





A solar injection powered system installed at a wellhead site.

# Diaphragm Pumps Enhance Chemical Injection Systems During EOR

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## A new way to solve old problems

If reality were like the movies, drilling for oil and gas would be as simple as digging a hole in the ground and waiting for the product to explode upward. However, the movies typically do not resemble reality. In fact, oil and gas production is a difficult and strenuous process, involving numerous techniques and large

amounts of heavy-duty equipment.

Oil and gas production is typically separated into three phases. The first of these phases is called primary recovery. During primary recovery, the natural pressure of the reservoir, combined with pumping equipment, brings the product to the surface. This is the easiest and cheapest method of

recovery, but usually produces only about 10 percent of a reservoir's original oil.

The next phase of recovery is called secondary recovery. During this phase, water or gas is injected into the reservoir, making displacing and driving the resources to the surface easier. This technique typically recovers anywhere from 20 to 40 percent of the original amount of product in the reservoir.

After primary and secondary recovery methods have been exhausted, the reservoir is usually only about half empty. Until recently, these wells were often abandoned because techniques for removing the remaining oil did not justify the cost. However, with so much product remaining in these wells, companies clearly saw the need to invest in other techniques to remove the remaining oil and gas. These techniques are used in the third and final phase of recovery. This phase is known as tertiary recovery or what is better known as enhanced oil recovery (EOR).

EOR is a complex method of recovery that helps increase production through one of three distinct methods: gas injection, chemical injection or thermal recovery. This article focuses on the chemical injection recovery process, touching on the types of pumping equipment used with EOR.

## Chemical Injection Method

Since oil and gas wells and production systems are located in different environments, they are subjected to an array of harmful effects that makes extracting the resources difficult. These include liquid loading, corrosive substances, sandy wells, extreme

temperatures and more. To help counteract these effects and help extract an increased amount of product, EOR methods are used.

Chemical injection recovery involves the use of systems that inject chemicals and polymers, usually as diluted solutions, into the reservoir. By introducing chemicals and polymers into the reservoir, trapped product is freed and, therefore, recoverable. Polymers help increase the effectiveness of water-floods and boost the efficiency of surfactants. Surfactants are cleansers that work to lower the surface tension that inhibits the flow of product through the reservoir.

Corrosion and scale inhibitor chemicals are also injected, providing a layer of protection on the well tubing to prevent damage and rusting. In addition, methanol can be injected into a natural gas line during winter months to prevent the product lines from freezing. Methanol injection helps maintain and increase production in a well over time.

Although chemical injection and other EOR methods can increase oil recovery by up to 75 percent, such techniques are expensive when compared to primary and secondary recovery methods. The prohibitive cost structure of these techniques has virtually shut down investment in the technology necessary to drive innovation in the chemical injection process. This includes the chemical injection systems currently deployed.

Many of these systems produce unreliable flow rates, which result in inaccurate doses of the chemical injection fluids needed to function properly. In addition, pump seal failure is not uncommon.

Such failures lead to chemical leaks that compromise the site's environmental integrity. These problems result in increased production costs

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and longer downtime.

With increased demand for more efficient and cost-effective chemical injection recovery, a corresponding increase in the demand for a chemical injection system that can keep production, maintenance and chemical costs low has occurred.

### **Need for a Better Pump**

To function at maximum efficiency, a chemical injection system must employ a reliable chemical pump that can inject chemicals into the reservoir properly and consistently. Today, many systems use chemical pumps that do not deliver the desired results. Root causes include pump seal failure and chemical leakage, as well as pressure fluctuations within the well that affect the pump's dosing rates.

At present, no one pump can accommodate every different well configuration and do so cost effectively. As a result, many different types of gas- and solar-powered pumps are now used in dosing applications. A number of the current pumps are pneumatically driven piston pumps or plunger pumps. Despite their widespread use, they may cause significant problems for many oil and gas producing companies.

Although low-cost, comparatively-simple-to-operate, gas-powered pneumatic pumps are popular among oil and gas producers, they are now being phased out due to pending government environmental emission regulations. These regulations have

been established because gas-powered pumps vent natural gas, or CO<sub>2</sub>, into the air with each cycle. A typical gas-powered pump emits from 250 to 650 standard cubic feet per day (SCFD) of dry gas into the atmosphere. Escaping CO<sub>2</sub> and/or natural gas is dangerous to the environment and can be harmful to personnel working around the well.

Gas-powered pumps often experience uneven performance in their principal function—delivering proper and consistent doses of a given chemical. Compared to other pumps, the injection rates of gas-powered pumps vary greatly due to pressure fluctuations in the gas supply. Chemical dosing is often inconsistent and inaccurate, necessitating oil and gas producers to regularly dispatch service personnel to the well to check dosing rates.

The bottom line is that companies must pay more simply to ensure that the pumps operate properly.

Downtime is also an issue with gas-powered piston pumps. Seal failure and leakage of chemicals into the environment through the piston seals is typically the root cause of the problem. Some pumps have more than 10 seals that are potential leakage points.

With gas-powered pumps being phased out, many oil and gas producers have begun using solar-powered pumps, most of which feature, almost exclusively, a reciprocating piston pump design with a cycle timer to control the pump. This design



Diaphragm pump used for chemical injection

includes many dynamic seals, such as stationary O-ring or V-packing, that tighten around the reciprocating rod to prevent fluid from slipping past the rod.

This creates wear points, such as when the rotating eccentric cam rubs against the rod. The faster the rpm setting on a reciprocating piston pump, the faster these parts wear and require replacement. As dynamic seals wear, they become loose, causing chemicals to leak into the environment.

To prevent this, these parts require service (tightening) at regular intervals. One caution: if over-tightening occurs, the dynamic seals can grip the rod too hard and cause more stress on the motor and drain the battery more quickly. This possibility requires oil and gas producers to regularly dispatch service personnel to the well.

Another issue is that solar-powered reciprocating piston pumps have a tendency to draw a large amount of precious solar power to be used. When this occurs, the flow-to-power ratio becomes very low. Also, many of

these solar pumps do not have remote monitoring capabilities. The ones that do have remote capability—which is essential for monitoring well operations—are costly compared to the price of a typical solar-powered pump. Remote monitoring gives operators the flexibility of monitoring well performance without spending time and money on “check-in” well visits.

### Diaphragm Pumps

With gas-powered pumps being used less and many solar-powered pumps not living up to expectations, oil and gas producers are in need of a new and innovative solar chemical injection system that incorporates a different type of pumping technology. Increasingly, they have turned to an innovative solar chemical injection system that features diaphragm pumping technology.

Diaphragm pumps are highly durable and resistant to many chemicals. Featuring few moving parts and no dynamic seals, diaphragm pumps are more reliable and easier to maintain than gas-powered and solar-powered pumps. The diaphragm completely separates the chemical side from the oil side. Regardless of the chemical to be injected, seal materials do not require change out. On the oil side, no O-rings are in use in the pressurizing piston sleeve, which means less wear on the piston rod.

Diaphragm pumps also feature a stainless steel head and check valves and a Teflon® coated diaphragm to

protect against corrosion. This robust design helps prevent chemical leaks while enhancing performance and uptime. It also reduces the cost of maintenance. Diaphragm pumps are also hydraulically balanced to reduce stress and increase pump life.

One major concern voiced by oil and gas producers relative to their pumping equipment is the degree of inconsistency in chemical injection rates. Since chemical injection recovery methods are usually limited by the cost of the chemicals, improving the efficiency with which these chemicals are injected is a requirement. Diaphragm pumps address this concern by dosing chemicals with extreme accuracy.

### Case Study

When speaking specifically about chemical injection systems that use diaphragm pumping technology, a wellhead solution provider recently launched a joint engineering effort with two of its sister companies to create a solar chemical injection pump system. This system solves many of the problems experienced with other chemical injection systems, thereby streamlining productivity and enhancing profitability.

This solar injection system is based on proven diaphragm pump technology that has been used in industrial chemical dosing for years. The system’s diaphragm pump features a brushless motor paired with a digital controller for precise, accurate

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injection rates. Over the pressure range of 300 to 1,200 psi, tests show that the system has a dramatically smaller deviation of injection rate within a 95 percent confidence interval. The result: over-injection of chemicals and corresponding waste rates are dramatically lowered.

At 1,200 psi, other solar chemical injection pumps' rates can vary by as much as 2.8 percent. By comparison, this solar injection system's rate varies only by as much as 0.9 percent. This reliability means fewer personnel trips to the well to ensure accurate rates. Injection rates on these diaphragm pumps are easily adjustable to ranges from 0 to 45 gallons per day, making the dip-switch timer obsolete.

This system's controls are digital, which allow users to cycle the pump for exact amounts of time to ensure highly accurate daily injection rates. An onboard calculation routine enables users to run a common rate test, record the results of that test and plug the values into the controls, along with the desired injection rate. The controls automatically set the desired cycle times. They can also be configured to allow for remote monitoring via cell phone at a substantially lower cost compared to other commercially available remote monitoring solutions.

The solar chemical injection system offers numerous benefits and advancements over and above what other systems offer, notably it:

- Is engineered to run independent of the well, using solar power stored in a 100-Ah, 12-VDC battery
- Consumes much less energy compared to other leading solar chemical injection systems
- Is environmentally friendly—emitting no atmospheric gases
- Dispenses accurate, safe,



This solar chemical injection system eliminates chemical leaks, offers simple calibration, reduces operator time at well sites and increases production while reducing chemical expenses.

energy-efficient doses, helping to lower chemical consumption and corresponding costs

When considering all these features and weighing the costs associated with previous pumping alternatives, the new solar chemical injection pump system using diaphragm pumps provides a highly efficient and superior solution for accurate dosing in oil and gas EOR processes.

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