Make Maintenance Mandatory

Centrifugal pumps must be kept in optimum shape to handle harsh chemical-processing operations

By Edison Brito

Centrifugal pumps play a prominent role throughout chemical plants. Keeping them in tip-top operating condition is a must to ensure that all chemical-processing applications run efficiently and effectively.

Introduction

It's a fact of manufacturing life that chemical processing plays an integral role in the ongoing success and relevance of a wide array of industries around the world. The chemical-processing industry most prominently includes the traditional chemical, petroleum and petrochemical markets, as well as major processing operations for industrial gases, plastic producers, inorganic chemicals, paints and pigments, coatings and detergent manufacturers.

The operating conditions at most chemical-processing facilities are quite similar—harsh, oftentimes corrosive, 24/7/365 operating atmospheres that require around-the-clock equipment reliability. In other words, any equipment downtime can affect the facility's operational effectiveness and profitability.

One of the key components in these facilities is the transfer pump. These pumps must deliver the ultimate in reliability because they are under constant assault and must be able to perform while handling a number of diverse operational characteristics, such as:

- Changes in ambient temperatures and other weather conditions, such as humidity
- Line shock from piping that is not anchored properly
- Piping systems that have inhibitive sharp bends instead of the preferred gentle curves
- Changes in the product type being pumped
- Changes in product viscosity
- High volume (unloading a 50,000-gallon tanker) at high flow rates (4,000 gallons per minute)
- Changes in product velocity and force
- Changes in hydraulic operating point

For decades, the No. 1 pump-style choice by operators of chemical-processing facilities has been centrifugal-pump technology. Centrifugal pumps enable them to handle many fluid-transfer applications. The pumps will perform at their very best, however, only if proactive steps in both preventive and protective maintenance are established and implemented. This article will demonstrate how attention to a strict maintenance routine can keep centrifugal pumps running reliably in chemical-processing environments with the ultimate goal of realizing optimized pumping-system efficiency and effectiveness.

Why Centrifugal?

Historians tell us that the first machine that can accurately be classified as a centrifugal pump was a mud-lifting apparatus that appeared in Europe as early as 1475 A.D.[1] A straight-vaned centrifugal pump was developed in the late 1600s by Denis Papin, a French inventor and physicist. The curved-vane centrifugal pump, which most closely resembles current-day technology, was brought to market in 1851 by British engineer John Appold.

Since their earliest invention, centrifugal pumps have moved liquids through the use of centrifugal force. Centrifugal pumps use bladed impellers to transfer rotational mechanical energy to the fluid primarily by increasing the fluid's kinetic energy, or angular momentum, while also increasing the potential energy (static pressure). The gathered kinetic energy is then converted into usable pressure energy in the discharge collector.[2]

Currently, the three most common styles of centrifugal pumps are:

- **ANSI** – These pumps meet centrifugal-pump manufacturing criteria established by the American National Standards Institute (ANSI) in 1977. ANSI centrifugal pumps are engineered for operational flexibility and durability. ANSI pumps can also be end-suction or self-priming, in-line, etc., styles.
- **Standard End-Suction** – Ideal for thin liquids and the top choice for most water-pumping applications.
- **Self-Priming** – This type of centrifugal pump has the ability to lift fluid, which gives it an advantage when the source is below the centerline of the pump.

Impeller adjustment is made by turning the jack bolts at rear of bearing housing.

No matter the operational atmosphere where these types of pumps are being used, a routine maintenance program will extend the life of the pump since well-maintained equipment lasts longer and requires fewer and less-expensive repairs. In fact, because many chemical-processing pumping systems can often have life spans of 15 years or longer, it is now a valid consideration for the plant operator to perform a life-cycle cost (LCC) analysis that factors in the costs of maintenance, along with purchase, installation, energy usage, operation, downtime, environmental and other costs when choosing the proper pump technology.

According to the Hydraulic Institute, while energy, at 40%, might represent the highest expected pumping-system-related expense in an LCC analysis, the second-most costly is often maintenance, at 25%.[3]

Maintaining An Edge

Therefore, in order to obtain optimum working life from a centrifugal pump, regular and efficient maintenance is required.[4] When the pump is purchased, the manufacturer will typically advise the plant operator about the frequency and extent of routine maintenance, but it is the operator who has the ultimate final say about how his facility's maintenance routine will function. The potential cost of unexpected downtime and lost production is also a significant concern when determining the total LCC of a pumping system. Again, the facility's maintenance routine

Temperatures above 350°F (117ºC) require a finned tube oil cooler to cool the bearing frame.

should determine what steps should be followed when an unexpected breakdown occurs, while a post-repair assessment should identify areas where a more proactive maintenance regime may have prevented the breakdown and resulting downtime.

The facility operator must also be certain to keep a detailed record of any preventive maintenance that was performed and repairs that were needed for each pump. This information will create an easily accessible record that can help diagnose problems and eliminate, or minimize, any future equipment downtime.

Moving into the nuts and bolts of centrifugal-pump maintenance, routine preventive and protective maintenance practices should include, at a minimum, the monitoring of:[5]

- Bearing and lubricant condition. The lubricant should be clear with no signs of frothing, while changes in bearing temperature may indicate imminent failure.
- Shaft seal condition. The mechanical seals should show no signs of visible leakage.
- Overall pump vibration. Unwanted vibration can occur due to a change in pump alignment, the presence of cavitation or resonances between the pump, its foundation or the valving located in the suction and/or discharge lines.
- Differential pressure. A gradual decrease in the developed head pressure of the pump can indicate that the impeller clearance has widened, which requires adjustments to restore the pump's intended design performance.

Also worth noting is that maintenance and monitoring intervals should be shortened if the pump is used in severe-service conditions, such as with highly corrosive liquids or slurries.

Quarterly Maintenance

- Check the pump's foundation and hold-down bolts for tightness
- The oil should be changed after the first 200 hours of operation for a new pump then after every three months or 2,000 operating hours, whichever comes first
- Regrease bearings every three months or 2,000 operating hours, whichever comes first
- Check the shaft alignment

Annual Maintenance

The pump's performance should be checked and recorded in detail at least once a year. Performance benchmarks should be established during the early stages of a pump's operation when the parts are new and the installation adjustments are correct. This benchmarking data should include:

- The pump's developed head pressure as measured at the suction and discharge pressures for three to five conditions should be obtained. Where possible and practical, a no-flow reading is a good reference and should be included.
- Pump flow rate
- Motor amp draw and voltage, corresponding to the three to five operating conditions mentioned above
- Vibration signature
- Bearing housing temperature

Counter-sinks are for the addition of vibration and temperature monitors.

The oil level must be at the halfway point in the sight glass.

When the annual assessment of a pump's performance is made, any changes in the benchmarks should be noted and used in determining the level of maintenance that may be required to get the pump back to operating at its efficient best.

When considering centrifugal-pump operation and maintenance requirements, one thing must be kept in mind: all pump bearings will fail eventually.[6] Particular attention needs to be paid to bearing lubrication in order to maximize bearing and, by extension, pump life.

If an oil is being used for bearing lubrication remember to use only non-foaming and non-detergent oils. The proper

Shaft run-out must be checked at both the coupling end and the mechanical seal end. Maximum run-out is 0.002TIR.

The Future is Now for Pump Maintenance

There is absolutely no question that the invention and growth in popularity of the Internet has affected the lives of most everyone on Earth in one way or another. One of the most important is the immediacy in which tasks that used to take hours or days can now be completed in a matter of seconds.

The "right now" affect of the Internet has also trickled down to the world of industrial transfer pumps. In years past, whenever a pump broke down, or routine maintenance needed to be performed, the facility manager had two choices: dig around for the IOM manual, identify the problem and then go about trying to fix it, or call the manufacturer or distributor, then wait for a service tech to arrive to assess and address the problem.

Realizing the power that the Internet can possess in instances like these, many pump manufacturers are developing maintenance videos for their distributors and end-users that are designed to help them properly rebuild or maintain their equipment. Now, for a task that may have taken days to complete, there may be available either on YouTube or the manufacturer's dedicated website a, for example, 10-minute video that shows the proper way to maintain or fix a pump.

Click image above to view video.

oil level is at the mid-point of the bull's-eye sight glass on the side of the bearing frame. It is important to avoid over-lubrication as it can be just as damaging as under-lubrication since excess oil will cause a slightly higher horsepower draw and generate additional heat, which can cause frothing of the oil. When checking the condition of the lubricating oil, if any cloudiness is observed it can be indication that an overall water content of greater than 2,000 ppm is present. If this is the case, the oil needs to be changed immediately.

If the pump is equipped with regreaseable bearings be certain to never mix greases of differing consistencies or types. Also note that the shields must be located toward the interior of the bearing frame. When regreasing, ensure that the bearing fittings are absolutely clean as any contamination will decrease bearing life. Overgreasing must also be avoided as this can cause localized high temperatures in the bearing races and create caked solids.

In instances where you may need to replace a part, or parts, on a malfunctioning pump, these circumstances should also be treated as an opportunity to examine the pump's other parts for signs of fatigue, excessive wear and cracks. Any worn parts should be replaced if they do not meet the following part-specific tolerance standards:

- **Bearing Frame and Foot** – Visually inspect for cracks, roughness, rust or scale. Check machined surfaces for pitting or erosion.
- **Bearing Frame** – Inspect tapped connections for dirt. Clean and chase threads as necessary. Remove all loose or foreign material. Inspect lubrication passages to be sure that they are open.
- **Shaft and Sleeve** – Visually inspect for grooves or pitting. Check bearing fits and shaft runout, and replace the shaft and sleeve if worn or if the tolerances are greater than 0.002 inches.
- **Casing** – Visually inspect for signs of wear, corrosion or pitting. The casing should be replaced if wear exceeds 1/8-inch deep. Check gasket surfaces for signs of irregularities.
- **Impeller** – Visually inspect the impeller for wear, erosion or corrosion damage. If the vanes are worn more than 1/8-inch deep, or if they are bent, the impeller should be replaced.
- **Frame Adapter** – Visually inspect for cracks, warpage or corrosion damage and replace if any of these conditions are present.
- **Bearing Housing** – Visually inspect for signs of wear, corrosion, cracks or pits. Replace housings if worn or out of tolerance.
- **Seal Chamber/Stuffing Box Cover** – Visually check for cracks, pitting, erosion or corrosion, paying special attention to any wear, scoring or grooves that might be on the chamber face. Replace if worn more than 1/8-inch deep.
- **Shaft** – Check the shaft for any evidence of corrosion or wear. Check the shaft for straightness, noting that the maximum total indicator reading (TIR) at the sleeve journal and coupling journal cannot exceed 0.002 inches.

Implementing all of these maintenance recommendations may seem daunting, but it is only through a routine such as this that a chemical-processing operation can maximize the service life of the equipment while enhancing the safety of plant personnel and the environment.

Conclusion

As mentioned, the harsh, difficult operating conditions found in chemical-processing operations can put a great deal of stress on the pumping equipment that is used to keep them running. The best way to ensure that instances of pumping-system failure that can lead to costly downtime and potential safety hazards do not occur is to be proactive in your maintenance routine. Chemical processors who stay ahead of the maintenance curve will reap the benefits that are to be found in a facility that operates without encountering the breakdowns and out-of-service situations that can have an adverse and costly effect on plant operations.

Edison Brito is the Chemical Market Development Director – Americas for the Pump Solutions Group (PSG™), Downers Grove, IL, USA. He can be reached at Edison.Brito@pumpsg.com or (973) 780-7985. PSG is comprised of several leading pump brands—Almatec®, Blackmer®, EnviroGear®, Griswold™, Maag®, Mouvex®, Neptune™ , Quattroflow™, RedScrew™ and Wilden®. You can find more information on PSG at www.pumpsg.com.

Notes:

1. Ladislao Reti, "Francesco di Giorgio (Armani) Martini's Treatise on Engineering and Its Plagiarists," Technology and Culture, Vol. 4, No. 3 (Summer, 1963)
2. Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions (ANSI/HI 1.1-1.2), Hydraulic Institute
3. Optimizing Pumping Systems: A Guide for Improved Energy Efficiency, Reliability & Profitability, Hydraulic Institute
4. Pump Life Cycle Costs: A Guide to LCC Analysis for Pumping Systems, Hydraulic Institute
5. Installation, Operation and Maintenance Manual, Griswold Model 811 ANSI Process Pump, Griswold™ Pump Co.
6. Ibid.