

New Technology

Extending Pump Life... The Cyclone Seal Chamber

Stan Knecht
Product Manager
Goulds Pumps/ITT Industries

Every Day on the Serengeti Plain the "King of the Wild," a lion, awakes knowing that if he is not the fastest, strongest and smartest hunter on this day, he will go hungry!

The lesson learned from this simple example is that even Market Leaders must seek to be better every single day. Goulds Pumps is a leader in the design and development of seal chambers which provide the optimum sealing environment for extended mechanical seal reliability. Recent developments include the patented TaperBore™ Plus which has been proven in thousands of installations to extend the life of mechanical seals on tough sealing applications containing solids, vapors or paper stock.

Even with the success of the TaperBore, ITT's engineers asked the question, "Can we do better?"

One of the benefits of the merger of Goulds Pumps to ITT Industries is synergy opportunities for exchange of technology. Leveraging this situation, discussions within the Fluid Technology Group revealed that recent development work had been completed on a patented, alternative seal chamber design for submersible pumps, which also had been shown to extend mechanical seal life. Like the TaperBore™ Plus, this design utilizes a conical shaped, tapered bore seal chamber design. However, at the heart of this design are two casted helical grooves



Figure 1 – Cyclone Seal Chamber, Patented by ITT Industries.

in the tapered walls of the seal chamber which serve to modify the flow pattern within the seal chamber to keep solids out of the seal environment. Additionally this design also offers improved ease of manufacture such that it can be manufactured in iron constructions.

Principle of Operation - How Does This Work?

Development research testing conducted by ITT Industries has shown that the flow pattern of solids within an un-enhanced conical/tapered bore seal chamber is such that:

Liquid containing solid particles will travel radially inward along the face of the seal chamber due to the differential pressure found at the OD of the impeller versus that near the shaft.

Solids are then shown to travel along the tapered walls until contacting the back wall of the seal chamber.

At the back wall of the seal chamber, momentum will tend to deflect the solids towards the shaft, yet centrifugal forces causes the solids to be shot back radially against the taper walls of the seal chamber. This action tends to capture and concentrate solids near the mechanical seal components resulting in accelerated erosion of the seal chamber and/or failure of the seal.

The Cyclone Seal Chamber has been proven to be the solution to eliminate this problem. In operation, the function of this design is as follows:

The casted helical grooves act as barriers, collecting inbound solid particles as they travel along the angled walls of the seal

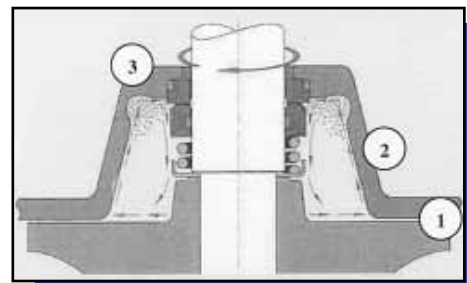


Figure 2 – Typical Flow Pattern of Solid Particles In an un-enhanced conical/tapered bore seal chamber.

chamber. Once caught in the grooves, the rotational velocity of the liquid within the seal chamber acts to rotate these solids along the helical path of the grooves until they are transported out of the seal chamber environment. The result is the maintenance of a seal chamber environment free of solids, preventing both seal chamber erosion and clogging/wear of the mechanical seal hardware.

Qualification Testing

A series of tests were conducted to evaluate the performance of the Cyclone Seal Chamber and it's potential for applications in process pumps. These tests were designed to evaluate the ability of this seal chamber design to maintain the optimum sealing environment in the presence of both vapor and solids, without the use of an auxiliary seal flush, in a process pump application.

Vapor Handling

Testing performed on a pump mounted in a vertical arrangement showed that the Cyclone Seal Chamber design does prevent vapors from collecting in the seal chamber for liquids containing up to 10% entrained gas. This is an important feature, as air vapors will compromise lubrication of the mechanical seal faces, which can result in premature seal failures.

Solids Handling

Similarly, a pump fitted with an aluminum Cyclone Seal Chamber was tested on solid laden liquids (diatomaceous earth), up to 10% by weight, at 3550 RPM. (Aluminum was

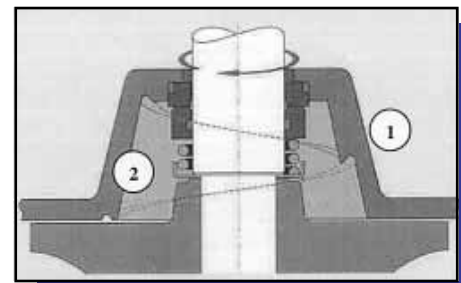


Figure 3 – Solids Transported Out of Seal Chamber Environment along Helical Groove in Cyclone Seal Chamber.

selected to accelerate wear and reduce the length of testing). After 80 hours of operation the impeller face of the seal chamber exhibited significant erosion, yet the seal chamber and the mechanical seal itself (John Crane Type 8-1T, SiC vs SiC), showed little or no signs of wear while continuing to operating perfectly.

Test Conclusions

Based on these tests results it was shown that the performance of the Cyclone Seal Chamber was similar to the TaperBore™ Plus in it's ability to maintain the optimum seal environment in the presence of either solids or vapors.

Customer Benefits

Mechanical seals failures are acknowledged as the number one cause of pump downtime. Most seal failures are typically not the result of a bad seal design, but the result of a poor sealing environment, one which lacks proper lubrication, cooling, and is free of solids.

The patented Cyclone Seal Chamber is the solution, increasing circulation and

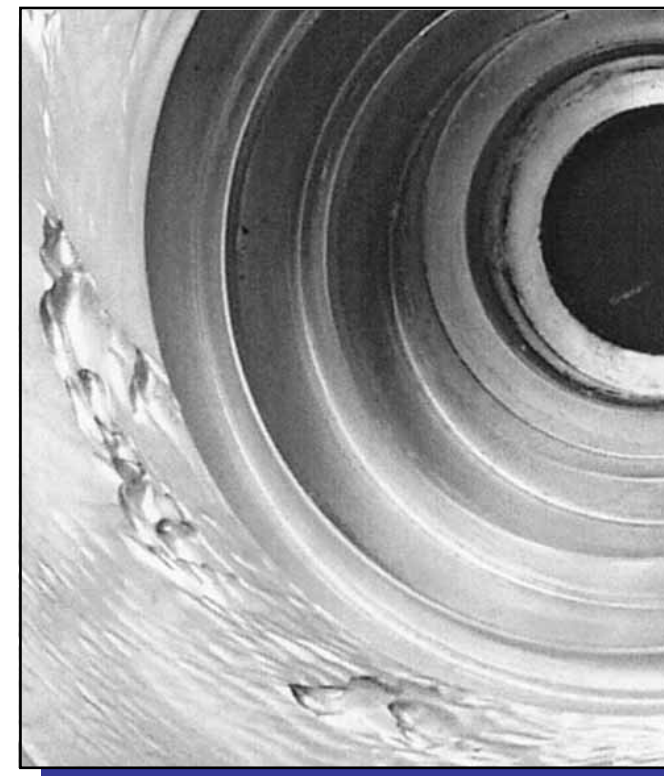


Figure 4 – Results after 80 hours, Significant wear on Impeller face, No Wear in Grooves or Seal Area. (Testing performed on Aluminium Cyclone Seal Chamber at 3550 rpm.)

volume of liquid near the seal faces, improving lubrication and cooling. The helical grooves act to maintain an environment which is free of solids.

The Cyclone Seal Chamber is also the optimum choice for most applications with less than 10% solids and will not require an auxiliary flush for the mechanical seal. The benefits of "flushless" operation are as follows:

- Reduced Operating Cost by eliminating the need to supply flush water.
- Operator Friendly - Eliminates Seal Failures at Start-up resulting from failure to open flush water valves.
- Product Contamination/Dilution by flush water is eliminated.
- Reduced Environmental Liability, as flush water will no longer need to be collected and treated.
- Reduced Installation Costs as auxiliary piping and connections to Flush Water System are eliminated.

- Simplifies Maintenance Activities due to increased accessibility to seal area and minimizes the number of secondary connection which need to be isolated prior to working on the pump.

The bottomline benefit is increased profits through increased seal and pump reliability and reduced expenses.

In the next issue of *Pumplines*, we will discuss specific applications for the Cyclone Seal Chamber in Process Pumps. ■

Material Matters

Ferrite in Cast Austenitic Stainless Steels

Stephen J. Morrow
Global Manager of Materials Technology
Goulds Pumps/ITT Industries

The topic of delta-ferrite, in cast austenitic stainless steels is extremely complex. The various and specific services in which these alloys are utilized require control of delta-ferrite for acceptable performance. The volume fraction of delta-ferrite present in these cast stainless alloys is related to the chemical composition balance and thermal processing history. The microstructures of cast austenitic stainless steels, are generally composed of islands of discontinuous ferrite pools in the austenitic matrix. This two-phase microstructure is in contrast to the single-phase microstructure characteristic of the wrought, fully austenitic stainless steels. In cast austenitic stainless steels, delta-ferrite can be both beneficial and detrimental.

Although the presence of some delta-ferrite in austenitic stainless steels provides some benefits, including reduction in some types of casting defects (e.g. shrinkage and hot tears); excessive ferrite levels may result in an overall reduction in corrosion resistance by selective dissolution in certain environments. Users are cautioned to bear this in mind when specifying cast austenitic stainless alloys. If the volume percentage of delta-ferrite is greater than 15% in the CF grades, or 18% in the CG grades, continuous delta-ferrite networks or stringers may form.

Cast stainless steels differ from their wrought counterparts in that they may contain ferrite contents more than 25% in the CF type alloys and up to 35% in the CG type alloys, which are well above the optimum maximums to prevent continuous ferrite networks, corrosion and cracking problems. Such high ferrite contents have resulted in "sweating" or "weeping" of pumpage through castings, corrosion, and cracking type failures in service. A high delta-ferrite content, resulting from an imbalance of ferrite-to-austenite stabilizers, fosters the formation of continuous ferrite stringers or

Ferrite in Cast Austenitic Stainless Steels con'd

a ferrite network, providing a continuous path for corrosion, and produces an effect similar to intergranular corrosion (IGC) and stress-corrosion-cracking (SCC) grain boundary attack.

In high alloy Chromium-Nickel austenitic stainless steels, Molybdenum is often added to improve localized corrosion (i.e. pitting and crevice) resistance in chloride media. Note that the composition ranges for cast alloys are not identical to their nearest wrought counterparts: casting specifications generally allow for a greater percentage of Chromium and Silicon, two ferrite promoting elements, and lower percentages of Nickel and Manganese, two austenite stabilizers. The variations in chemistry provide for optimum fluidity, formability, and castability for the wrought and cast alloys, respectively.

In certain environments premature failure of stainless castings have been attributed to a high ferrite content. The volume fraction of ferrite is determined primarily by the composition balance between elements that tend to stabilize the ferrite, and austenite; and to a lesser extent, by the casting thermal history. Casting process parameters and subsequent thermal processing also has an effect on delta-ferrite morphology, making microstructure control more difficult than just chemical composition control.

By adjusting the ratio of ferrite stabilizers, to austenite stabilizers, within the specified ranges for the elements in a given alloy, the casting producer can somewhat control the ferrite content and physical properties. ASTM practice A800 provides the standard practice for estimating the ferrite content of stainless alloy castings that have compositions balanced to form ferrite as a second phase. The ASTM specifications have a wide chemical range that can result in delta-ferrite from between 5 to 35% or more unless chemical balance is established for each grade of alloy. While ferrite levels are not specified in ASTM specifications, they are generally expected to be in the 5-15% range for CF type alloys, and 8-18% for CG types.

Ferrite content control is not an obvious requirement under ASTM A743 or A744 for those unfamiliar with ASTM specifications.

Supplemental requirements, which must be specified in addition to the basic ASTM specification on the purchase order allows for additional testing. Unless one knows where to look, *Supplementary Requirements*, which are a part of the basic ASTM specifications, are often missed.

When ferrite content needs to be controlled, specify A781 supplementary S11.1 requirement as follows:

"The chemical composition of the heat shall be controlled such that the ferrite content, as determined by the chemical composition procedure of Practice A800 shall be in conformance with the specified ferrite content range."

Finally, the service conditions under which the castings are to be subjected dictates control of delta-ferrite to specific levels for

optimum performance and life. Serious considerations should be given to specifying a ferrite range of 5 - 15% maximum for CF type and 8 - 18% maximum for CG type alloys in procurement documents. Foundries can avoid high ferrite by keeping Nickel on the high end of the range (above 10% in the CF grades, and above 12% in the CG grades), and by adjusting the Chromium and Molybdenum levels accordingly to balance out the composition.

The point is that the chemical compositions must be balanced such that the ferrite contents are controlled within any specified range. The procurement documents should specify the ferrite range desired, and require the casting manufacturer to report the actual ferrite contents when determined to be necessary. ■

Service Solutions

Terry McMahon

Global Market Manager, PRO Services
ITT Industrial Pump Group

Are your repairs and maintenance program out of control? Call a PRO!

Our customers are process companies such as Chemical, Refineries, Pulp & Paper Mills, Mining and Utilities. They are telling us it is more important than ever to have an efficient equipment repair and maintenance program in place. These companies are machinery intensive and usually have a maintenance organization and a substantial investment in spare parts to keep the plant running.

Many are also faced with the following dilemma. They have to meet tighter production goals, quality goals and increasing customer requirements with a shrinking and declining skilled labor force. In addition there is pressure to improve return on assets, increase uptime and increase productivity. On top of this, they have to comply with regulatory issues for environmental and safety.

Our customers have been looking to Equipment Manufacturers to help provide support and solutions to address this dilemma. Goulds Pumps has been responding. We have been and are

continuing to invest in PRO services to develop leading parts supply and inventory management programs coupled with field service programs and repair shops. Goulds Pumps provides quality repairs of all pump types of rotating equipment, regardless of manufacture and pump upgrades for improved equipment reliability.

We have been working with our customers to develop varying maintenance choices ranging from equipment repair to integrated maintenance strategies. Below is a list of measures used to measure various maintenance strategies and some typical savings that may be realized. Of course, an integrated solution addressing, inventory, equipment repair, reliability upgrades and predictive maintenance will generate more savings than any single effort. Working with you, a service program can be tailored to your needs.

ROI Measurements

- Increased Productivity (2 - 40%)
- Reduced Maintenance Expense (7 - 60%)
- Improved Repair Quality (Rework and Scrap reduced 5 - 90%)
- Extended Equipment Life
- Reduced Spares Inventory (10 - 60%)
- Increased Inventory Turns (to 75%)
- Reduced Energy Consumption
- Increased Safety and Environmental Protection ■

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