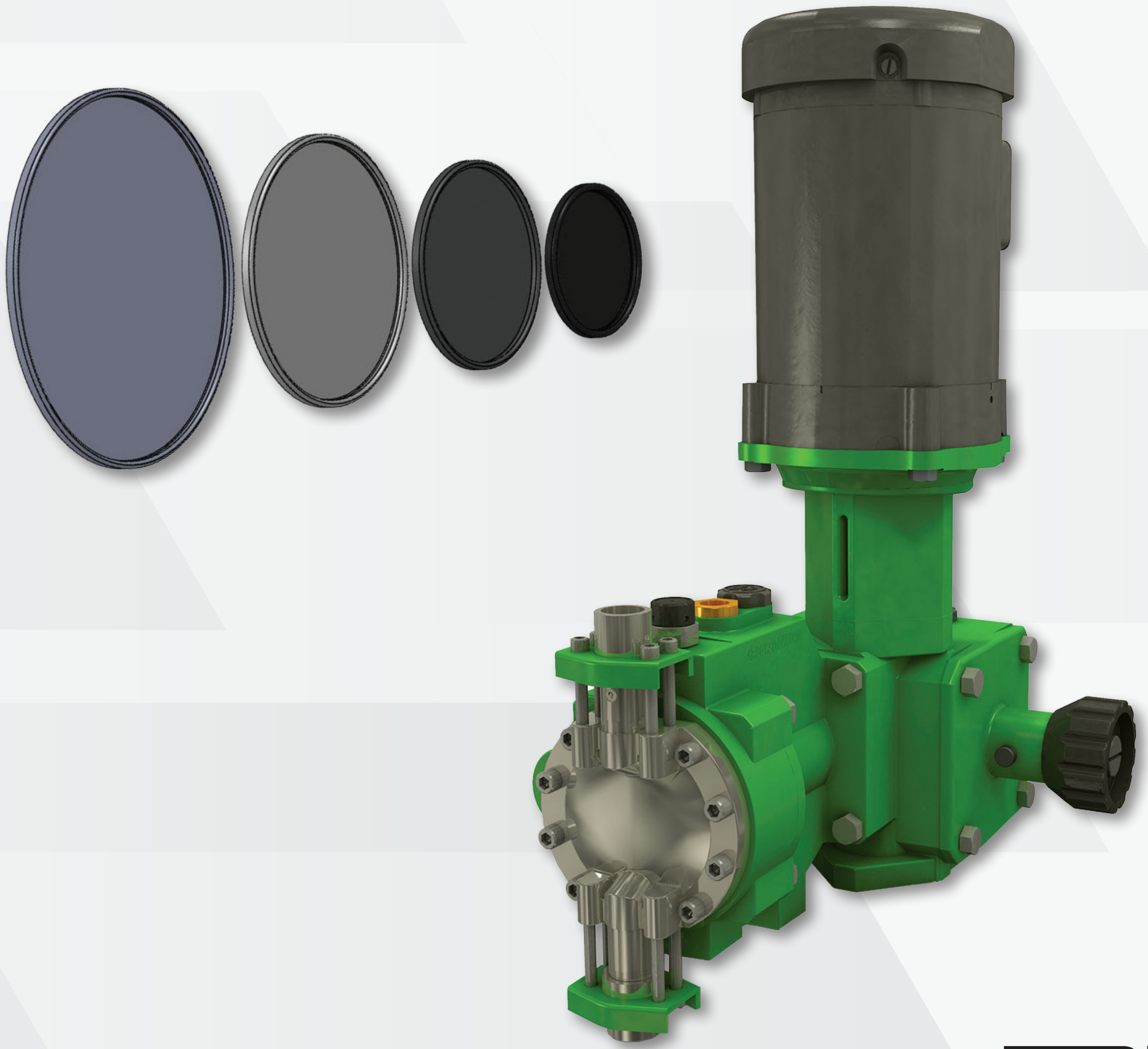
WHY EFFICIENCY IS PARAMOUNT FOR OFFSHORE PRODUCTION

HOW INNOVATIVE BREAKTHROUGHS WITH PTFE DIAPHRAGMS HAVE PRODUCED SMALLER AND LIGHTER METERING PUMPS WITHOUT COMPROMISING ON PERFORMANCE



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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.

According to recent Energy Information Administration (EIA) data, global offshore oil & gas production has increased in each of the last two years, even though prices remain low. The EIA estimates that crude production in the Gulf of Mexico is expected to reach record levels in the year ahead, with no fewer than six new deep water Gulf of Mexico fields scheduled to launch within the next two years.

Today, more than 50 countries produce oil & gas offshore, with almost half of the total offshore production (43%) coming from 5 countries: Saudi Arabia (13%), Brazil (10%), Mexico (7%), Norway (7%), and the United States (6%, and growing rapidly).

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.

FINDING EFFICIENCIES IN NEW PLACES OFFSHORE

Perhaps the silver lining in the recent downturn is the fact that cheap oil has forced offshore producers to find ways to lower per-barrel production costs. Innovation has come to platforms and FPSOs in multiple areas. Sensors and communications technologies are streamlining maintenance. Camera-equipped drones are being used to inspect flaring towers or areas below deck, to detect anomalies so that repairs can be made before they become costly.

One of the biggest areas where production efficiencies can be gained in offshore environments 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 all of the equipment clean and functioning at peak performance.

Many of these tasks are accomplished by metering pumps. The industry's latest metering pumps have recently achieved new design breakthroughs that can substantially 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 (both above and below the waterline) is carefully calculated. Each ton of equipment requires a ton of support steel topside, and two additional tons of support steel below the waterline. The ability to remove 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. Considering that hundreds of pumps are required on an offshore platform (to perform a variety of tasks), the weight and footprint of each pump matters.

THE METERING PUMP'S ROLE IN OFFSHORE PRODUCTION

Metering Pumps are positive displacement chemical dosing devices that deliver a range of chemicals in a variety of applications.

Flow Assurance

One of the most common offshore applications for metering pumps is flow assurance, which uses chemical inhibitors like methanol to prevent oil from cooling, and to ensure its fluidity from the reservoir to the surface. Chemical inhibitors lower hydrate equilibrium temperatures to levels where hydrates cannot form. These chemicals are delivered continuously by metering pumps, typically at high injection rates and at high pressures, which are needed to move the chemicals through long subsea tiebacks that can stretch for miles through hydrate forming conditions.

Cleaning and Protecting Pumping/Piping Infrastructure

Metering pumps are also used offshore to clean and protect pumping and piping infrastructure, as well as the cooling and flaring towers. These applications include injecting corrosion inhibitors and anti-scaling chemicals into the piping infrastructure on and below the platform or FPSO. Offshore environments are harsh, and hazardous to equipment, and maintenance is expensive (and much more difficult to administer than in onshore environments). Because the value of a single day's production exceeds the cost of the pumping and piping infrastructure, it is critical to protect the equipment and prevent scale deposits and corrosion from forming.

Separation and Initial Processing Activities

The transportation and refining costs for Oil & Gas recovered offshore are more expensive than product that is extracted onshore. As part of the continuous drive for efficiencies, operators realize that substantial midstream cost savings can be derived by spending a little more effort separating and treating the product on the platform.

API 675 compliant metering pumps used offshore must be able to deliver a wide range of harsh and corrosive chemicals ... at different concentrations and temperature levels.

The most common offshore processing strategy (in places like the Gulf of Mexico) involves separating gas from the crude; dehydrating the gas with chemicals like triethylene glycol (TEG), and treating heavy crude with a variety of chemicals so that each product (oil and gas) matches the specifications needed to efficiently move them through the subsea pipeline system. Metering pumps are used for a variety of treatment applications, and these applications do not require high pressures. Metering pumps are necessary 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.

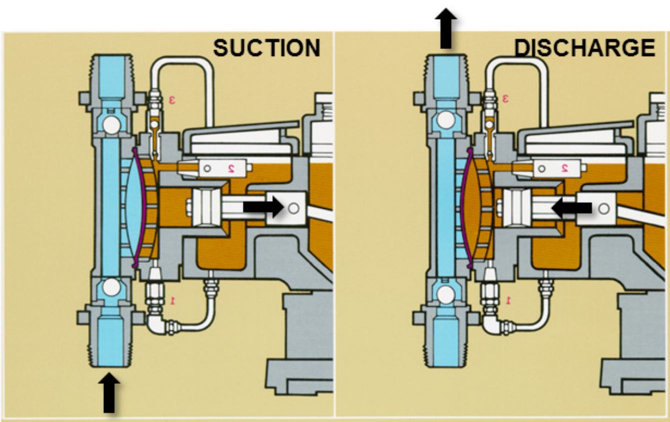


Figure A

HOW METERING PUMPS WORK

One of the largest and heaviest 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 *(Figure A)*.

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 extremely heavy pumps.

API 675 compliant metering pumps used offshore must be able to deliver a wide range of harsh and corrosive chemicals, such as biocides, cleaning compounds, coagulants, corrosion inhibitors, de-foamers, glycol, oxygen scavengers, polyelectrolytes, scale inhibitors, and emulsion breakers, at different concentrations and temperature levels. To accommodate this diversity, all the wetted parts of the pumps' liquid ends should be made in materials that are compatible with those chemicals. In particular, 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 DIAPHRAGMS

Essentially four parameters distinguish PTFE (Polytetrafluoroethylene) and metallic diaphragms:

1. **Flow –** PTFE allows for a smaller diaphragm diameter thanks to a higher deflection.
2. **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.
3. **Temperature –** Metallic diaphragms can withstand higher temperatures than PTFE without compromising the pumping accuracy. PTFE's thermal expansion coefficient (125E-6/K) is more than 5 times higher than the coefficient of stainless steel or aluminum. Temperatures in excess of 150°C negatively impact PTFE/plastic. The mechanics of 200 strokes per minute creates a lot of energy, which can raise the temperature of the viscous hydraulic fluid that comes in contact with the diaphragm. On some occasions, the diaphragm could soften, which impacts the degree of deflection and the resulting accuracy of the dosing. API 675 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.
4. **Chemical compatibility –** PTFE has a larger chemical compatibility than most metals due to its naturally high resistance to chemical corrosion.

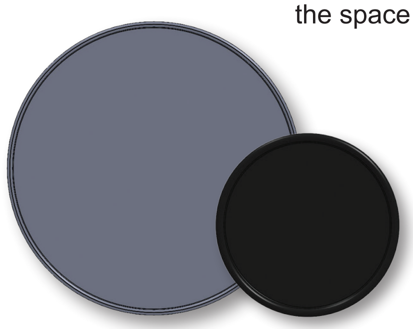
PTFE diaphragms have existed for a long time. The challenge overtime has been the use of this flexible material at high pressures. Because of the slippery nature of PTFE, it has always been difficult to clamp the diaphragm both tight enough to withstand the high piston thrust required for high pressure injection, and not too tight so 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.

PTFE is a very useful material for metering pump diaphragms, not only because it can be bent millions of times without breaking (which allows significant deflection even with small diameter diaphragms) but also because it offers a uniquely large chemical compatibility with all sorts of chemicals that have to be injected. Indeed, PTFE has one of the lowest coefficients of friction of any solid – and neither water nor water-containing substances wet PTFE.

As opposed to PTFE, metallic diaphragms can easily crack in the peripheral clamping area when significantly deflected back and forth by the pump's reciprocating motion. In order to fulfill 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 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 all of the stainless steel surrounding the pump's head. These materials are expensive, which not only increases the cost of each pump, but they also bring much larger ripple effects to the overall costs of the offshore platform.

Hundreds of pumps may be needed to extract, recover, separate, process, and transport product on and off an offshore platform. If the weight and footprint of each pump can be reduced, then the space and weight savings for the platform become significant.



PTFE DIAPHRAGMS ARE DELIVERING SMALLER, LIGHTER AND MORE EFFICIENT PUMPS

PTFE, or Polytetrafluoroethylene is a synthetic material consisting of carbon and fluorine, that 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.

When used as a diaphragm in metering pumps, PTFE allows far greater deflection than a metallic diaphragm. Greater deflection enables higher flow rates, but in a much smaller and 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 50-60% less expensive than metallic liquid ends.

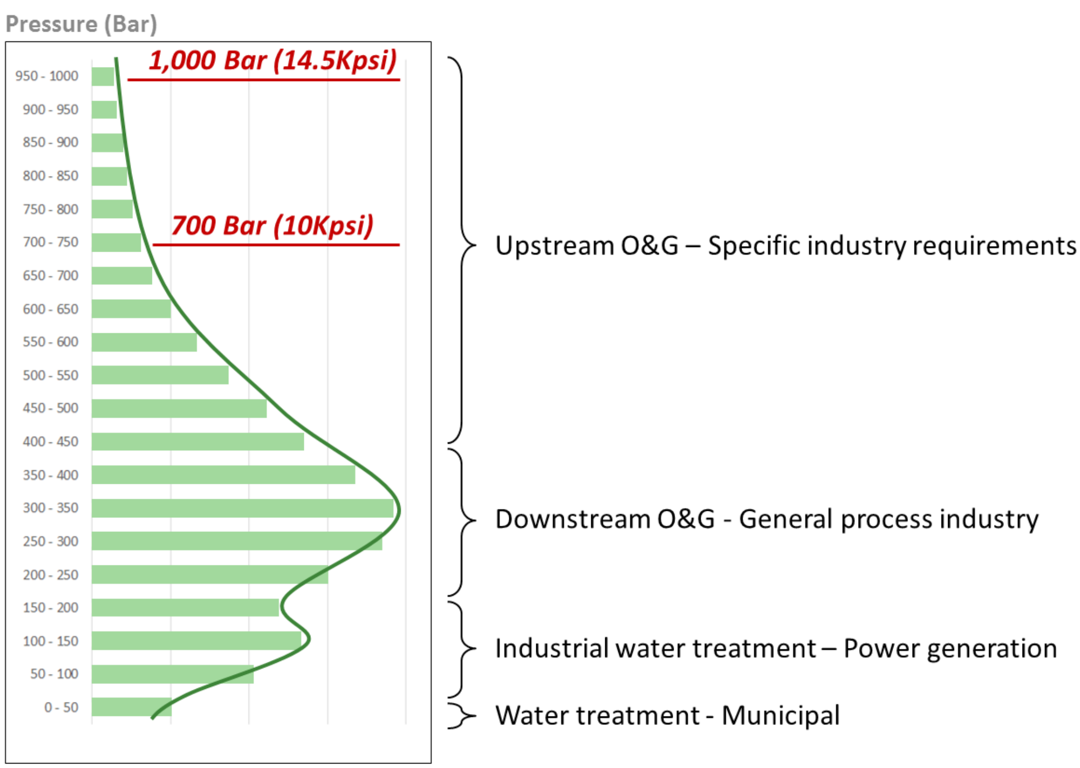
The primary limitation associated with PTFE diaphragms is High Pressure. The higher the pressure, the more difficult it is to hold a PTFE diaphragm in place. When pressure is amplified, the motion of the piston pushing aggressively on a frictionless surface could degrade the material density of the disk. 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.

Overcoming Previous Limitations

Through extensive research and development, and through collaboration with numerous chemical compound experts, Pulsafeeder 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 far less expensive pump that is suitable for a wide variety of metering pump applications on offshore platforms and FPSOs.

The new PTFE diaphragms are featured on the new PulsaPro Line of Reciprocating pumps – which is being rolled out to the industry in three phases covering pressures ranging from 5,000 psi to 15,000 PSI.



Pressure distribution of metering pump market size

EVERYTHING YOU KNEW ABOUT PTFE DIAPHRAGMS HAS CHANGED ...

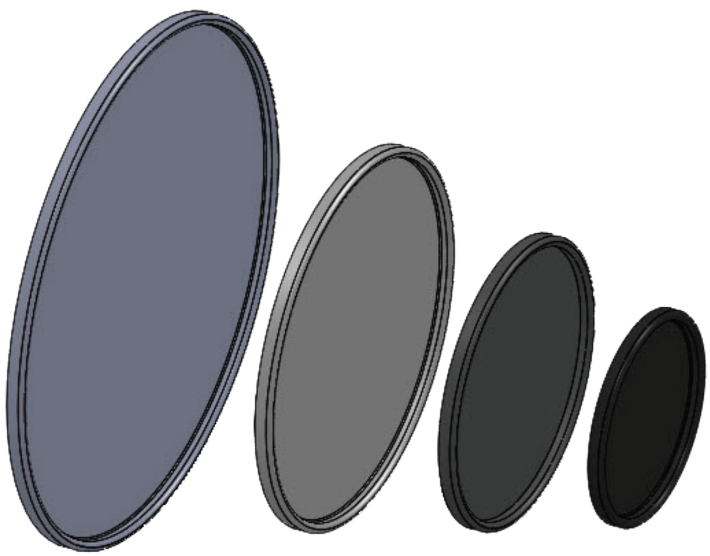
The age-old perception that only metallic diaphragms were suitable for Oil & Gas applications has changed. And with this change, goes all of the weight and bulk that comes with metallic diaphragm pumps.

PTFE Diaphragms are certainly not new. But Pulsafeeder's Research and Development team has produced a unique variant of PTFE that provides the path for all PTFE diaphragms moving forward.

These innovations have addressed the challenges that have limited PTFE pumps in the Oil & Gas space. The resulting PulsaPro pumps offer a unique 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.

Several leading offshore oil & gas producers have already ordered the new PTFE PulsaPro pumps, including the largest producer in the Middle East, for use in offshore metering applications.

To find out more about the new PulsaPro metering pumps and the new PTFE diaphragms, contact Pulsafeeder today.



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