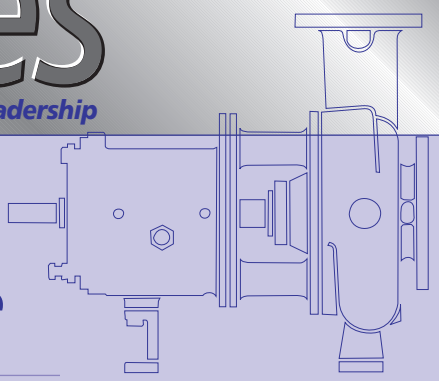
PumpLines
Innovation...Technology...Leadership
WINTER 2002



Investments in Energy Efficiency Result in Operational Cost Avoidance

Augusta Newsprint teams with DOE to implement many energy-saving projects.

Donald G. Meadows, Senior Editor *Solutions*
Mike Pemberton, Marketing Manager, PumpSmart Control Solutions

A Department of Energy sponsored showcase was held at Augusta Newsprint's Mill in Georgia recently. Several energy saving technologies have been installed for demonstration. One of the new technologies being highlighted is a PumpSmart system from ITT Industries' Goulds Pumps / PumpSmart Control Solutions business unit. This variable speed control system, with embedded intelligence, has allowed the removal of a cavitating control valve, reduced energy usage, and increased the MTBF of a 200 horse-power centrifugal pump.

Augusta Newsprint's roots go back to 1965, when, as Cox Newsprint, it consisted of one paper machine and a ground-wood mill. Today, the mill's facilities include two paper machines, a wood yard, a thermo-mechanical pulp (TMP) mill, a recycled newsprint (RNP) mill, a bark boiler, utilities, and support areas. Augusta Newsprint employs 390 people and produces 1,200 tons of newsprint per day. The raw material for the newsprint is 65% southern pine and 35% recycled content consisting of old newspapers and magazines.

Economic forces continually challenge the mill, like all forest product businesses in the country. To remain competitive, management is constantly seeking new ways to improve the bottom line. In May of 2000, Augusta Newsprint consulted with the Department of Energy's Office of Industrial Technology (OIT), which subsequently assisted mill management with assessing energy use and identifying energy-saving opportunities - all of this leading to an industry showcase.

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Goulds Pumps
ITT Industries
Engineered for life

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Mill Showcases New Energy-Saving Technologies

OIT showcase demonstrations are public events that highlight the latest energy-management practices and energy-efficient technologies emerging from OIT-sponsored research and development. These events spotlight energy and cost-saving technologies that have been implemented at industrial facilities.

The Showcase process usually begins with a plant-wide assessment performed with the assistance of OIT's Best Practices program or university-based Industrial Assessment Centers. Then plants implement assessment recommendations in the form of process or system improvements. Next, an independent third party validates the technology performance and costs.

"Showcases provide the opportunity for participants to learn from and exchange ideas with researchers, colleagues, and OIT staff about industry programs and projects, particularly those that are ready for plant floor application," explains Denise Swink, OIT's Deputy Assistant Secretary.

"Augusta Newsprint is open to new ways of doing things, taking some calculated risks, and trying new technologies," said Chuck Amos, the plant's Engineering Manager. "We saw it as a chance to learn and grow and to focus on energy costs and savings."

State-of-Art Technology Boosts Pumping System Efficiency at Augusta

When OIT performed the plant-wide assessment at Augusta Newsprint, the mill ranked high in overall energy efficiency. However, the assessment revealed numerous opportunities to improve electrical energy consumption across the various mechanical systems in the mill.

Among the areas that could be improved was Augusta's pumping system. DOE's *United States Industrial Electrical Motor Systems Market Opportunities Assessment* report, published in 1998, revealed centrifugal pumps, as a group, were the single largest energy consumers in pulp and paper mills. At Augusta Newsprint, pumps consume 21% of the mill's energy.

After OIT's initial assessment, Augusta decided to target process pumps, in general, and its thermomechanical pulp mill (TMP), in particular, for more in-depth study. Together, with project partners Dean Oliver International (DOI), an Atlanta-based consulting firm, and ITT Industries' Goulds Pumps unit, a major supplier of process pumps to paper mills and a Best Practices Allied Partner, Augusta Newsprint analyzed and reviewed more than 150 pumping systems at the mill. This review included motor and pump systems in the mill, the refiner mechanical pulp mill, and the TMP plant. The review also revealed areas of improvement in the process equipment and control strategies in the TMP plant.

PumpSmart® Control System

Among the technologies demonstrated at the showcase was the application of Goulds PumpSmart control system, which has improved control of the low-density stock level in one of the mill's TMP storage towers. Before the PumpSmart installation, the mill relied on a valve to control flow from the tower's 200-hp fixed-speed pump (Figure 1 & 2). This application consumed significantly more energy because of the high system head associated with the throttling control valve. Furthermore, throttling as a means of controlling flow caused severe cavitation across the flow control valve.

Cavitation often leads to valve and piping damage, resulting in frequent valve failures. The solution was the installation of a PumpSmart (on an Ahlstrom pump) a state-of-the-art variable frequency drive (VFD) that incorporates intelligent flow control (Figure 3). This new technology has significantly reduced energy usage and motor speed (reduced from 1150 RPM to around 450 RPM), while eliminating the control valve and its associated repairs. Augusta Newsprint will achieve ***a total saving of about $720,000***, over the 20-year life cycle of the pump, in maintenance, operation, and other life cycle costs. The company estimates ***energy cost savings of over $30,000 annually*** from installation of this new technology on just one pump.

Figure 1. Inefficient valve throttling controlled flow from 200 HP fixed-speed pump.

Figure 2. Flow meter replaces inefficient control valve.

Figure 3. PumpSmart intelligent flow control system will save $30,000.

Investmensts In Energy...

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PumpSmart Benefits

Goulds PumpSmart system uses any standard centrifugal process pump in conjunction with ITT Industries' unique and patented PumpSmart Control System and Software. Intelligent flow control protects the pump from catastrophic damage caused by cavitation, closed valves, and low flow conditions.

The software, which resides in the controller microprocessor, is the brain of the system, allowing the pump to monitor and react to any system condition (Figure 3). The result is lower total lifecycle cost, better process control, and improved asset management. According to Mike Pemberton, Marketing Manager for PumpSmart Control Solutions, "In a market place that is relentless on cost, PumpSmart offers mills a powerful tool to lower operating cost while optimizing asset utilization."

That reduced life cycle cost includes reduced installation costs because the wiring and piping of valves, flow meters and recirculation lines are eliminated. Operating costs are reduced with PumpSmart because the pump operation matches the system requirements without control valves. The variable speed control operates the pump closer to the best efficiency point (BEP) and at a slower RPM. Energy consuming control valves, flow meters and recirculation lines are eliminated. The energy savings are calculated and displayed at the DCS or on the PumpSmart keypad. PumpSmart also provides customers with reduced maintenance costs and increases MTBF.

Showcase Workshop Highlights Smart Pump Technology

Just as an intelligent flow control system helped Augusta Newsprint improve its TMP pump system, PumpSmart's advanced technology can also help other plants achieve energy and cost savings.

According to the DOE *Motor Market Assessment* report, most of the motor system energy savings in the U.S. pulp and paper industry are concentrated in pump system improvements, particularly those that involve mid- to large-size pumps. Efficiency measures such as replacing throttling valves with speed controls can yield savings that range from 5% to 50% of the system's total energy use.

The Finnish Technical Research Center (for Manufacturing Technology) Report: *Expert Systems for Diagnosis of the Condition and Performance of Centrifugal Pumps*, concurs that there is plenty of room for improvement when it comes to pump system efficiency. A review of 1,760 pumps at more than 20 industrial sites showed that average pumping system efficiency was below 40%, with 10% of the pumps operating below 10% efficiency. Furthermore, these studies estimate that 70% of pumping systems are oversized and operating with throttled valves, frequently less than 50% open. Throttled valves result in significantly higher energy consumption and reduced system reliability (Figure 4).

In the past, using oversized pumps has been the standard practice to ensure throughput during peak production periods or to accommodate capacity growth. However, smart VFD technologies such as PumpSmart offer many advantages to traditional valve-controlled fixed speed systems. Reliability and unit costs of VFD systems have improved dramatically, and as energy costs continue to increase, VFD technology is gaining wider acceptance as a fundamentally better way to run continuous and, in some cases, batch processes.

Augusta Newsprint has set a goal of reducing energy use by 1% each year for the next 5 years. Thanks in part to the energy savings supplied by one PumpSmart-equipped centrifugal pump, the mill will be able to achieve this goal for 2002.

Figure 4. Fixed-speed pump with throttling valve results in higher energy consumption and reduced system reliability.

Tech Talk

Improving Pump Reliability Through Robust Designs and Pump Selections

Stan Knecht
Global Market Manager - Chemical Products

Over the course of the past ten years, pump users have made much progress towards improving pump reliability. These activities started in the late 80's and early 90's mostly stemming from Total Quality initiatives where-by tools like root-cause failure analysis, statistical analysis techniques and a heightened awareness. Education through "Best Practice" forums have allowed users to identify some of the elementary issues which accounted for a significant portion of pump failures and downtime. Since that time most users have implemented or are implementing some form of Reliability Improvement programs. These typically involve some or all of the following activities which allow them to identify and implement corrective actions long before equipment failure occurs. Result, increased Mean-Time-Between-Failure (MTBF) intervals:

Typical Reliability Improvement Initiatives

1. Vibration monitoring and trending
2. Lubrication oil analysis and sampling
3. Improved pump alignment and pump installation practices
4. Improved rotor balance

The collective result of these initiatives have been impressive. Surveys of pump user in the North American chemical industry have shown typical improvements in MTBF from 15 months to 24 months.

While improvements like these have helped many companies to improve profitability and to maintain their competitiveness, the ever-increasing pressures of today's marketplace has many users now looking for additional measures to further increase MTBF to maintain their competitive edge.

When you analyze the actions taken to date one can see that the focus has been primarily on improving mechanical aspects of equipment reliability. In essence we likely have harvested the low hanging fruit, yet to begin to harvest the higher level fruit, one will need to take a more holistic approach and begin to

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Tech Talk

Improving Pump Reliability...

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gain a better understanding of how the equipment itself functions within the system.

Robust Pump Selections

During the design process of a pumping system designers and engineers must consider many variables. One area to consider which can improve equipment reliability is to look at the criteria which is used to select and hydraulically size pumps. Over the years there have been many guidelines and "un-written rules" established to help engineers specify pump. Basic selection criteria often include objectives such as "selecting a point to operate at its Best Efficiency Point (BEP)," "slower speeds are better," or to "provide adequate Net Positive Suction Head (NPSH)." While these all represent sound engineering practices, often in "real world" applications it is not practical or possible to meet these all of these criteria and the engineer is left to make a subjective judgement as to what pumps is best for the given service.

Three common factors, which are pertinent to most pump selections, are operating speed, impeller diameter and operating point. In situations where traditional "ideal selection criterion" cannot be satisfied one method proposed by Bloch [1] to help engineers predict and compare the projected reliability of one hydraulic selection to another is the concept of Reliability Factors. These factors are simply non-dimensional numbers used to provide a relative index ranging from 0 – 1 of one attribute as compared to the ideal for that given attribute. A rating of one (1.0) does not mean infinite reliability, rather that this would be the best selection possible; conversely a rating of zero (0.0) does not imply zero reliability, rather that this would not be recommended for this application. These factors proposed by Bloch have been further confirmed via laboratory testing as reported by Erickson, et al [2].

Operating Speed Factor (F_R)

The effects of operating speed or RPM on pump reliability are likely easiest for all to understand. It is likely best expressed by a phrase used in the sports world, "Speed kills." Operating speed affect pump reliability through rubbing contact primarily at the faces of mechanical seals in addition to having a significant impact on reduced bearing life though increased cycling, lubricant degradations and reduced viscosity due to increased temperature. Operating speed also has obvious negative impacts on pump component (impellers, casing, etc) wear especially in services where the pumpage is abrasive. Lastly speed has an inherent impact on a pumps suction performance which can ultimately lead to decreased reliability brought on by the increased susceptibility to cavitation problems due to high NPSHr requirements.

Figure 1 below provides a graph to predict the Operating Speed Factor (F_R). In practice a given pump designed with a maximum operating speed of 3500 RPM would be assigned $F_R = 0.2$ when applied on a service at 3500 RPM. However, the same pump operated at 1750 rpm, or a ratio of 50%, would be assigned an Operating Speed Factor $F_R = 0.6$.

Impeller Diameter Factor (F_D)

Many people might assume that selection of an impeller trim at the maximum diameter is the best selections as it is at this point where the geometry of the impeller and casing are best match as engineered during the hydraulic design of the pump. While this is true if the pump is in fact operating at its Best Efficiency Point (BEP) or design point, however off BEP operation with max trim impellers can result in some undesirable effects that are detrimental to pump reliability. Specifically when a pump is operating at an off BEP condition the exit angle of the fluid leaving the impeller is miss-matched with the angle of the "tongue" of the casing which results in a pressure pulsation that ultimate leads to increased shaft deflection which will decrease the life of the mechanical seal. It is important to note that at reduced speeds the effects of impeller diameter trim is somewhat reduced although still present.

To alleviate this phenomenon it has been found that if the clearance between the OD of the impeller and the tongue of the casing can be increased that the magnitude of the pressure pulsation can be decreased resulting in increased pumping reliability.

Based on the chart shown in Figure 2, which has been confirmed by lab testing, it can be seen that pump selections where the impeller trim is selected to be 60 – 80% of the total trim will result in the best pump life. Thus, a pump which has a maximum diameter of 10" and a minimum trim diameter of 6" would be best applied at a trim of 9" where the Impeller Diameter Factor $F_D = 1.0$.

Operating Point Factor (F_Q)

As mentioned earlier centrifugal pumps are typically designed toward achieving a single flow and head at a given speed. This point can is identified as the BEP on a pump given curve. At this point all the geometry of the pumps hydraulic design are matched and the pumps will typically operate at its highest level of performance, efficiency and have the lowest hydraulic loading. Like with the impeller trim, when this same pump is applied for a service for off-BEP rating operating points hydraulic loading and other pumps performances aspects are not optimized which typically results in decreased pump reliability. In practice this condition has been found to be less detrimental for smaller pumps, thus Operating Point Factor is shown to be contingent pump design size.

So while the use of each of these factors allows one to better understand the ramification of a given pump selection as compared to another for a given aspect, most real world pump application will involve a compromise of all these factors. One needs not to worry as an overall assessment can be made simply by

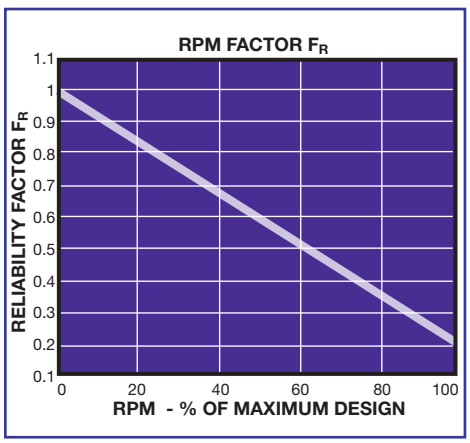


Figure 1. Operating Speed Factor (F_R). Courtesy of Gulf Publishing. All rights reserved.

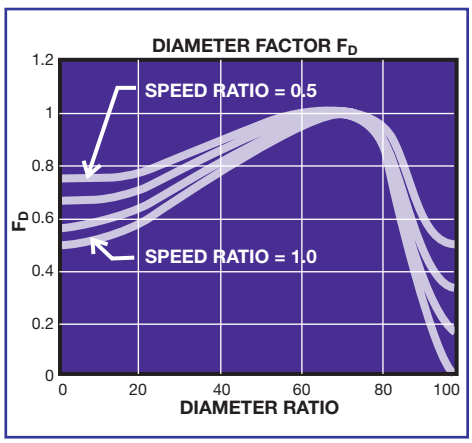


Figure 2. Impeller Diameter Factor (F_D). Courtesy of Gulf Publishing. All rights reserved.

Tech Talk

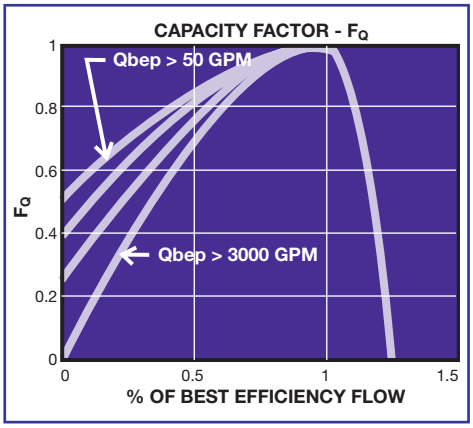


Figure 3. Operating Point Factor (F_Q). Courtesy of Gulf Publishing. All rights reserved.

multiplying all of these factors together to create a Reliability Index as follows:

$$RI = F_R \times F_D \times F_Q$$

The resultant from this calculation will give an engineer a quantifiable ratio that can be used to help decide the merits of one pump selection as compared to the other to determine which might offer best performance with regards to reliability. Like all the individual factors again a RI = 1.0 does not imply infinite reliability, likewise a RI = 0.0 does not imply zero reliability rather they simply are and indication that one selections might be better suited than the other. It is also important to note that this methodology must not be used to compare one pump design to another as the mechanical designs of these two pumps are likely to be different which can also influence pump reliability.

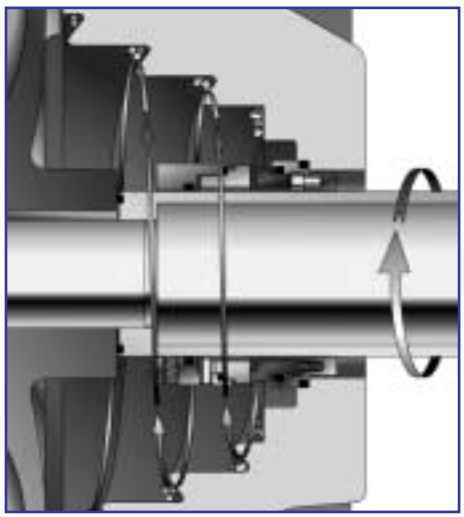
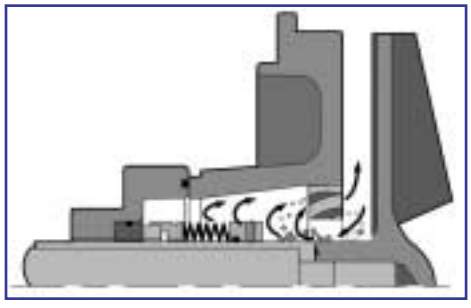


Figure 4. Typical Enlarged Tapered Seal Chambers



Robust Pump Designs

As stated above in addition to hydraulic selection, further improvements in pump reliability can be obtained by selecting pumps that have robust mechanical designs. One of the benefits of the TQ movements mentioned earlier was that a lot of data was collected and analyzed, from which it was found that the majority of pump failures were actually the result of seal failures. Using root cause analysis techniques it has been found that these failure were not the result of poor seal designs, rather they were the result of poor sealing environments. When you look at the basics of a mechanical seal design in principle they are a contacting design for which supply of a clean and cool sealing environment with adequate lubrication for the seal faces is critical to extending seal reliability. Based on significant testing conducted by both mechanical seal vendors as well as pump manufacturers it has been found that seal chambers designed with enlarged and tapered cavities similar to those shown in Figure 4 will for most applications provide the best sealing environment to promote extended seal life.

As a further improvement to these designs some pump manufacturers have made these seal chamber designs even more robust by incorporating devices into them which better controls the flow pattern within the seal chamber cavity. These devices (Figure 4) function to keep solids and grits, often present in process streams, away from the seal faces and spring mechanism of the mechanical seal to eliminate premature wear and failure of these components.

The second most common cause of pump failures was found to be the result of bearing failures. Like mechanical seals, as bearings are a wearing component a proper operating environment must be maintained for extended bearing life. As with mechanical seal, the proper operating environment is one that provides adequate cooling to dissipate the frictional heat generated and one that maintains a clean environment free of contaminants. Research conducted by ITT Industries – Goulds Pumps has shown that the use of a large capacity oil sump will significantly extend pump bearing life and reliability [3] See Figures 5 & 6. Reasons for this are as follows:

1. Larger Oils sumps have greater radiating surfaces to dissipate more heat.
2. The larger the oil sump the longer the oil stays in the sump allowing more cooling.
3. The longer the oil stays in the oils sump the more opportunities there are for contaminates to settle out to the bottom of the sump where they can be collected on the magnetic tip of the drain plug

In addition to large capacity oil sumps one other robust pump design feature to consider is labyrinth style oils seal. The primary benefit of a labyrinth style seal is gained from the fact that sealing of the bearing frame is achieved via a series of closely machined passages which are arranged to form a tortuous path which prevents the ingress of contaminant into the oil sump while at the same time retaining the lubricating oil within the oil sump without contacting the rotating pumps shaft. As compared to the more commonly used lip seal designs, which rely on the physical contact of an elastomer with the rotating shaft significant reliability improvements are gained for the following reasons:

1. Unlimited life and full time protections against contamination as Labyrinth seal do not wear out.
2. The non-contacting design does not produce any frictional heat that could be transmitted to the lubricating oil. This results in cooler oil temperature which lead to extended bearing life.

"Smart" Pumping Solution

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Tech Talk

Improving Pump Reliability...

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Yet even if one adopts all of the recommendations and best practices mentioned here and know to the industry, it is unlikely that one will achieve maximized reliability due to the fact that many failures experienced in the industry today are the result of random system upsets or operators errors. Failures which occur as the result of valves not opening, etc which then cause pumps to be "dead headed" or "running off" the pumps operating curve are difficult to predict and to prevent. However in recent years some pump manufacturers have begun to offer "Smart Pumping Solutions" that typically involve a robust pump design packaged with self contained monitoring and control system which can continuously monitor pump performance versus system demand. These "intelligent pumping solutions" are akin to the electronic ignition systems used in most automobiles today for which the package typically includes a pump, an array of pressures, temperature and flow sensors, a variable speed drive and "chip" which contains the pumps performance capabilities, DCS communication and control software. In operation these systems act continuously not only to provide diagnostic monitoring of the pumps operations to detect and prevent against failures, yet they also constantly regulate pump performance to match system demand resulting in maximized performance often leading significant energy savings.

A documented example of this was a Georgia-based chemical manufacture that had a problematic pump that was failing every 17 days due to cavitation damage created by unavoidable process operating conditions. Many "fixes" to this problem were attempted with limited success. This customer then retrofitted his pump installations with a Goulds Pumps - PumpSmart™, smart pumping solution and his pump has been running trouble free for the last 10 months without a single failure.

At another installation at a Texas industrial gas manufacturer, the PumpSmart systems was applied to a cooling tower system which had variable demand and was able to reduce energy consumption by 30% due to it's ability to regulate pump demand versus system performance. This system replaced a common fixed speed pump which "burned off" pump performance across a control valve in order to match pump performance to the needs of the system.

Summary

As industry seeks to elevate equipment reliability to the next higher level one must take a holistic approach to identify measures which can further improve reliability. Improvements can be found by implementing a more robust approach\method as to how pumps are selected and sized for a given system. The use of Reliability Factors and the Reliability Index give users a quantitative method to assist them to help make a more objective determination to compare one pumping selection to another to maximize reliability. Further one must look to the pump designs themselves to identify design features which will provide a more robust piece of equipment which is better able to sustain itself in less than ideal operating conditions. Features such as enlarged seal chamber, fitted with flow control devices, as well as oversized oil sumps and labyrinth style oil seals are a few concept which have been proven to provide results.

Lastly as we continue to prune the "low hanging" reliability improvements it will be likely that we will increasingly be faced with random and/or more complex problems as we pursue further additional opportunities. The use of "Smart Pumping" technologies will likely constitute a key component of the means which we will use to push Pumping Equipment reliability to it's maximum.

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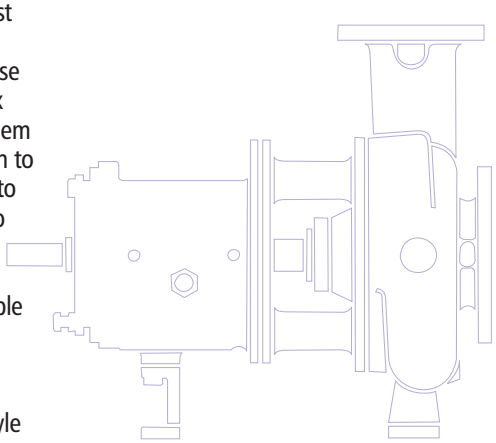

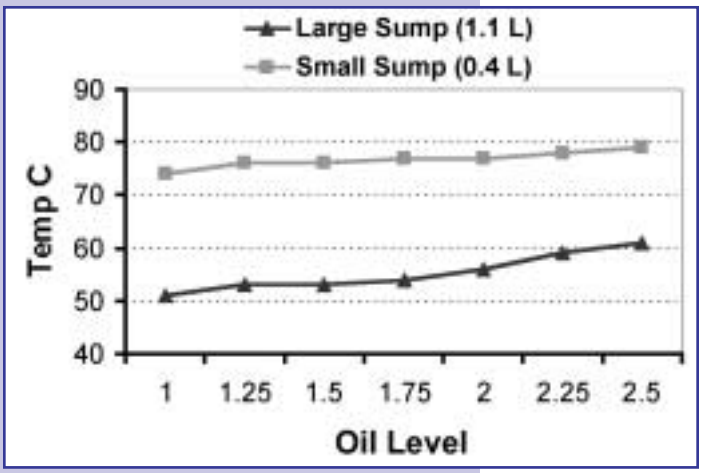

Figure 5. Effect Of Oil Sump Size on Oil Temperature [3]

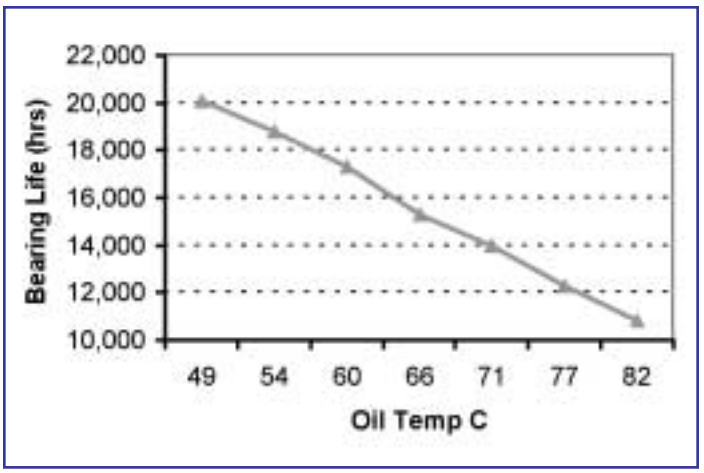

Figure 6. Effect Of Oil Sump Size on Oil Temperature [3]

New Products

New PumpSmart® Model PS200 Couples Greater Reliability and Control with Energy Savings

Ken Napolitano
General Manager – PumpSmart
Control Solutions

Goulds Pumps has introduced another major addition to its award-winning PumpSmart Control Solutions product line. Like previous offerings, the new Model PS200 is a micro-processor based, variable speed drive, programmed specifically for centrifugal pumps up to 700 HP.

The PS200 is designed for both simplicity and functionality, making it ideal for a wide range of applications where previously process controllers were too costly and complex.

Accurate control of virtually any process parameter is obtained by the continuous monitoring and reaction to both pump conditions and system demands. Pump output is matched to the exact flow and head required by the process. Energy savings in the 30-70% range are obtained because at lower demands, the PS200 reduces the motor speed eliminating the extra energy that's used to overcome the pressure drop of control valves.

PumpSmart PS200

The PS200 enables the control of 2 to 4 pump systems without the need for separate PLCs and custom programming. Load sharing is seamless, and automatic pump alternation provides even wear and maximum pump life.

Pump reliability is optimized because the PS200 protects the pump from upset conditions including dry running, low suction, cavitation, dead heading and, excessive flow. These conditions are the cause of most pump and mechanical seal failures.

The new PS200 can be applied to any centrifugal pump in a wide range of applications including: cooling water, transfer and loading, paper stock pumps, reboiler and bottom pumps, wastewater, filtration, slurry pumps and boiler feed.

Goulds Builds a Solid Foundation - Introducing ChemBase Plus™

Paul J. Biver
Product Manager - ANSI Process Pumps

Today more and more chemical pumps are being placed in corrosive environments or in highly corrosive services. The demand for new materials to meet these demanding service requirements has sent pump vendors back to the drawing board searching for something to make pumps last longer - and cost less. They have met this challenge head on providing users with the benefits of lower cost, high tech materials in pumps for aggressive services.

	Conventional Fabricated Steel Baseplate	ChemBase Plus™
Base w/SS drip pan	$ 654.00	$ 645.00
Sandblast SSPC6 (Top & Underside)	$ 400.00	Not Required
Top Epoxy Paint System	$ 280.00	Not Required
Prep underside of base For Epoxy Grout	$ 100.00	Not Required
Total Base Cost	$ 1434.00	$ 645.00
You can save 50% over a conventional base with similar features!!		

Table 1. Comparison of what the typical costs are to purchase a fabricated steel style baseplate with special surface preparation and additional features similar to what the ChemBase Plus™ offers as standard.

But what about an equally critical part of the installation - the baseplate? How much does it cost to have remove out a foundation if the base you install corrodes away? Traditionally the solution for pumps with steel baseplates in these environments has been to apply special coatings, or upgrade the entire baseplate to stainless steel. Both are very expensive and don't provide a permanent solution. In the case of a steel baseplate with a special coating on it, this is fine as long as the coating stays intact. More often than not however incidents occur during installation or routine maintenance which compromise this high cost protection. Something as simple as dropping a tool on the baseplate can cause the paint to chip and create a path for corrosion attack to the metal. If the damaged surface is not immediately repaired, within no time there will be evidence of this. In extreme cases, the end result is a baseplate and/or foundation that can look like Figure 1.

Figure 1. Standard baseplate foundation corrodes and erodes.

Goulds new ChemBase Plus™ can help stop this condition while at the same time saving customers significant amounts of money. Made of a state of the art polymer composite material it is corrosion resistant to most chemicals. The ChemBase Plus™ is also stronger and flatter than other vinylester based resin baseplates on the market today. Goulds guarantees standard flatness on the baseplate and motor blocks of 0.001" per foot. This is not only across the pump and motor pad but over the entire length of the base.

Table 1 is a comparison of what the typical costs are to purchase a fabricated steel style baseplate with special surface preparation and additional features similar to what the ChemBase Plus™ offers as standard.

Consider the additional money being spent for increased protection that is really only surface deep. The ChemBase Plus™ is a solid polymer mix through and through so you will never

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New Products

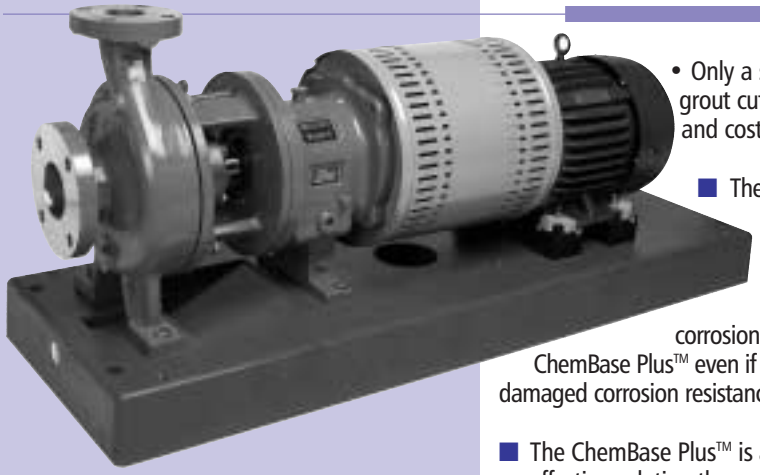

Figure 2. New ChemBase Plus™ features corrosion resistance and stronger/flatter foundation.

ChemBase Plus™...

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lose the corrosion protection and never need to maintain it as long as it's there!

Advantages of the product include:

- The ChemBase Plus™ is flat to 0.001"/ft. Compare this to conventional steel baseplates that are normally only flat to 0.005in/ft across the pump and motor pad. This translates into faster, more accurate alignment while greatly reducing any chance of soft-foot!
- The ChemBase Plus™ is more corrosion resistant than vinylester-based baseplates. Available in Zanite™ (standard) and optional Novalac the ChemBase Plus™ has your application covered!.
- The ChemBase Plus™ Polymer Composite construction inherently provides excellent vibration dampening. This translates to longer seal and bearing life-lower equipment maintenance costs!
- The ChemBase Plus™ is more rigid that conventional metallic baseplates. This rigid construction means no warping or twisting during shipment and fewer problems on site.
- Ease of Installation:
  - The solid design eliminates problems with air pockets or proper grout-to-base adhesion.
  - No special preparation of the underside of the baseplate is required.
  - It's rigid construction means less time is needed for leveling and less chance of soft foot.
  - Because there is no cavity to fill, it requires less grout and less time to cure.
  - Only a single thin set of grout cuts installation time and costs.
- The ChemBase Plus™ is solid polymer. Unlike painted steel baseplates which can chip causing corrosion attack, with the ChemBase Plus™ even if the surface becomes damaged corrosion resistance is maintained.
- The ChemBase Plus™ is a more cost effective solution than purchasing a regular steel baseplate with special surface preparations and far more cost effective than Stainless Steel! Plus it offers all the above advantages **as standard**.

If reliability, durability, performance and cost savings are important to you. Contact your local Goulds office for more information on the ChemBase Plus™.

Introducing the Newest Members of the 3298 Family

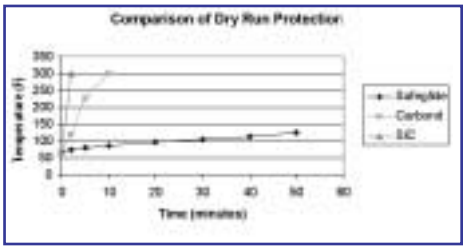
Teresa Parsons
Product Manager - Sealless and Non-Metallic Products

The family just got larger. Goulds is adding six new sizes to its model 3298 sealless magnetic drive family, enlarging the portfolio of this reliable design to fifteen sizes. The frame and sizes are:

XS	**1.5X2-6**	**S**	**1.5X3-7**
M	**1.5X3-8**	**L**	**1.5X3-10**
L	**2x3-10**	**L**	**3x4-10G**

These new sizes extend the 3298 performance range to 1200 gpm (270 m³/hr) capacity, 530 feet (162 m) head, 225 psig (1551 kPa) working pressure and 250°F (121°C) operating temperature.

The 3298 is an ETFE lined sealless pump which provides a cost effective pumping solution for corrosive applications. Its non-conductive containment shell eliminates the eddy current losses found in metallic sealless pumps resulting in efficiencies equal to mechancially-sealed ANSI pumps. The simple, robust design makes it a popular choice for other applications as well, such as remote installations or pumps with frequent seal failures.



Unique failure protection:

The 3298 family is available with SAFEGLIDE® bearings, providing unmatched dry run protection. SAFEGLIDE® bearings are silicon carbide bearings with a diamond like surface resulting in a 40% reduction in the coefficient of friction. The near frictionless surfaces allow even bone dry run protection.

Goulds PumpSmart® control solutions are also available for the 3298 providing unique protection and life cycle cost savings.

Bonus Interchangeability:

Two other recently introduced models round out the 3298 family. The V3298 is an in-line pump that can be pipe hung in-line or self supported with optional feet. It is ANSI/ASME B73.2M –1991 compliant and is interchangeable with ANSI in-line pumps. The SP3298 is a self-priming pump. Priming and air separation are accomplished in the casing without the use of an internal check valve or bolt-on priming chambers. The casing design ensures that adequate liquid to re-prime the pump is always retained. These pump styles utilize the same components as the 3298. Thus less spare parts inventory is required saving both space and parts investment.

The 3298 family is a key element of Goulds Pumps broad portfolio of chemical process pumps. Contact your local representative today to learn more about Goulds pumping solutions.

Material Matters

When Stainless Pumps Don't Appear To Be Stainless

Stephen J. Morrow
Global Manager of Materials Technology
ITT Industrial Pump Group

Question:

Why are my stainless steel pumps rusting? I thought they were supposed to be "stainless?"

The Problem

New cast CF8M *(Type 316)* austenitic stainless pump casings appear to be rusting from only atmospheric exposure. Without the normal "stainless" aesthetic appeal, the customer rejected the rust-stained pumps.

For a new service installation, dirty looking rusting pump casings were not expected. The plant engineer took one look and rejected them as defective. "Those can't be stainless-steel pumps; they're rusting!"

What's going on?

After some confusion and several discussions, the cause was determined. The pumps were in fact stainless steel that met the requirements and specifications called out on the purchase order. The casting supplier cleaned the casings through a combination of abrasive blasting and other mechanical means. Residual iron contaminants in the abrasives became embedded in the stainless casing surfaces, and were subject to oxidation to hydrated ferric oxide, which showed up as "rust-stains." Exposure to atmospheric moisture caused "rusting" or a "rust bloom."

The primary cause of rusting was the inability of the casing to form its continuous protective passivated surface. The cleaning methods used introduced iron-contaminated surfaces.

The Remedy

Clean the surfaces of scale, free-iron and other contamination to permit passivation to occur; or apply a suitable protective barrier coating (paint) over properly cleaned surfaces. Effective cleaning is done by chemical pickling or mechanical means using iron-free cleaning tools.

ASTM standard A380-96, "Cleaning and Descaling Stainless Steel Parts, Equipment, and Systems," provides guidelines for proper cleaning of stainless steel.

Lessons Learned

Stainless and other high-alloy steels cannot be processed as though they are carbon or low-alloy steels. Nor does "stainless" mean immune to rusting or corrosion from contamination. Contaminated surfaces are undesirable for developing a uniform passivated oxide film, which will never properly form unless the contamination is removed.

While minor contamination generally isn't a serious problem on rough non-machined casting surfaces, there are occasions when surface contamination can seriously affect corrosion resistance and cause rust staining.

Stainless steel pump casing showing evidence of rusting due to surface contamination.

As shown in the photograph, significant amounts of free-iron can be transferred to otherwise stainless surfaces, which with time, result in rust staining.

When the surface of stainless steels have become contaminated with iron, corrosion of the free-iron on the surface may establish corrosion cells resulting in localized pitting. To retain its stainless qualities, stainless steels must be kept clean and free of surface contamination.

Further Discussions

Stainless steels are selected for many services for their corrosion resistance and aesthetic "stainless" appeal. It's desirable to have clean uniformly passivated surfaces. For many services it's mandatory to prevent product or process contamination, and maintain sanitary conditions. Unfortunately, in some instances end users are disappointed to find stainless pumps that are "rusting." Frequently, a legitimate concern arises as to whether the pumps are stainless, or whether the alloy is in its most corrosion resistant condition.

Stainless steels do corrode. In fact, it's the formation of a tightly adherent and uniform chromium-rich oxide film *(passive corrosion layer)* that provides these alloys with their stainless properties and corrosion resistance. Damaging or preventing this "passive" surface film from forming can lead to corrosion and staining.

Certain production conditions or handling may make stainless alloys susceptible to localized corrosion, and produce surfaces that appear to be "rusting." Metallurgical changes and mechanical imperfections such as scratches, tooling and grinding marks, heat tint and heat treat scale, or other general surface contamination, can create problems. During various processing operations particles of iron or tool steel can become embedded or smeared into the surfaces. Properly passivated components do not exhibit rust staining, which is generally attributed to the presence of free-iron particles at the surface. If allowed to remain, these particles can corrode and produce rust spots or stains.

Iron contamination is almost always confined to the surface. However, if reasonable care is

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taken during production, simple inexpensive cleaning should be all that is required to restore passivity. Ideally cleaning and fabrication should be confined to areas where only one grade of material is being worked, to prevent cross contamination of materials. Cleaning tools should be segregated and dedicated for use on only one type material. Handling equipment such as chains, hooks, and lift-truck forks should also be protected with wood or other non-metallic buffers to reduce contact with iron surfaces.

Descaling and Cleaning

In many instances, surface rust is not harmful *(application dependent)*, but is aesthetically unappealing, and can lead one to belief that the steel is not truly a "stainless" alloy. The level of cleanliness required depends upon the service requirements. In some cases, no more than degreasing or sand blasting is required; while for others, such as pharmaceutical, food-handling, or other specialty services much higher levels of cleanliness may be specified.

Careful planning is required to achieve optimum surface conditioning and corrosion resistance. Surfaces that are to be contaminant free depend upon a combination of production planning, design, and post cleaning practices. Measures to protect cleaned surfaces should be taken as soon as cleaning is completed, and should be maintained during all subsequent handling, shipping, storage, and installation. If careful control of production processes and measures to prevent contamination are exercised, very little special cleaning is needed.

Stainless steel may be cleaned by mechanical methods (i.e., abrasive blasting, grinding, or brushing); chemical methods (i.e., immersion in acid solutions or pastes); or both. If a totally iron and scale free surface is required, most abrasive blasting should be followed by acid cleaning. Pickling or passivation should be specified on the purchase order, utilizing the guidelines in ASTM A380, if required.

Abrasive blasting methods that apply to castings include shot and sand blasting. Because of the likelihood of embedding iron into the surface, the use of carbon steel shot or iron grit is not recommended. While sand blasting is economical and effective for rapidly removing surface scale, it should generally be followed by a final pickling treatment to ensure complete removal of isolated contaminants.

The cleanliness of abrasives used is also critical to preventing contamination. Though surfaces may appear clean visually, residual films that prevent passivation might exist. Only clean, unused stainless shot or iron free sand should be used for abrasive blasting. While the use of stainless shot reduces the danger of iron contamination, it cannot eliminate the possibility of residual oxide scale contamination. If the blast media contains iron or becomes contaminated from prior use, minute contaminants can become embedded in the "cleaned" surface.

While, subsequent blasting may remove some of this contamination, it may also drive contaminants deeper due to impingement and surface peening. The only way to remove these contaminants and guarantee a thoroughly clean, rust-free surface, is to follow blasting with an acid pickling and passivation treatment.

Pickling and Passivation

Cleaning, pickling, and passivation of stainless steels are widely misunderstood. Pickling removes foreign contaminants, and permits the surface to equilibrate; allowing for the formation of a uniform passivated surface layer which provides corrosion resistance. Acid descaling or cleaning, also known as "pickling," is used to remove surface scale, free-iron and other corrosion products.

Pickling effects passivation simultaneously. Stainless steels are self-passivating, due to their high chromium content. A pickled surface passivates spontaneously when exposed to air, water, or other oxidizing environment. For austenitic stainless steels such as CF8M castings, pickling in an aqueous solution containing 6-25 % nitric acid and 1/2-8 % hydrofluoric acid is usually recommended. Sometimes an 8-11 % sulfuric acid solution is first used to remove tight adhering scale. Thorough scrubbing and rinsing to ensure removal of contaminating residues should follow immersion. The surfaces will self-passivate during the rinsing operation. *(See ASTM A380-96 Table A1.1 Treatment Codes A and B or Table A2.1 Part I, Treatment Code D).*

Stainless steel pump casing showing evidence of rusting due to surface contamination.

While nitric acid removes free-iron particles, it can not remove residual oxide scale. The nitric-hydrofluoric mixture, unlike nitric acid alone, provides a reducing component, which removes iron oxide scale and other metal oxides by chemical reduction. This mixture is not passivating, and corrosion rates are high during exposure, which should be limited to only a few minutes. A uniform passive oxide film forms over the freshly cleaned surfaces once removed from the pickling environment.

Passivation is often confused with pickling. Passivation treatments are not designed to remove heat tint, embedded iron, heat treat scale, or other contaminants embedded in the surface, since nitric acid does not readily remove the surface containing these contaminants. Elimination of these contaminants requires removal of the protective oxide layer from the metal by pickling the surface with a reducing component as previously stated.

Exposure to air is the primary passivation treatment for stainless steels. This produces a tenacious and durable chromium rich film that forms rapidly on the alloy surface, providing the characteristic "stainless" qualities. The primary function of a "passivation" treatment is to clean lightly contaminated surfaces to ensure the spontaneous formation of the chemically inactive "passive" film. Though stainless steel is naturally passivated by exposure to air or other oxidizers, additional surface treatments often are specified to ensure uniform passivity, and optimum corrosion resistance.

Contact with air, water or other oxidizers (e.g., Nitric acid) in the environment are usually sufficient to ensure good formation of the "passive" layer. Passivation treatments following pickling or mechanical cleaning generally are not needed provided thorough cleaning has been performed and maintained, and there is adequate exposure to air or other oxygen-containing environment. While passivation does not improve the corrosion

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resistance normally provided by the alloy, the enhanced passive film is somewhat thicker and more tenacious than that formed naturally.

To prevent staining of stainless steel and restore the corrosion resistance, finished parts are often given a passivation treatment, which consists of immersing in a solution of nitric acid. For removal of soluble salts, corrosion products, free iron and other metallic contamination resulting from handling or atmospheric contamination, an aqueous solution containing 20 to 50 vol% nitric acid is recommended for CF8M castings. *(See ASTM A 380 Table A2.1 Part II and Part III).*

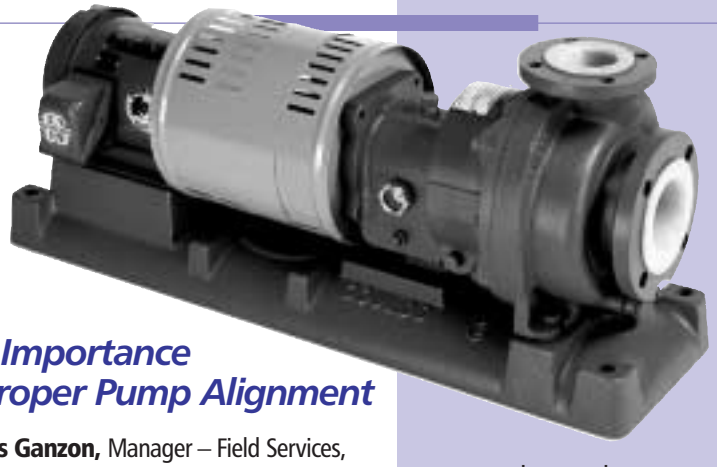
Final Comments

Regardless of treatments used, whether acid pickling, or mechanical cleaning, castings can eventually show signs of rusting if stored outside, due to the settling of ferrous particles or other wind blown contaminants in the environment. For this reason it is important to provide protection and store stainless steel equipment in a dry, iron free environment. An understanding of service conditions and surface cleaning requirements is essential to provide corrosion resistant "stainless" castings.

While it may appear confusing to determine which treatments ought to be specified for specific applications, the ASTM A380 document provides an excellent reference which should be reviewed thoroughly by those specifying, as well as those supplying stainless steel equipment.

Selected References:

1. Standard Practice ASTM A380-96, *"Cleaning and Descaling Stainless Steel Parts, Equipment and Systems;"* Annual Book of ASTM Standards, Vol. 01.03, p 145-156
2. *"Update on Cleaning Stainless Steels"* Staff Report, Metal Progress, June 1973, p 38-60
3. Robert R. Gaugh, *"Descaling and Cleaning of Stainless Steel and Heat Resisting Alloys,"* ASM Metals Handbook Desk Edition, 1985, American Society For Metals, p 29.42
4. C.P.Dillon, *"Cleaning, Pickling, and Passivation of Stainless Steels,"* Materials Performance, May 1994, NACE International, p 62-64
5. Arthur H. Tuthill, and Richard E. Avery, *"Specifying Stainless Steel Surface Treatment,"* NiDi Technical Series No. 10 068, Nickel Development Institute, (Reprint from: Advanced Materials & Processes, December 1992)



The Importance of Proper Pump Alignment

Nicolas Ganzon, Manager – Field Services, PRO Services - Goulds Pumps, ITT Industries

Why Align?

Why should a company embark upon a campaign of quality alignment? One word: Money. In the best case scenario, poor alignment will slowly and continuously suck money from your bottom line. In a worst case scenario, a catastrophic failure will cut your operations day short and cost more in repair and lost production.

Reliable Operation

The most common manifestations of poor equipment alignment are increased vibrations, reduced equipment reliability, or outright failure. Any of these reasons are good enough to justify proper alignment since, what is the use of having equipment if it is broken? If these reasons were not enough, the following list should help:

- Increased vibrations
- Shaft failure
- Bearing failures
- Mechanical seal leaks
- Noise

Poor alignment can seek its revenge anytime, and usually at the most inopportune time.

Operating Cost

The reasons for alignment are most often centered on equipment reliability, and for good reason. Poor reliability is closely associated with equipment downtime; the bain of a process industry. But while equipment reliability is the poster child for proper alignment, there is still a darker side: power consumption. Depending upon the severity of misalignment, increases in power costs between 2% and 9% may be seen. In some cases, it has been reported the power consumption may increase as much as 17% . The math is simple…A 2% impact on power consumption on a 20 horsepower pump translates into $154 per year in operating costs. A 9% impact is worth $692 per year. These costs affect the bottom line and can be quite significant in a typical process plant with hundreds, if not thousands, of pumps.

Equipment Alignment

Steps

1. **Installation quality** – Good alignment is predicated upon a quality installation. This means proper foundations, base-plate installations and piping. Before mounting alignment equipment, check for the following:

   - **Foundation soundness** – Overall condition of the foundation should be monitored and considered as equipment is aligned. Foundations can change over time, and this can affect the equipment alignment. Compare the quality of the foundation to the alignment records to determine if any problems correlate.

   - **Baseplate installation** – There are a couple of checks that should be performed that may directly impact the alignment: Baseplate-foundation separation, corrosion on the mounting pads, and broken welds or cracked castings.

   - **Pipe Strain** - The ideal condition should be where the piping can be maneuvered into place by hand and axial separation is no more than the gasket thickness ± 1/32". Additionally, the piping should be inspected for proper support during operation.

2. **Soft Foot checks** - Soft-foot is a condition where the pump or motor feet do not contact the baseplate properly. To check for soft-foot place a dial indicator on the contact

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foot of the equipment, and tighten the hold-down bolts. The indicator reading should not change more than .002". Repeat the process for all the other feet.

3. **Alignment** - There are several methods for aligning equipment: dial indicator [rim-and-face], reverse dial indicator, and laser. The Pros/Cons of each method are outlined in Table 2. For general process equipment, alignment is attained when the alignment criteria of Table 1 are achieved. As with every rule, there are exceptions:

   - For electric motors, the motor shaft initial (cold) parallel vertical alignment setting should be 0.05-0.10 mm (0.002-0.004 in.) lower than the pump shaft. Pump manufacturer should be contacted for more specific information.

   - For other drivers (e.g. steam turbines, engines, etc…) follow the driver manufacturers' recommendation.

Table 1
Maximum Allowable Misalignment

Parallel	Angular
0.05 mm (.002 in.)	0.03 degrees [0.125 mm/cm (0.0005in./in.) of coupling face diameter]

4. **Documentation** - Thorough documentation of the installation checks, final alignment values, and special findings should be made after each alignment. Equipment will move after initial alignment and operation. This information will help trend the movements to help identify any unusual occurrence and its cause.

Methods

While the scope of this article does not allow for the detailed description of each alignment method, there are benefits and limitations to each.

Elements of an Alignment Program

Skills

The ability to properly align equipment is a skill that must be continually practiced. Suffice it to say, purchasing the dial indicators or laser alignment equipment does not make one capable of aligning equipment.

Table 2, Alignment Methods

Methods	Pro's	Con's
Dial Indicator [Rim-and-face]	• Relatively simple with good accuracy, especially on short spans • Can be used on equipment whose shafts cannot turn	• Outer diameter of coupling flange [rim] must be smooth and concentric to shaft centerline. • Face of coupling must be smooth and square to shaft. • Accuracy affected by axial movement of shafts
Reverse dial indicator	• Good accuracy with larger spans [e.g. coupling spacers]. • Not affected by coupling concentricity and face perpendicularity. • May be performed without removing couplings	• More complicated than dial indicator or laser. • Shafts must be able to turn
Laser	• Good accuracy • Not affected by coupling concentricity and face perpendicularity • Simple to use	• High initial costs

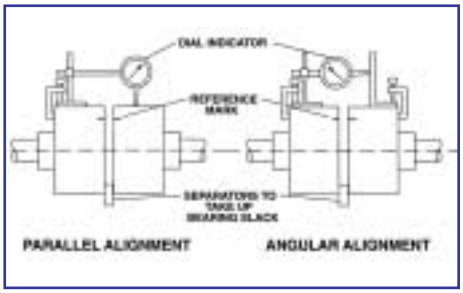
When to align

In general, equipment alignment should be checked after the pump is installed or any changes have been made to the pump, motor, or coupling. This would include repairing the pump, re-tightening loose hold-down bolts, or reconnecting piping to the pump. There are some additional periods in which to perform an alignment check:

- **Before grouting baseplate** - Occasionally a new pump and driver cannot be aligned. Motor feet may become "bolt-bound" when there is not enough clearance between the hold down bolt and the foot-hole to allow movement for alignment. Equipment should be aligned after positioning on the foundation, but before grouting to ensure that they can be aligned properly.

- **After connecting piping and grouting baseplate** - Excessive flange loads can distort the pump and/or pumps pedestal and alter the equipment alignment.

- **Hot Alignment** - After the pump and the piping system have reached their normal operating conditions, alignment should be checked to ensure that thermal expansion has not altered the alignment. Equipment should be aligned to hot conditions.



- **Periodically** - As mentioned earlier, even though equipment may be rigidly tied down, movement over time does occur and this will alter the alignment.

- **Before removing pump from system** - If a troublesome pump needs to be removed for repair, checking the ending alignment will assist in identifying the cause of the problem. If equipment is continually found to be out during these checks, it could mean improper tie-down of the pump/motor, or excessive flange loads.

Conclusion

While it may be a tedious task, proper equipment alignment benefits the reliability and cost effectiveness of a pump installation. Repair costs are reduced as less stress is placed on the equipment, and overall efficiency is improved, as less energy is lost.

Align early and align often for maximum benefits.

Send your comments or suggestions to:
John Beca - ITT Industrial Pump Group, 240 Fall Street, Seneca Falls, NY 13148 or email: jbeca@fluids.ittind.com
View the latest in pumping technology at: www.gouldspumps.com