

## 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

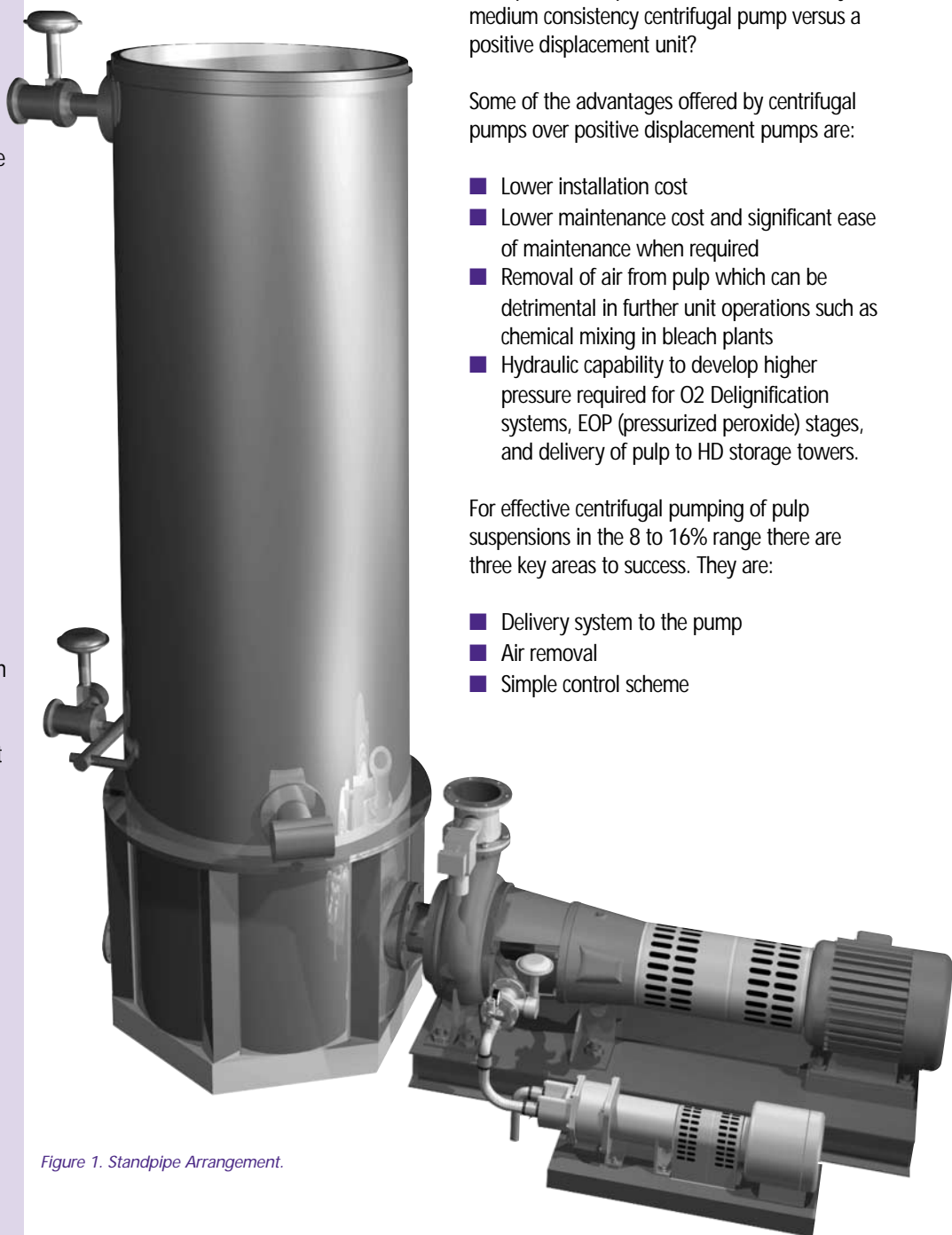


Figure 1. Standpipe Arrangement.

## 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 [%]

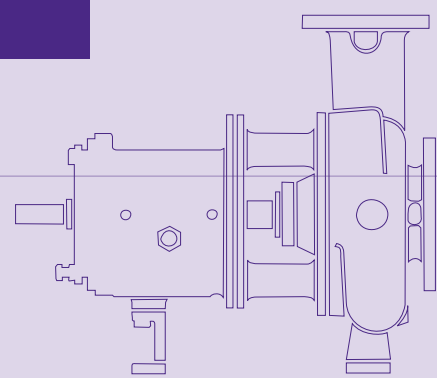
### Flow Rate at Different Production Rates

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.

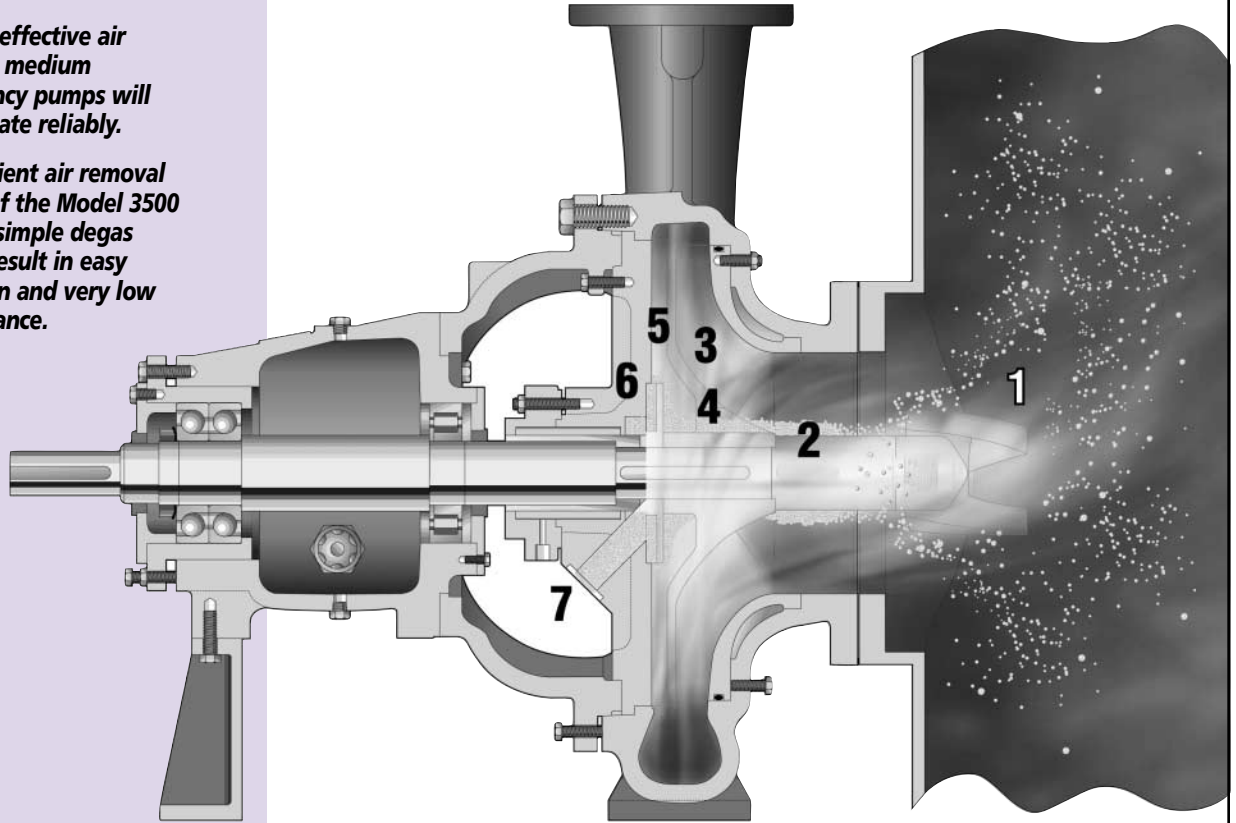
The level control scheme is most common for standpipe design units. The unit operates to a set point level. Should the level deviate beyond the deadband range of the set point, control valve modulation will attempt to control to the set point. If the level change continues, then dilution valves open 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.

*continued on page 8*

## 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.

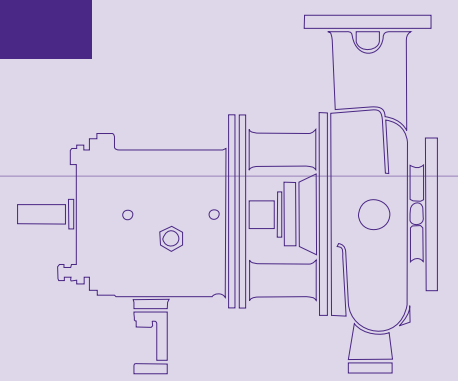
## Tech Talk

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

continued from page 7

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

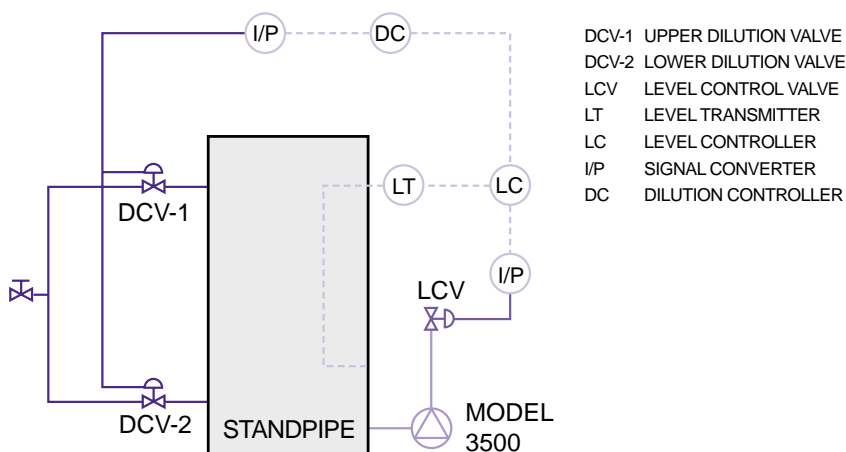
production rate is near its design will not allow the unit to regain control. Sequencing of dilution valves in the standpipe begins dilution of the pulp to reduce system friction and allow the pump to increase the flow rate. As the flow rate through the pump increases, the level begins to reduce and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