UNMANNED INSPECTION FOR OIL & GAS: ROVs, PIGS, ROI & OBSTACLES

It's a fact: the nature of the equipment and assets employed in the oil and gas industry, necessitates periodic and rigorous inspection and maintenance.

Due to the sheer detail required and the number of critical systems that need to be addressed during an inspection cycle, these vital tasks can be both highly complex and time-consuming.

The contemporary oil and gas industry employs a range of strategies and techniques in order to ensure inspections are both cost and time-effective. Many of these are in the unmanned realm, relying on the remote operation of vehicles from a control room or vessel.

In The Business Case For UAVs In The Oil & Gas Industry, we analysed the emerging influence of new fly-by-wire technology in the hydrocarbons industry. In this article, we look at two of the more established methods of unmanned inspection: remotely-operated vehicles (ROVs) and the non-porcine pig.

REMOTELY-OPERATED VEHICLES (ROV)

The first instance of a submersible ROV is the "Cutlet", a remotely operated underwater vehicle used by the Royal Navy in the 1950s to retrieve practice torpedoes fired in ordnance testing exercises. At the same time, the Hughes Aircraft Company began developing the Manipulator Operated Robot (MOBOT) for the US Atomic Energy Commission. The MOBOT was designed to operate in environments too radioactive for human participation.

In the 1960s, the world's pre-eminent naval power, the US Navy, took the lead in the development of ROV technology, creating the "Cable-Controlled Underwater Recovery Vehicle" (CURV). The CURV was designed to perform deep-sea recovery operations at ocean floor depths beyond the capabilities of conventional divers.

In the 1960s, the oil and gas industry took a shine to the idea of using ROVs in an offshore conext. Shell Oil Company began the task of converting the Hughes MOBOT into an underwater vehicle that could work submerged for extended periods of time. In 1962, the company successfully employed a MOBOT on a well off the coast of Santa Barbara, California, at a water depth of 80 metres.

In 1965, Shell's Howard Shatto Jr. received a patent for an "underwater manipulator with suction support device" that could work on offshore wells at depths of more than 180 metres, beyond the reach of deep sea divers. This would make Shell a world-leader in offshore oil field developments, and the next 10 years would see ROVs used on 24 offshore wells, operating to depths in excess of 300 metres.

The case for Unmanned Underwater Vehicles (UUVs)

In the 21st century, one third of the world's oil and gas fields are located offshore. As such the Unmanned Underwater Vehicle (UUV), of which ROVs form the majority of craft in operation today, has come into its own in the exploitation of underwater resources. The ROV presents several obvious advantages:

Manpower – Usually only a single, trained operator is necessary for the operation of an ROV, making it one of the most streamlined parts of oil and gas exploration and production operation.

Ease of deployment – Whether released into position on rail cursors, guide wires or via a moonpool delivery system, vehicles can be easily deployed to the required locale of operation in a multitude of conditions.

Flexibility – One of the main strengths of an ROV lies in its manoeuvrability and adaptability to suit various tasks and environments.

Time submerged – An ROV's working time underwater is only limited by the endurance and concentration span of its operator.

Despite these advantages, silver linings do have clouds. ROVs also suffer from some of the same drawbacks as conventional divers.

Weather – Strong currents may be a hindrance to the smooth running of ROV inspection tasks, pushing the vehicles off course.

Loss – The worst case scenario for an ROV operator is the possibility that the umbilical cable that connects the vehicle to its control craft is either severed or becomes entangled enough to cause the vehicle to terminally malfunction.

Add to these reasons the fact that the technological complexity of these submersible craft and their usage in an inhospitable environment means that maintenance activities are both high cost and high frequency.

The future

The UUV market is split into ROVs and autonomous underwater vehicles (AUVs), which have been used traditionally in seafloor mapping prior to the installation of subsea infrastructure. In 2014, the worldwide ROV market for oil and gas was worth $1.2 billion, roughly three times the amount spent on AUVs, which totaled $457 million.

By 2019, the combined UUV market is set to hit $4.84 billion, with the majority of this investment taking place in the North American arena. Much of this growth is based on the rapid development of deep sea and marginal resources and evolution and miniturisation of the traditional ROV into ever smaller and smarter craft.

The UUV interface is becoming easier to train for and the technology packages that can be integrated on board are constantly advancing. The UUV of today can house an array of new sensory systems such as next generation sonar and positioning applications, high-definition cameras, laser scanners and radiation detectors.

PIGS, THE OINKERS OF TRANSMISSION INFRASTRUCTURE

As long as there have been pipelines, there has been a need to unblock them. The original pigs were cylindrical straw bundles wrapped in wire which made a squealing noise when traversing a pipe, hence their relation to the humble swine. Nowadays, many count "pig" as a backronym, derived from the initial letters of the term with the meaning of "Pipeline Inspection Gauge".

The emergence of the first smart/intelligent pig can be traced back to 1959, when pipeline specialist, T.D. Williamson, introduced into its pigs a caliper tool for detecting dents in pipelines. In the decade that followed, client demands drove oilfield service companies to integrate increasingly more sophisticated technologies into their pigs, such as remote field eddy current sensors and magnetic flux leakage (MFL) tools.

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This progressed into pigs that housed an array of ultrasonic technique (UT) probes to provide accurate internal measurement of pipes but which require a liquid medium to transmit sound waves. Electromagnetic Acoustic Transducer (EMAT) inspection technology is a more recent step forward for pipeline inspection technology, which has the advantage over the standard UT systems of not requiring a couplant - or transmission medium- for the diffusion of sound waves.

Challenges

There is around 2.5 million kilometres-worth of hydrocarbon pipeline in the world today. In perspective, that is enough to wrap around the circumference of the Earth more than 62 times. The

challenges for the oil and gas industry to clean and perform internal inspection of these underground labyrinths are legion, but can be boiled down to several core concerns:

You can't pig the "unpiggable": A significant percentage of pipelines across the world are considered impossible to pig for a range of reasons:

- Pipes may have a number of different diameters which prohibit the passage of these torpedo-like structures.
- There may be no direct entry into a pipe.
- Blockages caused by sediments and contaminants may act as barriers to the path of a pig.
- There are valves in the pipeline that permanently obstruct the passage of anything but a gas or fluid.
- Tight bends in the pipe do not allow the rigid exoskeleton of the pig to pass through.

Pigs aren't infallible: The two types of pigs – cleaning and inspection – need to be used in that order for maximum efficacy. Even if the path has been properly prepared for the passage of a pig, sometimes positive detections of fissures and corrosion can elude even the most intelligent of systems. A prime example of this occurred in 2013, when ExxonMobil sent a smart pig through a section of the 1,400-kilometre long Pegasus pipeline in Arkansas. Despite a rigorous inspection run, the very next month a seven metre segment of the pipe ruptured, resulting in a 5,000 barrel spill.

There has to be a lot of money in the piggy bank: The business of pigging is not an inexpensive one: it is estimated that cleaning by pig can cost as much as $56,000 per kilometre. With around 25 per cent of the world's pipelines falling into the "unpiggable" bracket, we can estimate that companies are spending approximately $105 billion on pigging the world's hydrocarbon arteries. That is equivalent to the annual gross domestic product of Morocco.

It is hard work being a swineherd: Working with pigs of both the farmyard and pipeline persuasion is a messy and labour intensive process. As most pigging runs occur whilst pipelines are in service, a demanding planning process is crucial to make sure that operations are maintained within HSE parameters. After the planning is complete, it may take a trained crew hours to correctly load the pig into the pipe, whose running distance will only stretch to a handful of kilometres. As such, depending on the pipe, pigs may need to be launched several dozen times before a full clean is complete or an inspection pattern can emerge.

Whilst the UAV market is burgeoning by the quarter in the oil and gas inspection fold, it is the tried, tested and evolving arena of the UUV and pipeline pig that will be the mainstay of the hydrocarbon industry for decades to come.