Product News

Going Hog Wild!

Lean Manufacturing Results In Price Reductions on Trash Hog® Pumps

Goulds Pumps has recently announced savings up to 50% on most sizes and metallurgies of its popular Trash Hog solids handling, self-priming centrifugal pumps. These pumps are specifically designed to handle municipal and industrial wastewater. They are capable of handling solids up to 3" (76 mm) in diameter and are the ideal pump for sewage lift stations, sewerage treatment facilities, as well as many industrial processes.

Taking advantage of Lean Manufacturing techniques and leveraging ITT's size to maximize global sourcing opportunities, Goulds has been able to slash the price of many Trash Hog models.

Free Hats and Shirts
Celebrating this Lean success, Goulds is giving away Hog Hats and Hog Wild T-Shirts To every buying team purchasing a genuine Trash Hog through the end of the year.

Features
Trash Hog features include a non-clog design, a removeable wearplate, and a large lightweight cleanout covers, top and front. Trash Hog provides a heavy-duty power end which can extend pump life even in the toughest services. Optimum hydraulic performance can be renewed easily with an external impeller adjustment design requiring no shims.

Trash Hog offers capacities to 6,000 GPM (1363m³/h), heads to 140 feet (43 m) and temperatures to 225°F (107°C). It's available in cast iron, 316 stainless, CD 4Mcu and hardened chrome iron. Sizes range from 3 inches (7.6 cm) to 12 inches (30.5 cm).

For information on reduced prices for specific models call your local Goulds representative.

Material Matters

Duplex Stainless Steels For Sea Water Service

Stephen Morrow
Global Manager of Materials Technology
ITT Industrial Products Group

Introduction
Over the last several decades, there has been an increased interest in the use of duplex stainless steel for pumps used in marine environments. The synergistic effect of increased levels of chromium, molybdenum and nitrogen have been shown to provide outstanding benefits for localized corrosion resistance of the duplex alloys comparable to those of the highly alloyed austenitic alloys. Today both the super-austenitic and super-duplex stainless steels are widely being utilized in seawater pumps.

It has been noted for many years that it is mainly the lack of localized corrosion (i.e. pitting and crevice corrosion) resistance that has limited the suitability of stainless steels for seawater services. This understanding has provided the motivation for developing more highly alloyed duplex stainless steels that offer superior corrosion resistance in seawater and other chloride media.

None of the earlier first or second-generation duplex stainless steels were resistant enough for seawater use until nitrogen and higher molybdenum alloying was introduced, and the so-called super-duplex stainless steels were made available. The combined effect of molybdenum and nitrogen enhancement has been found to be beneficial for improved localized corrosion resistance.

Modern seawater resistant duplexes usually contain at least 25% chromium and have increased levels of molybdenum and nitrogen alloying over the standard duplex offerings such as wrought UNS S32900 (AISI Type 329), and cast UNS J93370 (ACI Type CD4Mcu).

Table 1 summarizes various wrought super-duplex steels mentioned in the approximate order they were announced in the literature. Two of the first super-duplex steels, UNS 31260 (DP3) and UNS 32550 (Ferralium 255 and SD40), were introduced to the market in the seventies and improved versions in the nineties. Throughout the eighties and nineties a number of new super-duplex steels were introduced, all containing 25-27% chromium, 3-5% molybdenum, 0.15 - 0.30% nitrogen, and some include copper and/or tungsten additions [1].

Factors Affecting Seawater Resistance
From a corrosion viewpoint, seawater may be considered a neutral chloride salt solution that promotes localized corrosion in stainless steels. In saline waters or seawater environments at or near neutral pH levels the protective passive film on stainless steels renders them virtually immune to general corrosion. Unfortunately this passive film can break down locally in certain environments containing chlorides. At the intermediate temperatures existing in many seawater pumps, crevice and pitting corrosion are the major forms of corrosion damage most often observed.

Over the past 25 years a number of highly alloyed duplex stainless steels offering superior corrosion resistance have been introduced for seawater service. Many researchers and much of the materials/corrosion literature indicates that excellent resistance to localized corrosion can be achieved in neutral and acid chloride containing media by increasing chromium, molybdenum and nitrogen content in these materials. In addition more noble values are exhibited in seawater with increases of these key elements.

Increased nitrogen content has led to improved corrosion resistance due to a better balance of alloying elements between the dual austenite and ferrite phases, resulting in a decreased susceptibility towards alloy partitioning between these two phases. I will say more about this phase balancing later.

Regarding other alloying elements, it should be noted that some duplex stainless steels contain tungsten additions in the range of

continued on page 6

Duplex Stainless Steels...

continued from page 5

0.5 % to 2.0 %. Tungsten additions have been shown to improve crevice corrosion resistance, with benefits similar to that of molybdenum. Copper additions in certain duplex alloys along the order of 0.5 % to 3.25 % are used primarily to extend the application to include sulfuric acid service, and offer better resistance in polluted seawater that contains hydrogen sulfide or other reducing reactants.

Pitting Resistance Equivalent

A familiar aspect of these newer seawater worthy duplex stainless steels is a high content of the alloying elements chromium, molybdenum, and nitrogen. Attempts have been made to establish a measure of the localized corrosion resistance by assessing the relative effect of these important alloying elements in a weighted form. This calculated sum is often referred to as the PRE (pitting resistance equivalent) or PREN factor (when nitrogen is included), with a common expression for the austenitic and duplex steels as follows:

$$PREN = \%Cr + (3.3 \times \%Mo) + (16 \times \%N)$$

The passive film on stainless steels is significantly improved in seawater services when the alloy composition contains higher levels of these key elements and provides a PREN value of at least 38 or more. Long-term exposure in natural stagnant seawater has determined that only the higher molybdenum and nitrogen bearing duplex stainless steels with a PREN greater than 40 are highly resistant to localized (pitting & crevice) corrosion. Those super-duplex alloys with PREN greater than 40 successfully compete with the most resistant super-austenitic 6% molybdenum alloys such as UNS S31254 (Alloy 254SMO) and UNS N08367 (Alloy AL6XN), and are considered to be most suitable for seawater service.

It should be noted that it is only those alloys offering a PREN value of 40 and greater that are usually referred to as "super" stainless steels. Several of these are listed as cast alloy grades in the ASTM Duplex Standard Specification (i.e. ASTM A890 [2] as grades 1C, 5A and 6A). Table 2 summarizes some of the various cast duplex stainless steels that are suitable for seawater service.

Importance of Nitrogen and Phase Balancing

As mentioned earlier, the two phases in duplex stainless steel have different compositions, resulting in a different resistance to localized corrosion in seawater. The austenite phase generally is less resistant to localized corrosion than the ferrite phase. This is because the chromium and molybdenum are more concentrated in the ferrite phase; while the nickel and nitrogen are more concentrated in the austenite phase. This is known as alloy partitioning, and one of the drawbacks of dual phase or duplex alloy systems.

Nitrogen enhancement is beneficial to increase localized corrosion resistance of the austenite where it is mainly concentrated, and it also reduces the partitioning of chromium and molybdenum between the two phases. The only way to make the austenite phase as resistant as the ferrite phase in a duplex stainless is to alloy the material with high amounts of nitrogen. I spoke of this in greater detail in the Spring 2000 issue of Pumplines [3]. Since nitrogen helps to maintain higher levels of chromium and molybdenum in the austenite, it improves its corrosion resistance. Therefore, duplex stainless steel enhancement due to nitrogen is mainly due to the improved corrosion resistance of the austenite.

In low-nickel duplex stainless steels, the diffusion of nitrogen into austenite is possible due to its large diffusion coefficient, but molybdenum and chromium (small diffusion coefficients) cannot be significantly redistributed, so they are unevenly distributed (higher in ferrite) between the ferrite and austenite phases. The main role of nickel is

Table 1. (Source Ref. 1)
Wrought super-duplex stainless steels.

Steel Grade		Typical Chemical Composition, wt%						
UNS	Trade name	Producer	Cr	Ni	Mo	Cu	N	W
S31260	DP3	1	25	7.0	3.0	0.5	0.18	0.4
S32550	Ferralium 255	2	25	6.0	3.0	2.5	0.18	
	Alloy 381	3	25	7.0	3.9		0.15	
S31200	UR 47N	4	25	7.0	3.0		0.18	
S32550	UR 52N	4	25	7.0	3.0	1.5	0.18	
S32760	Zeron 100	5	25	7.0	3.5	0.7	0.25	0.7
S32750	SAF 2507	6	25	7.0	4.0		0.30	
	Fermanel	2	27	8.5	3.1	1.0	0.23	
	Atlas 958	7	25	7.0	4.5		0.18	
	DPS 28	1	27	7.5	3.8	0.3	0.30	
S32520	UR 52N+	4	25	6.5	3.4	1.5	0.24	
(1.4469)	Marker G-4469	8	26	7.5	4.7		0.27	
S39274	DP3W	1	25	7.0	3.0		0.30	2.0
S39277	DTS 25.7 NWCu	9	25	7.5	3.9	1.7	0.28	1.0
(1.4501)	A911	10	25	7.0	4.0	0.6	0.23	0.7

Steel producers:
1 Sumitomo Metal
2 Langley Alloys
3 Climax Molybdenum
4 Creusot Loire
5 Weir Materials
6 Sandvik Steel
7 Atlas Foundry
8 Schmidt & Clemens
9 CSM
10 Bohler Edelstahl

Table 2.
Cast super-duplex stainless steels.

Steel Grade				Typical Chemical Composition, wt%					
UNS	ASTM A890 Grade/Type	Wrought Equiv.	Goulds Code	Cr	Ni	Mo	Cu	N	W
J93373	1C CD3MCuN	Alloy SD40	1384	24.0-26.7	5.6-6.7	2.9-3.8	1.4-1.9	0.22-0.33	
J93404	5A CE3MN	Alloy 2507	1361	24.0-26.0	6.0-8.0	4.0-5.0		0.10-0.30	
J93380	6A CD3MWCuN	Zeron 100	N/A	24.0-26.0	6.5-8.5	3.0-4.0	0.5-1.0	0.20-0.30	0.5-1.0
N/A	1B modified CD4MCuN	N/A	1338	24.5-26.5	4.7-6.0	3.0-4.0	2.7-3.3	0.10-0.25	

Material Matters

to control the ferrite/austenite phase ratio and the partitioning of the alloying elements between the two phases.

An optimum range of nickel content is about 4 to 8% in a 25% Chromium duplex stainless steel. Increasing nickel content above this optimum increases the austenite ratio in such a way that the dilution of nitrogen in larger volumes of austenite would be detrimental and lowers its resistance to pitting and crevice corrosion.

Increasing the chromium content raises the pitting potential, and is beneficial in both phases. The trend in materials development seems to be towards moving from the 25% to 27% Chromium duplex alloys for increased corrosion resistance.

Molybdenum content well in excess of 3% is needed within a 25% Cr nitrogen enhanced duplex to be fully resistant to pitting and crevice corrosion in seawater. Molybdenum content cannot be increased indefinitely because of severe problems with intermetallic phase precipitation, and it rarely exceeds 4.5 to 5.0% in even the highest alloyed duplex stainless steels.

Summary and Recommendations
In summary, for seawater services the duplex alloy selected should have a balanced nitrogen enhanced composition to provide for a PREN greater than 38 or higher to ensure freedom from localized corrosion. Those duplex alloys that offer PREN values of 40 or more are ideal for pumps and highly recommended for use in seawater.

An excellent way to specify any duplex alloy intended for seawater service would be to request that the chemical composition be balanced to provide a PREN greater than or equal to 40 as a minimum using the pitting resistance equivalent expression given above. This will ensure that the alloy selected has the optimum chemistry control to provide adequate localized corrosion resistance in the seawater environment.

Highly alloyed 25% Chromium duplex stainless alloys such as Goulds Code 1338 (Modified Cast Alloy CD4MCuN with 3% molybdenum), Goulds Code 1384 (ASTM A890 Grade 1C - CD3MCuN), or Goulds Code 1361 (ASTM A890 Grade 5A - CE3MN) are logical choices for sea water services.

References:

(1) Bengt Walle'n, "Corrosion of Duplex Stainless Steels In Seawater," Avest Sheffield AB, Research and Development, acom 1-1998, SE-77480 Avesta, Sweden

(2) ASTM A890, "Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion - Resistant, Duplex (Austenitic-Ferritic) for General Application," Annual Book of ASTM Standards 2002, Volume 01.02.

(3) Stephen Morrow, "Duplex Stainless Steels - Several Generations In The Making," PUMPLINES - Spring 2000 issue, ITT Industries- Industrial Products Group, Seneca Falls, NY

Sealless Vertical Sump Pump Provides Cost Efficient Operation

Looking for an alternative to maintenance intensive conventionally sealed sump pumps? Whether it's submersible, self priming, or foot valve equipped end suction pumps, they can be maintenance headaches.

The Goulds Model 3171 sealless vertical sump and process pump is capable of handling a multitude of industrial applications including process fluids, sump drainage, tank unloading, and chemical waste control. The sealless construction of the 3171 eliminates stuffing box problems, including expensive and maintenance intensive mechanical seals. Designed with a rugged, double-row thrust bearing, a heavy-duty one piece shaft that eliminates misalignment and provides for longer bearing life, the 3171 features an open impeller design which allows for external impeller adjustment for maximum efficiency. Available in 17 sizes with a wide range of alloys, the 3171 offers capacities to 3180 GPM (722m^3/h), heads to 344 feet (105m) and temperatures to 450º F (232ºC). The 3171 handles lifts from 2 to 20 feet.

For additional information on the Model 3171 visit **www.gouldspumps.com** or call your local Goulds Sales Office.

Service Solutions

Innovation Reduces Refinery Costs

Leonard Cadena, P.E., Manager, Project Engineering PRO Services

Problem:
A major Oil Refinery on the Gulf Coast was spending several hundred thousand dollars per year to strip their tank farm vessels. The refinery was renting pumping systems on a regular basis to strip their tanks. The issue was the continual annual rental costs. They performed a complete assessment and found the costs of solvents and other cleaning fluids to be recurring with no corrective action available at this time. The cumulative cost of renting the systems was compared to the cost of owning a single system that would accommodate the needs of the tank farm with reasonable maintenance costs. It was assessed that the cost of a new system would be paid for in less than a year and the annual maintenance costs would be a small fraction of the rental costs.

Solution:
Through a continuous effort to reduce costs in their operations they found this opportunity and worked with ITT PRO Services Project Engineering Group to resolve the large annual expenditure issue. Utilizing CAD generated conceptual drawings the initial idea began to evolve. Through several meetings with the customer and PRO Services representatives, we were able to take the basic idea of a pump on a trailer with a driver and piping to a completely automated and self-contained system.

The system consists of a process pump capable of 2000 GPM, a 625 HP Diesel Engine driver, and a specially designed skid to completely isolate the pump system from the trailer for long term eventless operation due to alignment and torsional issues. The engine alone was a task as diesel engines are not made for CCW rotation. They are manufactured in CW rotation so an inverter was required to operate the pump in a CCW rotation. All the torsional loading on the skid and trailer had to be reviewed and designed for. The piping was designed using the latest piping design software and empirical information. Though this was an API application, we utilized stainless expansion joints to reduce the potential for pipe strain. The piping was supported throughout with

continued on page 8