The business case for digitalisation in the refining sector

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When we use the word 'digitalisation' what do we really mean? Computers have been used for process control since Fortran 77 was developed in the late 1950's. Commercial transactions have been executed in ERP computer systems for decades. So, what's new about 'digitalisation' for the energy and chemicals sectors and how can the industry benefit from getting ahead of the curve?

Artificial intelligence (AI), the internet of things (IoT), big-data and 3D artificial reality are all examples of sub-sets within the broad digitalisation agenda. Each of them is being applied daily to have a positive impact in various aspects of the diverse energy and chemicals sector.

Chemicals distribution companies are using IoT technologies to track highly valuable storage assets and chemical cargoes in ISO tank containers. AI is incorporated into process training simulators to give operators a risk-free learning sand-pit where they can get a head start on their preparations for operating new process equipment. Big-data is being used to capture and analyse thousands of process-control data points which are then combined with AI to make process optimisation recommendations to maximise production yields or minimise energy consumption in process operations. And, 3D artificial reality is now commonly used to train process operators in the physical layout of new process plant that they will soon be responsible for operating.

Revenues can be maximised, costs can be reduced, safety is improved, and start-up times are minimised. Everything adds up to a powerful business case for an ongoing digital transformation in the energy and chemicals sectors.

Case study – EH&S improvements on refineries with wireless fixed location gas detection systems to augment existing hard-wired systems

Fixed gas detection systems are used as an early warning system or refineries and storage terminals to prevent fires and explosions in the event of a flammable gas leak. They also sniff for toxic gases such as the BTEX group of Benzene, Toluene and Xylene to minimise health risks to the plant operators. High level readings of flammable or toxic gases can be set to trip process equipment or set flow control valves to a safe position and thereby minimise the risk of an incident and the associated losses, injuries and long-term health risks.

Increasingly, gas detection systems are also being used for environmental monitoring of VOC emissions from valves, flanges, pumps, compressors and pressure relief devices. Fixed detectors can monitor for leaks 24 hours a day and are replacing hand-held portable systems that require operators to walk the site sniffing for leaks. This results in cost-savings in labour and demonstrates to the environmental regulators that improvements in monitoring are being made. Furthermore, through continuous improvement in process equipment with maintenance for leak reduction, the monitored results can also demonstrate a long-term reduction in VOC emissions. The result is better for the environment and better for the process economics: leaks represent waste. This application is an emerging reason to augment existing fixed gas detection systems with new devices.

Some refineries operate with a process safety target of zero incidents. But, to achieve the holy-grail of zero requires an absolute and unrelenting commitment to continuous improvement in safety practices and related equipment. This is an additional driver for the augmentation of existing gas detection systems with additional devices to increase the coverage density of gas detection and further reduce the risks of potentially hazardous leaks going un-detected.

So, from the perspective of environmental management and the desire to increase process safety, there are two strong drivers to augment an existing gas detection system with additional new devices. So, the 'burning platform' for change is clear, the next question is how and where to jump?

On an established refinery the idea of digging and laying new cable trenches for hard-wired fixed gas detection systems would immediately raise a long work list of permitting, engineering management of change reviews, HAZOP studies and costly ground-work. The expense, complexity and timeline of the installation would demand an extremely strong benefit case to proceed.

But in the modern digital world of Industry 4.0, there is an alternative that may result in a much simpler project at lower cost and faster execution: to use wireless gas fixed gas detection units. And, if they are battery powered and can communicate with an existing site communications protocol, such as the HART open protocol communications technology, their installation and configuration can be achieved in a matter of hours or days, not weeks or months.

Ten years ago, the thought of using a battery powered wireless gas detector would have either been a technical fantasy or the costs for a pilot unit would have been prohibitive for general applications. Today, with sophisticated power management systems to increase the battery life to an acceptable multi-year period and high production volumes of the required electronics have combined to mean that the costs of these devices have tumbled. Unit for unit, they are still more expensive than a wired device of a similar quality and specification, but the break-even point for an installation now typically lies in the order of 3 to 5 devices.

The economics mean that for smaller augmentation projects with relatively few fixed gas detectors, the hard-wired option is likely to be cheaper in terms of materials and installation costs. But the tipping point is often around 4 devices. And, as with all technology, costs will continue to fall meaning that in the future, it is possible that even for small jobs the wireless system will be favoured.

All this being said... in some cases the installation project cost is not the deciding factor. If an installation is required immediately, then the wireless system may be the only option that is quick enough to be installed in an acceptable time window. Consider that the environmental regulator or a safety audit has mandated that operations be terminated until corrective action is taken. The daily costs of non-operation can quickly add up to many multiples of the cost of the gas detection installation project, so speed will be the governing factor, not the installation project cost.

Throughout this case study, we have referred to 'augmentation' of existing systems not 'replacement'. Why? Is the state of the art for wireless devices not yet ready to eliminate the fixed systems? Well, no, that's not the case. With self-repairing communication meshes which communicate through multiple pathways in constellation that looks more like a spider's web than a linear chain, modern networks of wireless can withstand devices being removed from service for maintenance and the communication of the gas detection readings from the network to the base receiver is extremely robust.

To replace a hard-wired system, we do not need better wireless technology, we need a paradigm shift in how this innovative technology is perceived and used. For good reasons, refinery operators are generally extremely cautious of change and will generally want to observe new systems in parallel to trusted techniques before trusting them 100%. But, in the future, when the test of time has been passed, it is likely that critical alarms and process trips will also be triggered by these wireless networks in the same way that their hard-wired cousins have been doing for the past few decades.

That will be the time when new refineries are being built with wireless communications for all process signals and turn-around projects on existing operating refineries are going beyond augmentation of existing systems are undertaking full replacement of aged systems and exploiting the resultant benefits of the digital transformation.

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