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ENHANCEMENTS IN PTFE DIAPHRAGM TECHNOLOGY

THE BENEFITS OF SEAL-LESS PUMPS

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NEW CONCEPTS IN HUMAN-ROBOT COLLABORATION

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Enhancements in PTFE Diaphragm Technology

Deepwater Oil & Gas represents some of the industry's greatest rewards, as hundreds of billions of barrels remain sitting in known, yet untapped offshore reserves around the globe.

The Energy Information Administration (EIA) estimates that offshore crude production in North America is expected to reach record levels in the year ahead, with no fewer than six new deep water fields scheduled to launch within the next two years.

Even though offshore forecasts look promising, one requirement continues to permeate offshore planning decisions, which is the need to continuously increase efficiency to lower the Break-Even-Point for offshore production.

One area where efficiencies can be gained in offshore production comes from the hundreds of pumps that are used to assure the flow of Oil & Gas from the seabed, to separate it on the platform, to move it to processing facilities via pipelines, and to keep the equipment clean and functioning at peak performance.

These tasks are accomplished by metering pumps. The industry's latest metering pumps have recently achieved new design breakthroughs that reduce their weight and footprint. Space and weight matter to top-side operators, and the costs are easy to quantify.

When platforms are built, the amount of steel required to support the platform and everything on it is carefully calculated. Each ton of equipment requires a ton of support steel topside, and two additional tons of support steel below the waterline.

Removing a single ton of pumping equipment enables EPCs to reduce the weight of the entire platform by up to four tons. If an offshore platform costs $30,000 dollars per ton to build – then reducing the weight of the pumping equipment on the deck surface can save up to $120,000 for each ton saved.

Because hundreds of pumps are required on an offshore platform (to perform a variety of tasks), the weight and footprint of each pump matters.

PTFE, or Polytetrafluoroethylene is a synthetic material that can be flexed in a manner that produces high flow in a smaller, lighter and less expensive package than metal diaphragms.

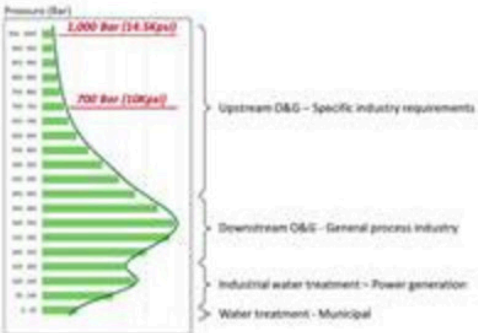
The metering pump's role in offshore production

Metering Pumps are positive displacement chemical dosing devices that deliver measured volumes of chemicals to different applications. For offshore Oil & Gas production, metering pumps are typically used for the following applications:

Flow assurance

Flow assurance is achieved by pumping chemical inhibitors like methanol, which prevent oil from cooling, by lowering hydrate equilibrium temperatures to levels where hydrates cannot form.

These chemicals are delivered at high injection rates and high pressures, which are needed to move the chemicals through long subsea tiebacks that can stretch for miles.



Different metering pump applications require a wide range of pressures.

Cleaning and protecting pumping/piping infrastructure

Metering pumps are also used to clean and protect an offshore platform's pumping and piping infrastructure. These applications include injecting corrosion inhibitors and anti-scaling chemicals into the piping infrastructure on and below the platform. Offshore environments are harsh and hazardous to equipment. Because a single day's production exceeds the cost of the pumping and piping infrastructure, it is critical to protect equipment and prevent scale deposits and corrosion from forming.

Separation and initial processing activities

Transportation and refining costs for Oil & Gas recovered offshore are more expensive than product extracted onshore. Operators realize that significant midstream cost savings can be derived by placing more emphasis on separating and treating product on the platform.

The most common offshore processing strategies involve separating gas from crude; dehydrating gas with chemicals like triethylene glycol (TEG), and treating heavy crude with a variety of chemicals to make it easier to move through subsea pipelines.

Metering pumps are used for a variety of treatment applications, because of their ability to inject chemicals with high accuracy. Accuracy is important because over-injecting treatment chemicals upstream can create additional costs to eliminate those chemicals downstream.

How metering pumps work

One of the largest components of a traditional metering pump is the Liquid End, or the wetted chamber. Chemicals enter the liquid end when the pump's motor drives a piston to create a vacuum that sucks chemicals into the liquid end from external tanks. Alternating piston strokes create pressure that closes the inlet valve, opens the outlet valve and forces the liquids out to the process. Within the liquid end is a diaphragm, which acts as a barrier between the piston and the process fluid.

The piston's pumping motion is applied to hydraulic fluid which causes the diaphragm to flex back and forth as the piston reciprocates. The movement of the piston, which is called deflection, flexes the diaphragm between concave and convex positions. The periphery of the diaphragm is clamped and does not move during the deflection. The greater the deflection of the diaphragm, the higher the flow rate for the pump.

Because many offshore processes require high flow rates, pump manufacturers have had to build large diaphragms, with large liquid ends and large housing areas, to deliver the volume and pressure required. As expected, this results in large and heavy pumps.

API675 compliant metering pumps used offshore must be able to deliver a wide range of harsh and corrosive chemicals, at different concentrations and temperature levels. To accommodate this diversity, all the wetted parts of the pumps' liquid ends should feature materials that are compatible with those chemicals. The pump should be equipped with a diaphragm - either metallic or plastic - whose material plays a key role in the equipment cost and weight.

Comparing metallic and PTFE (or Polytetrafluoroethylene) diaphragms

Four key parameters differentiate PTFE from metallic diaphragms:

1. Flow – PTFE allows for a smaller diaphragm diameter thanks to a higher deflection.

2. Chemical compatibility – PTFE has a larger chemical compatibility than most metals due to its naturally high resistance to chemical corrosion.

3. Pressure – Without the slippery properties of the PTFE material, metallic diaphragms can easily be clamped to withstand piston pressures up to 20,000 psi and above, whereas reaching high pressure levels with PTFE diaphragms is said to be the biggest technical challenge for metering pump manufacturers.

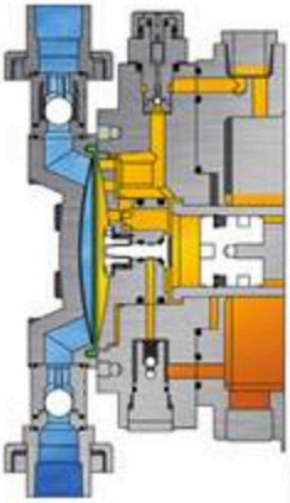
4. Temperature – Metallic diaphragms can withstand higher temperatures than PTFE without compromising accuracy. Temperatures in excess of 150°C negatively impact PTFE/plastic.

On some occasions, the diaphragm could soften, impacting the degree of deflection and the resulting accuracy. API675 requirements stipulate that metering pumps must be able to inject chemicals with +/- 1% accuracy. So to be considered a viable alternative for offshore applications, pumps with PTFE diaphragms needed to overcome this limitation.

PTFE diaphragms have existed for a long time. The challenge overtime has been the use of this flexible material at high pressures. Because of the slippery nature of PTFE, it has always been difficult to clamp the diaphragm tight enough to withstand the high piston thrust required for high pressure injection, but not too tight, to prevent densification, buckling, and even rupture – which can occur if the diaphragm material gets pushed from the periphery of the diaphragm toward the center.

A smaller diaphragm enables pump manufacturers to design smaller liquid ends, which leads to smaller and lighter pumps that can still produce high flow rates.

As opposed to PTFE, metallic diaphragms can crack in the peripheral clamping area when significantly deflected back and forth by the pump's reciprocating motion. In order to fulfil the pump's high flow requirements and conciliate it with a small metallic diaphragm deflection, the only solution is to increase the diameter of the diaphragm. This results in a much larger diameter liquid end when using a metallic



Chemicals enter the liquid end from external tanks, and the pump's diaphragm pushes a specific volume of chemical out to the process.

diaphragm versus a PTFE diaphragm. Additionally, it requires more construction stainless steel, which brings higher cost and weight, and a larger footprint for the pump head.

Additional tradeoffs associated with metallic designs include the size and the weight of the diaphragm, the liquid end, and the stainless steel surrounding the pump's head. These materials are expensive, which increases the cost of each pump, and also brings much larger ripple effects to the overall costs of the offshore platform.

PTFE diaphragms deliver smaller, lighter and more efficient pumps

PTFE has one of the lowest coefficients of friction for any solid. Almost nothing sticks to PTFE, and the material is essentially impervious to corrosive chemicals.

PTFE allows far greater deflection than a metallic diaphragm, enabling higher flow rates in a much lighter package. A smaller diaphragm enables pump manufacturers to design smaller liquid ends, which leads to smaller and lighter pumps that can still produce high flow rates, due to the increased deflection of the PTFE diaphragm.

PTFE liquid ends can be 50% less expensive than metallic liquid ends.

The primary limitation associated with PTFE diaphragms is High Pressure. When pressure is amplified, the motion of the piston pushing aggressively on a frictionless surface could degrade the material density of the disk.

A catch 22 scenario had previously existed: clamping the round disk too tightly negatively impacted the density of the material: but not clamping it tight enough prevented it from withstanding the pressures required for certain applications.

Through extensive research and development, one metering pump manufacturer has designed a new PTFE diaphragm that features a unique chemical composition of PTFE, which offers the best of both worlds - combining the benefits of PTFE with the temperature and high-pressure resistance of metallic diaphragms. The result is a smaller, lighter and less expensive pump that is suitable for metering pump applications on offshore platforms and FPSOs.

Everything you knew about PTFE diaphragms has changed...

PTFE Diaphragms are not new. But the latest variant of PTFE provides a new path for all PTFE diaphragms moving forward. The age-old perception that only metallic diaphragms were suitable for Oil & Gas applications has changed.

And with this change, goes all of the weight and bulk that comes with metallic diaphragm pumps.

New innovations have addressed the challenges that have limited PTFE pumps in the Oil & Gas space.

New metering pumps can now offer the combination of performance and efficiency - in a small, light and compact footprint - that is not just optimized for Oil & Gas applications, but also for chemical processing, refineries and industrial water treatment applications.

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