

PumpLines

Innovation... Technology... Leadership

PumpSmart® Helps Scepter Inc. Toss High Energy and Repair Costs into the Recycling Bin

Ever wonder where all of those aluminum cans wind up? Over 100 billion aluminum cans are produced annually in the U.S.A. The aluminum can is the most recycled item in this country. Over 60% of them are recycled. Many of them find their way back to Scepter Inc.



Scepter Inc. of New Johnsonville, TN is a company that recycles scrap aluminum. It produces reprocessed, cast aluminum ingots that are used by beverage manufacturers in making aluminum cans for their products.

Two furnaces are utilized by the plant for melting the scrap aluminum. Each one is capable of processing thousands of cans. As the melted aluminum leaves the furnaces it is poured into the cast ingots. These ingots are then cooled down by water pumped from a cement pit and circulated back to a cooling tower. After the cooling liquid leaves the furnace area, the temperature of the liquid can reach over 200 °F.

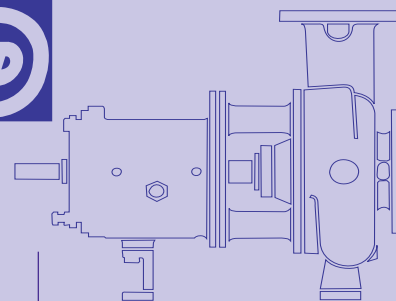
Scepter's problems started with the pump used to circulate the cooling liquid. It was a 6" 88 HP submersible pump which had its motor submerged in the pit. Keeping a constant flow of liquid to the furnace meant that the pump was working overtime. High cycle rates caused the pump to start and stop continually. This continuous starting and stopping caused the pump's motor to fail. The motor failure happened three times over a one-year period. The repairs cost Scepter between \$10,000 and \$13,000 for each breakdown. These costs were coupled with high-energy consumption from the old existing pump. Scepter faced some serious cost and downtime problems that were eating into the company's profits and productivity.

Wayne Keith, the plant manager of Scepter, was looking for solutions to help him eliminate the high energy and repair costs. He found help when Steve Green, a sales engineer for Tencarva Machinery Company of Nashville, TN called on him. Steve suggested replacing the old submersible pumping system with a Goulds 30 HP VIT model vertical turbine pump equipped with a PumpSmart PS200 unit, coupled with a liquid level controller. Steve explained how the PumpSmart PS200 could be the answer to the costly pumping problems that Scepter was experiencing. He went on to explain how PumpSmart could easily save Scepter at least 30% in energy savings alone.



PumpSmart PS200

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Goulds Pumps



PumpSmart Helps...

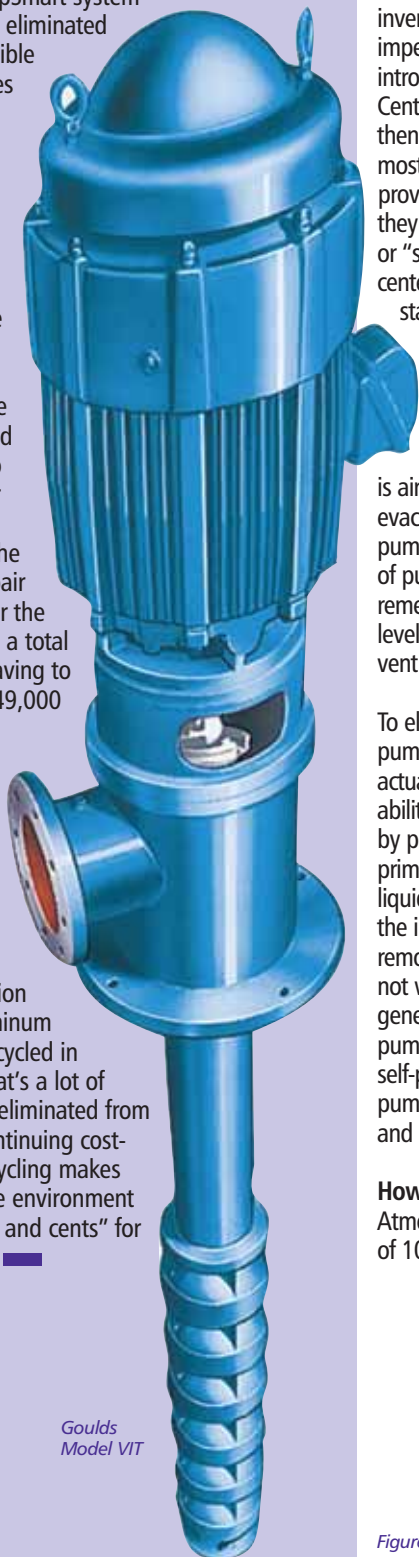
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PumpSmart's continuous monitoring and reaction to the pump performance conditions meant greater reliability and longer life.

Wayne was sold. The new PumpSmart PS200 system was installed. The VIT had a TEFC motor that was mounted on a structural steel frame 10 feet below grade. The new Goulds PumpSmart system immediately eliminated the submersible pump failures due to high temperature and continuous cycle rates.

What's more, by reducing the HP by 65%, savings in energy alone are estimated at \$7,000 to \$10,000 per year. It also eliminated the constant repair bills to repair the old motors-- a total estimated saving to Scepter is \$49,000 per year! PumpSmart certainly was the smart choice.

In the last thirty years, over 14 million tons of aluminum has been recycled in America. That's a lot of solid waste eliminated from landfills. Continuing cost-effective recycling makes sense for the environment and "dollars and cents" for the recycler. ■



Goulds
Model VIT

Tech Talk

Self Priming Centrifugal Pumps: A Primer

John Kanute

Application Engineer, Goulds Pumps

Centrifugal pumps can be traced back to the late 1600's, when Denis Papin, a French born inventor, experimented with straight vane impellers. British inventor John G. Appold introduced a curved vane impeller in 1851. Centrifugal pumps continued to evolve since then. Next to the electric motor, they are the most popular machines in the world. Pumps will provide satisfactory service to the user, assuming they are in a system offering a flooded suction or "suction head" (fluid is located above the centerline of the pump). The drawback of standard end suction centrifugal pumps is that they do not fare well when the liquid is below the pump centerline. Liquid must be delivered to the pump so the process can begin. The pump can not lift liquid vertically to begin the process. The reason is air in the suction side of the pump can not be evacuated from the casing. The centrifugal pump will become "air bound" and incapable of pumping any additional liquid. The only remedy for this situation is to raise the liquid level to the pump inlet and have the operator vent the suction line before starting.

To eliminate this problem, self-priming centrifugal pumps were developed. The term self-priming is actually an industry term that describes the ability of a pump to create a partial vacuum by purging air from the suction line. The self-priming pump unit uses an initial quantity of liquid (usually water) to create the vacuum at the impeller eye and continuously "digest" or remove air from the suction line. This benefit is not without cost. Self-priming pumps are, in general, slightly less efficient than an end suction pump. Marlow Pumps manufactured the first self-priming centrifugal pump in 1932. This pump design would go to the source and get liquid to be pumped.

How it works.

Atmospheric air exerts a pressure of 101.3 kPa (14.7 PSI) all around



Figure 1. Closed, Open and Semi-Open Impellers



Typical Self Priming Centrifugal on Industrial Sump Service

us. The pump creates a partial vacuum as it removes air from the suction line. The vacuum causes atmospheric pressure to push water up to the pump through the suction line. In a laboratory, with perfect vacuum, the atmospheric air would push liquid 10.3m (33.9 feet) up a column. The practical application limit for self-priming pumps is about 7.62m (26 feet) of liquid.

The self-priming process occurs automatically once the pump is started with the initial quantity of liquid. Without operator involvement, the pump can prime itself with the pumpage and begin pumping. If the vacuum is broken, the pump is able to reprime and continue pumping. The savings in time, effort and cost are substantial; especially in dewatering applications such as in mining where pumps often run dry for brief periods.

The advantages of using a self-priming pump are clear. It should be pointed out that numerous varieties of self-priming methods are in existence today. Most are related to the two methods that will be discussed now: diffuser priming and volute priming.

Volute Priming

Just as in a standard centrifugal, everything starts with the impeller.

There are three common impeller designs (Figure 1).

The Closed Impeller has shrouds on both sides of the vanes. It is a desirable design for higher pressures and clear liquids.

The Semi-Open Impeller has a shroud on one side of the vanes. It can handle a moderate amount of solids in the liquid.

The Open Impeller has the shroud cut back completely except where the vanes are located.

It can pass a high concentration of solids.

The impeller is placed inside a progressively expanding spiral-shaped casing called a volute. At one point on the inside of the volute, there is a close clearance between it and the outer edge of the impeller. This point of close clearance is usually called the "cut water" or "peeler." The purpose of the volute is to collect liquid being flung off the whirling impeller vanes and direct it to the discharge of the pump. The volute takes high velocity liquid from the impeller and increases the flow area gradually; liquid entering it at a high velocity is gradually slowed. As the liquid slows down, the pressure is increased, since these two are inversely related. It is this action which produces the pressure that the pump develops. The volute can either be cast into the pump casing or bolted in, depending on the design.

The priming process begins with filling the casing with liquid. The liquid is usually added through a tapped plug in the casing. This initial liquid is used to create the vacuum and seal against leakage. The casing is divided into two sides: the suction side and discharge side. The division is made by a solid partition inside the casing with the only opening between the two sides at the impeller "eye" or center. Once the casing is filled from an external source it is ready to begin the process.

As the pump is started the impeller takes liquid from the "eye," or center of the impeller, and throws it to the circumference. This action will create a vacuum at the eye that is the source for the self-priming pump. The liquid filling the casing is pulled through the impeller from the suction side. Once the initial liquid is pulled from the suction side, the impeller will continue to create the vacuum and begin pulling air from the suction line. (Figure 2)

Air is drawn toward the vacuum in the impeller eye and mixes with the liquid at the impeller tips. The air / liquid mixture is peeled away by the cutwater. Then air/water mixture percolates upward through the casing because it is now less dense than the liquid around it. The air separates as it rises and is vented to atmosphere in the discharge line while the liquid falls back to the casing to be used again. It is this action that digests the air from the suction line and creates the partial vacuum. The process continues until all the air has been evacuated and full prime is achieved. It is important to vent the air on the discharge side. The pump will not compress the air and will not prime unless the air is allowed to escape. (Figure 4)

Advantages of Volute Priming

The advantage of volute priming are solids handling ability. The pump has a single cutwater allowing solids to be passed without clogging. When used with a trash handling impeller the unit will effectively pass large

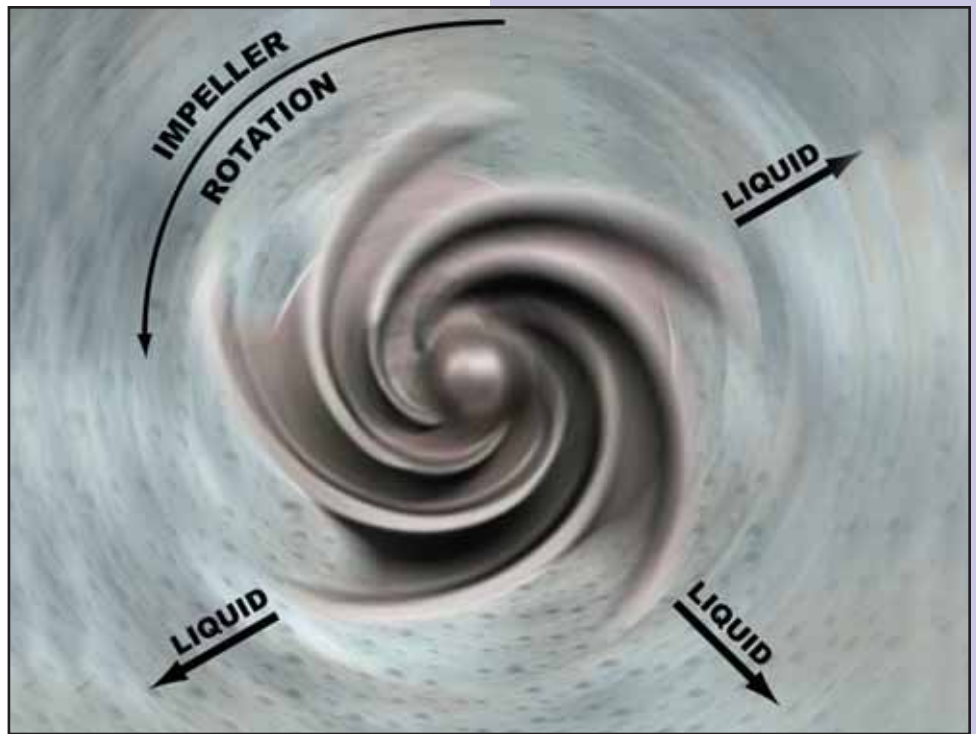


Figure 2. Impeller Rotates and flings liquid.

solids. This design is also maintenance friendly. In some units the rotating end can be replaced as a unit. There is no need to remove suction or discharge piping to work on the power end. This can be used to minimize down time by keeping a spare rotating end. The drawback of volute priming is wear at the cutwater usually means the casing needs to be replaced.

Diffuser Priming

Diffuser priming is similar to volute priming in concept. A diffuser contains multiple stationary vanes or "peelers" that peel away air and water mixture during the priming phase. The multiple stationary vanes each act like a cutwater in volute priming. These stationary vanes are cast into a replaceable ring that surrounds the impeller. The impeller and diffuser combination

are mounted inside a pump casing just like in the case of volute priming.

The priming cycle occurs exactly the same way: An initial quantity of liquid is added to the casing. The pump is started and a vacuum is created at the eye of the impeller. The multi-vane diffuser peels the air / water mixture from the impeller where it is separated in the discharge side of the casing. Vacuum is created in the suction line and atmospheric pressure forces liquid into the pump tank. (Figure 4)

Although this design has limited solids handling capability due to the diffuser surrounding the impeller, it does have several advantages over volute priming.

continued on page 4



Figure 3. Volute Priming



Figure 4. Diffuser Priming

Tech Talk

continued from page 3

Advantages of Diffuser Priming

- Pump maintains efficient priming for a longer period of time due to the multiple peelers.
- Lower radial loads due to balanced design extends seal, shaft and bearing life.
- Replaceable diffuser allows return to original performance without expensive casing replacement.

With these advantages the diffuser priming method can achieve higher efficiencies than volute priming.

Utilizing self-priming pumps

It is important to note that self-priming pumps will have special considerations that end suction pumps will not. For example a small vacuum leak in the suction line will prevent the unit from priming. The pump will continuously pull air from the leak instead of the suction line until all the priming liquid in the casing is evaporated. This is a common cause of priming failure as the leak can be very small or invisible to the naked eye but will prevent priming.

Another common cause of priming failure for both types of priming methods is venting the air from the discharge line during priming. The pump is not capable of compressing the air during the priming phase and it must be allowed to escape through the discharge and vent to atmosphere. This will prevent all but the shortest priming lifts.

The self-priming pump should also be located as close as possible to the source. It is best to be located directly above the sump with few elbows as possible to reduce friction. Once the unit is primed and pumping it will require net positive suction head (NPSH) as any centrifugal pump. Without sufficient NPSH the unit will cavitate. Therefore lifts through long suction lines or lifts with obstructions will be plagued by cavitation type problems. It could be the case where one problem is solved only to create another. It is these special considerations that must be examined before the installation is cast in concrete. Many owners have puzzled over problem applications because one of these factors had been neglected.

Self-priming pumps have been providing economical and reliable service to their owners for many years. They offer an alternative to vertical or submersible pumps in sump applications, and can help where overhead space is limited. They can be found in virtually any industry; farms to petrochemical. They solve the very basic problem of how to get liquid to the pump. ■

NEW EDUCATIONAL INITIATIVE: "Pump Systems Matter"™

Goulds Pumps is supporting the Hydraulic Institute's new National Pump Systems Educational Initiative called "Pump Systems Matter."™ The program will place a primary focus on pump systems education and outreach, addressing energy savings, and total cost of pump ownership.

Optimization of pumping systems represents a significant opportunity for U.S. companies and municipalities to save money and energy while reducing maintenance costs and increasing productivity. U.S. Department of Energy (DOE) studies indicate that pumping systems account for nearly 20% of the world's electrical energy demand and range from 25% to 50% of the energy usage in certain industrial plant operations. DOE case studies have shown that better system design and more effective application of pumps can save 20% or more in energy costs and represent a large, frequently overlooked savings opportunity.

HI has begun a national educational initiative to support the development and deployment of pump system educational materials and tools, to administer related training programs and to address outreach and educational efforts to various audiences. The primary goal of the education initiative will be to transform the market for pump systems and services to one based on system life cycle costs rather than equipment first costs. As anticipated by the HI Market Transformation Committee and Board of Directors, an effective pump systems educational initiative will serve to transform the market for pumps and pumping systems by:

- Changing owner/operator and contractor focus on lowest first cost to a total life-cycle cost in purchasing pumps, pump systems and services
- Create opportunities for expanded demand among owner/operators and contractors for value-added services from the pump industry and expand the capacity within the pump industry to meet this need
- Develop new educational materials and tools to train and educate pump and supplier OEMs, owner/operators, contractors, and others
- Develop appropriate outreach efforts to get the message out that "Pump Systems Matter,"™ and begin to transform the market for energy efficient pump systems and services.

For the past few years HI has been involved with developing new educational materials related to pump systems, especially the Pump Life Cycle Cost (LCC) Guide. The e-learning site,



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www.pumplearning.org, with its first course on "Centrifugal Pumps: Fundamentals, Application and Design," and the new Variable Speed Pumping Guide are other valuable resources for pump users.

As a DOE Allied Partner, HI has partnered with DOE to provide technical input for the development of the Pump System Assessment Tool and to offer training for Qualified Pump System Specialists. The "pumps" section of the HI web site already provides considerable "energy savings" guidance, tips, U.S. DOE case studies and tools, including downloadable versions of PSAT software for the benefit of users and non-government organizations. Free downloadable copies of the Executive Summary of the Pump LCC and Variable Speed Pumping Guides are also available from the HI web site, www.pumps.org.

"HI and its members, such as Goulds Pumps, are working with the DOE and others to advance the concepts of total cost of ownership. We wrote the book on Pump Life Cycle Cost: A Guide to LCC Analysis for Pumping Systems. Those who focus on total ownership costs, carefully match their pumping needs to system requirements will best be able to reduce their total cost of ownership including energy, operating and maintenance costs. That's what "Pump Systems Matter"™ is all about," explained Robert K. Asdal, Executive Director of the Hydraulic Institute.

The Hydraulic Institute, established in 1917, is the largest association of pump producers in North America, serving member companies by providing forums for the exchange of industry information. The Institute has an 87 year legacy of writing pump standards, and is widely acknowledged as the spokesman for the pump industry in North America. HI invites expressions of interest in pump systems market transformation with a major focus on pump systems education, advancing the concept that "Pump Systems Matter."™ Expressions of interest in "Pump Systems Matter"™ should be directed to HI Executive Director **Robert Asdal** at (973) 267-9700 x 13 or via e-mail at rasdal@pumps.org.

Membership in "Pump Systems Matter"™ will be open to utilities, market transformation organizations, government agencies, pump users, contractors, consultants, engineering companies, trade and professional associations as well as North American pump manufacturers and suppliers of motors and drives, seals, couplings, bearings, housings, instrumentation and control systems and pump specific software. ■

Material Matters

Steel Casting Design Considerations

Rafael Nariman

VBSS Black Belt, IPG – Ashland PA

INTRODUCTION

Needless to say, that as a pump manufacturing company, IPG is highly dependent on castings. Performance characteristics such as flow, pressure, temperature, corrosion and wear resistance are all contained in one set of cast parts forming the liquid end of a pump.

Despite their bad rapport in issues of quality and delivery, castings represent the simplest path from an engineering design to a complex metal shape. They provide a freedom of design and choice of engineering materials unequaled by any other metal forming process.

Furthermore quality castings are not more difficult to attain than any other quality product in other fields of manufacture. Typical of all engineered items, castings reflect quality only after a detailed study, application of basic principles and adherence to proven methods.

The casting process has gained a reputation as a technique to create almost any shape the designer can envision, but whether or not that shape can be cast economically is another matter. Many casting defects are not due to lack of foundry capability.

Acceptable castings, both in quality and cost, start at the design stage, therefore close cooperation between competent foundry and design engineering groups is paramount. This is an important consideration when selecting High Alloy casting suppliers.

Regrettably, many cast parts for all types of machinery have been designed without much consideration to the casting process itself, and it is left to metal casters to implement ingenious but costly means to overcome manufacturing odds posed by the design. In Lean-Six Sigma terms, this is inherent waste and variation that generates scrap, rework and excessive cycle time and cost. None of that can be fully corrected until both, design and tooling are improved.

In this article we will cover steel castings, which are particularly sensitive to geometric factors. In the case of IPG, we are mainly concerned with materials from the High Alloy Steel family, representing a wide variety of complex corrosion resistant alloys used in some of the most demanding applications.

Some of the fundamental metal casting principles required to understand steel casting design will be discussed. Further related material such as design rules and methodology, engineering specification aspects, process simulation etc. may be covered at a later date if interest exists.

NOTE ON GRAPHICAL INFORMATION:

Most of the pictures in this article are graphic outputs from the casting simulation program ProCast, which is an advanced finite element software package, capable of reproducing casting processes with a high degree of accuracy.

HEAT TRANSFER

The production of a casting is, to a large extent, the manipulation of heat in a mass of metal. Starting at the beginning, melting and refining furnaces convert electrical or chemical energy into heat. This heat is put into the metal to melt it and provide the energy required for various chemical reactions. Hence we have liquid metal of the desired chemical analysis. How we remove the contained heat in the metal between the furnace and the mold shakeout operation will govern much of the quality in the casting.

After metal is poured, heat is extracted by the mold mass. Heat flow occurs by all three modes of transfer – conduction, convection and radiation. In the case of sand molds the mode is predominantly conduction by the sand grains with some convection through vapor transfer. In the case of investment castings, where the shell mold is preheated at high temperatures, the mode is predominantly radiation.

In sand molds the heat transfer driving force is, of course, the temperature difference between casting and mold. The temperature difference over a finite length is called the thermal gradient; this variable is a major factor in our ability to produce sound sections as we will see. Of course, the thermal gradient changes with time, in other words, as the casting cools down the mold get hotter (Figs. 1 and 2).

THE SOLIDIFICATION PROCESS

Depending on section size, liquid steel may take seconds or hours to become solid. It is during this period of time that many important characteristics affecting casting quality are determined. The primary crystal structure is established upon which many physical and mechanical properties depend. It is also during this time that a variety of major defects are formed such as shrinkage and hot tears. Thus it is important to consider the mechanisms by which a metal solidifies and the techniques which the metal caster has at his disposal to control the solidification process.

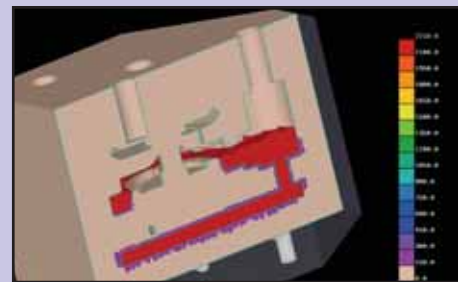


Fig. 1. Temperature distribution in a sand mold during the pouring of a casting. The mold at large is still at room temperature.

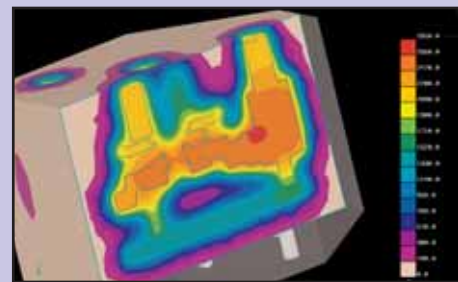


Fig. 2. The same part later on towards the end of solidification. Notice sand regions as hot as the metal that surrounds them.

SOLIDIFICATION MODES

The conditions in a pool of liquid steel can be compared to those inside an erupting volcano, hence highly energized particles of liquid and gas move about violently in a state of apparent disorder. When metal solidifies, its atoms arrange themselves into highly organized primary structures called crystals. These crystals nucleate into tiny grains in the liquid metal and then grow under the physical and thermal conditions that prevail. For metal casting purposes, the most important consideration is dendritic growth, that is, the formation of Christmas tree like structures growing into the liquid in opposite direction to the heat flow (Fig. 3).

The solidification of high alloy steels is highly complex, however for foundry practice purposes they can be treated as binary (two component) solid solutions which solidify over a temperature range. As an example, grade CF8M (type 316) cast stainless steel begins solidification at near 1400°C (Liquidus temperature) and finishes at near 1370°C (Solidus temperature). The difference between these two temperatures is called the “freezing range”; hence the freezing range for CF8M is 30°C.

The freezing range determines to a great degree the way shrinkage porosity forms in castings and how difficult it is to prevent it. CF8M would

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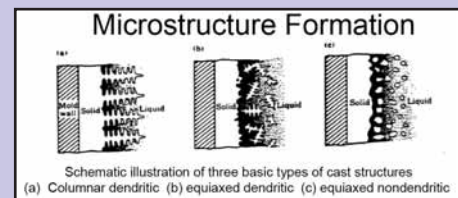


Fig. 3 – Structure on the left typical of steel castings.

Material Matters...

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be classified as a narrow freezing range alloy while the duplex grade CD4MCU (Around 170°C FR) would be a medium to wide freezing range alloy. Narrow FR alloys tend to concentrate most of the shrinkage at hot spots and centerlines and develop few but large voids, these alloys respond well to feeding with risers and other techniques. Wide FR alloys tend to have the shrinkage dispersed over larger areas and are more difficult to feed with risers.

VOLUMETRIC CONTRACTION

From pouring to room temperature, steel undergoes three distinct volumetric changes:

Liquid contraction: The liquid mass is contracting as it cools towards the melting point. The main result is a loss of volume at the top of the casting. Liquid contraction increases with pouring temperature and will affect the severity of shrinkage cavity defects in many cases.

Solidification contraction: There is a major contraction taking place throughout the freezing range. For instance, in the case of CF8M there will be around a 5% volume loss between 1400°C and 1370°C. If not corrected, this volume change will result in shrinkage cavities in the casting.

Solid state shrinkage: The contraction from the Solidus to room temperature results in dimensional changes in the casting. The average contraction per unit of length is the patternmaker's shrinkage rule for a particular alloy. This contraction also affects solidification by the formation of air gaps at the mold metal interface, which impair heat flow.

SHRINKAGE ELIMINATION BY RISERING:

Shrinkage takes place on casting zones last to solidify, therefore solidification time is an important consideration in the prediction of shrinkage cavities and it is influenced by shape and dimensions. This relationship is best expressed by the Chovorinov equation:

$$T = k(V/S)^2$$

Where T is the solidification time, V the volume of a discrete casting zone and S the cooling surfaces in that zone. The constant k is mainly related to alloy composition. The ratio V/S is the solidification modulus SM. The greater the SM the longer the solidification time, therefore by calculating SM values in the casting we can predict the solidification sequence and the presence of isolated hot spots.

Risers are added metal shapes with a greater solidification modulus than that of the casting; therefore they are last to solidify and act as a

reservoir of liquid that compensates for the loss of volume in the casting. Thus the risers will contain the shrinkage cavities and, after they are removed, the actual casting will be sound (Figs. 4 and 5).

Mold yield or the ratio of saleable casting weight to poured weight is an important cost factor. In the design of risers we strive for shapes that contain the least amount of metal for a given SM, and that are easy to mold. Hence cylinders of high aspect ratio are the most common shapes. The following rule is most important in the performance of risers:

$$SM_{\text{(riser)}} > SM_{\text{(riser connection)}} > SM_{\text{(casting section being fed)}}$$

The metal caster also makes use of a variety of mold materials to manipulate heat flow. Some materials increase solidification time (insulating and exothermic), some decrease solidification time (chilling).

PROGRESSIVE AND DIRECTIONAL SOLIDIFICATION

In the case of uniform thickness plates, steels begin to solidify at the mold wall and progress more or less evenly towards the center of the casting, we call this progressive solidification. When solidification fronts meet at the thermal center, shrinkage accompanies the solidification of the remaining liquid. Because any channels for additional feed metal are closed off, this results in centerline shrinkage. (Fig. 6)

When solidification begins at a point in the mold far from the riser and moves uniformly towards it, because of the shape of the solidification front, feed metal can reach this area and centerline shrinkage is eliminated. This is directional solidification.

Both types of solidification will occur in the same casting. We attempt to design our castings so that directional solidification prevails and castings can be produced functionally sound with a minimum number of risers (Figs. 7 and 8).

HOT SPOTS

Hot spots are slow solidifying localized casting zones that can result in major shrinkage defects. A typical hot spot is the "Y" junction at the cutwater in casings. Hot spots are formed by section junctions of various types. For instance "T" junctions caused by the addition of ribs and bosses to the pressure wall of a casting are difficult and costly to feed and will increase the probability of defectives.

In designing for improved castability we attempt to reduce the number of hot spots by

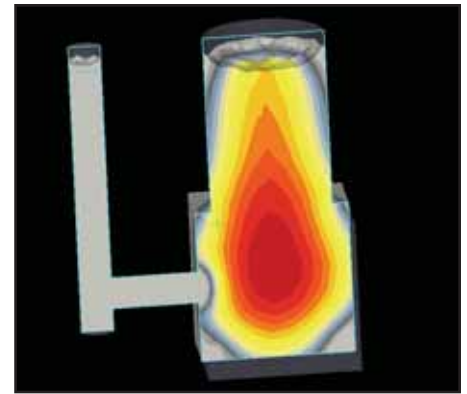


Fig. 4. Solidification of cube casting with improperly designed riser and riser connection. Shrinkage will occur in the dark red zone.

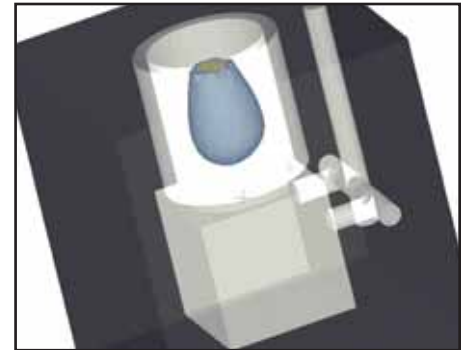


Fig. 5. Shrinkage porosity plot of the same cube casting with a well designed riser system. Notice, the shrinkage is only in the riser.

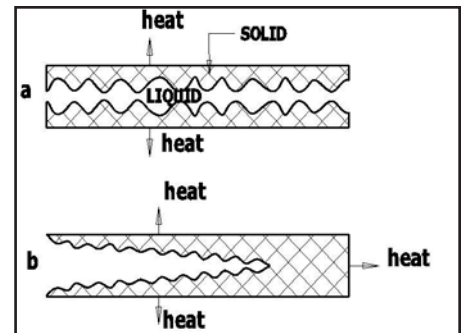


Fig. 6. Solidification of steel plates:
 (a) - Progressive solidification.
 (b) - Directional solidification.

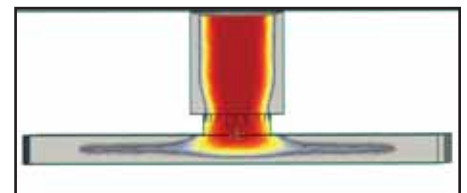


Fig. 7. Progressive solidification taking place between riser temperature gradient and plate end zones. This will result in centerline shrinkage.

eliminating or simplifying junctions and by bridging two or more hot spots into one. The aim is to design directional solidification along as few solidification paths as possible, thus minimizing the number of risers required.

OTHER TOPICS RELATED TO CASTING DESIGN NOT COVERED IN THIS PAPER:

- Natural end zones and feeding distances.
- Analysis of solidification by the inscribed

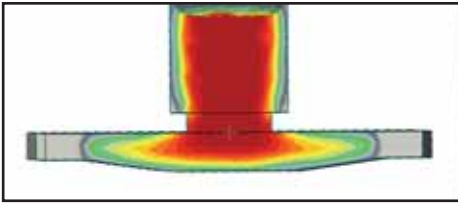


Fig. 8. Same plate as on Fig. 7 with directional solidification artificially generated by adding taper to the plate. Casting will be sound.

circle method (Heuvers).

- Increasing the thermal gradient by chilling or insulating.
- Sequential feeding of plate sections.
- Feeding pads and tapers.
- Metal flow in molds- Gating systems.
- Hot tearing and hot cracking: Stress-strain casting cooling considerations.
- Casting design and heat treatment distortion issues.
- Improving ease of molding and cleaning through casting design.

A WORD ABOUT PROCESS SIMULATION

The application of 3D modeling and process simulation techniques are a great aid in casting design engineering. As stated earlier the Ashland Foundry uses the program ProCast to evaluate many of our castings. At present we have the ability to simulate coupled metal flow and heat flow, solidification and cooling. Other software modules exist to simulate mold cooling stresses, and to predict as cast microstructure and mechanical properties.

With the metal flow module we can evaluate cooling conditions during pouring as well as turbulence, air pockets, speed of fill and unbalance in the flow rates at the different points of entry into the mold cavity (ingates). This information is helpful for improving gating systems that is the set of channels that direct molten metal from a pouring ladle into the mold cavity.

With the solidification package we can evaluate feeding, hot spots and predict casting soundness.

The output is empirical data in the way of various color coded animations and maps. We can also obtain charts of various kinds. The quality of the information depends on the accuracy of the CAD models and on input variables, such as the thermo physical properties of the materials involved. As a rule, simulation results should not be taken as criteria for conclusive action but rather as guidelines for quality decision making.

COMMENTARY

A few examples of design improvements in actual IPG stainless steel parts are shown in Figs. 9 to 14. As mentioned in the introduction the material covered in this text is only intended to give an idea of the possibilities for improvement by an understanding of the basic principles involved.

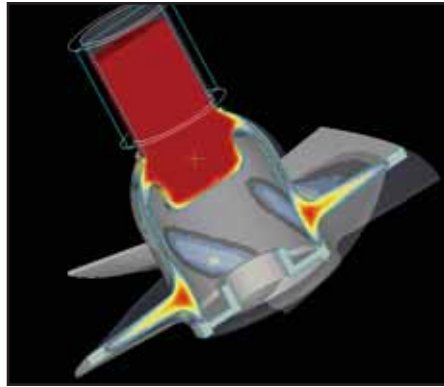


Fig. 9. Axial flow impeller with hot spot at the vane-hub junctions. Major shrinkage will take place near cavitation prone surfaces.

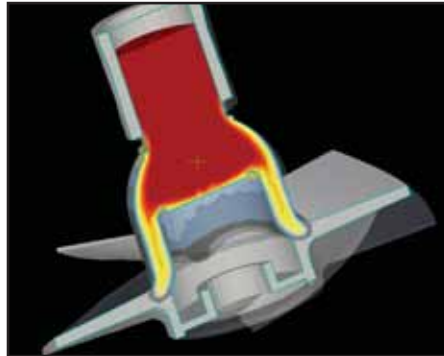


Fig. 10. Axial flow impeller junctions made sound by providing directional solidification towards the riser through desing change.

Many cast metals do not respond to directional solidification feeding, thus the approaches indicated in this write up do not apply to them. Such is the case with gray iron, ductile iron, white irons, high carbon steels and the majority of non ferrous alloys.

Over-specification and the fear of it is another common cause for excessive risering and non value added foundry operations. Attaining level 2 radiographic quality may be easy in a stuffing box cover but it is nearly impossible with a double suction impeller. The goal in the manufacture of a product is to provide the required performance and functionality at minimum cost. In the case of castings, it may mean avoiding overly conservative risering systems and allowing the possibility of centerline shrinkage in ways that the service of the part is not affected. It may also mean talking our customers away from costly NDE inspections and upgrade repairs, which do not improve part performance at all.

CONCLUSION

Reiterating previous comments, good design improves ease of manufacture. Ease of manufacture translates into castings that are purchased at a lower cost, are of high quality and are delivered on time. We should add that, over the years, the Ashland Foundry has received excellent cooperation by the SFO, AO and VPO engineering groups in the design

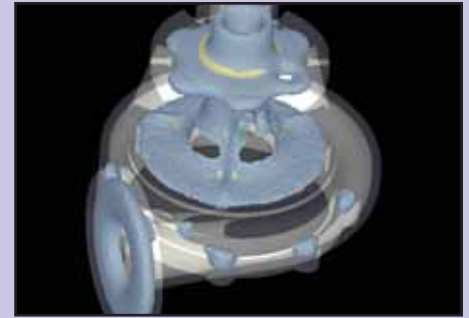


Fig. 11. Solidification of 3171 casing showing eleven isolated liquid pools likely to result in shrinkage.

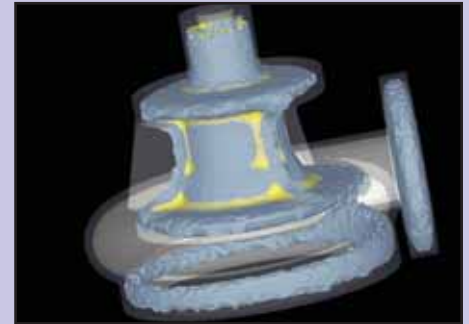


Fig. 12. Design modifications in the 3171 casing have reduced the number of feeding zones from eleven to three. The result will be an improvement in integrity and manufacturing costs.

improvement of many cast parts.

All aspects of this topic cannot be covered in a single article, however much can be accomplished through an understanding of the basic principles involved. If anyone would like to probe deeper into this subject, please contact the writer. ■

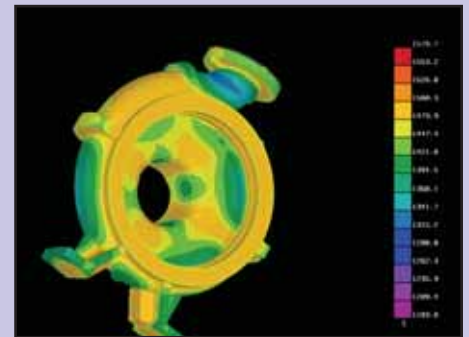


Fig. 13. Temperature plot of casing with a ribbed design. This part needed eleven risers and was prone to hot cracking.

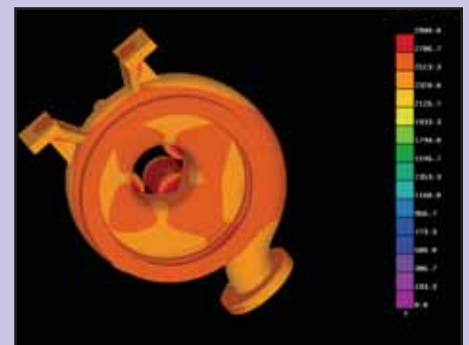


Fig.14 – Reductions in the number and size of ribs resulted in improved temperature uniformity. The number of risers was reduced to seven.

New Products

API 610 9th edition fully compliant VS4 sump pump is now available



Goulds is proud to offer an updated version for the Model 3171 called the API3171. The hydraulics are the same as our 3171 hydraulics that have been proven through many years of service. Slight modifications in the design have been made to make this pump **FULLY compliant** with the latest edition of API610. These modifications include changes to the thrust bearing arrangement to allow for optional oil mist lubrication, along with INPRO labyrinth

seals above and below the two single row bearings with machined brass cages. The API3171 also includes a more robust steel housing that can accommodate vibration probes and sensors, larger lubrication lines for the steady bearings, 300# discharge flange as standard, a tighter bearing spacing on the column bearings, and steeper curves due to changes in the discharge reference as required by API610.

Feel free to contact the Goulds 3171 team for further information; **Charlie Burrows** +1-570-875-6281 or **John Kanute** +1-570-875-6104 ■■■

PumpSmart® Model PS200 v 4.0 Provides Enhanced Pump Control and Protection

PumpSmart Control Solutions has introduced Model PS200 Version 4.0, a major addition to this award winning PumpSmart product line. Like previous PumpSmart offerings, the new Model PS200 Version 4.0 is a microprocessor based, variable speed drive, programmed specifically for water and wastewater centrifugal pumps up to 700 HP. The new PumpSmart Version 4.0 has new features that improve pump reliability and performance by protecting the pump from operating in upset conditions and matching pump speed to process demands. The integrated logic also

enables the ability to monitor the condition of the pump and predict wear to the hydraulic components.

The new Model PS200 Version 4.0, provides the following major improvements: a patent pending feature called **Torque Pump Protect (TPP)**. TPP provides advanced pump protection without the need for external sensors. TPP is an algorithm that monitors pump loads to determine conditions of operations such as running below minimum flow, dry running and run out conditions. TPP has the unique ability to compensate for speed changes, and for mechanical losses that are common on smaller pumps with mechanical seals. TPP is capable of being used on all operating macros, including speed control and multi-pump processes.

The new **MultiVariable Control** feature is a ratio controller that allows a set point to be manipulated by three ranges of a second process transmitter. This feature is perfect for advanced temperature control, blending applications or to help protect against pump cavitation caused by varying suction conditions. The MultiVariable Control feature on PumpSmart Version 4.0 eliminates the need for a PLC or DCS system.

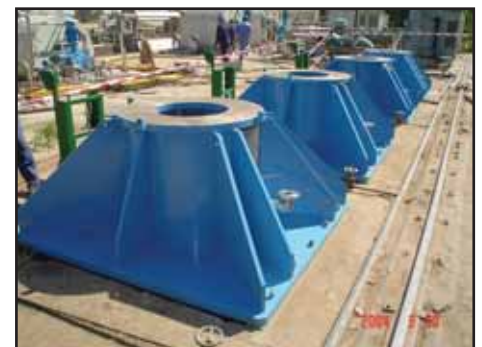
The Model PS200 Version 4.0 contains a **patented pump wear monitor**, which enables it to automatically identify pump performance decreases due to the wearing of hydraulic components. This wear monitor works on any centrifugal pump and does not require performance data to be fed into the drive. The Model PS200 Version 4.0 provides multi-pump control, controlling up to 4 pumps in coordinated fashion to meet system demand and maximize pump performance and reliability. In addition, the units can alternate lead and lag as desired.

The PumpSmart PS200 v4.0 is available in a number of engineered configurations including bypass starting, low harmonic options, and SCADA control integration.

As with previous PumpSmart models, energy savings in the 30-70% range are obtained because at lower demands the Model PS200 Version 4.0 reduces the motor speeds eliminating the extra energy that's used to overcome the pressure drop of control valves. This new model can be applied to any centrifugal pump in a wide range of industrial and municipal applications. ■■■

Goulds Aids the Reconstruction Effort in Iraq

In support of reconstruction efforts in Iraq, Bechtel is under contract with the U.S. Agency for International Development (USAID), for the emergency repair, rehabilitation, and reconstruction of critical elements of Iraq's infrastructure. This includes assessing and repairing power, municipal water, and sewage systems. ITT Engineered Products Division has been a major supplier to Bechtel of Goulds and A-C pumps for power, water and wastewater services. We have received a Certificate of Recognition for the Iraq Infrastructure Reconstruction Program for meeting and exceeding expectations. ■■■



Four 36" Goulds vertical cooling water pumps are installed in an Iraqi power facility.

Send your comments or suggestions to:

John Beca - ITT Industrial Products Group, 240 Fall Street, Seneca Falls, NY 13148 or email: john.beca@itt.com

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