Corporate Report

a report by
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Introduction

Historically, wireline or slickline technology has been limited to mechanical devices that manipulate tools downhole. These tools are used for a variety of purposes but include setting and pulling packers, plugs, performing drift runs, setting and retrieving memory gauges, side pocket mandrels, and moving sliding side doors.

Historical

Wireline tool strings have always been used in conjunction with gauges at surface (depth and weight) that allows the operator to see forces on the wire at surface in order to stay within wire strength specifications. The use of surface weight indicators is a common practice and is used every day in many aspects of wireline-deployed systems. The limiting factor when using surface weight indicators is that only the surface wire tension is visible. The 'feel' of the winch and the skill of the operator are paramount in the execution of a successful intervention.

In the event a misrun occurs due to lack of force downhole, the surface weight indicator will not supply the operator with enough information to react to the situation. The 'feel' factor is no longer sufficient to prevent additional misruns and as such technology was required to aid the operator in the decision-making process.

Data Stem

Impact Guidance Systems (IGS) embarked on a two-year development strategy to develop the world's first downhole impact sensor that could be used to aid the operator.

The systems known as 'Data Stem', offers the oil and gas industry a memory-based sensor capable of recording forces applied by the mechanical toolstring up to 150,000lb of impact force in a small modular bi-directional unit. The system is implemented below the mechanical jarring tool and records, at depth, the forces applied by a given toolstring design to a given device.

In the event a device cannot be deployed or retrieved, Data Stem supplies impact data charts that give visible data showing what forces were applied and what action is required to reconfigure a selected toolstring in order that adequate forces are then re-applied to the device for a successful intervention and reduce or completely negate a further misrun.

The wireline/slickline industry has been around for decades and the use and methods implemented have remained relatively unchanged for at least the past 20 years. Quick connectors and efficient roller stem have revolutionized intervention methods and success. Memory gauges have permitted the use of slickline for well-logging operations and drastically reduced operator cost, high load mechanical and hydraulic impact jars have allowed for higher forces to be applied to devices that have proven problematic and all of the above have aided in the ability of the service provider to get wire further, deeper, quicker and at higher angles than ever before with a much better success rate. So why are we still guessing as to what forces the toolstring is applying downhole?.

The primary reason is that only recently has technology caught up and we can now have electronics downhole that can accommodate temperatures up to 400° F. Only in recent years has the ability to miniaturize electronic components to fit into a small enough area to deploy down hole. Ultimately no one thought the requirement for a downhole impact sensor was needed. Misruns on slickline, whilst unsavoury, were not unusual and the reason for the misrun and possible consecutive miss-runs could be blamed, of course, on well conditions. There was generally no reason to think otherwise, until now.

Reliability

Impact Guidance Systems has spent the last 12 months performing verification tests to ensure our systems have a high degree of accuracy and reliability. Having no other base-line to work from and being the only company globally to design a downhole impact sensor, the calibration of the memory-based, battery-powered system would prove to be an exceptionally difficult task.

More than a year of testing and acquiring data from various sources, our systems are now calibrated and have gained an accuracy approaching 1% of full scale. At the lower end of the sensors spectrum (200lb) accuracy is around 10%. To ensure consistency of sensor calibration and longevity, IGS built 'solid state' sensors that have no moving parts or crystal that would otherwise break under severe loading, making the system extremely reliable.

To date IGS have had only one field failure out of 60 plus interventions.

Lessons

The primary reason for developing an impact sensor is to acquire data that will aid in the understanding of what exactly is happening during toolstring jar action. To understand the forces being applied to a device, say during a fishing operation, will permit the operator to reconfigure the toolstring to better manipulate the fish downhole. The ability to view impact data from a toolstring or to not view this data is the question an operator needs to ask. Will the impact-force data, supplied by the tool, benefit my intervention programme? Will the cost of the system outweigh its usage and benefits?. Will the cost of a misrun, where Data Stem was not in use, cost me more in the long run?

During the study phase, a lot of end-users felt the system would be beneficial after they found they had a problem and they would call off the tool. However, since using the technology, they have realised that the reverse is true. To have the system on a toolstring as a standard piece of equipment allows them, in the event of a misrun, to immediately evaluate the situation and re-direct the intervention programme. This allows them to better serve the needs of the client by reducing downtime due to additional misruns caused by guesswork evaluation as to what was happening downhole.

Several operators are now using the technology daily as a standard piece of equipment in the UK, US and South-East Asia. Some operators have requested that the providers of impact-jarring tools have their systems tested to ensure their impact accuracy. Several jar manufacturers have supplied their jars for testing and the results have aided them in both their design upgrades and their approach to fishing operations with certain jar designs.

Other work conducted with the Data Stem impact sensor is with tractor and jarring technologies. The combination of these technologies has allowed major operators in the US to understand the forces required to shear a ceramic disk in a horizontal well section. It will also aid in the application of tractor plug setting and retrieval.

Training

Present-day training of new recruits to wireline or slick-line operations takes place in the classroom, in front of winch simulators, and finally with on-the-job training. Enabling a new hire to understand the forces involved in wireline and slickline operations is no easy task. When pulling on a wireline unit to impact a device downhole, there is no recognition of the forces involved other than the surface weight indicator. The ability to ask a trainee what forces he thinks he is applying downhole, and then retrieving the toolstring and showing the trainee what actually happened, aids immensely in the trainees understanding of the toolstring operation and capabilities. To date, this has never been implemented as a standard piece of wire line or slick line training equipment. The ability to train our new wireline/slick line operators with this technology can only benefit all in the long run. Even if the trainee never uses Data Stem again, they will have been given the best set of training tools that will allow them to perform more confidently on operator assets and assert themselves with a knowledge base that will enhance operations for all.

Emerging Sensor Technology from IGS

Data Stem also incorporates a temperature sensor for both logging and depth correlation. IGS is currently enhancing the current version of Data Stem with a new multi-sensor module that will incorporate the following sensors built into the existing Data Stem chassis:

- Impact Sensor – capable of up to 150,000lb.
- Angle Sensor – detects toolstring angle and informs the operator of friction loss.
- Pressure Sensor – records all pressure events during intervention operations.
- Temperature Sensor – temperature log and depth indicator.

The above system has the capability of switching any of the four sensors "on" or "off" in the event that not all sensors are required for a specific intervention. This system is available January 2007.

Installation History and Client List

To date, IGS has performed over 60 installations in four countries and recorded thousands of impact points, permitting better intervention techniques and new insight into toolstring operation downhole. Data Stem has been used to determine forces in the following systems:

- sliding side door movement at 72°;
- side pocket Mandrel force;
- crown plug removal/install in a subsea well at 3,200ft;
- toolstring fish retrieval at 15,000ft and 65° subsea;
- toolstring fish retrieval at 15,300ft and 35° land;
- tractor system and jarring tool combo, force recognition whilst shearing a ceramic disc;
- bailing sand;
- jarring through tubing restrictions;
- slickline activated TCP guns;
- testing third part mechanical jars;
- slickline operations as a standard piece of equipment; and
- fishing operations as a standard piece of equipment.

The application of impact technology has offered a new dimension to slickline operations. The enhancements will benefit the service provider and operator in reducing rig time and intervention risk, and finally offer an explanation for some of the unknowns that have caused many a long shift. ■