Horizontal Multistage Pumping System for Natural Gas Liquids

By Matt Cray & Jim Rector, Schlumberger

Water injection and disposal and services—such as offshore crude oil main pumps, onshore pipeline oil, amine and pipeline CO₂—can be accomplished with this system.

North American natural gas activity has created many opportunities and challenges for natural gas liquids (NGL) plant operators who need cost-effective pumping solutions to treat, fractionate and move natural gas liquids from remote processing sites to pipelines bound for end markets.

Horizontal multistage centrifugal pumps can be a cost-effective, operationally efficient and safe alternative to reciprocating vertical turbine can pumps and axial-split case pumps that have historically been used in these high-pressure applications.

Although first developed in the 1940s, the horizontal multistage pump did not truly evolve until the oil boom of the early 1980s. Water injection had become a pervasive need, which was difficult to maintain with traditional reciprocating pumps. The quick delivery and increased reliability of the horizontal multistage pump made it a suitable replacement for the older, more conventionally used pumps.

Reciprocating pumps in Texas and Oklahoma were quickly replaced, making the horizontal multistage pump a popular choice in the water injection/disposal industry. It was eventually recognized as an industry standard. Its application expanded rapidly from pumping water injection

Above: Image 1. Installed in 2009 at the NGL plant in Carthage, Texas, the horizontal multistage pumps have been in continuous operation without any downtime other than regularly scheduled oil changes.
and disposal, to services such as offshore crude oil main pumps, onshore pipeline oil, amine, pipeline CO₂ and many other uses.

**NGL Pumping Shift**

With the growth of the product from oilfield services to industrial applications, some horizontal multistage centrifugal pumps have experienced a series of engineered improvements to meet the requirements of the surface pump industry and the demands of API 610. Although not an API 610 pump, the horizontal multistage pump incorporates many industry needs such as a 20-year run life, a back pullout design, API seal chamber and API mechanical seals.

In 1997, the horizontal multistage pump entered the NGL pumping industry pumping propane. This signaled a paradigm shift in NGL pumping worldwide. These units still operate today.

For NGL pumping, the gas processing industry has historically relied on reciprocating (positive displacement) pumps, split-case pumps and vertical can pumps. Each of these methods has challenges. Reciprocating pumps are designed to leak, cooling the pump packing along the shaft. This leaking causes safety-related issues from NGL vapors and volatile organic compound (VOC) issues. Combined with the vibration and annual maintenance, reciprocating pumps have been slowly phased out of the NGL industry.

Vertical can pumps are another common method for pumping NGL. One issue with the vertical turbine is that the seal sits on the high pressure side of the service, which makes its seals more expensive. If service work is required, the site will need a crane and an electrician to remove the pump. This can be costly because most service work is not performed on site and requires that the pump be sent to the manufacturer for repair.

Immediate challenges for most new split case centrifugal pump installations are that they typically are expensive and require lead times of more than 40 weeks. Most gas plant installations require 25 weeks. Additionally, section 5.3.9 of API 610 does not recommend use of axial split pumps for fluids under 0.7 specific gravity (SG).

NGL unit operators are increasingly attracted to the quick deliveries, low installation costs, ease of installation, utility savings and elimination of onsite parts inventory. NGL unit operators have been implementing the horizontal multistage pumps for pumping applications during the last decade.

**Less Maintenance**

Compared with more conventional pump systems, maintenance of the horizontal multistage pump can be more efficient and cost effective. All major wear components can be removed individually using a small, truck-mounted hoist or forklift. The horizontal multistage pump unit has a back pullout design, which allows the mechanical seal and bearing assembly to be removed and replaced in the field without moving the pump, motor or piping. This is another savings for operators since it can eliminate non-productive time (NPT).

When pump-related issues are experienced, the pump can be removed with a forklift. Comparatively, a vertical turbine pump would require a crane and electrician to perform similar operations, which can be difficult in remote locations, such as the emerging shale locations throughout the U.S. and globally.

With the exception of oil changes every six months, the horizontal multistage centrifugal pump is designed for years of trouble-free service with no daily maintenance requirements. The modular housing and flexible plug-and-play design enables simple and quick reconfiguration of pumps and motors, which minimizes downtime. Major components of the horizontal multistage pump can be exchanged within two to three hours, as opposed to the days or weeks required for pump options. The horizontal multistage pumping system includes API 610-compliant designs and new bearing sections with enhanced pump pressure capabilities and less heat generation.

Minor modifications were made to develop the horizontal multistage pump as an NGL pump, including the use of pump bearings made of metal-impregnated graphite to combat low NGL viscosity, tandem mechanical seals to keep the hydrocarbon...
contained and an API seal flush plan 11/52 to operate in conjunction with the tandem seal. The pumping system incorporates a tandem mechanical seal to keep fluid from leaking. Any potential leakage is fully contained and pump vibration is minimized.

**East Texas Haynesville**

Working in the Haynesville Shale, MarkWest Energy Partners, L.P., selected a specified 23-stage horizontal multistage pumping system with a variable speed drive for handling pipeline pressures at its Carthage, Texas plant. Installed in 2006, this system pumps NGL with a SG of 0.5 into the outgoing pipeline, flowing 13,500 barrels per day with inlet and outlet pressures of 900 psi and 1,500 psi, respectively.

In 2009, a second plant came online with two horizontal multistage pumping systems in series to deliver 5,300 barrels per day of NGL with a SG of 0.47. A 45-stage pump raises the pressure from 300 psi to 1,080 psi, and the subsequent 31-stage pump raises it to 1,400 psi. To treat gas and remove impurities in the gas system, a lean amine unit was also installed.

The pumps have been in continuous operation since they were installed at the two plants without any downtime, aside from regularly scheduled oil changes. MarkWest now uses these pumps for all its NGL pipeline, ethane pipeline and amine circulation operations. Other plant operators have also switched. More than 500 horizontal multistage pumps are now in use at NGL plants globally.

**Matt Cray** joined Schlumberger in 2004 and is currently the national sales manager for North America. During this time, he has been heavily involved in product design, operations and execution for the REDA HPS division. Cray has worked with pumps and packaging since 1992 after graduating from the University of Texas, Austin, with a BS in chemical engineering.

**Jim Rector** joined Schlumberger in 2000 and has held various roles related to the HPS product line, including senior sales engineer, engineering manager and app engineer manager. He has been involved in the surface-pump-related industry for more than 20 years and has worked for OEMs, reps and packagers in roles such as sales, application engineer, engineering and project management. He holds a BSME from USMA at West Point and is a member of ASME and SPE.

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