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7 Steps for High-Pressure Centrifugal Pump Efficiency

By Tom Helmreich, August 22, 2019

Extend maintenance intervals and reduce total cost of ownership of pumps used in chemical and petrochemical applications.

Chemical, petrochemical and refining applications such as pipeline transfer services, waxy oil charge, polyethylene terephthalic acid (PTA) reactor feed or water injection require American Petroleum Institute (API)-compliant pumps that can deliver typical flow rates of 300 to 1,500 gallons per minute (gpm) (68 cubic meters per hour [m3/h] to 340 m3/h) and heads up to 15,000 feet (4,572 meters).

The pumps commonly used for these applications include API multistage, integrally geared pumps and BB3- or BB5-style pumps. They achieve higher pressures by connecting multiple liquid chambers in a series, sometimes at higher speeds. Increased final discharge pressure is accomplished through increased rotational speed, impeller trim size, number of stages (impellers) and diffusion pressure recovery.

The plants using these pumps run operations around the clock, so unplanned downtime should be avoided at all costs, as the value of a lost day of production vastly exceeds the cost of the pump. How do plants ensure pumps are optimized to run at peak efficiency, in a manner that extends the mean time between maintenance and reduces maintenance costs?

Proper Selection & Design

It starts with proper selection and process design. Two stage pumps that use the addition of a speed increasing gearbox can replace up to 12 stages, which offers a significant reduction in material costs. It minimizes the complexity of setting clearances and takes up about 25 percent as much space in the plant. Sizing the pump properly at the outset is critical. This is accomplished by advanced analytics and computer-tailored hydraulics, which place the best efficiency point (BEP) at or slightly below the rated point, resulting in optimum efficiency and reduced end-of-curve horsepower (hp).

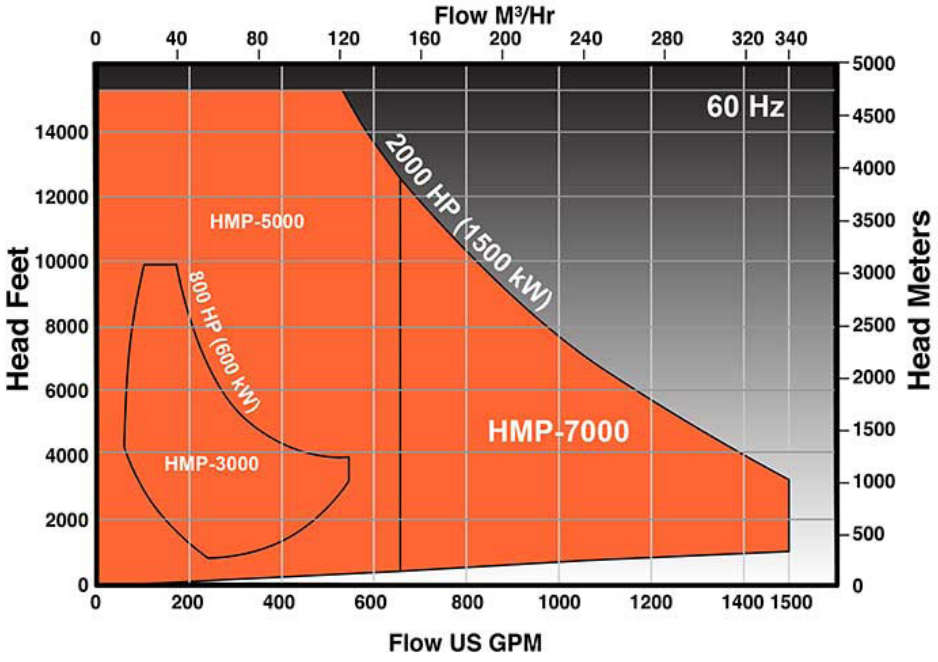

Image 1. Users should monitor pump performance to identify when pumps need to be re-rated. (Images courtesy of Sundyne)

This enables smaller drive sizes to be used, which can still deliver the required output while saving energy. Because process conditions change over time, it is important for users to monitor pump performance and identify when pumps need to be re-rated to ensure the most efficient and reliable operations (Image 1).

Keeping the pump operating within the API limits for high-energy pumps—ideally between 70 and 100 percent of BEP—is critical. Running at flows above or below design can result in cavitation, bearing damage, seal failures, excessive shaft deflection, high vibration and motor overloads.

Pump failures of any kind result in poor mean time between repair (MTBR), plant downtime and increased maintenance costs. Maintenance and operational costs can make up as much as 80 percent of a pump's total life cycle costs (Image 2).

Many multistage centrifugal pumps used in chemical and petrochemical plants have been in service since the late 1980s. This longevity can be attributed to proper manufacturing, quality materials and diligent maintenance. But there is another factor—a modular design that makes it easy to swap out parts when necessary.

The adage, "if it isn't broke, don't fix it," often applies to pumps and other equipment. But this does not mean that pump companies are not seeking (and making) improvements. Advances in analytics such as finite element analysis (FEA), computational fluid dynamics (CFD) and multiphase modeling have greatly improved both hydraulic and mechanical designs. Coupled with improved materials,

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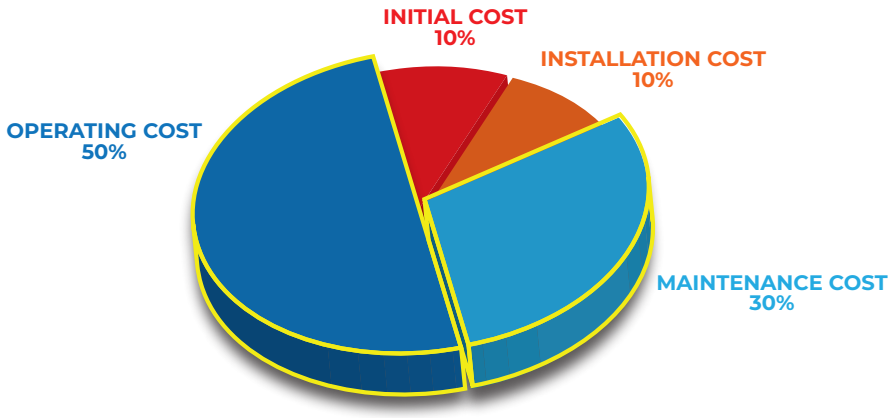


BREAKDOWN OF PUMP LIFE CYCLE COSTS

Image 2. Maintenance and operational costs can make up 80 percent of a pump's total life cycle costs.

increased reliability is readily achieved, particularly if upgrades are coupled with re-rates to match pump flows to the required process conditions.

Enhancements in manufacturing, combined with extensive customer feedback from dozens of chemical, refining, fertilizer and PTA manufacturers, have identified seven key areas for optimizing pump performance, extending maintenance intervals and reducing total cost of ownership.

7 Upgrades on Multistage Integrally Geared Pumps

1. **Process seals**—Many new materials have been developed that improve seal performance and life.
2. **Process seal rotating face**—Today's "soft-mount" design creates a more stable sealing surface. Removing old hard-mount hardware allows the rotating face to better handle fluctuations in temperature and pressure while improving the running flatness of sealing surfaces.
3. **Seal housing**—Modifications are needed to accommodate the newer and more reliable rotating face, and also to improve fluid flow through the seal housing and remove high-point vapor pockets, which improves seal life.
4. **Gearbox seal**—Today's latest gearbox seal designs offer better sealing capabilities and reduce leakage of gearbox oil, reducing process fluid entry into the gearbox.
5. **Shaft sleeves**—These are machined to extremely tight tolerances. They maintain proper parallelism and flatness for optimal seal life and low vibration. This type of upgrade specifically complements the new seals and rotating faces.
6. **Inboard bearings (motor side) and outboard bearings (pump side)**—The latest generation of inboard bearings offers better rotor stability over a wider operating range and improves bearing stability, while enhanced outboard deflection pad bearings improve rotor stability, damping and reduced vibration and enable improved seal longevity.
7. **Instrumentation**—Updated instrumentation for monitoring vibration and temperature accommodates the new bearing designs.

Upgrades Offer Better ROI

Upgrading these key elements reduces MTBR and provides operational flexibility while leveraging improvements in materials and design technology.

Upgrading these elements can double the service life of the bearings and seals at a fraction of the cost of replacing the entire pump.

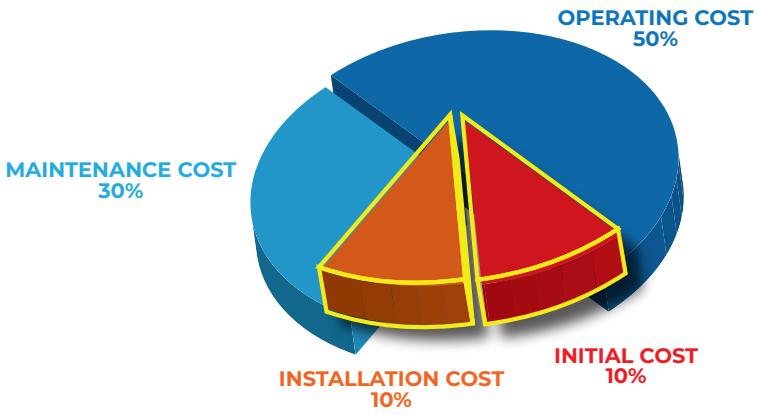
In most cases, this eliminates the need to make any changes to piping and foundations. Because of the modular design, upgrades to key components can refresh an aging pump in a manner that delivers longer service life.

Upgrading eliminates the cost of installing a new pump, which in refineries or fertilizer plants involves a customized process defined by nonstandard piping, different foundations, space limitations and steel structures. A re-rate of the pump with an upgrade to the key components can be easily accomplished in a matter of days, during a standard turnaround, at a fraction of the cost.

Benefits of an Upgrade

Operating costs—These costs can be minimized by reducing energy costs, vibration, eliminating leakage and ensuring that pumps are operating at their BEP.

Maintenance costs—Upgrading the key components such as the seals, bearings, seal housings and shaft sleeves with newer



BREAKDOWN OF PUMP LIFE CYCLE COSTS

Image 3. Extending a pump's life cycle can save installation costs.

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and warrantied parts extends maintenance intervals and reduces overall maintenance costs. Improved seals specifically limit environmental leaks and reduce the risk of process fluid entering the gearbox, which could result in corrosion and damage. In this case, an ounce of prevention is truly worth a pound of cure, because this upgrade hardens and protects a critical area that helps maintenance professionals avoid unplanned maintenance down the road. Extending a pump's service life by up to 30 years eliminates replacement costs, avoids the need to incur installation costs, and saves time for plant operators and maintenance personnel (Image 3).

Plant uptime—For refineries using multistage integrally geared pumps in a variety of applications, such as reactor-charge, liquefied petroleum gas (LPG) injection or pipeline transfers, plant uptime is the true measure of all optimization efforts. Specialized applications such as PTA dissolver feed pumps and fertilizer plants using these pumps for applications such as carbamate recycling or ammonia injection benefit equally from these upgrades.

Pump re-rates and upgrades to key components can extend the life of the initial investment and reduce maintenance costs by extending MTBR.

Tom Helmreich is Sundyne's global product line director. He has worked in operating units, plant design and construction, and pump design and manufacturing for 33 years. For more information, visit www.sundyne.com.