Measuring what matters in oilfields

This case study from the Indian oil and gas industry highlights the use of VEGA's MINITRAC 31 radiation-based sensor for non-contact density measurement of liquids and bulk solids, and the VEGA radiometric multipoint density array (MDA) profiling system for characterising the oil extracted from the Mangala field in the Rajasthan desert.

India's population is nearing 1.4 billion, and as a developing country, its energy needs are increasing. According to UN forecasts based on current economic growth of 5 to 7%, consumption will double from 2020 levels by 2035 to 2040. This has already led to increased domestic production and the expansion of domestic oil refineries. Oil companies face challenges in meeting demand, however, as they extract and refine oil in remote regions under difficult climatic conditions, where resources take many years, even decades, to access.

Enhanced oil recovery

The oil extraction process often yields a mixture of difficult-to-characterise products due to varying densities and viscosities across different drilling sites. Conditions at the wellhead, such as pressures, gas content, temperature and contamination, are rarely consistent. This variability affects extraction and processing costs, presenting a significant challenge in improving yields while pursuing discoveries.

Enhanced oil recovery (EOR), also known as tertiary recovery, addresses key industry challenges. EOR employs methods such as chemical injection, ultrasound or steam to boost crude oil recovery by up to 20%.

Once EOR is implemented, downstream treatment processes can improve. Crude oil first passes through a slug catcher, which separates liquid slugs. At this stage, oil, water and sand are sorted for further processing, using measurement technology to optimise efficiency and ensure safety.

Cairn Oil & Gas, a subsidiary of Vedanta Ltd, utilises multi-density arrays (MDAs) made up of vertically arranged radiometric density sensors in its slug catcher to enhance separation efficiency. Here, VEGA's MINITRAC 31 non-contact sensors monitor density over a vertical range of 0 to 5 000 mm using advanced scintillating-crystal technology to avoid contact with the process medium. This setup enables real-time data transmission to the control centre, ensuring smooth operations at the Rajasthan Field.

The Mangala field

Large oil reserves are becoming increasingly rare, and the costs of developing and producing them continue to rise. As a result, there is a growing interest in enhancing yield. To this end, Cairn Oil & Gas and Vedanta Ltd. secured a significant area in the Rajasthan desert back in 2002. This remote location lacks water access and transport links, but prior seismic surveys provided encouraging sonic data suggesting the presence of extensive oil deposits beneath the surface.

It took another two years and the drilling of 15 expensive exploratory wells before success finally came in January 2004, when Cairn tapped into the new 'Mangala' oil field in the vast North Indian desert. Globally, this discovery turned out to be the most significant oil find of the year, and India's biggest onshore discovery in 25 years.

It wasn't until five years later, in 2009, that oil extraction finally began. According to India's Economic Times, the Mangala field has since produced 473 million barrels of crude oil. To put that into perspective, if this oil were transported

VEGA's radiometric system precisely monitors separation layers in the slug catcher, protecting equipment and maintaining crude quality under extreme conditions.

in standard-sized freight train cars, the train would wrap around the globe nearly 40 times. Notably, Cairn produces almost 25% of India's annual crude oil output from this single field.

VEGA MDA profiling

The oil from this site is unique due to its waxy characteristics, which cause rapid solidification upon surfacing. The pipeline, therefore, which extends about 700 km, is the world's longest heated crude oil pipeline. Before reaching refineries, the oil is cleaned at the extraction site to remove water, sand and impurities.

Thorough simulations were essential for pipeline construction and designing the slug catcher. Slug catchers manage slug flow, temporarily storing liquids between the pipeline outlet and processing facilities to protect downstream equipment. These slug catchers rely on droplet separators, which can reach capacity quickly if overloaded. To prevent solid contaminants from accumulating, the VEGA MDA density profiling system monitors density data at various heights within the slug catcher. This ensures efficient separation by accurately tracking the movement of the separation and emulsion layers.

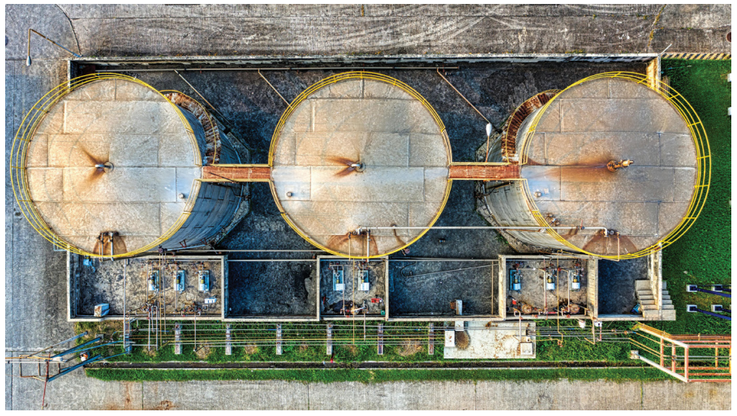
Reduced maintenance

The density-measuring system selected by Cairn is designed for minimal maintenance, as all detectors are mounted externally on the vessel, avoiding direct contact with the process. A flexible mounting system allows for a straightforward yet robust installation, and the detectors remain easily accessible for any necessary maintenance. With multiple measuring points operating independently, issues with a single detector won't disrupt the entire system's performance.

Ease of use for the VEGA MDA system begins even earlier in the process; rapid commissioning and calibration of the measuring system significantly reduce start-up times and costs. Additionally, extensive diagnostics via the PACTware® configuration software, along with its device type manager (DTM) and electronic device description (EDD) technologies, connect the field devices and controllers to provide a clear, straightforward overview of the system's health.

Sensor intelligence

In the oil production industry, yield is influenced by more than just the volume of material that reaches the surface. There is a growing emphasis on optimising raw materials before they head to the refining stage. This is why Cairn has taken a close look at every step of the crude oil processing journey.



With oil reserves dwindling and costs rising, Cairn Oil & Gas and Vedanta Ltd are driving yield gains in the Rajasthan desert.

One of the common issues that has received particular attention is slugging, the formation of plugs that hinder flow. The precise monitoring of separation layers in the slug catcher, facilitated by the VEGA radiometric system, enables efficient operation of this critical separation process. This reliable measuring system performs effectively in extreme temperatures, preventing large solid slugs from being carried downstream.

This helps protect downstream processes and components, ensuring the quality of crude oil is maintained as it moves through pipelines to the sea for loading onto ships for further transport.

VEGA is known for its long history of innovation and is recognised as a global leader in measurement technology. The company is dedicated to precision and reliability, and its customised solutions have positively impacted businesses worldwide, improving processes, efficiency and quality standards.

www.vega.com/en-za

Left: To prevent solid contaminants from accumulating, the VEGA MDA density profiling system continuously monitors density at multiple heights. Right: Oil yield depends on more than extraction, optimising raw materials before refining boosts efficiency and output.