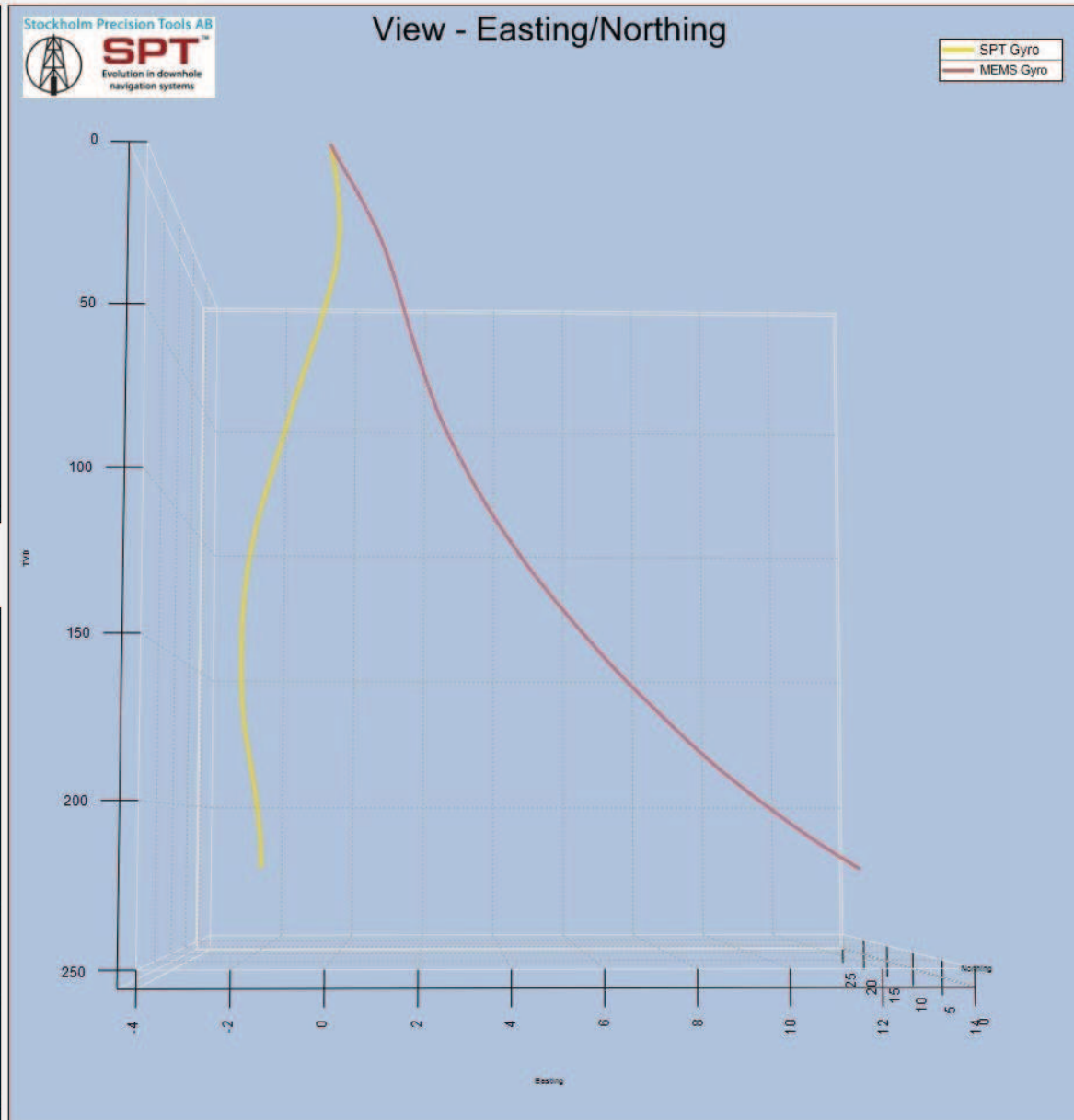
SPT GyroTracer

MD	Inc	Azimuth	Northing	Easting	TVD	DL/30m
140.00	6.76	355.61	10.71	-2.41	139.49	0.88
145.00	7.03	356.26	11.31	-2.45	144.46	1.69
150.00	7.30	356.90	11.93	-2.49	149.42	1.69
155.00	7.56	357.54	12.58	-2.52	154.38	1.64
160.00	7.83	358.19	13.25	-2.54	159.33	1.70
165.00	7.89	359.32	13.93	-2.56	164.29	0.99
170.00	7.94	0.45	14.62	-2.56	169.24	0.98
175.00	7.99	1.59	15.31	-2.55	174.19	0.99
180.00	8.05	2.72	16.01	-2.52	179.14	1.01
185.00	8.32	2.28	16.72	-2.49	184.09	1.66
190.00	8.59	1.84	17.46	-2.46	189.04	1.67
195.00	8.87	1.39	18.22	-2.44	193.98	1.73
200.00	9.14	0.95	19.00	-2.43	198.92	1.67
205.00	9.62	0.14	19.81	-2.42	203.85	2.99
210.00	10.10	359.34	20.67	-2.42	208.77	2.99
215.00	10.59	358.53	21.57	-2.44	213.69	3.07
220.00	11.07	357.72	22.51	-2.47	218.60	3.02
225.00	11.52	357.72	23.48	-2.51	223.51	2.70
230.00	11.98	357.72	24.50	-2.55	228.40	2.76

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140.00	7.12	34.94	9.71	5.77	139.45	1.33
145.00	7.12	34.97	10.22	6.13	144.41	0.02
150.00	7.32	35.43	10.73	6.49	149.37	1.25
155.00	7.68	35.34	11.26	6.87	154.33	2.16
160.00	7.91	36.47	11.81	7.27	159.28	1.66
165.00	8.00	37.90	12.36	7.68	164.23	1.30
170.00	7.71	37.78	12.90	8.10	169.19	1.74
175.00	7.98	37.83	13.44	8.52	174.14	1.62
180.00	8.01	38.90	13.99	8.95	179.09	0.91
185.00	8.33	40.25	14.53	9.41	184.04	2.24
190.00	8.79	39.98	15.10	9.89	188.99	2.77
195.00	9.34	40.20	15.71	10.39	193.92	3.31
200.00	9.85	39.24	16.35	10.93	198.85	3.21
205.00	10.07	39.35	17.02	11.47	203.78	1.32
210.00	10.40	39.76	17.70	12.04	208.70	2.03
215.00	10.93	40.03	18.41	12.63	213.61	3.19
220.00	11.42	40.24	19.15	13.26	218.52	2.95
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Drill Hole 1.



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View - 3D

