Side Channel Sealless Magnetic Drive Pumps

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These pumps are the low flow/high head problem solver.

Today's modern magnetic drive pump technology continues to serve a vital industry role within systems in which process leaks are unacceptable. The most recent sealless magnetic drive pumps reach flow rates up to 20,000 gallons per minute (gpm), heads of 3,000 feet, system pressures of 3,000 psi and drive power exceeding 700 horsepower—all while handling liquids up to 840 F without external cooling.

Are there a few pumps with too many mechanical seal failures and more maintenance than can be tolerated? Is there a pump that runs in constant cavitation mode? Is entrained vapor in a system causing a pump to lose suction and stop pumping? All these situations occur more than many end users would like to admit, but there can be relief. For a practical pump solution that can alleviate seal failures, cavitation and vapor lock, examine the features of the side channel pump.

The side channel (regenerative turbine) sealless magnetic drive pump is one of the lesser known and understood specialty pumps in the marketplace. The side channel pump—multi-stage with low net positive suction head first stage (NPSH)—design has been used commercially since around 1950. At about the same time, magnetic drive technology was introduced to pumps for handling hazardous products, without the need for a mechanical seal, which could leak product to the environment.

Side channel pump cut-away

The side channel pump has a hydraulic design with specific and unique characteristics—such as self-priming capability, vapor handling and low flow/high head hydraulics. The sealless magnetic drive does not employ a mechanical seal to stop shaft leakage. Instead, an isolation shell statically seals the process side of the pump (see Figure 1). A drive shaft outside the process, carried on anti-friction bearings, synchronously couples to a driven shaft/impeller assembly sealed inside the process side of the pump and running on journal bearings. Drive torque needed to do the work is transmitted across the sealed isolation shell via a set of powerful samarium cobalt, rare earth magnets.

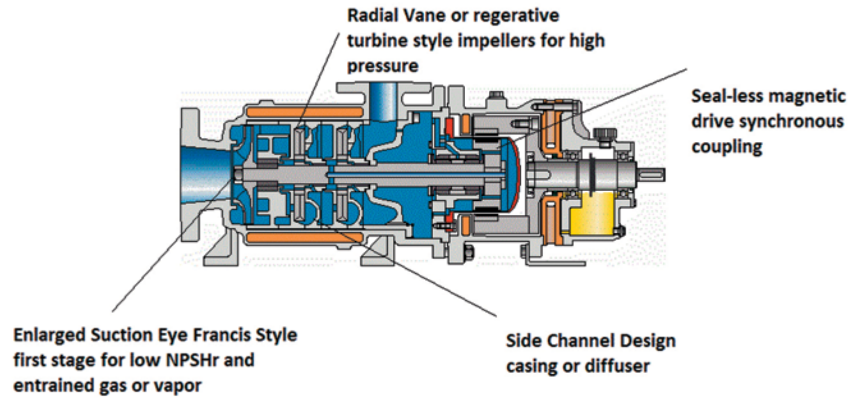

Figure 1. Cross section

Comparative Hydraulics

Traditional single-stage overhung centrifugal (Francis vane) pumps have a parabolic performance curve, whereby flow can change dramatically with pressure. In processes in which system pressures can fluctuate, the side channel pump design can maintain a relatively stable flow within a range of pressure swings based on its straight line performance. Figure 2 illustrates the performance curve shape of the typical overhung centrifugal versus the side channel hydraulics.

The typical centrifugal pump draws more horsepower as the flow rate increases, but the side channel hydraulic draws more horsepower as the flow rate decreases. Care must be taken when sizing the overall maximum horsepower required for a side channel pump, making sure to cover the lowest flow range requirements. These radial vane pumps typically run at maximum speeds of 1,200 rpm or 1,800 rpm to ensure greater reliability and efficiency.

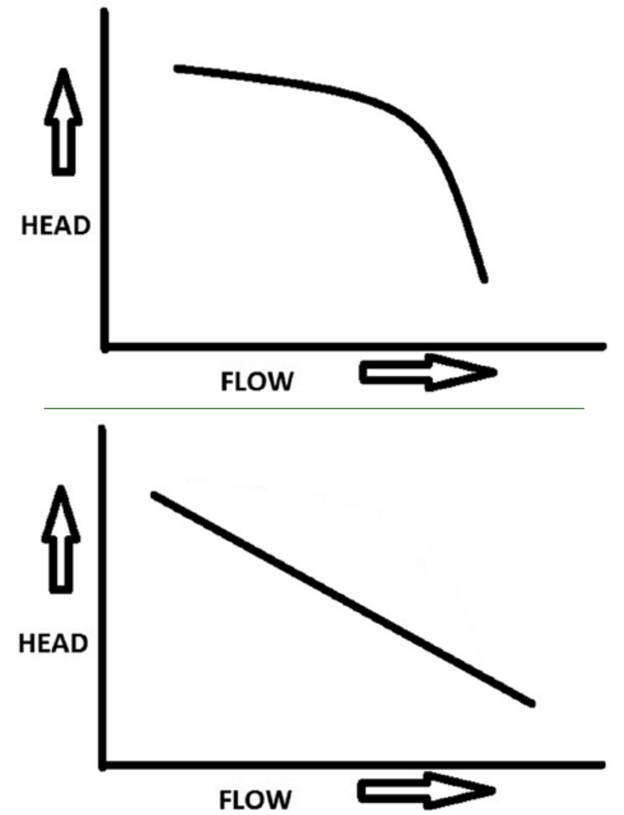

Figure 2. Centrifugal performance typical (top) versus side channel performance typical (bottom)

How It Works

Pump operation begins with a large eye, Francis vane style first-stage impeller, which creates the low NPSH requirement and typically has 5 to 7 curved vanes. The discharge from this impeller is directed into the subsequent radial or straight vane style impeller, which has an average of 24 vanes per impeller. This design allows each radial impeller to generate up to 10 times the head of a standard centrifugal impeller of the same diameter and speed. The high head capability of the side channel design is achieved using up to eight series impellers or stages.

As Figure 3 illustrates, the radial vane impeller accelerates the fluid at each vane tip, sending the flow into the side channel, where it is redirected in a circular pattern back into the impeller, where a subsequent vane repeats this acceleration of the fluid. The term "turbine" associated with this pump design comes from the radial vane impeller, which looks like a turbine wheel.

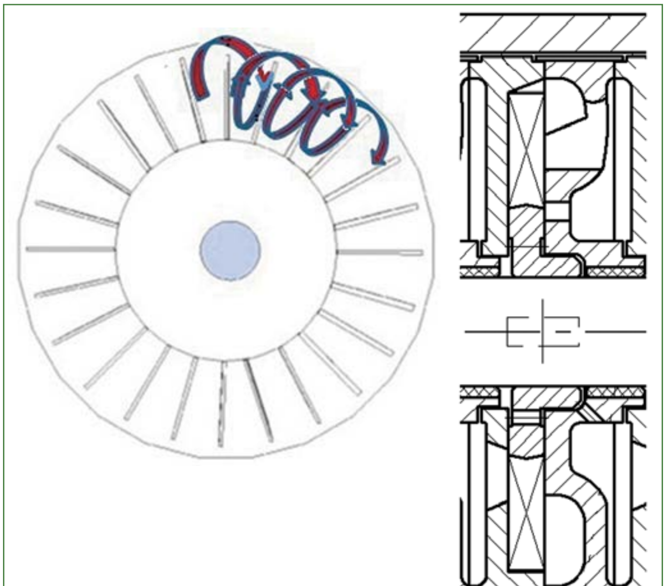
Figure 3. The radial vane impeller accelerates the fluid at each vane tip.

The impeller housing or diffuser geometry is critical to the operation of the pump. The suction or entry port of each radial stage is oriented at the lower half of the pump so that these cavities always remain flooded when the pump is stopped. This feature allows the pump to self-prime. Up to 50 percent entrained gas is not a problem with the side channel design. Centrifugal force sends the higher mass liquid outward while the vapor is forced toward the shaft, where it can be routed to the series stages and eliminated from the pump. A typical horizontal centrifugal pump can stop pumping altogether if too much vapor enters the eye of the impeller and air locks the pump. In this instance, the pump may have to be stopped, the vapor would have to be released (vented) and the pump would have to be re-primed to return it to working order.

A positive displacement pump might work for a while, but it may not be the best choice for lower viscosity applications for a few reasons—hydraulic pulsations can cause excessive stress on piping and valves, metal on metal wear issues and limited diaphragm life. If you have a clean, low-viscosity application with a relatively low flow but high head requirement, then consider the side channel or regenerative turbine design.

Booster Application

A real-world example comes from a Gulf Coast petrochemical end user who was previously using air-operated diaphragm pumps to boost chemicals at low temperature. The air-operated diaphragm pumps had a limited life cycle because of diaphragm fatigue and pulsations were problematic, causing piping leaks. A three-stage sealless magnetic drive regenerative turbine pump was selected to replace the air-operated diaphragm pumps and has been working trouble free for more than a year. The side channel pump is self-priming just like the air-operated diaphragm pump. More pumps are currently being added to the system.

Figures 4 and 5 highlight typical applications and benefits of the side channel regenerative turbine sealless magnetic drive pump.

Typical Applications for Side Channel Regenerative Turbine Mag Drive Pumps
Liquefied gas transfer (i.e. refrigerants)
Pumping liquids close to their boiling point
Pumping from underground storage (i.e. gasoline)
Truck and railcar loading and unloading
Low flow, high head, clean, low viscosity liquids
“Hard-to-seal” liquids

Figure 4. Typical applications for side channel regenerative turbine magnetic drive pumps

Benefits of the Side Channel Regenerative Turbine Mag Drive Pump Design
No mechanical seal required
Low flow (up to 180 gpm) and high system head applications (up to 1,400 feet)
Liquids with entrained gas or vapors (up to 50 percent)
Self-priming- NPSH of 1.5 feet
1,800 rpm max operating speed = less wear and tear

Figure 5. Benefits of side channel regenerative turbine magnetic drive pump design

Choosing the Best Pump

As with any piece of rotating equipment selection, a thorough application review is critical to successful operation. Tightening environmental and process requirements continue to make sealless magnetic drive pumps a logical and cost-effective solution for many systems. Today’s designs are reliable, user friendly and, most of all, field-repairable. Learning about and selecting from many specialty pump designs will help end users find the best overall pump for their projects.

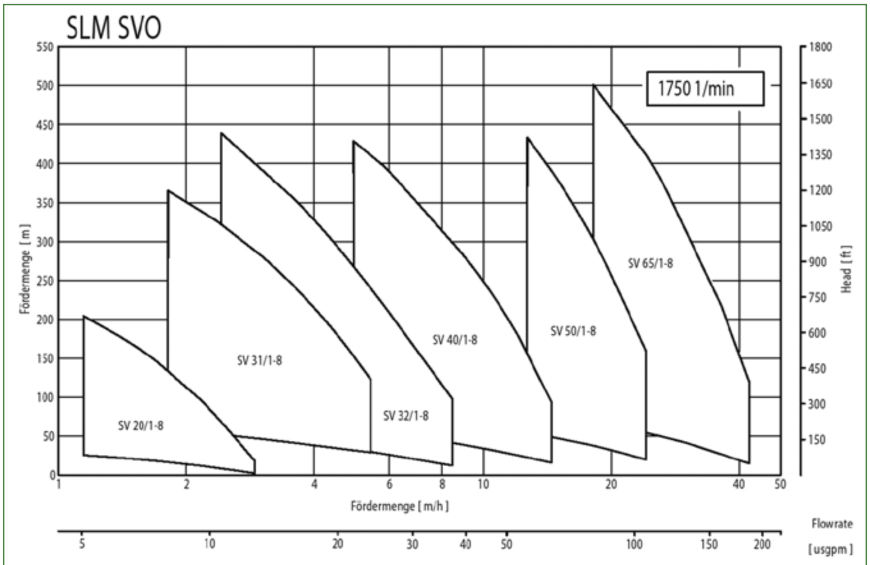

Figure 6. Typical performance envelopes

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Tony Marty currently works for Klaus Union Incorporated, a manufacturer of industrial magnetic drive pumps used primarily in the petrochemical industry for corrosive, toxic and explosive liquids under severe environmental and safety conditions. He has worked in many facets of the pump industry during the last 21 years. Marty graduated from the USL at Lafayette, College of Engineering, with a Bachelor of Science in industrial technology. He can be reached at tmarty@klausunion.com or 225-505-1504.