Regenerative Turbine Pumps Can Help Optimize Autogas Applications

AS GLOBAL AUTOGAS CONSUMPTION CONTINUES TO ESCALATE, SUPPLIERS OF THE FUEL SHOULD CONSIDER REGENERATIVE TURBINE PUMPS FOR THEIR AUTOGAS-HANDLING APPLICATIONS

September 2020 *By Stephen Basclain*

As global demand for Autogas as an alternative motor fuel grows, there is a corresponding increase in the need for pumps that can optimize its handling. One technology that has risen to the fore in this realm is the Regenerative Turbine Pump, with PSG® brand Ebsray® the leading developer of this technology, which offers a level of efficiency, differential-pressure buildup and flow rates that centrifugal and side-channel pumps can't match.

Introduction

For more than a century, gasoline and diesel fuel have dominated the global motor-fuels market. Still, many meaningful attempts have been made to add "alternative" fuels to the motor-fuel pool, from biofuels to electricity to compressed natural gas, in an attempt to curb the general reliance of motorists on these two fossil fuels.

Today, the most popular of the alternative motor fuels around the globe is Autogas, the name given to automotive liquefied petroleum gas (LPG) when it is used to power a vehicle. LPG is the generic name for mixtures of hydrocarbons that transform from a gaseous to liquid state when compressed at moderate pressure or chilled. The chemical composition of LPG can vary, but is usually compromised of predominately propane and butane (both normal butane and iso-butane). Autogas generally ranges from a 30% to 99% propane mix. In some countries, the mix varies according to the season as the physical characteristics of the two gases differ slightly as ambient temperature changes.

Autogas has been gaining in popularity because it possesses a number of operational characteristics that are desirable to vehicle manufacturers and operators, namely that it is clean burning, high octane, abundant, affordable, safe to use and environmentally friendly.

According to the World LP Gas Association's (WLPGA) 2019 report, *A Global Roadmap for Autogas,* global Autogas consumption in 2017 rose to 27 million metric tons (59.5 billion pounds) with more than 27 million Autogas-powered vehicles in use around the world, almost four times as many as in 2000. Servicing this growing fleet is a network of 76,000 Autogas-refueling stations. The WLPGA report projects that global Autogas consumption will reach more than 31 million metric tons (68.3 billion pounds) in 2030, an increase of 18% from 2017.

While gasoline and diesel refined from crude oil still dominate the transport-fuel market in most parts of the world, the share of alternatives, including Autogas, is growing rapidly: in aggregate, alternative fuels accounted for around 7% of total road-transport energy consumption in 2016, up from less than 2% in 2000. Total consumption of alternatives was 42% higher

Regenerative turbine pumps are more energy-efficient because they typically require a smaller motor than competitive technologies, but despite that, they are still able to produce flow rates of up to 160 gpm (600 L/min) or more.

in 2016 than in 2010 and almost 5.5 times higher than in 2000. Autogas is the leading unblended alternative for light-duty vehicles (LDV) and the second-most important one for all vehicle types after natural gas, accounting for 1.2% of total fuel use.

Currently, Europe has more than 15 million vehicles powered by Autogas with 46,000 refueling stations; Asia has more than six million Autogas-powered vehicles and more than 10,000 stations; and North America has more than 200,000 Autogas vehicles, most of which are buses, taxis and police cars.

In the United States, in fact, there are many federal subsidy programs that reward fleets for converting to Autogas. One such program encourages public-transit agencies and school districts to apply for grants from the U.S. Department of Transportation's Federal Transit Administration's "Low or No (Low-No) Emission Bus Program." The program is designed to award grants – with upwards of $85 million in total funds available – based on the applicant's need, project benefits, implementation strategy and capacity.

So, while the global consumption of Autogas—3% of the total motor-fuels market share, according to the WLPGA—pales in comparison to gasoline and diesel, it is becoming a significant part of the motor-fuel landscape in a number of countries. In those areas, retailers of Autogas must utilize a pumping technology that will optimize the dispensing of the fuel. This white paper will illustrate how regenerative turbine pump technology can be the best choice for those Autogas-dispensing operations.

The Challenge

Autogas, as mentioned, is a utilization of LPG, which is a propane-butane mixture. This makes it unique in that it can be transported and stored as a liquid, but when released it will vaporize and burn as a gas. In other words, Autogas is easily changed from a liquid state to a gas state. Autogas can also be a safer choice than most motor fuels since it has a narrower window of flammability.

However, there are a few main challenges that Autogas retailers must confront and overcome when handling the fuel:

- As a liquefied gas, Autogas must be stored in an enclosed container under pressure. When stored in a pressurized container, the Autogas takes the form of a liquid with any gas vapors on top, providing the pressure to keep the liquid from vaporizing (also known as "boiling.") Any upset in this state of equilibrium will cause the Autogas to vaporize or boil off.

- Autogas has a viscosity of about 0.1 centipoise (cP), which makes it approximately 10 times thinner than water. This low viscosity can make Autogas difficult to pump since a liquid with low viscosity is harder to seal and there is a greater risk that pump "slippage" will occur during transfer operations.

- During a pumping operation, if the pump's inlet pressure falls below the vapor pressure, vapor bubbles will form in the Autogas. As the bubbles travel through the pumping chamber and pressure increases, they will implode and cause cavitation. Cavitation causes pressure spikes and results in noise, vibration and damaged pumping-system hardware.

Over the years, various types of pumping technologies have been used for the handling and dispensing of Autogas. Two that have been utilized extensively, but have been found to have significant downsides in these applications are centrifugal and side-channel pumps.

The centrifugal pumps used in Autogas handling are not self-priming unless they are submersible; however, the main shortcoming of them when handling Autogas is that they are prone to experiencing vapor lock. Another area of weakness for centrifugal pumps is the net positive suction head required (NPSHr). Traditional centrifugal pumps, either single or multi-stage, have relatively high NPSH requirements. When dealing with liquids at a boiling point, net positive suction head available (NPSHa) is normally very low, which leads to cavitation and premature failure of the pump with damage to impellers, mechanical seals and bushings or bearings.

While side-channel pumps are self-priming, the main disadvantages of these pumps are in terms of size, maintenance complexity and relatively high capital cost. Specifically, side-channel pumps, when used in Autogas-handling applications, may require 4 to 8 stages to work effectively. This many stages increases design complexity, which makes them difficult to maintain. Side-channel pumps also require a large installation footprint in order to accommodate both the pump and its motor.

A final pump technology that has been used with Autogas is the sliding vane pump. While more effective than centrifugal and side-channel pumps, sliding vane pumps can't quite meet the performance standards of a technology such as regenerative turbine pumps when handling Autogas.

Ebsray® Regenerative Turbine Pumps excel in the transfer of Autogas because they can create more than enough differential pressure between the storage tank and the vehicle's fuel tank. At rest, an LPG storage tank can typically have a pressure of 8 bar (116 psi), left photo, but when fueling begins the Ebsray pump can create 21 bar (305 psi), which is more than enough to facilitate the fueling process.

The Solution

A better choice than centrifugal or side-channel pumps in Autogas-handling applications is the regenerative turbine pump. Their performance in poor suction conditions is dramatically better than centrifugal pumps and they provide the same flow and head as a side-channel pump with only one stage rather than, as mentioned, the 4 to 8 stages in the side-channel pump.

Regenerative turbine pumps are smaller than traditional centrifugal pumps and substantially smaller than side-channel pumps, meaning they require a smaller footprint for installation and in nearly all cases, due to their efficiency, a motor with a lower power rating. They also have fewer moving parts, which makes them much less complex to operate and maintain, as well as quicker to repair and rebuild due to easier access to the seal and impeller. Regenerative turbine pumps can also produce up to 14 bar (200 psi) of differential pressure when pumping Autogas, while side-channel pumps can only reach 14 bar with multiple stages, which increases cost.

PSG®, Oakbrook Terrace, IL, USA, a Dover company, offers standard-setting pump technologies for use in Autogas-handling applications via its Ebsray® brand of Regenerative Turbine Pumps.

For more than 75 years, Ebsray, based in Cromer, Australia, and acquired by PSG in 2013, has built a reputation as the leading developer and supplier of industry-standard regenerative turbine pumps for use in the LPG markets of Europe, Asia and Australia. Upon its acquisition by PSG, the distribution of portions of the Ebsray regenerative turbine product portfolio in North America was incorporated into the U.S.-based Blackmer® operation in Grand Rapids, MI. Like Ebsray in Europe, Asia and Australia, Blackmer is the strongest brand in the North American LPG market.

Ebsray Regenerative Turbine Pumps excel at transferring liquids with high pressure, low flow and low viscosity, while handling entrained vapors or liquids at or near their boiling point. These liquid conditions generally cause most pump technologies to struggle and even fail in their performance, but regenerative turbine pumps maintain their efficiency in any pumping and liquid conditions, eliminating the damaging impact of cavitation and pulsation on pumps and systems. In addition to withstanding cavitation, regenerative turbine pumps will operate quietly without vibration and noise under extremely low NPSHa conditions.

Since they are members of the rotodynamic pump family, regenerative turbine pumps are usually grouped with centrifugal pumps; however, their performance characteristics more closely resemble that of a positive displacement (PD) pump. Regenerative turbine pumps offer multi-stage performance from a single-stage impeller that optimizes hydraulic performance, resulting in high differential pressures even at low flow rates. The pumps feature a compact design and have far fewer rotating and wearing components than competing pump technologies.

The design of Ebsray pumps centers around a rotating, non-contact, free-wheeling disc impeller that has upwards of 60 small cells on each side of its periphery. When liquid enters the suction port it is picked up by the impeller and accelerated around the narrow hydraulic channel surrounding the cells. Kinetic energy is imparted to the liquid while circulating radially around the channel. The resultant spiraling of the liquid many times within one revolution builds energy and pressure. This winding up or incremental regeneration of the numerous small liquid cells creates the differential pressure capability of the pump – hence the name Regenerative Turbine Pump. The regeneration that happens in the cells reduces the impact of any cavitation that does occur. Any vapor bubbles that are produced collapse gently, resulting in smooth operation with no damage to pump internals.

Other benefits of Ebsray Regenerative Turbine Pumps include:

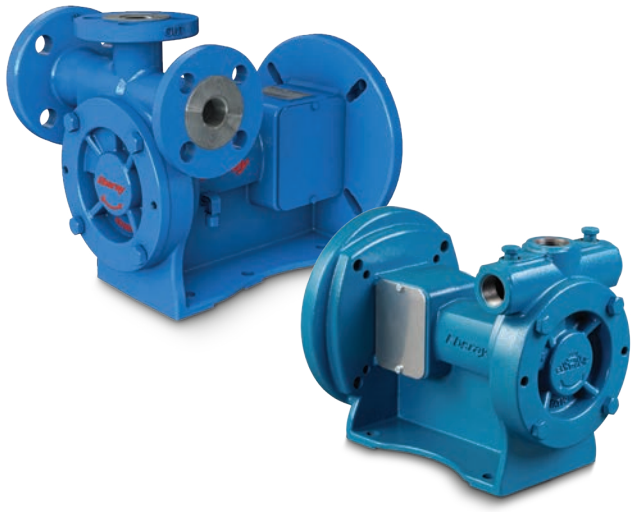
- Continuous-duty operation
- Can handle viscosities 0.1 to 50 cSt

- Service that can be performed in the field
- Operates without need of a Best Efficiency Point (BEP), meaning it has the performance-curve flexibility of a PD pump
- Pulsation-free discharge
- More efficient than competitive regenerative turbine pumps; smaller pump = smaller motor = improved efficiency with less operational cost

Ebsray Regenerative Turbine Pumps are offered in various models and configurations designed for underground, above ground and submersible LPG installations and applications. In the U.S., Ebsray specifically offers three product families:

- The RC20, RC25 and RC40 are all models of the RC Series of Regenerative Turbine Pumps. All RC Series models feature two discharge ports, either of which can be used as a bypass connection. Additionally all models have a low-maintenance single-stage impeller designed for high-pressure transfer applications. The RC20 offers flow rates up to 16 gpm (60 L/min) and flow rates up to 28 gpm (105 L/min) for the RC25. Both pumps can operate at differential pressures up to 200 psi (14 bar). The RC40 offers higher flow rates up to 51 gpm (195 L/min) and operates at differential pressures up to 200 psi (14 bar). When used in Autogas dispensing, the RC40 pump can accommodate up to four hoses.
- The R75, R77, R80 and R82 models form the HiFlow Series which is designed for larger flow rates with some models designed specifically to be flange mounted for transport applications. The operation of the HiFlow Series models creates no contact between the impeller and pump body, resulting in less wear and vastly increased mean time between repair (MTBR) while still achieving the elevated flow rates required for high-speed Autogas transfer. The HiFlow Series pumps can achieve flow rates ranging from 40 to 160 gpm (150 to 600 L/min) at a maximum differential pressure of 203 psi (14 bar) with a speed range of 2,100 to 3,500 rpm.
- The RX Series features two submersible models for use in applications with underground or above ground storage tanks: RX10 and RX35. Flow rates range from 24 gpm (90 L/min) to 43 gpm (160 L/min), with the RX10 having a maximum differential pressure of 130 psi (9 bar) and the RX35 capable of accommodating operating pressures up to 174 psi (12 (bar). The submersible design ensures rapid priming and immediate product flow and pressure even in particularly hot or cold environments where surface-mounted pumps can have difficulty operating.

When compared to competitive regenerative turbine pump brands and models, the Ebsray offering stands out. The ability to generate flow rates up to 160 gpm (600 L/min) dwarfs the competition, which can only produce 26 gpm (100 L/min). Ebsray pumps are also designed to be integrated with any



Ebsray® offers a complete family of Regenerative Turbine Pumps, one that is able to facilitate the transfer of Autogas whether the storage tank is underground, aboveground or submerged.

motor and do not require a proprietary motor like other models. After installation, Ebsray pumps do not ever need to be adjusted, while some other models may need to be shimmed in order to maintain performance as the impeller or pump body wears. Finally, Ebsray pumps are more efficient and cost-effective since they require a smaller motor size to perform the same duty.

Conclusion

The ongoing search for viable alternatives to gasoline and diesel fuel sees Autogas gaining ground and becoming an even larger player in many regions of the world. When determining which type of pumping technology to use at Autogas-dispensing facilities, there is only one standout alternative: Regenerative turbine pump technologies, especially those offered by Ebsray through distribution in the U.S. by Blackmer. Regenerative turbine pump technology has been proven to offer the operational characteristics and reliability required to successfully optimize Autogas-handling operations.

About the Author:

Stephen Basclain is the Business Development Manager for Ebsray® based in Sydney, Australia. He can be reached at stephen.basclain@psgdover.com or +61 289 782 702. For more information on the full line of Ebsray pumps, please go to ebsray.com. Ebsray is a product brand of PSG®, Oakbrook Terrace, IL, USA, a Dover company. PSG is comprised of several of the world's leading pump brands, including Abaque™, All-Flo, Almatec®, Blackmer®, Ebsray®, em-tec, EnviroGear®, Griswold®, Hydro Systems, Mouvex®, Neptune™, RedScrew™, Quattroflow™ and Wilden®. You can find more information on PSG at psgdover.com.