EARLY WARNING SYSTEM TO PREDICT WELL CASING FAILURES

A reliable method of predicting the impending failure of well casings in the oil and gas industry has been proven following successful trials using Sensornet's strain sensor. BP sponsored this trial to push forward the industry's understanding of the mechanics of oil well tubular collapse failures, which not only carry unquantifiable costs in terms of lost production but also the potential for causing severe health, safety and environmental incidents.

CLIENT REQUIREMENTS

BP wished to verify an accurate and cost-effective method of remotely monitoring well tubing and casing throughout their installed life. Well casing damage such as casing failure or casing collapse, can result in reduced flow and efficiency. Earthquakes and other ground movements can also cause damage. Small breaks can occur which lead to sand infiltration causing a gradual loss of pump efficiency, requiring longer pumping cycles to deliver the required volume translating into increased pump energy costs. Eventually, this may lead to a blockage, completely clogging and shutting it down and an eventual repair or replacement of the pump. A compression break is usually caused by excessive force during installation when inserting the casing, resulting in a deformation to the casing. Accurately identifying these problems can lead to efficient solutions and significant cost savings.

THE MONITORING GAP

Traditional measurement technologies do not offer continuous, cost effective monitoring of compressional strain in well tubing and casing. Point strain gauges fitted to the casing only provide point measurements, rather than distributed information. However, by taking distributed rather than point measurements, the strain sensor can provide strain field information that is otherwise unobtainable. In particular, the Sensornet strain sensor identifies when the yield point is reached, and accurately pinpoints the location of the resultant "necking" – information that is missed by conventional point sensors.

THE SENSORNET SOLUTION

In what is believed to have been the first direct measurement of compressional strain in an optical fibre using Brillouin scattering, the Sensornet strain sensor proved its ability to detect the yield point of the tubing, and pinpoint which sections were under the highest strain once that yield point had passed.

A unique feature of the Sensornet strain sensor is its ability to measure strain and temperature independently by analysing the full Brillouin spectrum, eliminating the usual cross-sensitivity to temperature.

To simulate a range of operating conditions in a well casing, a 15.5ft length of 7" tubing was installed in a 40-million pound load frame. Bare fibre and sensing cable, attached to the external faces of the casing in a series of runs along the top, sides and bottom, acted as the sensor.

Data was acquired while the casing was subjected to a variety of tensional, compressional and bending strains at temperatures ranging from ambient (around 20°C) to elevated (between 114°C and 137°C) to stress the casing to its failure point.

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SUBSTANTIAL BENEFITS

The tests proved the ability of the Sensornet strain sensor to take reliable distributed measurements of temperature and strain. The Sensornet strain sensor was able to isolate compressional and tensional strain, and so could simultaneously determine the direction and amount of bending along with any additional compression or tension applied to the casing.

The tests confirmed the potential role that the strain sensor system could play in predicting potential failures in well tubulars, thus enabling preventive action to be taken. In doing so it will meet the industry's demands for an accurate and cost-effective method of remotely monitoring well tubing and casing to meet performance targets throughout their installed life.

Sensornet is now developing a production strain sensing system capable of the long-range monitoring of well casings and other structural elements. The development will also deliver the necessary fibre optic cabling, installation techniques and data interpretation software. Applications range from high-temperature wells where thermal expansion creates significant challenges to casing collapse caused by subsidence.

MEASURABLE PERFORMANCE

The strain sensor measured the full distribution of tensional, compressional and bending strains. The system provided a 1°C temperature resolution and a 20με strain resolution at a spatial resolution of 1m. The sensor detected the elastic limit of the casing, the onset and exact location of necking and continued to measure at very high strains (to the point where the chuck holding the casing failed at 2.6% strain), where point gauges had failed.

The test was a complete success and confirmed that distributed fibre optic systems are able to provide oil and gas operators with reliable early warning of potential failures in well tubulars, with all their consequent costs and impacts.

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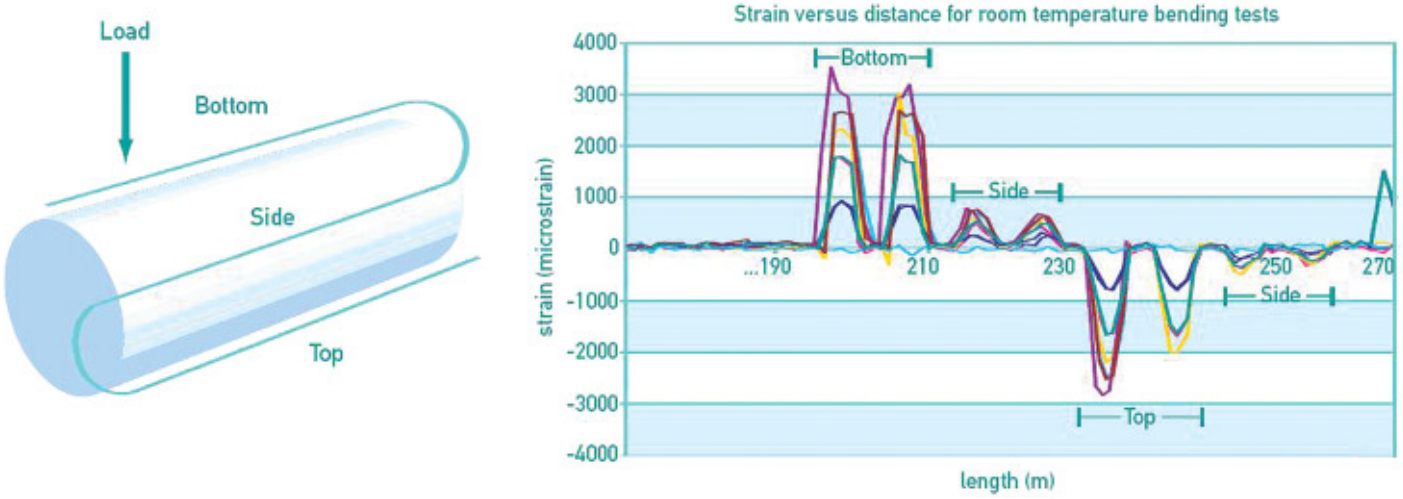

Demonstration of Sensornet's strain sensor detecting strain in well casing. The industry must reduce well tubular and casing failures to meet performance targets.

To close your monitoring gap, call +44 20 8236 2550 or visit www.sensornet.co.uk

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