PUMP TECHNOLOGY IN INDIA

Pipeline sampling: **Paul Davis, MD, Wanner International Ltd.,** explores an alternative to magnetic drive gear and centrifugal pumps.

Magnetic drive gear and centrifugal pumps: for many years the preferred types of pumps for automatic fast-loop sampling of petroleum products at analytical stations have been replaced in India along a number of major pipelines and in refineries by zero-leakage seal-less diaphragm pumps.

The need to find an alternative to magnetic drive technology on this application was first prompted by premature wear and pump failures associated with the ingress of fine particles of abrasive pipeline scale, resulting in serious damage to the gear pumps.

The pumps replacing them are Hydra-Cell diaphragm pumps manufactured by Wanner Engineering. Embodying a unique seal-less design concept, they can handle abrasive liquids without difficulty. They have proved themselves able to satisfy all system parameters while working 24 hr/d for long periods in remote locations with little or no maintenance.

Practise makes perfect

Analysing petroleum products on the move through pipelines and associated facilities is a widespread practice in the oil industry. Typically, its objectives are to identify the liquid in transit, determine its properties and in many cases verify its compliance with international fuel standards or their local variants.

Figure 1. Scale contamination in a liquid petroleum product.

Among the properties targeted, density and sulfur content are particularly significant. The density of a petroleum liquid is a reliable indicator of its type, grade and quality, while the sulfur content of petroleum fuels is a major environmental concern; expressed in parts per million, it correlates with the maximum sulfur content level permitted under a given fuel standard.

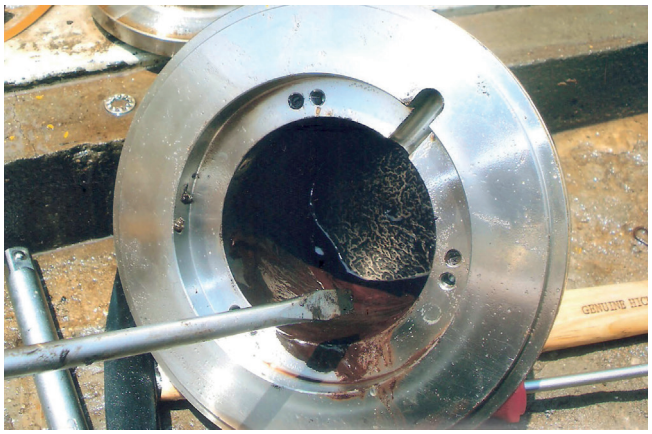

Figure 2. Scale deposits reach magnetic ring of a magnetic drive centrifugal pump.

India employs a 2-tier system enabling the government to prioritise at each stage of a progressively applied programme by setting lower permitted parts per million limits for selected big cities than those applying to the country at large.

Collecting samples

Before liquid in the pipeline can be analysed, samples must first be taken from the line. Both operations are continuous. In practice, sampling and analysis of liquids are combined into single dedicated systems

There are two main ways in which liquid samples can be collected from a pipeline: the inline probe and the bypass or 'fast' loop.

The inlet diameter of a bypass loop is several times larger than that of the inline probe – an economical but more limiting method of sample extraction. The loop is not only less prone to block, it takes larger samples more representative of flow in the pipeline at sampling point and more suited to simultaneous analysis of various liquid properties.

Liquid for sampling in a bypass loop system must be independently pumped, requiring a small high-pressure pump integrated into the loop immediately ahead of the analyser system itself. Its job is to deliver a continuous supply of sampled liquid to the analyser and complete the loop by returning it to the main line at a pressure high enough to override pipeline pressure.

Velocity and pressure

Flow velocity through the system should not differ widely from that of flow in the main pipeline. At a lower speed, associated with pressure losses during transfer through pipework of much smaller bore, the properties of the liquid can change. One authority – ASTM D4177-95 (2010) – suggests that average velocity through the sample loop should be near to the maximum average velocity expected in the main pipeline, and proposes a minimum value.

The pump is a critical component of sampling/analysis systems. The demands placed on it can be severe. It must be flexible in operation, able to pump over a wide range of pressures Pumping must be continuous and leak-free, sustaining 24 hr/d performance reliably over long periods of duty.

India: pumps and pipelines

The petroleum liquids handled by pipelines and associated facilities in India are thin and non-lubricating (many pumps have seals that rely on the pumped liquid to lubricate them. Drying out will cause rapid wear).

Some Indian pipelines carry fine particles of abrasive scale picked up from older sections of the network. Many sampling stations are remotely sited and unmanned. Frequent, regular pump maintenance is impractical.

But the need to sample and analyse petroleum products remains, and the level of these activities continually rises. An underlying growth factor is the accelerating increase in fuel consumption, led by road users. Between

2003 and 2013, India's vehicle population rose from 50 million - 130 million. Meanwhile pipelines in India are rapidly increasing their share in fuel transportation – directly stimulating the requirement for automatic sampling.

What is being carried?

Facilities for refined products are most often shared, between users and between the types and grades of liquids they carry. A single pipeline might handle, for example, different grades of diesel oil and gasoline for road vehicles, as well as jet fuel for use in aircraft and oil for heating.

Individual batches may be directed to different destination, but in the pipeline they follow closely on one another and there is mingling at each interface, which may call for the contaminated 'transmix' segment to be separated and re-processed in a refinery.

In these circumstances pipeline operators, their customers and other interested parties need to establish throughout the line precisely what is being carried, its chemical content, purity and other relevant properties. The most accurate, cost-efficient way of gathering and assessing this data is by means of automatic sampling and analysis.

Case study: Rewari to Kanpur pipeline

The 440 km Rewari to Kanpur pipeline (RKPL) under construction for Hindustan Petroleum Corporation Limited (HPCL) – one of India's major refinery companies – is an ongoing project of strategic importance in the country's distribution network. It is a multi-product pipeline for transporting high-speed diesel fuel, kerosene and various Euro grades of petrol, with a planned capacity of 8 million tpy.

To identify individual products, and to check quality parameters, fast loop analyser systems for measuring density, viscosity and other properties are installed at lengthy intervals along the main pipeline. They are also located at associated refineries and at distribution centres, where refined product is received for distribution to the consumer channel. Each loop has its own pump, which is required to work reliably 365 dpy on a 24 hr/d duty cycle.

In line with previous practice, pumps typically used for this application on the RKPL and other networks in India have been magnetic drive (gear or centrifugal) pumps, in which torque is transferred from motor shaft to impellor or gear assembly using magnetic force to bridge a deliberate gap in the mechanical power train.

Magnetic drive pumps are primarily designed to prevent leaks. But drive elements and the pumped liquid are not totally isolated from each other. The pumps can still be vulnerable when handling non-lubricants and liquids containing abrasive solids. Experience on the RKPL and other Indian pipelines has highlighted this problem.

Much of the RKPL network will be newly constructed pipelines, but it does also draw from and includes sections of older pipelines in which scale has accumulated as they age. In consequence, refined hydrocarbon fuels may contain fine particles of scale. Through time, scales were being deposited on the inner magnetic ring of gear pumps and and causing serious internal damage.

To inhibit the ingress of scale particles the magnetic drive pumps would need the protection of fine filtration systems in the pump inlet piping – not a practical solution in an unsupervised location.

The difficulties afflicting the RKPL and other networks were eventually resolved by using pumps of a different type for sampling systems – seal-less diaphragm pumps in the Wanner Hydra-Cell range that can handle abrasive and other problematic liquids by design, and do not need fine filtration. On the RKPL Hydra-Cell pumps are incorporated in sampling systems for analysing density (manufacturer Emerson Process Management) and sulfur content (manufacturer Bartec).

Similar circumstances

Comparable issues were being faced and overcome in density analysis systems elsewhere; at the Government-owned Mumbai-based refinery for example, and along the pipeline that links it with markets across the country.

At another large refinery, operated at Vadodara (Gujarat) by Yokogawa, magnetic drive gear pumps in sulfur content analyser systems had to be replaced every two months because of gear damage, attributed partly to scale ingress and partly to handling non-lubricating fuels (high-speed diesel and petrol) at high pressures and temperatures up to 45°C or higher.

For many years the refinery had used magnetic drive gear pumps for sampling - but with their life expectancy so low it was decided to make a change. For a new system manufactured by Chemtrols Industries the pump specified by the manufacturer was a Hydra-Cell G10.

Figure 3. Hydra-Cell G10 and G15 sampling pump installations by Emerson Process Management (HPCL – Rewari Kanpur Pipeline network).

The pump began running at Vadodara in January 2011. Three years later, with no maintenance needed and no troubles to relate, it was still working reliably. Similar reports have come from other pipeline and refinery sites – including the world's largest refining and petroleum complex, operated by Reliance Industries at Jamnagar.

Zero leakage is a given requirement for an unsupervised pump handling petroleum liquids on a pipeline sampling system. In Hydra-Cell pumps it follows automatically from a unique design concept in which flexible hydraulically-balanced diaphragms deflect in sequence to provide the pumping action while totally isolating the pumped liquid from the drive mechanism. This is always submerged in lubricant. There are no dynamic seals, packings or close-tolerance mating surfaces in the pump – no potential for leaks or premature wear.

Out of these features come further benefits relevant in sampling applications: the pumps can run dry indefinitely without damage; they can handle virtually any liquid, hot or cold, including thin non-lubricants and those containing abrasive particles; they do not need fine filtration; being hydraulically balanced the diaphragms are stress-free, enabling the pumps to work efficiently at any discharge pressure up to 70 bar (or higher, depending on the model).

On sampling/analyser systems flexible operation is needed. Discharge pressure requirements vary with the application. application. On Emerson installations along HPCL's Rewari-Kanpur, the Hydra-Cell G10 pumps are operating at pressures up to 40 bar and G15 pumps also in use are working at pressures up 100 bar; the G10 at Vadodara from 10 - 60 bar, while a system at the refinery in Mumbai calls for operating pressure of only 9 bar.

Hydra-Cell technology also has advantages on the suction side of the pump. Analyser stations are typically sited at some distance (sometimes up to 100 m) from the main pipeline, and the interconnecting small-bore pipework may have numerous bends, drops and rises: features that together create adverse suction conditions at the pump inlet.

Pressure drop through the pipework can reduce NPSH available to less than that required by the magnetic drive pumps. Hydra-Cell pumps are better able to handle these conditions, and perform with equal efficiency in the less common situation where inlet pressures are substantially higher than those typically encountered in sampling applications. WP

Note

With thanks to the Hydra-Cell support company in India, Machinomatic Engineers.