

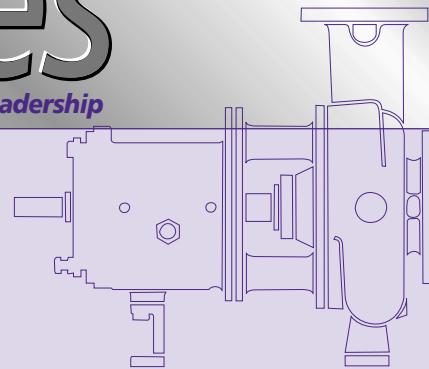


PumpLines

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SPRING 2000

HSS: Web Based Pump Selection Program



Web-based means real-time, current information. Worldwide availability 24 hours a day, 7 days a week, 365 days a year.

That ten pound catalog just became a door stop. Now you can easily size pumps without spending hours thumbing through a burdensome catalog.

It took over two years to develop a pump selection program that would meet our expectations as well as our customers' requirements. Based on successful testing by a select group of pump users, we introduced the Goulds Pumps Hydraulic Selection System, HSS. Accessible via the internet at www.gouldspumps.com, HSS provides comprehensive information about Goulds extensive line of pumps. Based on selection criteria provided by the user, HSS will identify the Goulds models which will meet the hydraulic and application requirements.

You ask, what's so new and dynamic about that?

- Web-based means real-time, current information. Worldwide availability 24 hours a day, 7 days a week, 365 days a year. No CDs or updates to worry about. No compatibility issues.

- Goulds Pumps' HSS will select from a database of over 5,000 pump models and sizes, to match the customers' exact parameters.
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- E-mail a request for quotation. Need immediate response. You'll get it.
- HSS will post all models meeting the basic selection criteria and also display limit violations, allowing the user to make alternate selections.

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John Beca
Director - Communications

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Goulds Pumps

 **ITT Industries**
Engineered for life

New Products

Industrial Hydrovar™ Variable speed pumps create benefits for Austria power station

Manfred Sacher

Product Manager - ITT Vogel

Major energy savings, up to 50% are achievable, by simply enabling pumps to run at variable speeds. ITT Vogel has introduced a 'smart' speed control system, with many additional capabilities, which can extend energy savings to almost 70%. A Viennese power station reports on the advantages of having installed 23 of these pump-mounted Hydrovar™ units.

However, variable speed units have greater capital cost because of the electrical equipment and the extra work involved with control panels and other electrical installation. Hydrovar pumps overcome these objections by the use of microprocessor technology which optimizes pump performance, allows the control gear to be mounted on the pump itself and gives complete 'plumb in and switch on' capability. (Figure 1)

With installation costs dramatically reduced and the plunging costs of electronic components, Hydrovar pumps pay for their higher capital costs many times over during their lifetime. Throughout the world, possibly about 80 per cent of pumps are still constant speed units so the scope for energy saving worldwide is huge.

Basic principle

The heart of the energy-saving principle of variable-speed pumps is the basic hydrodynamic law that the power consumed by centrifugal pumps varies as the cube of impeller speed. So if pump speed is reduced by 10%, energy consumption may be reduced by as much as 27%.

At low fluid flow speeds the head lost by friction is proportional to the velocity but at higher speeds, the head loss is proportional to the square of the velocity. The Hydrovar system maintains a plant curve which reduces pump speed to reduce fluid flow wherever possible to below the critical speed where linear losses become square law losses; this function results in energy savings by some 20 per cent. In

addition, the units have a patented cut-out which switches off the pump when the flow is zero.

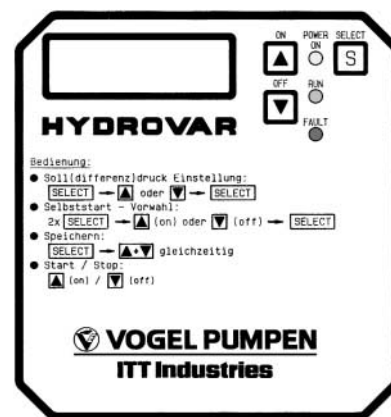
An analogy

The Hydrovar speed control system is like a car. Constant speed pumps operate very much as if a person was driving a car with one foot constantly on the accelerator and using the brakes to control the car's speed and to stop. The Hydrovar system is like a car with an automatic gearbox; and, extending the analogy, even like an automatic car with cruise control.

With a constant speed pump there are basically three flow control methods. Firstly, the flow can be reduced mechanically by throttling the discharge or returning excess flow to the suction side of the pump. Secondly, a by-pass system can reduce the flow to the pump; apart from wasting energy, this system can induce cavitation in the impeller causing additional wear. Thirdly, hydraulic accumulators can be used to absorb excess flow and store it under pressure. When the pump output drops below demand, the accumulator can be used to bring the flow up to the desired level. Accumulators are expensive, take up space, have limited capacity and seldom produce a smooth and constant flow.

Frequency conversion

The speed of a simple induction motor depends on the frequency of the AC power supplying it. In most of Europe electric main supply is at 50 Hz (cycles per second) and in the United States 60 Hz, so motors connected directly to the mains turn at multiples of these figures depending on how the motor is wound. To alter the frequency of the motor supply and thus regulate pump speed, the Hydrovar system rectifies the mains supply to DC and then inverts it under command from the controller to provide the frequency required to match pump demand.



BLOCKPUMPS



FREQUENCY CONVERTER
totally enclosed IP 54

PRESSURE TRANSMITTER
or DIFFERENTIAL
PRESSURE TRANSMITTER



CONTROL by
MICROPROCESSOR
incl. automatic switch over



Figure 1.

New Products

Input to the frequency controller comes from pressure and flow sensors; these inputs are integrated with the operator's programme to provide a fully flexible operating regime. The system provides not only economical pumping but also incorporates safety features and provides solutions to special requirements.

Packaged system

The key to this level of automation and flexibility in the Hydrovar is the inclusion of a micro processor actually in the Hydrovar unit. Pressure and flow sensors are also attached to the actual pump. The Hydrovar concept therefore is to have all the equipment necessary for a variable speed control system mounted on the pump itself. One of the many advantages to this 'pump-mounted' solution is that air from the motor cooling fan can be used to cool the electronics. Exceptionally, for pumps operating in hostile environments, the control gear is available as a wall mounted unit. Since the Hydrovar unit is so self-contained, it can be moved from one pump motor to another and can also be retrofitted to existing pumps.

Several competitors offer frequency inverters but without microprocessors which must be supplied separately. This means that they have to be connected to remote control units, thus introducing additional installation costs. They also have to be programmed before the variable speed system can be used. Many inverters are limited to a maximum rating of 7.5 kW whereas the Hydrovar is rated up to 22 kW.

Multi-pump systems

Another unique feature of the Hydrovar is its application in multi-pump systems. With the plumb in and pump principle, the only extra installation work is for each pump in the system to be connected with an interface cable to its neighbor and for the pumps to be named so that the micro processors can identify each pump. Hydrovar can be retrofitted to existing multi-pump systems and it can include the friction loss compensation system.

The multi-pump system is available for a maximum of four units and it ensures a step-less transition between each pump coming to maximum speed and the next one starting. Uniquely to Hydrovar, built-in redundancy ensures that if any component on any one pump fails, for example sensors, inverter or

micro processor, the other three can maintain system pressure and avoid breakdown.

Advanced features

Another feature of the Hydrovar is referred to as "the inverse function." Normally, speed control systems depend on signals from sensors located on the discharge side of the pump. Hydrovar can also be programmed to respond to signals from a pick-up on the inlet side of the pump. An example of where the inverse function might be used is in cooling water systems where the temperature of the incoming water would be a factor in the control of pump speed. This would enable flow through the heat exchanger to be increased to augment the cooling effect.

Hydrovar can be programmed with two different pressure levels to accommodate different operating regimes, for example, daytime and night time, with a timer to switch over to each pre-determined setting. The system can also use different variables, for example pressure, fluid level or fluid flow. The pump could be programmed to operate at a constant pressure up to a point determined by flow or water level and then its speed would be determined by the second variable.

Hydrovar is not simply a pump speed control system. It acts as the independent brain on a pump. It can enable operators to get optimal pump performance without having to acquire a quantity of additional equipment

Hydrovar in action

Some 23 pumps with Hydrovar control systems are installed in the Theiss Power Station about 70 km north west of Vienna. (Figure 2) The plant was originally built in the 1970s and during the most recent phase of expansion in 1998/99, the Hydrovar systems were installed to work in four distinct applications. Horst Kleinrath, supervisor for heating, ventilating and air conditioning (HEVAC) at the plant explains:

Oil pre-heating

Firstly in the two gas pre-heating stations. The plant is dual fuel, oil and gas fired, and when the gas arrives by pipeline from Eastern Europe it is cooled by expansion on emerging from the pipeline. Its temperature is lowered to below 0 degrees centigrade and it must be heated with



Figure 2. Theiss Power Station utilizes twenty three Hydrovar™ equipped pumps to control operating costs.

warm water at 90 degrees centigrade to prevent freeze-up of the pipework, valves and other equipment. Each pre-heating station has two Vogel pumps with Hydrovar systems to drive the warm water through heat exchangers. One pump is the duty unit while the other is on standby.

Burner Feed

The oil fuel also arrives by pipeline from Eastern Europe and needs to be heated to about 150 degrees centigrade to lower the viscosity so that it can be fed to the burners. Heat exchange takes place in two stages, the first up to about 100 degrees centigrade with water as the heating medium and the second, to final temperature, using steam. The system uses ten Vogel Hydrovar pumps in different sections. They are installed in pairs, again with one operating and one on standby. This system is normally set to a 24 hour duty cycle, which can be adjusted to other periods in special circumstances.

Plant heating

The third Vogel Hydrovar application at the Theiss power station is to heat the entire plant during shut-down. Plant heating is especially important if it burns high viscosity oil and needs to be fired up with the minimum delay. There are five pump stations for the heating system, each with two Vogel Hydrovar pumps in it.

Horst Kleinrath points out that plant heating is a very important function because of the way the national grid operates in Austria. The bulk of the country's electricity comes from hydro-electric plants on the Danube and in the mountains and fossil fuel power stations like Theiss are used mainly to smooth out peaks in demand. They

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New Products

Industrial Hydrovar™

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therefore tend to be shut down and restarted about three or four times a month. So maintaining the plant in restart condition is important for maintaining supply to the grid.

District heating

The final application for the Vogel Hydrovar pumps at the Theiss station is for pumping hot water to the district heating system supplying the nearby community of Krems, 6 km from the plant. Cooling water leaves the power station between 90 and 120 degrees centigrade and this heat would go to waste without the district heating system. (Krems, incidentally, is famous for its white wines and peach growing.)

Hydrovar experience

Commenting on his experience of the Hydrovar speed control system in the plant, Horst Kleinrath says: "The energy saving is the most important feature for us. We have almost certainly saved about 40% of the energy we would have used without the Hydrovar speed control. None of our pumps ever need to run at full power so the control system has been very useful for us."

He also comments that the soft start of the Hydrovar pumps simplifies the plant restart. 'Hard' pump starts, i.e. from zero to immediate full speed, can cause water hammer which can damage a system so without soft start facilities, automatic relief valves would have to be fitted. A minimum of one such control valve would be needed for each of the pumps, making a total of 23-24 valves at least. These are not required when Hydrovar equipment is fitted.

Another big advantage that Horst Kleinrath has noted, even after this relatively short period of operation with the Hydrovar, has been the noise reduction. Not only does this make for a much more pleasant work environment but it also enables the station to meet noise control regulations. In areas where personnel work the noise level may not exceed 80 dB and the variable speed pumps provided by Hydrovar ensure compliance.

The Theiss power station is owned and operated by EVN (Energie Versorgung Nieder-Österreich) which translates as Energy production and distribution for lower Austria. ■

Material Matters

Duplex Stainless Steels - Several Generations in the Making

Stephen J. Morrow

Global Manager of Materials Technology

Question

What is duplex stainless steel, how does it differ from the austenitic stainless steels such as CF8M or Type 316, and what are its advantages or disadvantages? Also, what's the significance of nitrogen all about?

Introduction

Duplex stainless steels (DSS) comprise a family of stainless steels with a wide range of compositions and corrosion resistance. They are typically higher in chromium and lower in nickel than austenitic stainless steels have similar molybdenum levels, generally contain nitrogen, and some grades contain copper

The term "duplex" will refer to those stainless steels that are chemically balanced to solidify primarily in the ferrite phase, with austenite forming as the secondary phase upon cooling. Composition balancing results in these dual-phase alloys (hence the name duplex), with yield strengths two-to-three times that of the austenitic grades.

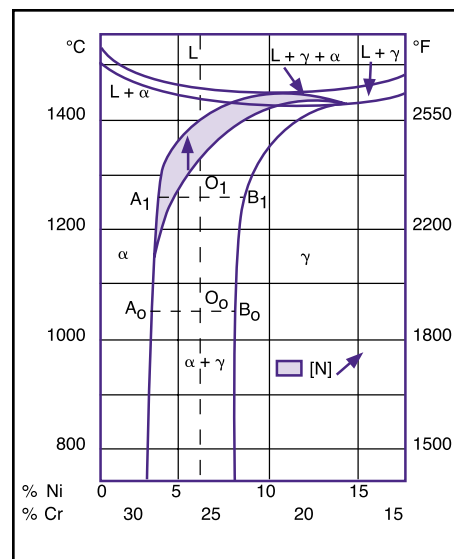
Historical Background & Alloy Development

DSS were principally developed to provide an alternative material having improved resistance to chloride stress corrosion cracking, compared to the austenitic stainless steels such as CF8M or Type 316. At first glance, the literature might appear to suggest that the duplex stainless steels are a recent development. However, DSS first appeared in the late 1920's. A nickel shortage in the early 1950's sent steel producers looking for alternative alloys to replace nickel. Manganese and nitrogen were tried, but the materials were difficult to cast and had insufficient corrosion resistance. After considerable testing, alloys of approximately 22Cr-5Ni (2205) showed promise, but were later shelved when the nickel shortage ended, and interest diminished.

In the late 1950's, the Alloy Casting Institute (ACI) commissioned metallurgists at Ohio State to develop a high strength cast stainless steel having a corrosion resistance comparable to CF8M but with improved chloride stress cracking resistance. This cast alloy became known as CD4MCu and appeared as a standard duplex grade in 1959. Wrought alloys were also developed during this period, with Type 329 being the first grade commercially offered.

While these "first-generation" DSS offered improvements, the localized corrosion resistance and weldability were inadequate since the welded alloys lost their optimal microstructure balance. In order to restore corrosion resistance, a post-weld solution anneal heat treatment was needed to restore properties. CD4MCu was particularly troublesome due to cracking tendencies, resulting from a microstructure imbalance that could exceed 70% ferrite in welds, and heavy casting sections.

Significant refinements occurred in the following decades, which improved the welding, ductility, and corrosion resistance through the use of nitrogen. The introduction of the argon-oxygen-decarburization (AOD) steel melting technology, which began in the early 1970's, permitted precise and economical control of nitrogen. The effect of the AOD and related processes opened up new ranges of alloy compositions to commercial development. The distinction between first, and second-generation duplex stainless steel, focuses on the use of nitrogen as a deliberate alloy addition.



Effect of nitrogen addition on the pseudo-binary diagram at constant iron section (68 wt% Fe) of the Fe-Cr-Ni ternary system.

Material Matters



Typical CD-4M Cu alloy. Solution annealed at 2000°F.

Composition And Microstructure

Duplex stainless steels (DSS) are dual-phase alloys based on the iron-chromium-nickel system. The structure is achieved by proper control of the composition and thermal processing. DSS solidify primarily as ferrite with the austenite forming as a secondary phase upon cooling. Solidification and processing temperatures affect the transformations, which affect the amount of ferrite formed during cooling or heating.

DSS contain elements that promote the formation of ferrite (e.g. Cr, Si, Mo, W); and those that promote the formation of austenite (e.g. Ni, Mn, Cu, C, N). It is composition balancing that determines the final microstructure and properties.

Selecting the proper ferrite level depends upon the application and service requirements. The steel industry generally accepts a range of 40-60% ferrite in DSS, although the ASTM A890 cast duplex stainless steel standard specification recognizes a range of 30-60%. Ferrite levels below 30% decrease the strength and increase the risk of stress corrosion cracking; while levels greater than 60% reduce corrosion resistance, toughness, and increase the risk of cracking. A minimum of 55% austenite is suggested to maintain toughness and localized corrosion resistance. Yet a level of 55% ferrite is also recommended for strength, resistance to corrosion fatigue, and chloride stress corrosion cracking resistance. Adjusting the composition to provide for an optimum ferrite level of about 45-50% is widely recommended.

Nitrogen Enhancement

The addition of nitrogen (a strong austenitizer), allows the chromium and molybdenum levels (strong ferritizer) to be increased. This has led to more highly alloyed "second-generation" DSS

in use today. Although nitrogen was first utilized to replace the more expensive nickel as an austenite former, it was discovered that it offered additional benefits such as improved weldability, increased strength, toughness, and better corrosion resistance. Nitrogen also causes austenite to form from the ferrite at higher temperatures, which increases the austenite volume, and greatly reduces cracking.

As stated previously, the AOD technology permitted the precise and economical control of nitrogen, which allowed for composition optimization. Nitrogen greatly reduces the chromium partitioning between the two phases, and enhances the localized corrosion resistance. Preferential partitioning of elements between the ferrite and austenite occurs, leading to increased Cr, Mo, and Si levels in the ferrite phase. This increases corrosion resistance of the ferrite, but also increases susceptibility to alpha-prime, and sigma-phase embrittlement. Partitioning also lowers the corrosion resistance of the leaner austenite phase, unless the alloy is nitrogen enriched. Nickel and nitrogen partition mainly into the austenite, improving its corrosion resistance. Nitrogen along with nickel also reduces the tendency towards sensitization, suppressing the formation of sigma phase, and other brittle precipitates. When considering corrosion performance, the effect of alloy partitioning (between phases) and nitrogen enhancement is very important.

Advantages & Disadvantages

DSS offers several advantages over conventional austenitic stainless steels. The combined mixture of ferrite and austenite provides unique properties, which makes the duplex alloys excellent choices to solve many problems. They are more resistant to sensitization and intergranular corrosion; chloride stress corrosion cracking; exhibit better localized and general corrosion resistance in many environments; and have yield strengths that are two-to-three times stronger.

Since ferrite and nitrogen increase the yield strength, the threshold stress required to produce stress cracking is higher. Improved fatigue strength, erosion resistance, and cavitation resistance are also offered due to greater strength and hardness. Pump and valve manufacturers have taken advantage of this strength benefit to allow for higher operating

pressures, while offering cost effective designs that can reduce weight by utilizing DSS of thinner wall thickness.

Although DSS provide good mechanical properties and corrosion resistance, their use has some restrictions. Even with their advantages, DSS are more likely to form harmful compounds due to improper processing, than the austenitic stainless steels. The high alloy content makes them susceptible to embrittlement when exposed to high temperatures. For this reason a maximum operating temperature is usually placed on the duplex alloys, which is seldom considered for applications over 575°F (300°C), due to alpha-prime precipitation within the ferrite. This results in embrittlement and reduces impact toughness. The severity increases with chromium content and other ferrite forming elements. Since the maximum rate of embrittlement occurs around 885°F (475°C), it has become known as 885°F embrittlement.

The higher chromium and molybdenum content in DSS increases sensitivity to sigma-phase, which reduces ductility, impact toughness, and corrosion resistance. The high chromium content of the sigma phase leaves the surrounding matrix depleted of chromium, reducing the corrosion performance. The probability of sigma becomes important during solidification of heavy cast sections, prone to sigma formation when slow cooling. Proper solution anneal treatment, followed by a water quench will generally eliminate sigma and reverse its adverse effects.

Applications

Duplex stainless steels have found widespread application in recent years owing to their competitive combination of properties, corrosion resistance, and economics. Cost efficiency is one of the main reasons for selecting DSS. Reduced nickel (an expensive alloying element) and higher mechanical properties (reduce design thickness and weight savings), improve cost ratios. The corrosion resistance, increased strength, and erosion resistance make these alloys very attractive when considering life cycle cost.

The duplex alloys are produced in both cast and wrought forms in a number of chemical

Tech Talk

Duplex Stainless Steel

continued from page 5

compositions of varying alloy contents. In recent years DSS have become increasingly popular for seawater service, pulp & paper, and other process industries because of their corrosion and erosion advantages. They are commonly used in aqueous, acidic or chloride-containing services as replacements for austenitic stainless steels that have suffered either from chloride stress corrosion cracking, localized pitting or crevice corrosion, or when greater erosion resistance and strength are needed.

In many environments, duplex alloys show excellent resistance to general and localized corrosion. In this regard, they often rival the performance offered by more expensive high-alloyed austenitic stainless and nickel alloys. The slowness to adopt the DSS has been due to inherent conservatism within the engineering community, fear of prior generation welding issues, and the lack of specific performance details. While much of this is changing, the challenge for application engineers is to know when to make informed cost-effective use of the duplex stainless steels.

Concluding Comments

While I hope this has helped dispel much of the mystery and confusion associated with these materials, there are many other related topics that could be discussed in a general overview, but due to time restraints, must be omitted. Much more could be said about duplex stainless steel (DSS), and each grade could be discussed in detail with specific services in mind. However, this can not be accomplished here. Those who have specific applications in mind should contact their nearest application engineer to discuss the possibility of a duplex stainless solution to their service problem.

For those interested in learning more about duplex stainless steels there are many excellent publications and handbooks on the subject available from ASM, NACE, and numerous stainless steel producers or associations. Many technical papers and conference proceedings have been published over the past 30 years, which are generally available from these organizations, and others. ■

Initial Considerations of Medium Consistency Stock Pump System Design in the Pulp & Paper Industry

Mike Day

Senior Product Specialist, ITT Industries

Paper stock pulp in the consistency range of 8 to 16% is referred to as medium consistency pulp. Pulp fibers become a strong interlocked network and create high friction between the fiber and pipe wall. The fluid characteristics of

pulp are clearly non-Newtonian. Traditional methods to pump pulp in the 8 – 16% consistency ranges began with positive displacement pumps and were extended to centrifugal pumps over the past twenty years.

The non-Newtonian fluid characteristics both within the pump and with respect to friction loss characteristics in the pipe system along with air content of the pulp present specific challenges for either positive displacement or centrifugal pumps in order to operate satisfactorily. This will explore some of the aspects involved with medium consistency centrifugal pump systems. Perhaps the first question to address is - Why a medium consistency centrifugal pump versus a positive displacement unit?

Some of the advantages offered by centrifugal pumps over positive displacement pumps are:

- Lower installation cost
- Lower maintenance cost and significant ease of maintenance when required
- Removal of air from pulp which can be detrimental in further unit operations such as chemical mixing in bleach plants
- Hydraulic capability to develop higher pressure required for O2 Delignification systems, EOP (pressurized peroxide) stages, and delivery of pulp to HD storage towers.

For effective centrifugal pumping of pulp suspensions in the 8 to 16% range there are three key areas to success. They are:

- Delivery system to the pump
- Air removal
- Simple control scheme

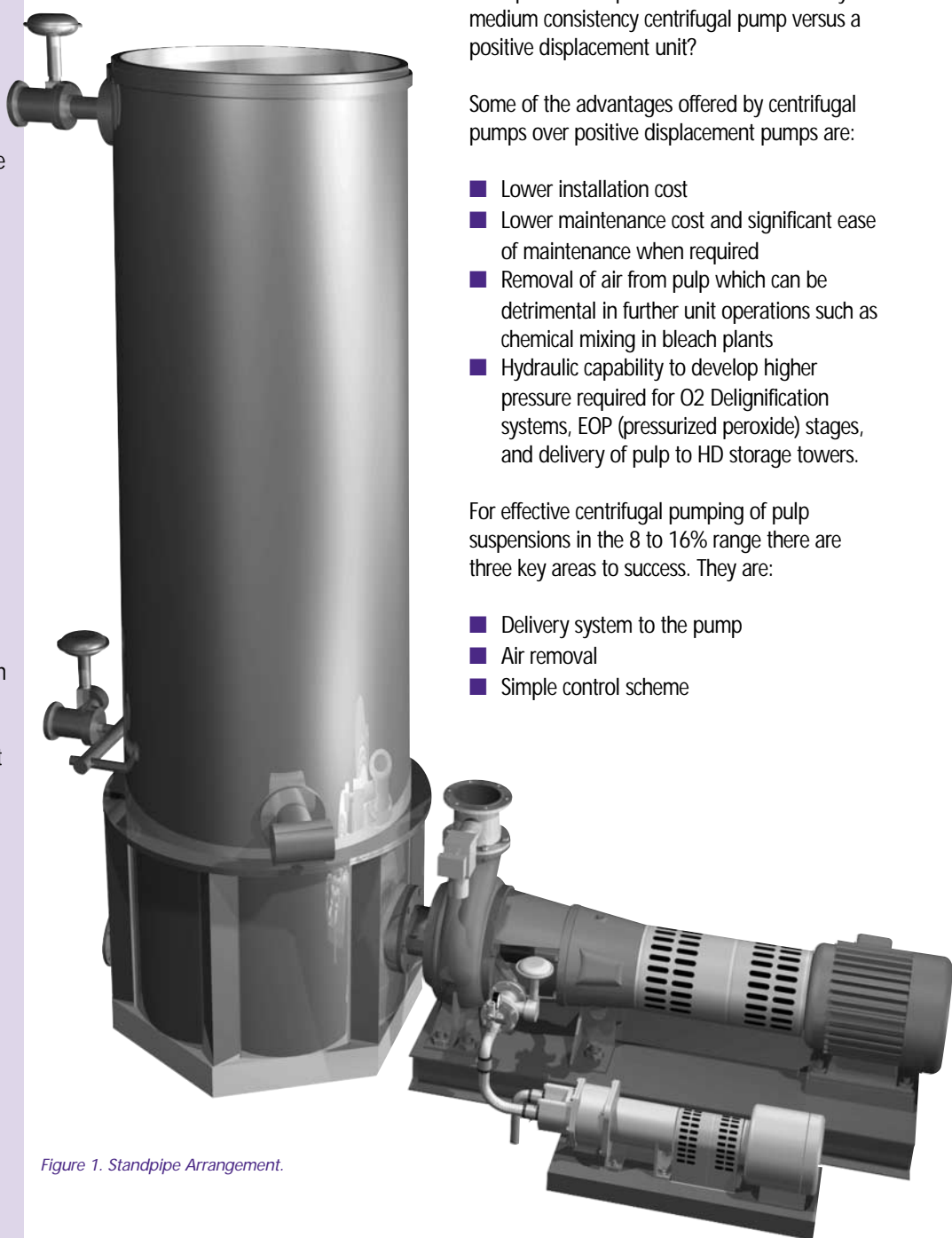


Figure 1. Standpipe Arrangement.

Tech Talk

Let's explore each of these areas in more detail.

Delivery System to the Pump

Figure 1 represents the most common configuration of medium consistency pump installation. The standpipe arrangement receives pulp from the stock source and provides a self-contained entity to accomplish delivery of pulp to the pump and the means to control the unit.

Common sources of stock to the medium consistency pump can be a vacuum or pressure washer or disk filter. The feed to these devices will have an impact on the end consistency coming from the washer or filter. If the feed consistency fluctuates, so will the consistency at the discharge of the washer or filter. In many cases this will not be a serious issue but when mixing chemicals downstream of the medium consistency pump this can cause variations in bleaching levels or mixing effectiveness. This may often result in additional chemical usage. A variation of this situation is the discharge of pulp from a diffusion washer that causes a surge of pulp after each downstroke of the diffusion washer.

Often limitations of the repulper or device which breaks up the pulp mat coming off the washer will impose limitations on the maximum consistency of pulp which can be delivered to the pump. These limitations might be the HP sizing of the repulper screw or discharge design of the repulper to the medium consistency pump standpipe.

Production rate changes translate into flow rate changes for the medium consistency pump. The table below illustrates the pump flow rate as a function of production rate with pulp consistency held constant.

The relationship of flow rate to production rate is:

$$Q = P \times 15/C$$

Where Q = flow rate [GPM]
P = production rate [air dry short tons/day, adstpd]
C = pulp consistency [%]

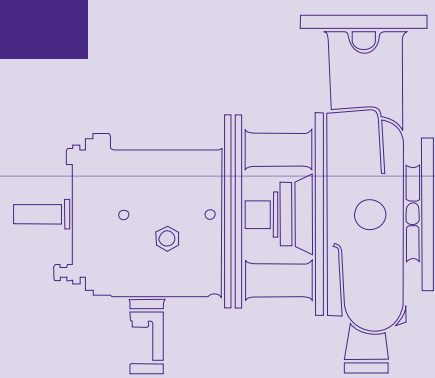
Flow Rate at Different Production Rates

Production Rate, P, adstpd	% C	Q, GPM
1000	12	1250
750	12	938
500	12	625

A last important aspect of the pump suction system relates to the pulp temperature. Operation up to 170°F can be readily accomplished in a normal 14' tall standpipe. This will allow from 3' to 5' suction head of pulp above the pump centerline. If the pulp temperature will be above 170°F, then the suction level above the pump must be increased to prevent flashing to vapor at the pump inducer or in the degas system. This increase in pulp operating level must be accompanied by a corresponding increase in standpipe height. On occasion this can be a problem such as when a steam peg mixer is installed between the washer and the pump and height becomes a potential restriction. For long term reliable operating performance this aspect cannot be compromised.

Degas or Air Removal System

This aspect of the pump system design is vital to successful operation of the pump. Figure 2 illustrates the ITT-Goulds Model 3500 degas design. The objective is to achieve simple and effective air removal to maintain efficient pumping action. The internal components of the pump are configured to collect the air contained in the pulp along the shaft then remove it through the degas system. As many have experienced, the presence of even small amounts of air can reduce the effective performance of a conventional centrifugal



pump. With medium consistency pulp suspensions between 8 and 16%, one will encounter air content at least equal to the pulp consistency and often higher. Without air removal the pump operating control design will falter and flow rate reduction – or production rate tonnage from the operation viewpoint - will occur.

The air removal must be effective over a wide range of flow rates (production rates) and consistencies. Operation at consistencies above 9% normally requires a vacuum assist. For this to properly occur requires the functional integration of the design of the casing volute configuration, impeller and air removal holes, centrifuge and the inducer.

Control Scheme

Figure 3 illustrates the control scheme normally used for a standpipe configured medium consistency pump. The importance aspect of the control scheme is the effective response to system changes. The scheme should allow pumping at the highest possible consistency. The system should be automatic and not require manual control or monitoring to make adjustments.

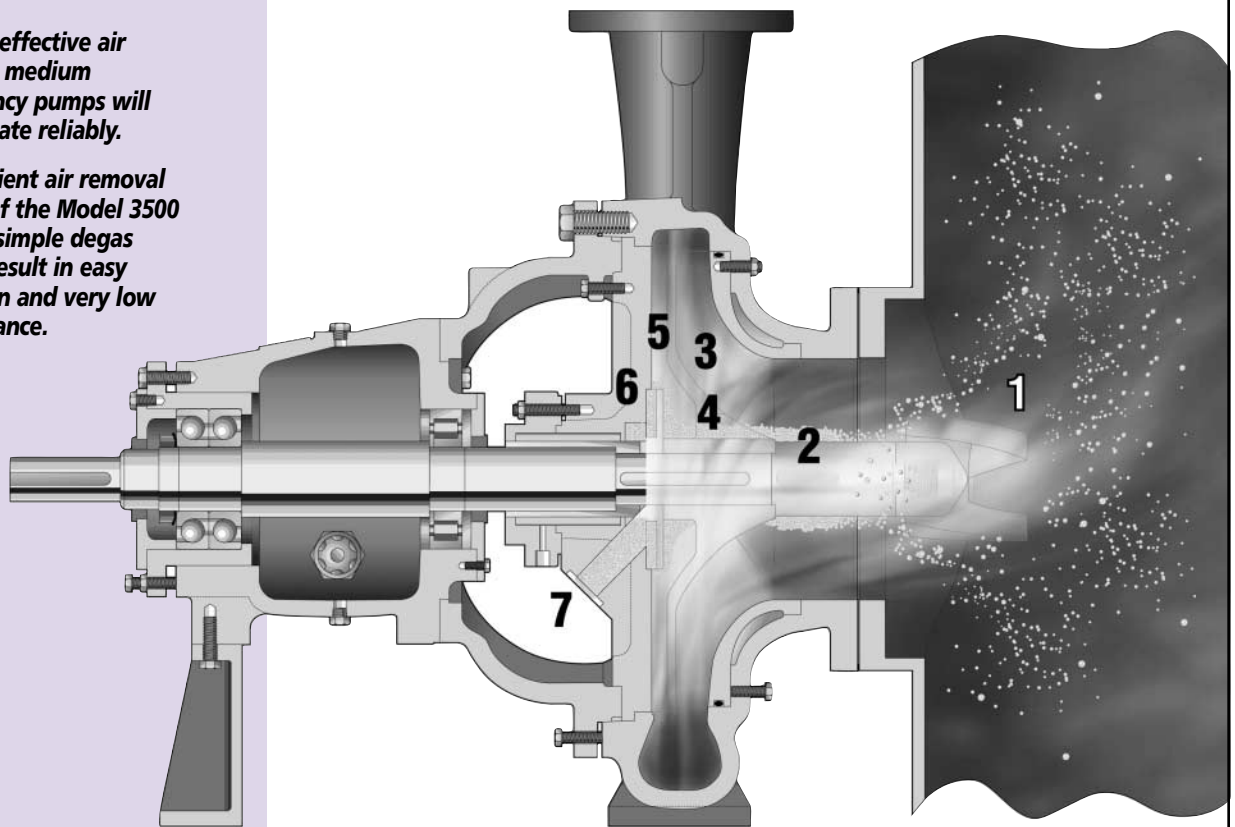
The level control scheme is most common for standpipe design units. The unit operates to a set point level. Should the level deviate beyond the deadband range of the set point, control valve modulation will attempt to control to the set point. If the level change continues, then dilution valves open and the consistency is reduced. This allows the pump to regain control and return to the level set point. As the level returns to the set point, the dilution is reduced until it once again it is off and the unit is controlled to the set point.

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Tech Talk

Without effective air removal, medium consistency pumps will not operate reliably.

The efficient air removal system of the Model 3500 and the simple degas system result in easy operation and very low maintenance.



1 Induce Flow, Begin Air Separation

Inducer agitates pulp to assist flow into pump inlet. Also inducer action begins to separate air from fiber and water.

2 Centrifuge forms air core along shaft

Centrifuge performs key function of separating air from fiber and water. Fiber and water move to the periphery of the centrifuge, then are picked up by the impeller vanes. The air becomes concentrated in a core along the shaft for removal through the balance holes by the degas system.

3 Fiber and water are pumped by impeller vanes

Fiber and water suspension are subjected to pumping action by impeller vanes. Modified concentric casing design allows for operation over wide flow range.

4 Vacuum pulls air with some water & fiber through balance holes

Air and water, plus a small amount of residual fiber, pass through impeller balance holes.

5 Fiber and water pumped to impeller periphery

The large pump out vanes pump the fiber and water to the periphery of the impeller.

6 Air with water is extracted past secondary air separation device

Air with water is extracted across the top surface of the patented (US Patent#5,087,171) secondary air removal device into the vacuum system. This device permits separation of any remaining fiber which might be present at this point. Fiber pull through the vacuum system is virtually eliminated.

7 Air and water are removed through vacuum system

The air and water pulled by the vacuum system is discharged to drain. At high suction standpipe levels and low consistencies, the pump may operate in the self-venting mode without vacuum assist.

Figure 2. Model 3500 Air Removal System.

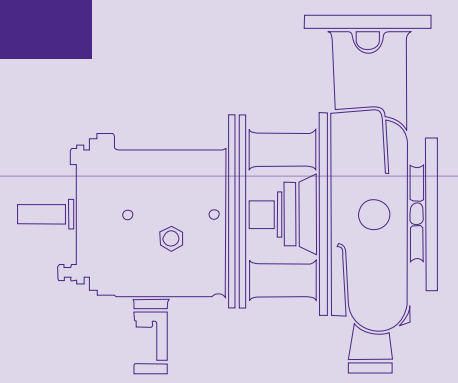
Tech Talk

Initial Considerations of Medium Consistency Stock Pump System Design...

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Let's review with an example. A common situation that can arise would involve an increase in consistency from the washer. Assume a unit is designed to handle 12% consistency pulp. If the consistency increases quickly to 14%, the system TDH would begin to increase dramatically. This is because consistency has, by far, the greatest impact on friction in the system. As the level moves rapidly outside the deadband (usually +/- 10%), the pump moves back on its curve to develop sufficient TDH to deliver pulp through the system. Modulation of the valve when the

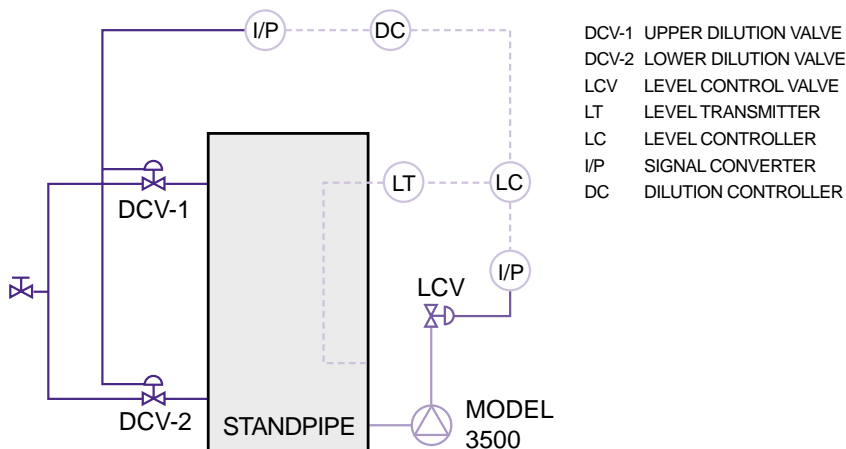
production rate is near its design will not allow the unit to regain control. Sequencing of dilution valves in the standpipe begins dilution of the pulp to reduce system friction and allow the pump to increase the flow rate. As the flow rate through the pump increases, the level begins to reduce and the unit returns to its set point. As the consistency of the pulp being delivered to the pump returns to its design range, the system returns to control and dilution is stopped.



This occurs automatically. With operator awareness, but without the need for manual control by the operator.

There are numerous other considerations in the proper design and application of medium consistency pumping systems. They include how the pump TDH is determined and key aspects of control valve sizing which are topics for discussion in future articles. ■

Standpipe Level/Dilution System



- Constant standpipe level maintained by LC controlling LCV on pump discharge.
- **Alarms** set at 85% and 10% level.
- Start up **Interlock** at minimum of 10% level to prevent dry running of pump.
- Automatic dilution system to assist pumping when standpipe level exceeds its setpoint.

Figure 3.

Tech Talk

Industrial Pump Group Standardizes on Pro/Engineer

Doug Paddock

Manager, Product Engineering

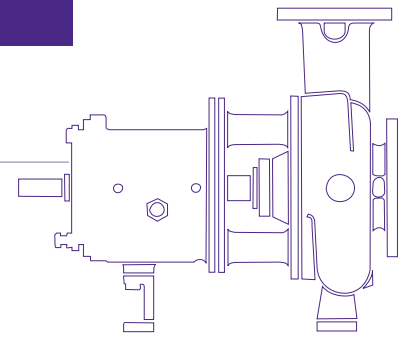
Parametric Technology Corporation's (PTC) Pro/Engineer (Pro/E) will become IPG's standard design tool for existing and future products. Currently, different CADD (Computer Aided Design and Drafting) systems are used in different locations. Individual operations chose the software conducive to their needs at the time and have been creating databases since then. Of course, different software packages are unable to directly read each other's files. Although conversion programs exist to overcome this problem, often something gets lost in the translation. By standardizing on Pro Engineer throughout IPG all organizations will ultimately be able to communicate data directly with one another.

Pro/E uses 3-D electronic models as an operating platform. In other words, all individual parts exist electronically in three dimensions, rather than the current two-

dimensional drawing format. Drawings will still be created to transmit dimensional information, but will be driven by the model.

Once integrated into the organization, it will be possible to take an impeller design from one Operation, a casing design from another and a rotating assembly from still another, and electronically integrate them into a complete pump within hours or days, rather than weeks or months. Not only can the parts be assembled together, but the assembly can be checked for interference that wouldn't normally be discovered with the current tools until patterns are made and parts machined.

Pro/E's selection as the standard CADD package came after extensive evaluation by ITT. Its selection was based on the ability to use one common database for multiple purposes and the large quantity of analysis tools available. Packages included in the current toolbox include:



- Pro/Manufacture – Creates programs for machining of individual parts. Turning, milling and drilling tool paths can be viewed prior to actually placing a part on the machine. Potential tooling "crashes" into fixtures, bosses, etc. can be prevented.
- Pro/Mechanica – Allows FEA (Finite Element Analysis) of parts/assemblies requiring more definitive results than can be obtained with conventional calculations. Examples include stress and deflection/displacement analysis, temperature gradients, natural frequency determination, etc. It has already been valuable in evaluating alternative design modifications for field trouble jobs.
- Pro/Piping – Used for routing piping for auxiliary flush, lubrication and cooling water plans.
- Pro/Surface – Connects points and lines to create a surface. Useful for viewing a complete shape.

Additional software from sources other than PTC exist and can be utilized to analyze cooling of castings to minimize internal defects, predict flow of liquid through passages such as volutes and impellers to optimize performance and calculate tolerance stack-ups to prevent overly restrictive dimensions.

As a result of the ability to analyze in detail at the design stage, and to evaluate the producibility of the product prior to manufacture, customers will be assured of receiving products that assemble properly, operate optimally, and will receive them in a shorter lead time.

To take advantage of these capabilities in our existing products a major project currently under way is conversion of selected model lines' drawing information into 3-D Pro/E models. The project is expected to take until at least mid-2001. Because conversion of all the "legacy data" is estimated to require 60 person years of work, selected model lines covering the majority of our product shipments were selected. All new product lines will be created in Pro/E from the beginning.

Future articles will cover some "success stories" in more detail. ■



Service Solutions

Time to Perform

Randy Milton

VPO Applications Manager

On a recent Wednesday morning, our Vertical Pump Operation (VPO) located in City of Industry, California, received an e-mailed inquiry from our Chicago Area Salesman. His customer was looking for nine large Cooling Water pumps for a combined flow of 560,000 gpm, complete with motors for an on-site, in eleven weeks. The quote was due the next morning for a 10:00 a.m. meeting with the customer in Chicago.

After determining that the project was viable, VPO Application Engineers went to work on the easy part, the pump quotation. A selection was made based on offering nine units. The pump pricing was completed early that afternoon and rfq's went out to the motor suppliers. It was quickly determined that VPO would have to focus on one motor vendor to meet the lead-time. During the course of the afternoon, several meetings were held regarding the customer requirements. The first was the "Pre-Bid Review" meeting which VPO holds on all large quotations. The customer had advised through our salesman that an order would be placed no later than the coming Monday. The "normal" lead-time for the size and quantity of the required pumps was 24 weeks. It was obvious that the most critical issue regarding this quotation was meeting the customer required on-site date. A final meeting was held that afternoon and by 4:04 p.m. the completed VPO quotation including the motor pricing was e-mailed back to our salesman. VPO had committed to the pumps and motors being on-site in eleven weeks.

The next day, VPO received a phone call from our salesma. The customer now needed two of the pumps and motors on-site two weeks

earlier. A quick meeting was held. We reviewed casting, pipe & plate, shafting and motor requirements with our suppliers all of whom gave us the green light.

Friday morning, we received another phone call. Now the customer needed to have a total of sixteen complete pumps and motors on-site in the shortened eleven week leadtime. Again we contacted all the key suppliers. The result of several discussions was the same. We committed to all sixteen pumps being delivered in eleven weeks.

VPO received the order and the customer received the pumps. . . on time.

Three days of hectic activity, from inquiry to order acceptance, resulted in a satisfied customer and a nice sale. This could not have been accomplished without the total commitment of our Sales, Engineering, Purchasing and Production Departments. Everyone worked together to insure our customer's needs were met. When it's time to perform, VPO performs on-time. ■



VIT-FF design with
900 hp motors
running at 505 rpm.

Service Solutions

Solving Problem Extends Pump Service Life

Leonard Cadena, P.E.

Manager Project Engineering, PRO Services

PRO Project Engineers work with customers and our PRO Service Centers to solve our customers' pumping problems by analyzing pumping systems and providing turnkey solutions that make commercial sense.

Problem: A gulf coast refinery was experiencing excessive maintenance costs on a backup barrel charge pump (diffuser type). The pump is a 3x11 CB 12 Stage, Hydrocarbon Service, C-6 Metallurgy, 3560 RPM, 591 GPM, 5447 TDH, .8 Sp. Gr., 20' NPSHr, 23' NPSHa, 550-600 Deg. F, 1000 HP Motor Drive. The pump runs only short periods of time each year. Due to repeated patches and the inherent design of the original pump, the working tolerances and its reliability had exceeded all reasonable levels. The pump was the top priority of the facility for review and upgrade.

Due Diligence: To properly analyze this and all pumping systems, we first reviewed the current requirements of the pumping system to better direct our efforts.

Was The Pump sized correctly?

The pump was still sized correctly, as the system requirements had not changed dramatically enough, with regards to NPSHr, GPM, TDH and HP, from the original design requirements.

What mechanical and metallurgical issues need to be addressed?

As can be seen in the cutaway of the pump (Fig. 1), the rotor is a multi-stage design with impellers back to face through the length of the rotor. This requires a unique balance device with very defined dimensions. Without proper sizing the pump will thrust excessively. Thrust bearing failure could result in severe damage to rotor and diffusers. In this case the balance drum diameter had been modified over the years, which was adding to but not the main cause of the reliability issues.

After a complete inspection of the pump in our PRO Service Center, several areas of a mechanical and metallurgical concern were discovered. The pump was originally designed with a rotor that utilized shrink fit impellers with locating split rings on the shaft, which meets current design. The diffusers and barrel registers, however, were not within current design standards. The diffusers were fitted with a loose slip fit to each other, which allowed for a stack up sag (run out) in the diffuser assembly as shown in Fig. 2. This sag can easily allow wear parts to rub excessively while in operation. Current API running clearances are typically more liberal than the original design of these pumps. The registers of the barrel to covers were also found to be excessively loose due to years of use. The metallurgy for the wear parts in this pump were all standard heat treated 410 SS. Even with the recommended 10 Rc variance in the stationary and rotating parts, the short life of the parts merited a close look at a better selection for the working surfaces.

Solution: We proposed a complete weld up and re-machine of all registers between the diffusers. This would provide a tight fit, a more rigid bundle, and no stack up sag. The registers of the barrel to its covers were welded and re-machined to allow for a low clearance register fit. These register corrections allowed for a very tight pump assembly with little stack up sag. The wear parts were all replaced with new wear parts over-laid with Colmanoy #5 and #6 to give a harder, less galling surface, still with the required hardness differential. The pump has run successfully for several years now without any pump downtime. It was clearly viewed as a successful upgrade by the owners.

For more information on this upgrade or to explore an upgrade opportunity on another pump please contact your local PRO Service Center or Service Sales Engineer. ■

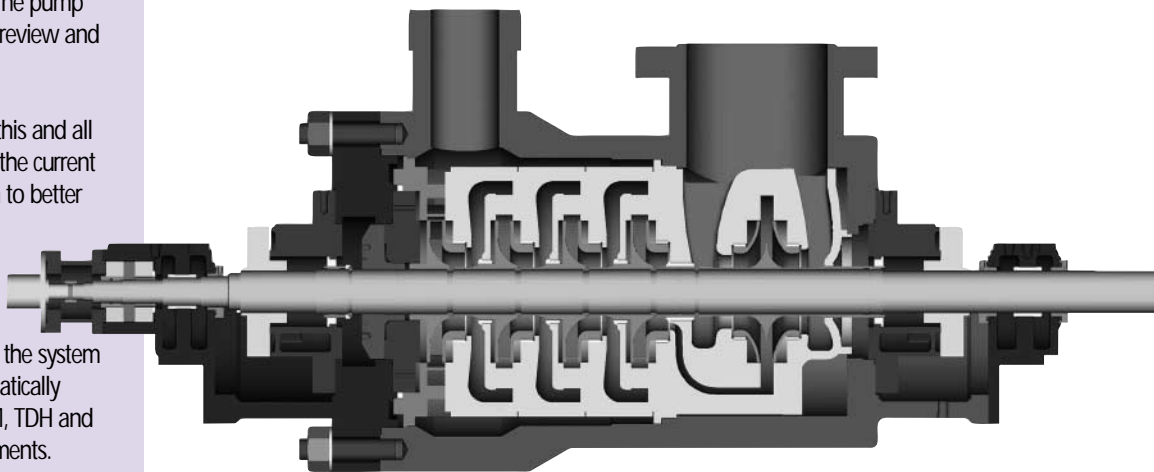


Figure 1.



Figure 2.

Send your comments or suggestions to:

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View the latest in pumping technology at: www.gouldspumps.com