Ductile Iron News

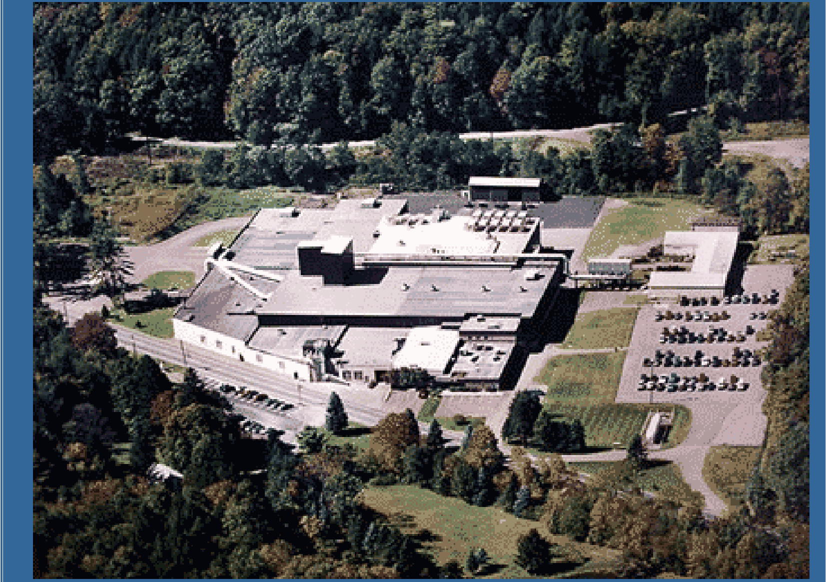
Ductile Iron Society

To Promote the production and application of ductile iron castings Issue 2, 2003

FEATURES

DEPARTMENTS

DIS Visits Benton Foundry - June 2003



Touring Benton Foundry
See Photos from the Technical Meeting

Located in Strongsville, Ohio, USA
15400 Pearl Road, Suite 234; Strongsville,Ohio 44136
Billing Address: 2802 Fisher Road, Columbus, Ohio 43204
Phone (440) 665-3686; Fax (440) 878-0070
email:jwood@ductile.org

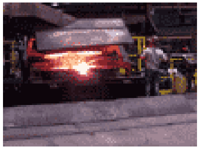
Ductile Iron News

Ductile Iron Society

To Promote the production and application of ductile iron castings

Issue 2, 2003

Touring Benton Foundry - June 2003


Melting Operations


Laboratory


Covered Scrap Storage


Molding Lines

See Photos from the Technical Meeting

Located in Strongsville, Ohio, USA

15400 Pearl Road, Suite 234; Strongsville,Ohio 44136

Billing Address: 2802 Fisher Road, Columbus, Ohio 43204

Phone (440) 665-3686; Fax (440) 878-0070

email:jwood@ductile.org

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings *Issue 2, 2003*

FEATURES

- Cover Story - DIS Visits Benton Foundry
- DIS Annual Award to Kathy Havrynen
- College Industry Conference Preview
- Nodule Count - Why and How!
- A Review of the North American Foundry Industry
- Metalcasting Industry Releases 2003 Operational Cost Survey Results
- AFS Cast Iron Marketing Committee Introduces New Website for Material Property Comparisons
- Boron Related Hardness Problems
- Survey on Ductile Iron Practice

DEPARTMENTS

- News Briefs

Technical Meeting at Benton Foundry


Retiring Director Frank Headington receiving certificate from Denny Dotson


Our Host from Benton Fritz Hall


Denny Dotson receiving the Retiring President Award from Alan Druschitz


Jim Csonka - Speaker


Gideon Malherbe - Speaker

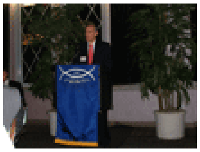

Bob Voigt - Speaker


Dan Mayton - Speaker


Steve Otten - Speaker


Look I found a cousin!
Jim and Frank Headington


Technical Chairman Gene Muratore

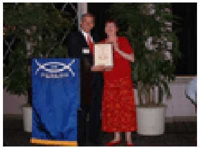

Denny Dotson
Annual Report

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings *Issue 2, 2003*

DIS Annual Award Goes to Kathy Hayrynen

Kathy Hayrynen accepts the Annual Award. From left John Keough, Kathy Hayrynen, Kristen Brandenberg, Jerry Wurtsmith

Kathy Hayrynen with John Keough



Kathy Hayrynen accepts the Annual Award from Denny Dotson

Immediately upon joining Applied Process, Kathy became one of the most active members of our Research Committee.

While on the committee Kathy has initiated research projects, designed the experiments, monitored the projects and edited the results before publication. She has also served as a subcommittee chairperson. All this work has been done without any complaint about too much to do.

In addition to this, Kathy was the prime mover in the organizing of our recent ADI Conference. She contacted the speakers, reviewed the papers, coordinated with our cosponsor AFS and made this one of our most successful meetings.

Keep in mind that all this could not be accomplished without the support of Applied Process and we thank John Keough for this.

We congratulate Kathy on a job well done and hope that she will continue her fine service for many years to come.

FEATURES

- Cover Story - DIS Visits Benton Foundry
- DIS Annual Award to Kathy Hayrynen
- College Industry Conference Preview
- Nodule Count - Why and How!
- A Review of the North American Foundry Industry
- Metalcasting Industry Releases 2003 Operational Cost Survey Results
- AFS Cast Iron Marketing Committee Introduces New Website for Material Property Comparisons
- Boron Related Hardness Problems
- Survey on Ductile Iron Practice

DEPARTMENTS

- News Briefs

College Industry Conference Preview

November 13-15, 2003

The banquet on Thursday night, November 13, 2003 will be back at the Drake Hotel. We are turning the Grand Ballroom into the city of Chicago complete with downtown buildings and various neighborhoods serving local foods. Guests will enter through a replica of one of the entrances to Grant Park complete with two brick columns, faux green wrought iron arch with park bench and lamppost to mark the way. We will also feature a Jazz group and various street artists to complete the ambiance of Chicago in a delightful evening with the sights and sounds and tastes of this great city.

Student Delegates will be taking a 90 minute Chicago Trolley Tour of the city complete with a slice of Chicago style pizza and a trip to the top of the Hancock Building.

The Annual College Industry Conference is the most positive event in metal casting. It is still the most well attended event in our industry. Your participation helps to cover the costs to bring students to this event which is extremely influential for students in making their career choice. Each year this conference brings together the top engineering students from all of the FEF affiliated schools in North America, Key Professors, University administrators, along with foundry men and women and their spouses from every size company. It is a magical time for students to see the leaders in our industry and for industry to see the future in the lives of these young people. It is an experience never to be forgotten. Check the website for more information, or wait for the detailed brochure which should arrive in late August.

The speakers this year include Dwight Barnhard, AFS; David Broski, Bradley University; Cheryl Machovec, Ford Motor Co.; Mark Osborne, GM Powertrain; and Todd Sternamen, Grede Foundries.

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings
Issue 2, 2003

FEATURES

DEPARTMENTS

Nodule Count - Why and How!

By James D. Mullins
Mullins Professional Services

The Nodule Count is usually defined as the number of graphite particles per a specified unit of area. The terminology is usually expressed as the quantity of nodules per square millimeter on a polished surface examined under a microscope at 100 magnifications (100 X). See picture below. To be considered, a nodule should be round or nearly so. When a graphite particle's length is two or more times its diameter, it is usually no longer considered a nodule. What is and what is not a nodule is part of what we call the nodularity rating, which can be from 0 to 100 %. A 100 % rating, which is the ultimate goal, means that all nodules are completely round, no matter how many there are. However nodularity rating is a separate subject and will not be considered in the balance of this article.

Why is nodule count so important? Nodule count can define the quality of the iron. Generally the higher the count, the better, but a certain relationship between the nodule count and the casting section modulus should be maintained. As casting section size increases (meaning slowed solidification), the nodule count generally goes down. Counts below 100 nodules mm^2 are common in 4 inch and over sections, whereas ¼ inch sections may have over 400 nodules. As the number increases the structure and properties become more uniform, segregation is reduced and carbides generally will be minimized. Higher counts will also generally produce more uniform nodule size. Additionally the fatigue strength for a given matrix structure will improve as will machinability.

The charge materials, alloy additions and metal processing including treatment and of course, inoculation, all affect nodule counts. It has always been my philosophy that the liquid base iron melt, before treatment, should have a low chill value. Whether this value is measured by the wedge test or through measurement of undercooling by thermal analysis, the results should be the same, indicating a well-nucleated base iron. Sulfur levels in the base iron are also very important. A minimum of 0.008% S should be maintained. Lower S levels can result in more carbides being formed as well as keeping nodule counts low. Preconditioning the melt with virgin charge materials and silicon carbide contribute to good base iron nucleation.

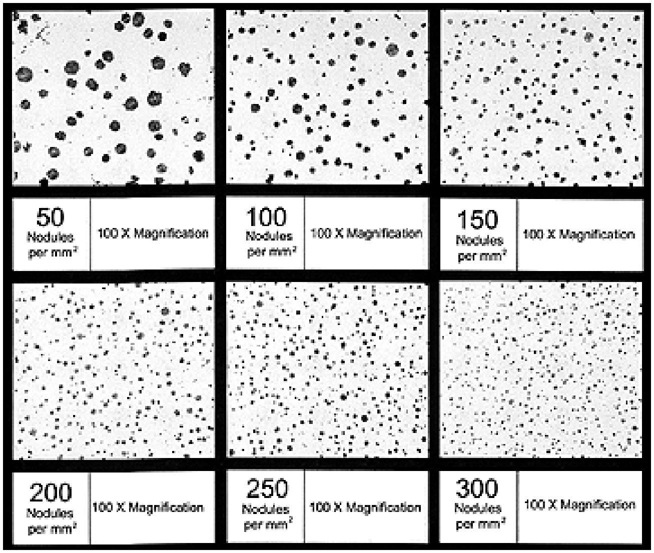
While the magnesium treatment reaction with MgFeSi does tend to remove some nucleating particles, it creates others. This iron is then most often, quite well nucleated before the inoculation step. This is not the case with pure magnesium treatments, which require a more severe inoculation addition, because most of the nucleating particles are reduced in the treatment reaction.

Inoculation is the next important step in the process. Increasing inoculation will usually increase the nodule count, but care must be taken to avoid the higher silicon concentration that can come with it. Usually the later the inoculation step is done just prior to pouring, the better, since inoculation fades with time. So in-stream and in-mold inoculation has gained much favor since fading is eliminated and the iron is somewhat cooler at the time of pouring thereby increasing the count.

The strength of the inoculant can change the result. In addition to the normal calcium and aluminum found in most FeSi alloys, elements such as Cerium, Lanthanum, Barium, and Bismuth are added to increase nodule counts. They may do this at a smaller addition rate than regular FeSi, as well.

Research work done by the Ductile Iron Society (Research projects 11 & 12) have shown the following regarding the promotion of higher nodule counts:

- Temperature of metal when inoculation was done - lower temperatures were better and fading is reduced.
- Faster solidification (thinner sections and those cast in green sand) increase nodule counts up to section sizes of about ½ inch.
- Calcium level around 1% in FeSi gives good nodule counts.
- Rare earth (RE) content should be at an optimum level.
- Higher nodule counts were obtained with La containing RE (40% La) than with Ce alone.
- Special inoculants, such as those containing Bi or Ba work well, giving higher counts. (Note that rare earths (Ce) must be used when Bi is employed.)



Nodule count per mm² at 100X. Courtesy of Rio Tinto Iron & Titanium

Nodule counts in various castings and different section sizes should be checked constantly to insure that the process is under control. Many foundries routinely check the nodule counts in all test bars that are tested as a quality measure. As previously mentioned the count should be as high as possible and consistent to avoid carbides and shrinkage and have good fatigue properties.

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings
Issue 2, 2003

FEATURES

- Cover Story - DIS Visits Benton Foundry
- DIS Annual Award to Kathy Hayrynen
- College Industry Conference Preview
- Nodule Count - Why and How!
- A Review of the North American Foundry Industry
- Metalcasting Industry Releases 2003 Operational Cost Survey Results
- AFS Cast Iron Marketing Committee Introduces New Website for Material Property Comparisons
- Boron Related Hardness Problems
- Survey on Ductile Iron Practice

DEPARTMENTS

- News Briefs

A Review of the North American Foundry Industry

Eugene Muratore
Rio Tinto Iron & Titanium America

The face of the U.S. foundry industry continues to change. The change in mix by metal types can be seen in Figures 1 and 2.

The Changing Foundry Mix
1965

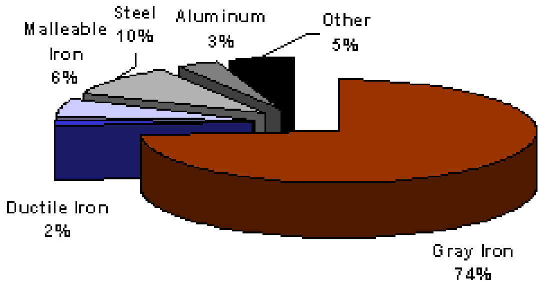


Figure 1

The Shipment Mix - 2002

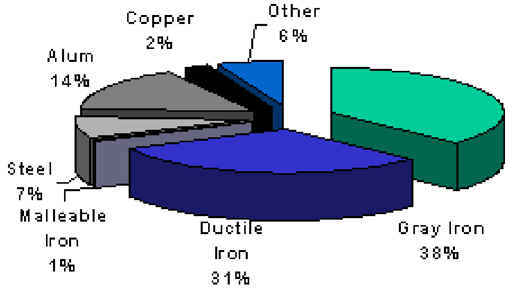


Figure 2

As can be seen from the chart, the casting market by metal type continues to grow in aluminum and Ductile Iron castings while gray iron and malleable iron castings continue to shrink. Steel castings remain relatively constant at about 10% of the entire market (by volume).

In terms of sales dollars, the U.S. foundry industry had $28.5 billion in sales in 2002. This represented 13.14 million tons of castings shipped. This level of shipments was virtually flat from 2001, but marked the first time in history that the U.S. was not the world leader in casting shipments. The People's Republic of China (PRC) reported casting shipments of over 14 million tons for 2002. The U.S. does remain the global leader in casting application.

U.S. foundries experienced demand and expansion during the 1990's. Historical trends point to the fact that casting shipments tend to peak in the mid decade years, and drop of at or near the end of each decade (See Figure 3). The current climate is one of fierce price compression and competition, not only within the U.S., but with more foreign competition than ever.

Cast Shipments 1943-02

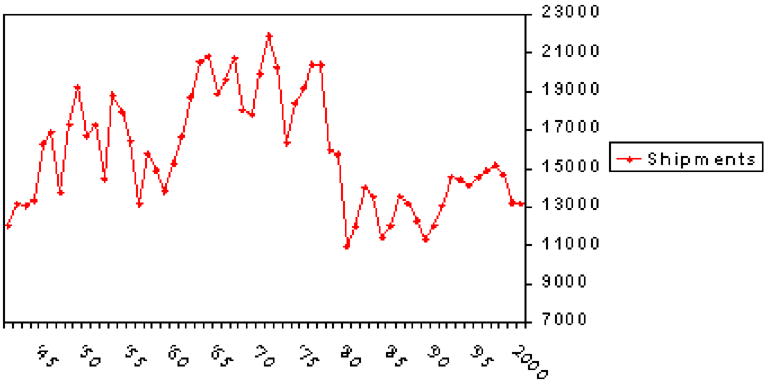


Figure 3

Gray iron shipments totaled 4.9 million tons in 2002, slightly less than 2001. The largest markets for gray iron castings remain automotive castings, municipal castings, and internal combustion engines. The shipment high for gray iron occurred in the mid 1960's to early '70's when gray iron shipments totaled over 15 million tons annually. Tonnage is forecast to remain flat or decrease over the next five years.

Ductile Iron shipments totaled 4.1 million tons in 2002, exhibiting a slight increase over 2001. The largest markets for Ductile remain pressure pipe, automotive castings and valves and fittings. The forecast for Ductile Iron is for growth each year. Sales dollars of Ductile Iron surpassed gray iron for the first time in 2002 and shipped tonnage is forecast to surpass gray iron near the end of this decade.

The practice of using imported castings in U.S. built equipment has been in place for over 20 years. Many of the early imported castings were directly supported by U.S. firms. The 1990's saw the tonnage of imported castings increase dramatically. In 2003, 15% of the entire U.S. demand for castings was filled by imports. This is more than double the amount of imported castings from 1998. These imports are valued at $4 billion and are felt across the board. That is to say, it is no longer the case that only inexpensive gray iron castings or simple to make parts are being imported.

Several factors fueled the increase in imported castings. A strong U.S. dollar gives U.S. residents a great deal of buying power on an international basis. Strong currency has a downside for manufacturers in that domestically produced goods are very expensive to economies with weaker currencies (e.g. South Korea, PRC, UK, and the EU). The expected result is a trade deficit. Secondly, labor rates are much lower in the countries that export heavily to the U.S. (PRC, Mexico, India, Brazil). In addition, subsidies, tax incentives and governmental policies may encourage, or even make possible, export or import situations that would not normally occur. Finally, corporate greed and a "flywheel effect" can also fuel imports. By "flywheel effect", a casting consumer may feel that since large corporations are placing casting orders into low labor rate economies, they will be left with limited choices if they aren't quick to join the ranks of "global sourcing".

As a first attempt to measure the effect of imported castings on the U.S. foundry industry, Modern Castings Magazine conducted a confidential trade survey in 2002. Of the foundries surveyed, over one third reported sales losses to exports in excess of 16%. Sixty percent of the respondents reported that imported pricing was 20-50% under the domestic sales price. The countries identified as sources for these low cost castings were PRC, India, Brazil and South Korea. As a result of this survey, the AFS Trade Commission was formed in April 2002 under the direction of Chuck Kurtti. The commission has 15 members and is committed "to facilitate an understanding of the full impact of global competition on the metalcasting industry and identify and create a roadmap of actions available for future consideration."

The domestic foundry industry can take several steps in an attempt to curb the flow of imported castings. First and foremost is to take a marketing approach to the sale of castings. An examination of the major casting end use markets (See Figure 4) reveals that although cars andlight trucks consume a high proportion of the castings produced, the margins on these castings.

are the smallest. An alternative approach is to identify markets that are not represented on the pie chart. There are thousands of applications for castings in components that are currently forged, fully machined from bar stock, or fabricated from metal. Conversions from these other forming methods offer cost savings to the end user and may offer profitable casting opportunities to the metalcaster.

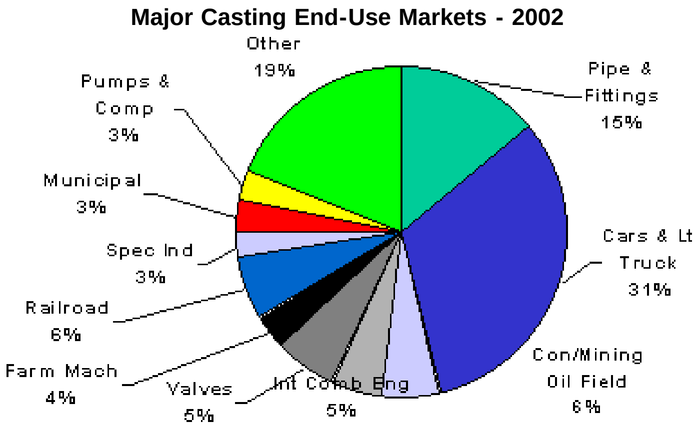

Major Casting End-Use Markets - 2002

Figure 4

A second action to increase domestic casting sales is the use, transfer, and communication of technology. There has been sufficient research performed on the steps necessary to produce thin wall (less than 3mm) Ductile Iron castings and implementation can and should now take place. Through the use of predictive modeling and casting simulation, cast iron has become and is a “high tech” material. Austempered Ductile Iron continues to grow at a double digit rate. All of the above technical advantages of castings, and specifically Ductile Iron castings, must be effectively communicated to the design community and the materials acquisition sectors. An even more specific illustration is the following comparative analysis:

Material	**$ Cost per Unit of Yield Strength (Newtons)**
Gray Iron	$6/N
Steel Casting	$6/N
Malleable Iron	$5/N
Ductile Iron	$3.4/N
ADI	$2.5/N
Aluminum Casting	$40/N

Finally, foundry management must continue to evaluate productivity improvements, responsiveness to customer demands, and partnership opportunities with value added operations such as machining or surface hardening.

(The author is indebted to Mr. Mike Lessiter of Modern Castings and Mr. Ken Kirgin of Stratecasts Inc. for their invaluable data and insight.)

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings
Issue 2, 2003

FEATURES

DEPARTMENTS

Metalcasting Industry Releases 2003 Operational Cost Survey Results

FOR IMMEDIATE RELEASE
Contact: Mike Lessiter, mlessiter@afsinc.org
June 9, 2003 800/537-4237 x 213

In order to provide vital benchmark information for U.S. metalcasters, the 2003 Metalcasting Operational Cost Survey was commissioned by the American Foundry Society (AFS) and the North American Die Casting Assn. (NADCA) and conducted confidentially by Sapolsky Research, Inc. of Tallahassee, Florida. Surveys were distributed to U.S. metalcasting operations in March 2003 to complete based on their most recently completed fiscal year.

More than 125 companies participated in the survey and the results were combined for the entire industry as well as broken down by metal type, process type, employment size and sales dollars. The sales of the participants amounted to approximately $2.05 billion and covered 16,074 employees.

The results of this report, which cover more than 30 individual expense categories, revealed that the operating profit for the average metal casting company was less than 2%. A total of 62% reported a profit, with the remaining 38% participants reporting a loss. The average expenses for all the major areas of metalcasting operations, as a % of sales for both profitable and unprofitable firms, can be seen in this report.

As a service to the membership, customized reports were prepared for each survey participant that was a member of either the AFS or NADCA. The results of the survey are detailed in a report available for purchase by contacting one of the following organizations.

American Foundry Society
505 State Street
Des Plaines, Illinois 60016-8399
800/537-4237 * 847/824-0181 * Fax: 847/824-7848
www.afsinc.org

North American Die Casting Assn.
9701 West Higgins Rd., Suite 880
Rosemont, Illinois 60018-4721
847/292-3600 * Fax: 847/292-3620
www.diecasting.org

View Ductile Iron Related Publications

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings
Issue 2, 2003

AFS Cast Iron Marketing Committee Introduces New Website for Material Property Comparisons

Des Plaines, IL. In order to facilitate better decisions regarding material selections and component designs, a new interactive website, www.ironcastings.org, has been unveiled by the Cast Iron Marketing Committee (5-M) of the American Foundry Society (AFS). This free online resource allows engineers to quickly create side-by-side material property comparisons between cast metals and other materials for a more informed material selection decision.

When designers do not have access to full comparative property data, a material or process selection often results in a sub optimized design. This results not only in higher costs, but also designs that are unsuited for the intended application, or those that have not considered cast-in features or part consolidations. The website is a tool to gain that knowledge.

Conceived by previous Committee Chairman John Keough of Applied Process and coordinated by his staff, the site is linked to MatWeb, a comprehensive database of more than 33,000 metals, plastics, ceramics and composites.

"Our committee set out to provide a tool that design engineers could use to compare the engineering characteristics of today's cast irons-and all metals for that matter-against alternative materials," said Committee Chairman Ken Moore, Interstate Castings, Indianapolis.

In addition to its use for the component designer, metal casting engineering and sales personnel are also encouraged to use the web-based tool to collect information that can be useful in stating castings' attributes to customers.

Founding sponsors of the site include: Applied Process, Inc.; Bremen Castings, Inc.; Citation Corp., Ductile Iron Society, Engineered Casting Solutions; Gartland Foundry; Interstate Castings; Metal Technologies Group and Siempelkamp.

For more information about the AFS Cast Iron Marketing Committee and its projects, contact committee liaison Mike Lessiter at mlessiter@afsinc.org.

Headquartered in Des Plaines, Illinois, AFS is a not-for-profit technical and management society that has existed since 1896 to provide and promote knowledge and services that strengthen the metal casting industry for the ultimate benefit of its customers and society.

Instructions: This page allows you to quickly access all of the polymers/plastics, metals, and ceramics/other en
the MatWeb material property database. Just select the material category you would like to find and then click t
to its box. You can then follow the links to the most complete data sheets on the Web, with information such as
Poisson's ratio, glass transition temperature, dissipation factor, and Vicat softening point.

Notes:

Shown is a screen capture of www.ironcastings.org.

[View Ductile Iron Related Publications]

Located in Strongsville, Ohio, USA
15400 Pearl Road, Suite 234; Strongsville,Ohio 44136
Billing Address: 2802 Fisher Road, Columbus, Ohio 43204
Phone (440) 665-3686; Fax (440) 878-0070
email:jwood@ductile.org

Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings
Issue 2, 2003

Boron Related Hardness Problems

Presentation to DIS T & O meeting
Daniel A. Mayton
June 3, 2003

I spoke about the process of identifying and correcting the most nefarious problem we ever encountered in all the years we have been making Ductile Iron at Urick Foundry.

Urick Foundry was started sometime around 1900. It was a Gray and Ductile iron foundry that made large motor castings until 1985, when it was converted to a Disamatic, 100% ductile iron shop. Presently the melting is in a water walled cupola with channel induction holding. The pattern tooling is plastic and the treatment method is "Delayed Inmold". This method was used because of its simplicity, ability to use automatic pouring, lack of fade, and the high elongation properties due to the late inoculation. Our parent company is Ridge Tool, Elyria Ohio, a subsidiary of Emerson Electric, but we also make castings for several other customers. The primary trade customers are railroad, truck hardware, valves, and electrical insulators. We also do some work with recreational vehicle hitches, dentist chairs, ATV parts, and compressor crankshafts. Our castings are finished in cells and shipped quickly since the finished goods storage space is limited. We use an 92 AFS base molding sand, primarily for the finish on the pipe wrenches, but also on other castings where cosmetic finish is important. Much of our product is Austempered, and we also coordinate machining and painting with local shops in Erie for those customers who have those requirements.

When we started to see changes in our BHN numbers, we wondered what was going on in our process. It had been running well since 1985. The "soft iron" was a problem that hit us like a tornado and left us stumped.

On February 13, 2002 we saw the first symptoms. I received word that the pearlitic ductile iron we were producing was below the hardness requirements. What normally gave us BHN's of 229 to 255, began to be about 217. We immediately quarantined the castings and checked the chemistries to see what was wrong. The Copper content was correct, and all the other elements were within range. We looked into the Boron content, realizing that back in 1986 we had a similar problem when we had used briquetted cast iron materials. This melt stock was supposed to be made from chips from our own castings. However, we found that the material sent to the briquette operation was mixed with some Malleable Iron turnings, which had boron in them. Consequently we had a boron buildup in our metal. We stopped using the briquettes and the problem immediately disappeared. The cost was some heat-treating, but the problem was solved quickly. This time, we saw no evidence of Boron in our chemistry so we were stumped. We immediately contacted our alloy suppliers for help, sent samples from castings before and after February 13, and waited for the results. In the meantime, we tried several solutions such as increasing the copper level, with no change. We finally resorted to alloying with Tin and that produced the hardness and microstructure we needed. It was the first time we had used Tin and had no comfort level with it. According to the Ductile Iron Handbook, the pearlite stabilizing influence of Tin is at least ten times times that of copper, and six times that of chromium, but even it had no effect until we used more than 0.04%.

When the results of the initial investigations from our suppliers turned up without a clear answer, we remained stumped. Their chemical analyses did not show anything amiss, and the Boron contents were practically nonexistent. Actually, in one report, the Boron content was higher in the "good"" sample. A literature search produced an article that looked familiar, it was written by Lyle Jenkins in Ductile Iron News, 1995, and talked about Boron causing soft pearlitic iron. He stated that it was caused by new linings in electric furnaces, by wrought iron base alloys, by Boron treated steels, by Malleable iron, and by cast Cobalt based superalloys. He stated that Boron is difficult to measure in a spectrometer because the spectral lines of sulfur and boron are very close and sulfur can affect the Boron reading. He suggested a need for research to determine if Boron, causing soft castings, also causes reductions in toughness and fatigue strength. About that time, I ran into Professor Carl Loper at an FEF meeting and discussed the problem with him. He told me Boron was the culprit, and to repolish my micros and look for tiny nodules which would be the result of Boron Nitrides. I told him I would but did not really think that was the answer. I subsequently called Professor Wallace and discussed the problem with him. I asked if there was anything else beside Boron that would cause these problems. Initially I thought our iron was either too clean, since we use about 10% Pig Iron, or some other element was creeping into the melt that we didn't analyze for. He told me that Boron was the probable culprit, but that I should analyze all the materials going into the iron and see if anything had changed. We began an investigation of all the materials, but that took some time to complete.

In early April I called AFS and talked to Norm Bliss, the Technical Director, to see if AFS had any information of what may be the cause. He said he would do a search, but that he had received numerous calls from others having the same problem. We had a meeting at the AFS Casting Congress and hash it out. When I entered the room that Norm scheduled for the meeting and was surprised that it was packed. Several professors, many foundry men and suppliers were all there. It seemed incredible that we all were experiencing the same problem. I remember Bill Powell of Waupaca foundry saying he had never experienced "such an odd phenomena". He stated that he had to "junk up the iron with tramps" to get the Brinell hardness he needed in his pearlitic iron. The result of that meeting was that there was in fact something in the steel we were buying, probably Boron, which had to be the culprit. We were all going to go back and check our sources and see what we could find. I also learned that this phenomenon occurred in both Gray and Ductile irons, in both Cupola shops and Electric melt shops, and was happening from Kansas to Pennsylvania and beyond. We did however; open up a dialog that was very helpful. It seemed that Boron could indeed be the culprit and that we needed to take a fresh look at our chemistries.

In early May, we began an in depth study of all the possible changes that might have occurred at Urick in the previous months. Anyone involved with melting was interviewed, as were our suppliers of steel and alloys. We listed several possible causes: the pig, the steel, the sand, the alloys, the cores, and the inoculants. We sent each out for analysis for Boron. We also started to take another look at the Boron content of the pearlitic ductile and the ferritic ductile.

We noticed for the first time that the Boron content of the pearlitic ductile was higher than that of the ferritic ductile. We thought that was strange since all the materials going into the charge were the same, except for the copper. We filed this away for further study. In the interim, we started receiving Boron analyses from the outside labs. Finding nothing, we began to really look at our chemistries, downloading all the numbers to an excel worksheet to allow us to graph them.

Finally, about May 7 or so, we discovered that we had an increase in Boron over time. When we graphed all the data, there was a peak in boron coinciding with the times we ran pearlitic ductile. We found out that we were standardizing with a different standard, because of the copper, and that the system did not recognize Boron in our standard iron. Since we ran pearlitic iron once per week at most, we had not recognized the trend, until it was separately graphed. See spreadsheet graph of B concentration by date.

When we analyzed the historical chemistries for Boron, we noticed that the jump was a very small one. We went from about .001% to .002% with our standards and on our spectrometer. This seemingly small jump however, is exactly where the problem occurs for us. Below .0012% or so the iron seems to act normally. Above this number, the effect is enormous, until you reach about .01% where the effect reverses itself and Boron Carbides form causing loss of elongation, machining problems, etc. This small amount can come from anything; refractory material, steel, alloys, even the bark of trees used to make paper bags that we use to add alloy. We even wondered if the Boron Nitride disc in the spectrometer was the culprit. The graphs showed that clearly this phenomenon occurred over time and had a distinct jump on February 13. The problem with trying to discover the source of Boron is the variation in results from one lab to another. We checked steels, both at our lab, at our source lab, and at outside labs. Most of the time the results were inconclusive, but over time we found a pattern emerging.

We found that a certain type of slitter scrap seemed to have more Boron in it than punching scrap. We also found traces of Boron in other materials such as Copper, discs we use in our inmold process and in the FeSi and FeMn we use, and even in the CaC_2 we use to desulfurize. All these however, were so low that they could not affect the overall Boron chemistry when one looked at their total contributions on a mass balance level. We even looked at our sands, cores, and outside purchased cores, only to find the same thing. We needed something significant, something that was high in Boron, and something that was a large part of the charge. Until we found the main source, we started controlling where we bought our steel and by the end of May, we noticed a drop in Boron content of about .0005% to .0008% per day. This was encouraging, but we realized that since Boron was in our sprue and that we only used the pearlitic sprue once per week, it would take a long time to flush it out of the system. Things progressed and by the end of June, we were finally in a position to stop adding Tin. We did notice that our Boron levels plummeted when we changed SiC suppliers. We didn't know if this was significant or was caused by a water leak in the cupola, but we were at the .006 % B level, a place we hadn't been since February.

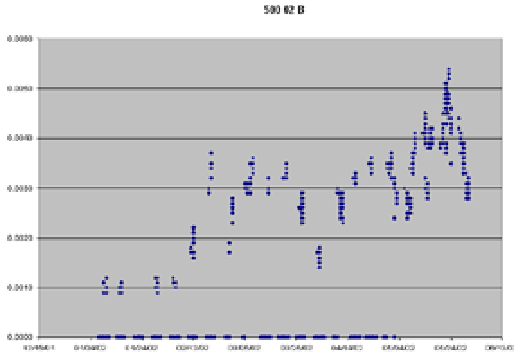
The results were short lived however, as Boron came back with a vengeance in mid July and August. Finally, on August 16, six horrible months after the start of the problem, we found that one day (while we were running low Boron levels), the Boron spiked. The concentration went from .0005% to .0011% and then to .0032%, all in two hours span.

Fortunately the lab and the melt department were looking for anything like this and they immediately went to the Cupola and discovered a lone skid of SiC that was left over from the previous month was brought out and used during the night. We immediately stopped using it and the Boron returned to normal. We had our culprit, and all that was left to do was find out why the various SiC sources varied in Boron Content. Our suppliers analyzed their components and found that the source appeared to be a filler used in the SiC. It was made from crushed SiC crucibles, which contain Boric Acid, the same material that causes problems in recently sintered coreless furnaces. One of our suppliers went so far as to analyze all his SiC materials, both domestic and Chinese. He found that the Chinese 50% SiC had the highest value, while the 88% had the lowest. He also found that the domestic material was low, both the 45% grade and the 85% grade. He found "Plate scrap" to be the highest (.0059%) vs. Chinese 88% and domestic 45% to be the lowest at .001%. Our own analysis from several outside labs showed similar results, although results often varied widely. In my last discussions with our current supplier, I suggested that they market a "Low Boron" grade of SiC similar to "Low Sulfur" graphite. They said the cost for analysis was high but they would think about it.

Although Tin can is used to increase hardness, it must be handled with care. Tin causes a decrease in machinability at the same hardness value, and a drop in impact resistance. It is important to discuss this with customers so they know what the options are. Both heat treatment and Tin additions affect the overall costs negatively, and must be used only when necessary.

Conclusions and Recommendations

1. Be sure that your Boron channel on your spectrometer is accurate. Round robin test it against other labs to be sure it is giving you the information you need.
2. Discuss SiC chemistry with your suppliers and determine where they are with Boron. You may have to use several independent labs to find one you can trust. Work with your suppliers to get the lowest Boron content materials you can. Higher Boron SiC can be from the source as well as additional ingredients added.
3. Work with your steel suppliers to find trusted sources. Avoid spot buys and short-term suppliers. Test all incoming steel. Watch not only for Boron, but other tramps as well. Titanium, Manganese, and Chrome are other tramps that frequently occur. Add Boron to the list of elements you chart. If Boron climbs above .001%, take action to reduce it.
4. And a final note; until a magic pill can be found to neutralize Boron, the only practical way to deal with it in Ductile Iron is to eliminate it. It has been found that increasing the Titanium content will tie some of it up, but this doesn't work well in Ductile. The base Titanium in your iron should be a known value however, because changes in Pig iron may alter long-standing relationships with Boron and Titanium in your base iron, negatively affecting the hardness values. If the Titanium is lower than normal, Boron will go after Nitrogen, forming Boron Nitrides, increasing the count of very small nodules, thereby making the iron virtually self-annealing. The answer seems to be total control of two of the most important raw materials in the system, Steel and Silicon Carbide. If either one begins to show increasing amounts of Boron, take immediate action to eliminate it.



Ductile Iron News
Ductile Iron Society
To Promote the production and application of ductile iron castings Issue 2, 2003

Survey on Ductile Iron Practice

Due to the size of this article, the table of contents is not shown - Return to the Ductile Iron News Home Page

AFS Molten Metal Processing Committee 5-L

J. M. Csonka - Hickman, Williams & Company, Brook Park, Ohio
E. C. Muratore - Rio Tinto Iron & Titanium America, Rosemont, Illinois
J. E. Woods - Hickman, Williams & Company (retired)

ABSTRACT

The AFS Molten Metal Processing Committee (5-L) sent out a survey (see Appendix) to North American ductile iron producers, which requested information on each foundry's ductile iron practice. The information requested included the areas of melting, base iron chemistry, nodulization, post inoculation, quality control and the types of ductile iron that were being produced at each shop. The results contained are for the fourth of a series that originally started in 1957 and were then followed up in 1978, 1988, and 1998. The foundry responses were broken down into two groups, those producing more than 200 tons of ductile iron per week and those producing less than 200 tons of ductile iron per week. The response data should provide insights into historical process trends.

DISCUSSION OF RESULTS

Surveys were sent out to 508 foundries in the United States, Canada and Mexico. The committee received 196 responses, which would have put the return rate at 38.5%. However, 9 of these responses had little or no information and were deleted from the data pools. This brought the actual responses used to 187 and gave a 36.8% return figure. The committee felt this was an exceptional rate of return for a survey this large. In the 1988 survey, there were 77 returns, but those 77 responses corresponded to about a 50% return rate. As in the past, the results of each sub-category are reported as a percentage of the total return for that group. Also, as in the past surveys, the results were split with foundries producing more than 200 tons of ductile iron per week and less that 200 tons of ductile iron per week. There were 74 responses for foundries producing more than 200 tons, and 113 responses for foundries producing less than 200 tons per week. Foundries that included more than one response per category rationalize the group totals that exceed 100%. This would include foundries that have multiple types of melting groups, treatment methods, treatment sizes and others. Group totals that are less than 100% are due to foundries that did not answer the given question. This would include foundries that do not use certain processes or foundries that were confused by what the survey was asking.

Please note that in the text the terms "foundries that produce more than 200 tons of ductile iron per week" have been replaced with "large foundries". Likewise, "foundries that produce less than 200 tons of ductile iron per week" have been replaced with "small foundries". This is done only to make the text easier to read and is not to be taken as an indication of the size of the foundries that responded to the survey.

Designing a survey that can cover such a diverse process as ductile iron production is a difficult task. While the pipe shops use certain practices, these can differ greatly from the high volume ductile iron producer's practices and even more from the shops that are only occasionally producing a few ductile iron castings. These diverse practices yield trends that vary greatly from each other, but the trends within each group give very good indications of where each group is headed. The survey has been changed every time it has been sent out. This survey is entirely new as the edition from 1988 could not be located and therefore could not be replicated. To ensure that the future surveys are comparable, the survey that was used for this study is included with this report. Responses listed as "not applicable" correspond to survey questions that were not asked in this, or previous, surveys. The data from this and the past surveys are listed in the master data table (Table 1.)

MELTING AND HOLDING

The 1957 survey revealed that primary melting was conducted in a cupola for 65% of those responding to the survey. Cupola melting has since changed dramatically for both responding groups. For the groups producing more than 200 tons of ductile iron per week cupola melting dropped to 39% in 1978, increased to 61% in 1988 and again dropped back to 30% in 1998 (Figures 1 and 2). Coreless induction melting has been on the reverse curve as it went to 45% in 1978, dropped to 38% in 1988 and then rebounded to 62% in 1998. The foundries that are producing less than 200 tons of ductile iron per week have not changed nearly as much in the last 10 years. Cupola melting went from 25% in 1978, dropped to 4% and then 8%

in 1988 and 1998 respectively. Coreless induction melting remained at the 84% level for both 1988 and 1998, increasing from 44% in 1978. Holding iron was reduced across the board for both production rated groupings going from 92% to 64% for the greater than 200 ton group and 36% to 13% for the other. While the channel holders and coreless induction holders remained about the same for the greater than 200 tons per week grouping over the last 10 years the arc furnaces and fore hearth holders both decreased. For the less than 200 tons per week group channel holding furnaces took the biggest drop in the last 10 years decreasing from 24% to 7%.

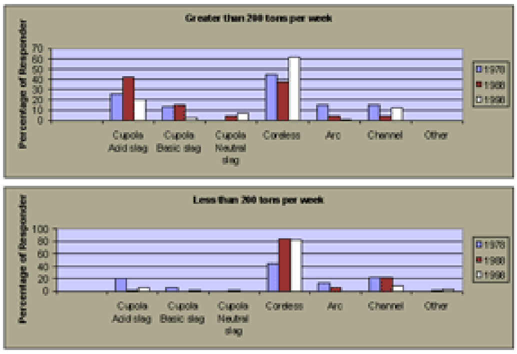


Figure 1. Melting.

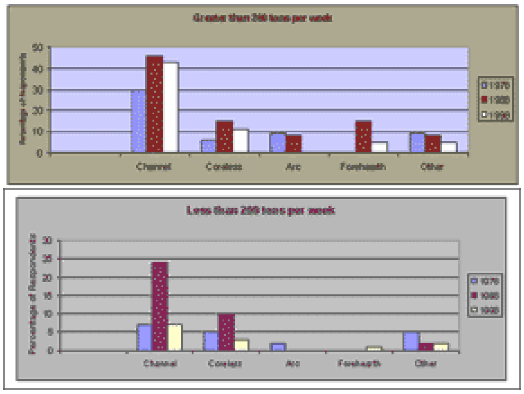


Figure 2. Holding.

BASE IRON INFORMATION

For both size groups, the carbon levels remained very stable with the 3.60% to 3.90% level being the most favored. The larger foundries showed a dramatic shift downward in sulfur levels from 54% greater than 0.036% in 1988 to only 26% in 1998, and correspondingly an increase in the less that 0.015% group (27% in 1988 to 42% in 1998). This makes perfect sense as the number of larger foundries melting in cupolas has dropped by 22% in the last 10 years. The smaller foundry drop to favor the less than 0.015% grouping. Although the melting furnace types for the smaller foundries did not change, the lower sulfur base iron levels suggest higher quality melting materials are being used. This is also reflected in the silicon levels for both foundry groups moving upward from the less than 1.30% level up into the 1.30% to 1.60% grouping.

DESULFURIZATION

For the smaller foundry group, 8% use cupolas and 8% show some type of Desulfurization. For the larger group the number of foundries that desulfurize is down to 34% from 55%, again reflecting the drop in cupola melting shops. Batch desulfurization has declined in all groups and the only real increase is in the two larger tonnage groupings of the continuous desulfurization, 20 to 30 tons per hour and greater that 30 tons per hour. For the larger foundries, the use of calcium carbide declined from 54% in 1988 to 18% in 1998 while the use of CaO/CaF2 showed the only increase from 0% to 12% for the last 10-year survey.

PRECONDITIONING

Across the board, preconditioning appears to have taken a severe blow in the last 10 years (Figure 3). For the larger foundry group 78% show no preconditioning is used while 85% of the smaller foundries likewise show no preconditioning. Using graphite as a preconditioner has taken the largest drop for both groups but the number of foundries using ferrosilicon and silicon carbide have also dropped significantly. There is some concern that the survey may have confused some of the respondents in this section.

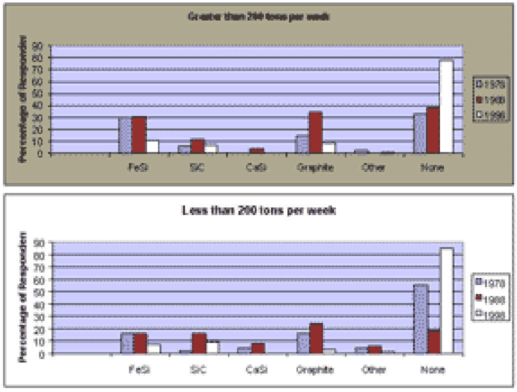


Figure 3. Preconditioning.

NODULIZING

Using tundish ladles has made the largest jump of all treating practices and now accounts for 50% of all large foundry treatments and 42% of all small foundries (Figure 4). The sandwich practice has taken the brunt of the blow in the larger foundries being down 16% in the last 10 years and the open ladle practice has dropped 24% in the smaller foundries. The smaller foundry grouping has shown increases in two areas with one being a 7% increase in the use of sandwich practice and a 5% increase in the flow through method to account for the large drop off in the open ladle practice. The larger foundries have shown an 8% drop in using the flow through method. Interestingly, in-mold treatment in the larger production group has taken a 5% drop in the last 10 years after taking a 3% drop in the 1988 survey. Magnesium containing cored wire is running a very small 3% of all foundries with pure magnesium treatment running at 7% in the larger foundries and 2% in the smaller group.

The MgFeSi use of the both groups has remained relatively unchanged in the last 10 years with the majority of users in the 5% to 6% grouping. Both groups show a 1% usage of 9% MgFeSi with the smaller foundries dropping in this category from 12% in 1988. The 3% MgFeSi group has taken a 7% drop in the larger foundries but remained unchanged in the smaller group. The only MgFeSi category that gained in both groups is the 6% to 7% MgFeSi which has taken some of the 5% to 6% users. The rare earth issue is undoubtedly still unclear in the minds of some as 27% of the larger foundry users and 39% of the smaller foundries claim not to use any rare earths in their MgFeSi at all. For those who do acknowledge using rare earths, the low cerium rare earths seen to be in the majority of both groups.

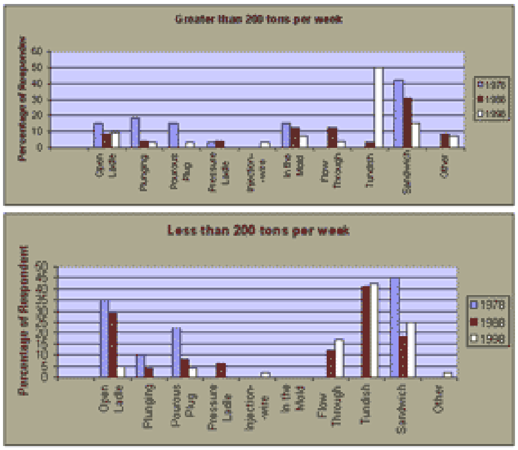


Figure 4. Treatment method.

Nickel magnesium alloys have shown a severe reduction in the last 10 years with only 1% of the smaller foundries showing any use at all. Magnesium ingot or bar has taken a slight drop with 7% of the larger foundries still using this product, mostly in pure magnesium converters.

With more tundish ladles being used, the addition level of the MgFeSi alloy has dropped off with 46% of the larger foundries running in the 1.0% to 1.5% range. This has been brought about by the focus on improving production practices and lower treatment temperatures that are obtainable when using tundish ladles. The smaller foundries are using fewer tundish ladles, running higher treatment temperatures and therefore are still running higher percentages, 1.6% to 2.0% of MgFeSi usage.

POST INOCULATION

Most all of the foundries surveyed indicated that they used post-inoculation this time as opposed to 42% of the larger foundries that indicated no post inoculation in the 1988 survey (Figure 5). At that time, it was felt that the lack of post inoculation was due to foundries using the in-mold process or pressure pipe producers. In-mold magnesium treatment has dropped off since the last survey so that may account for some of the difference, however, it is felt that there may have been some confusion on this subject during the last survey that was issued.

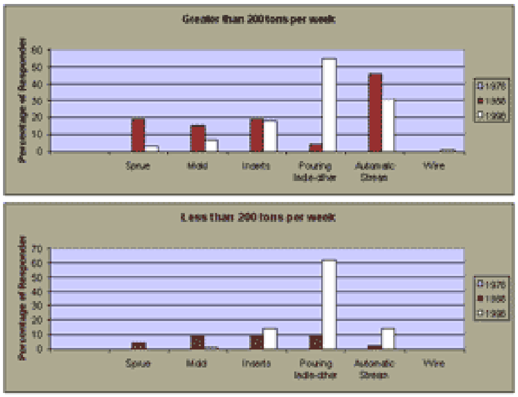


Figure 5. Supplemental inoculation.

Both foundry groups showed more than 50% of the post inoculation was occurring in the pouring ladle. A large number of the bigger foundries, 31%, are using in-stream inoculation. This figure is down from 46% in 1988. The smaller foundries in-stream usage has increased from 2% in 1988 to 14% in 1998. Inserts still have a steady fraction of the post inoculation practices with 18% of the larger foundries and 14% of the smaller foundries using inserts.

The most prominent post inoculant being used is a foundry grade 75% with greater than 0.8% calcium and 1.0% to 1.25% aluminum. This inoculant is being used in 50% of the larger foundries and 35% of the smaller foundries and these figures are very close to the last survey numbers. As in the past, other inoculants are 50% FeSi, 75% FeSi with 2.0% barium, 75% FeSi with 3.0% aluminum, 65% FeSi with calcium and barium and 75% FeSi with lower than 0.8% calcium and lower than 1.0% aluminum.

FINAL CHEMISTRY

Final carbon and silicon levels have changed very little when compared to the last survey issued in 1988. The larger foundries tend to run 3.65% to 3.84% carbon and 2.45% to 2.64% silicon while the smaller foundries tend toward carbon levels of 3.40% to 3.64% and silicon levels of 2.45% to 2.64%. Both groups are showing strong preferences for final magnesium levels of 0.030% to 0.040%.

TYPES OF DUCTILE IRON PRODUCED

The 1988 survey asked what percentage of each foundries work was ferritic, pearlitic, ADI or ni-resist. The current survey requested each foundry report the types of ductile iron that they produced. It is no surprise that both pearlitic and ferritic grades are the most common types of ductile iron that are produced. Pearlitic castings were reported as being produced by 85% of the larger foundries and 78% of the smaller foundries. The percentages of foundries that produce ferritic castings are 82% and 87% for the larger and smaller foundry groups respectively. Austempered ductile iron (ADI) castings are being produced by 9% of the larger and 6% of the smaller foundries, while SiMo iron was listed for 7% of the foundries that are producing more than 200 tons per week. Only 2% of the smaller foundries are currently making SiMo castings. Likewise, 2% of these foundries are also making ni-resist. None of the larger foundries currently responded to making any ni-resist castings.

POURING TEMPERATURE

Note here that the numbers for the 1998 survey exceed 100% by a large amount. This may be because the last survey asked the foundries to report temperature ranges and this current survey asked for temperatures only. The ranges that were previously established overlap by 50 degree segments and thus the higher than 100% responses. The two ranges that are preferred for both larger and smaller foundry groups are 2500F to 2600F and 2550F to 2650F for the first iron poured. These are very much in line with the last survey. However, there is a trend toward pouring at the 2400F to 2500F and 2550F to 2650F ranges for both groups of foundries when comparing with the 1988 survey.

QUALITY CONTROL

More than 70% of each foundry group used either a separately cast coupon or a flow off to check the nodularity as their primary source of nodularity control. The frequency that these tests were performed was not asked for the primary source. Some of the other methods to check the iron were 100% final chemistry check, 100% UT testing and 100% sonic testing. Using a cooling curve analysis was used in only 1% of the larger foundry group while 4% of the smaller foundries used this method for the primary quality control check of their iron. Some other methods mentioned were ring testing, ball impression, bend testing and cutting up a casting.

Table 1. Master Data - 1978, 1988, 1998

Melting	**Greater than 200 tons/week**			**Less than 200 tons/week**		
Cupola	1978	1988	1998	1978	1988	1998
Acid Slag	26	42	20	20	2	6
Basic Slag	13	15	3	5	0	2
Neutral Slag	N.A.	4	7	N.A.	2	0
Coreless	45	38	62	44	81	83
Arc	15	4	1	13	6	0
Channel	15	4	12	22	22	8
Other	0	0	0	0	2	3
HOLDING	1978	1988	1988	1978	1988	1998
Channel	30	46	43	7	24	7
Coreless	6	15	11	5	10	3
Arc	9	8	0	2	0	0
Forehearth	N.A.	15	5	N.A.	0	1
Other	9	8	5	5	2	2
BASE IRON INFORMATION						
% Carbon	1978	1988	1988	1978	1988	1998
<3.60	12	19	11	25	14	8
3.60 to 3.90	73	77	72	64	86	63
>3.90	9	4	7	15	4	4
% Sulfur	1978	1988	1988	1978	1988	1998
<0.015	24	27	42	5	29	38
0.016 to 0.025	30	12	15	36	61	23
0.026 to 0.035	18	4	7	25	6	1
>0.036	15	54	26	33	4	9
% Silicon	1978	1988	1988	1978	1988	1998
<1.30	45	23	8	44	41	19
1.30 to 1.60	58	31	47	40	37	27
>1.60	21	35	34	18	24	27
Carbon Equivalent	1978	1988	1988	1978	1988	1998
<4.0	N.A.	8	12	N.A.	10	4
4.0 to 4.3	N.A.	58	30	N.A.	57	42
>4.3	N.A.	65	47	N.A.	27	28
DESULFURIZATION						
Quantity Treated, tons Batch	1978	1988	1988	1978	1988	1998
0 to 2.5 tons	9	4	3	16	14	5
2.6 to 5 tons	9	4	1	4	4	1
10 to 15 tons	12	12	4	2	0	0
> 15 tons	6	4	1	5	10	0
Continuous	1978	1988	1988	1978	1988	1998
<10 tons per hour	N.A.	4	0	N.A.	0	0
10 to 20 tons per hour	N.A.	12	7	N.A.	0	2
21 to 30 tons per hour	N.A.	0	7	N.A.	0	0
> 30 tons per hour	N.A.	9	12	N.A.	0	0
Method Used	1978	1988	1988	1978	1988	1998
Porous Plug						
Batch	12	4	4	29	10	4
Continuous	N.A.	27	22	N.A.	0	1
Stirrer	6	12	0	0	0	0
Shaking Ladle	6	4	1	2	0	0
Other	12	8	7	9	0	3
Desulfurizer Used	1978	1988	1988	1978	1988	1998
CaC_2	12	54	18	33	6	7
CaO/CaF_2	N.A.	0	12	N.A.	0	1
Mg	N.A.	4	4	N.A.	2	0
Zorvex	N.A.	N.A.	1	N.A.	N.A.	0

Other	N.A.	N.A.	0	N.A.	N.A.	1
Desulfurization Temp. °F	1978	1988	1988	1978	1988	1998
<2600	0	4	1	4	2	0
2600 to 2700	9	12	12	9	6	4
2710 to 2800	30	38	16	27	12	3
>2800	4	4	3	4	4	1
Temp. Loss, °F	1978	1988	1988	1978	1988	1998
<50	N.A.	19	N.A.	N.A.	4	N.A.
50 to 100	N.A.	31	N.A.	N.A.	10	N.A.
110 to 150	N.A.	0	N.A.	N.A.	2	N.A.
160 to 200	N.A.	0	N.A.	N.A.	2	N.A.
>200	N.A.	0	N.A.	N.A.	0	N.A.
% Sulfur Prior to DeS	1978	1988	1988	1978	1988	1998
<0.015	N.A.	0	N.A.	N.A.	4	N.A.
0.016 to 0.025	N.A.	0	N.A.	N.A.	8	N.A.
0.026 to 0.035	N.A.	4	N.A.	N.A.	6	N.A.
>0.035	N.A.	58	N.A.	N.A.	4	N.A.
% Sulfur After DeS	1978	1988	1988	1978	1988	1998
<0.01	N.A.	23	N.A.	N.A.	6	N.A.
0.01 to 0.017	N.A.	35	N.A.	N.A.	10	N.A.
>0.017	N.A.	0	N.A.	N.A.	8	N.A.
PRECONDITIONING	1978	1988	1988	1978	1988	1998
FeSi	30	31	11	16	16	7
SiC	6	12	7	2	16	9
CaSi	0	4	0	4	8	0
Graphite	15	35	9	16	24	3
Other	3	0	1	4	6	1
None	33	38	78	55	18	85
NODULIZING Size of Batch, lb.	1978	1988	1988	1978	1988	1998
>1000	N.A.	19	12	N.A.	27	31
1000 to 2000	N.A.	23	41	N.A.	63	45
2001 to 4000	N.A.	35	30	N.A.	6	21
>4000	N.A.	35	31	N.A.	18	10
Treatment Method	1978	1988	1988	1978	1988	1998
Open Ladle	15	8	9	35	29	5
Plunging	18	4	3	10	4	0
Porous Plug	15	0	3	22	8	4
Pressure Ladle	3	4	0	0	6	0
Injection	0	0	3	0	0	2
In-Mold	15	12	7	0	0	0
Flow-through	N.A.	12	4	N.A.	12	17
Tundish	N.A.	3	50	N.A.	41	42
Sandwich	42	31	15	45	18	25
Other	N.A.	8	7	N.A.	0	2
Nodulizing Agent	1978	1988	1988	1978	1988	1998
9% MgFeSi	6	0	1	20	12	1
5 to 6% MgFeSi	67	77	72	51	78	64
2.5 to 3.5% MgFeSi	6	12	5	15	12	11
Other % Mg	N.A.	4	11	N.A.	2	9
Rare Earth's:						
Yes	N.A.	31	70	N.A.	55	61
No	N.A.	58	27	N.A.	0	39

Type: High Ce	N.A.	12	22	N.A.	25	25
Type: Low Ce	N.A.	19	49	N.A.	25	36
NiMg	0	8	0	9	20	1
NiMgSi	0	0	0	0	2	0
Mg Ingot, Bar, Pig	9	12	7	0	2	0
Gran Mg	N.A.	0	0	N.A.	4	0
Briq Mg-Fe	N.A.	0	0	N.A.	6	0
Other	0	8	0	5	0	1
% Addition of Material	1978	1988	1988	1978	1988	1998
<1.0%	6	4	9	0	0	1
1.0 to 1.5%	27	12	46	13	16	17
1.6 to 2.0%	9	35	16	35	33	24
2.1 to 3.0%	24	4	11	36	25	16
>3.0%	6	0	0	5	2	1
Treatment Temp. ^{o}F	1978	1988	1988	1978	1988	1998
<2600	3	0	11	15	2	4
2600 to 2700	33	46	41	44	24	22
2701 to 2800	52	38	35	5	55	43
>2800	3	4	4	11	6	9
% Mg Added	1978	1988	1988	1978	1988	1998
<0.06%	N.A.	4	11	N.A.	2	2
0.06 to 0.09%	36	46	41	25	27	30
0.10 to 0.15%	27	23	19	40	29	22
>0.15%	9	4	5	15	4	1
Fade Time, Min.	1978	1988	1988	1978	1988	1998
<10	15	9	N.A.	20	18	N.A.
10 to 15	55	50	N.A.	38	55	N.A.
16 to 20	6	9	N.A.	4	6	N.A.
>20	3	9	N.A.	4	6	N.A.
Treatment Temp. Loss, ^{o}F	1978	1988	1988	1978	1988	1998
<50	N.A.	9	N.A.	N.A.	4	N.A.
50 to 100	N.A.	62	N.A.	N.A.	45	N.A.
110 to 150	N.A.	9	N.A.	N.A.	22	N.A.
>150	N.A.	0	N.A.	N.A.	12	N.A.
POSTINOCULATION						
Addition Methods	1978	1988	1988	1978	1988	1998
Separate Addition	70	15	85	76	33	74
Simultaneous Addition	15	31	31	15	18	25
% Si Added	1978	1988	1988	1978	1988	1998
<0.20	N.A.	0	23	N.A.	2	13
0.20 to 0.40	N.A.	15	35	N.A.	12	19
0.41 to 0.60	N.A.	9	7	N.A.	10	15
>0.60	N.A.	0	4	N.A.	18	10
None	N.A.	42	0	N.A.	0	0
Supplementary Inoculation	1978	1988	1988	1978	1988	1998
Sprue	N.A.	19	3	N.A.	4	0
Mold	N.A.	15	7	N.A.	10	1
Inserts	N.A.	19	18	N.A.	10	14
Pouring Ladle/other	N.A.	4	55	N.A.	10	62
Automatic Stream	N.A.	46	31	N.A.	2	14
Wire	N.A.	N.A.	1	N.A.	N.A.	0
Inoculating Agent	1978	1988	1988	1978	1988	1998

75% FeSi-						
Ca < 0.6	15	4	3	16	39	11
Ca 0.6 to 0.8	21	8	18	22	25	9
Ca > 0.8	27	58	50	11	24	35
Al < 1.0	12	12	4	24	20	10
Al 1.0 to 1.25	24	50	51	13	33	35
Al > 1.25	12	0	14	6	4	5
Low Al 75% FeSi	N.A.	0	1	N.A.	4	3
CaSi	N.A.	8	0	N.A.	4	1
FeSi with Mg	N.A.	0	0	N.A.	2	5
Other	23	21	11	18	6	6
FINAL CHEMISTRY						
% Carbon	1978	1988	1988	1978	1988	1998
<3.40	3	8	5	5	2	5
3.40 to 3.64	3	23	23	5	45	35
3.65 to 3.84	55	65	57	47	53	27
3.85 to 4.00	6	0	3	2	0	4
% Silicon	1978	1988	1988	1978	1988	1998
<2.20	6	0	0	13	0	1
2.20 to 2.44	15	31	26	12	18	15
2.45 to 2.64	58	65	49	47	59	35
2.65 to 2.84	12	15	7	16	25	16
2.85 to 3.00	0	0	4	2	6	4
>3.00	0	0	3	2	0	1
% Magnesium	1978	1988	1988	1978	1988	1998
<0.030	0	8	12	2	0	3
0.030 to 0.040	36	42	55	24	39	31
0.041 to 0.050	45	46	16	47	51	7
0.051 to 0.060	9	8	0	16	10	0
0.061 to 0.070	N.A.	0	0	N.A.	4	0
>0.070	0	0	0	6	0	1
% Cerium	1978	1988	1988	1978	1988	1998
<0.005	N.A.	19	N.A.	N.A.	2	N.A.
0.005 to 0.010	N.A.	23	N.A.	N.A.	6	N.A.
>0.010	N.A.	15	N.A.	N.A.	12	N.A.
DI PRODUCED						
Types	1978	1988	1988	1978	1988	1998
ADI	N.A.	N.A.	9	N.A.	N.A.	6
Ni-Resist	N.A.	N.A.	0	N.A.	N.A.	2
Si Mo	N.A.	N.A.	7	N.A.	N.A.	2
Ferritic	N.A.	N.A.	82	N.A.	N.A.	87
Pearlitic	N.A.	N.A.	85	N.A.	N.A.	78
Percent of Total Work	1978	1988	1988	1978	1988	1998
ADI < 2%	N.A.	12	N.A.	N.A.	16	N.A.
ADI < 10%	N.A.	4	N.A.	N.A.	10	N.A.
ADI > 10%	N.A.	0	N.A.	N.A.	6	N.A.
Ni Resist < 10%	N.A.	0	N.A.	N.A.	2	N.A.
Ni Resist 10 to 30%	N.A.	0	N.A.	N.A.	6	N.A.
Ni Resist > 30%	N.A.	0	N.A.	N.A.	0	N.A.
Ferritic < 30%	N.A.	8	N.A.	N.A.	12	N.A.
Ferritic 30 to 60%	N.A.	42	N.A.	N.A.	55	N.A.

Ferritic > 60%	N.A.	46	N.A.	N.A.	31	N.A.
Pearlitic < 30%	N.A.	15	N.A.	N.A.	27	N.A.
Pearlitic 30 to 60%	N.A.	46	N.A.	N.A.	59	N.A.
Pearlitic > 60%	N.A.	12	N.A.	N.A.	12	N.A.
POURING TEMP. RANGE, ^{o}F						
First Iron, ^{o}F	1978	1988	1988	1978	1988	1998
<2400	0	0	1	2	0	1
2400 to 2500	3	8	12	6	0	12
2450 to 2550	18	4	27	16	14	46
2500 to 2600	24	23	66	27	24	46
2550 to 2650	30	65	68	18	57	45
>2650	15	0	3	22	6	12
Last Iron, ^{o}F	1978	1988	1988	1978	1988	1998
<2400	N.A.	8	3	N.A.	6	5
2400 to 2500	N.A.	12	47	N.A.	29	48
2450 to 2550	N.A.	23	64	N.A.	43	42
2500 to 2600	N.A.	46	47	N.A.	10	30
2550 to 2650	N.A.	13	24	N.A.	14	11
>2650	N.A.	0	0	N.A.	0	3
QUALITY CONTROL						
Primary Control Used	1978	1988	1988	1978	1988	1998
Separate Micro	N.A.	N.A.	77	N.A.	N.A.	70
Flow Off	N.A.	N.A.	0	N.A.	N.A.	3
100% Final Chemistry	N.A.	N.A.	3	N.A.	N.A.	12
100% UT Testing	N.A.	N.A.	4	N.A.	N.A.	0
100% Sonic Testing	N.A.	N.A.	4	N.A.	N.A.	2
Cooling Curve	N.A.	N.A.	1	N.A.	N.A.	4
Other	N.A.	N.A.	5	N.A.	N.A.	10

APPENDIX - Survey on Ductile Iron Practices - in pdf format.

Back to top

Survey of Ductile Iron Practices

American Foundrymen's Society
Committee 5-L, Molten Metal Processing

Please take a few minutes to complete the following AFS survey, or route the survey to the appropriate person in your organization. All data will be treated as confidential for AFA committee use only. Check or fill-in those items that pertain to your operation:

( ) Tons of metal treated per week:

( ) 1.2 Greater than 200 tons treated/week   ( ) 1.2 Less that 200 tons treated/week

Principle Type Castings Produced:

( ) Automotive ( ) Farm Machinery & Equipment ( ) Truck ( ) Pole Line Hardware
( ) Pressure pipe ( ) Valves & Fittings ( ) Other, describe _________________________

Melting Unit(s):

( ) 3.1 Cupola: How Many?_______ 1) Melt zone diameter___ inches 2) Melt zone diameter____ inches
( ) 3.1.1 Liningless/water wall
( ) 3.1.2 Refractory lined
( ) 3.1.3 Front Slagger
( ) 3.1.4 Rear Slagger
( ) 3.1.5 Slag separator
( ) 3.1.6 Acid Slag, B < 0.9
( ) 3.1.7 Basic Slag, B > 1.1
( ) 3.1.8 Neutral Slag, B 0.9 – 1.1
( ) 3.2 Coreless Induction: How many?____ Size:_______tons, Power_______Kw
( ) 3.3 Channel Induction: Vert ( ) Horiz ( )   How many?____ Size:_______tons, Power_______Kw
( ) 3.4 Direct Arc: How many?____ Size:_______tons, Power_______Kw
( ) 3.5 _______________________________   How many?____ Size:_______tons, Power_______Kw

Holding Unit(s):

( ) 4.1 Channel Induction: Vert ( ) Horiz ( )   How many?____ Size:_______tons, Power_______Kw
( ) 4.2 Coreless Induction: How many?____ Size:_______tons, Power_______Kw
( ) 4.3 Direct Arc: How many?____ Size:_______tons, Power_______Kw
( ) 4.4 Forehearth: How many?____ Size:_______tons, Power_______Kw
( ) 4.5 _______________________________   How many?____ Size:_______tons, Power_______Kw

Desulfurization:

( ) 5.1 None
( ) 5.2 Name the method used? _______________________________________ ( ) Batch ( ) Continuous
( ) 5.3 Amount of iron desulfurized? Batch_____lbx. Mins/batch______ Continuous_____________T/hr.
( ) 5.4 Type(s) of desulfurizer used? 1)______________________2)_____________________________
( ) 5.5 Typical percent of desulferizer used? 1)_________________% 2)_________________________%
( ) 5.6 If gas stirring, type gas ____________________ Rate of usage ________________ft^3/ton iron.
( ) Typical iron temperature at desulfurization? ___________________%F

<u>Iron Chemistry</u> (typical):

Location	**% TC**	**% Si**	**%S**	**%Mg**	**%Cu**	**%Cr**	**%Mn**
At melter tap – Pearlitic				NA			
At melter tap – Ferritic				NA			
After Desulferization				NA	NA	NA	NA
At Holder – Before Mg Treatment				NA	NA	NA	NA
After Mg treatment							
In last casting/pipe poured in batch							

6.1 Any Special Charge Material Selection? Describe____

____

6.2 Time after Mg treatment that %Final Mg sample taken? ___________ minutes

6.3 Name the grade(s) of iron poured: _____________________________

<u>Alloys added between the melter and the holder</u>: (Enter "NONE" if none used)

( ) 7.1 Alloys added for chemistry trim

( ) 7.1.1 FeSi Typical amount added?________________ lbs./ton

( ) 7.1.3 Graphite Typical amount added?________________ lbs./ton

( ) 7.1.4 Typical amount added?________________ lbs./ton

( ) 7.2 Alloys added for preconditioning (if preconditioning is practiced):

( ) 7.2.1 FeSi Amount added?______________ lbs/ton

( ) 7.2.2 SiC Amount added?______________ lbs/ton

( ) 7.2.3 Graphite Amount added?______________ lbs/ton

( ) 7.2.4 ___________________ Amount added?______________ lbs/ton

<u>Mg Treatment</u>: (Enter "NA" if not applicable)

8.1 Method used?____________________________ Treatment Vessel type?____________________

Typical fill time:____________________ Do you use a cover/lid on the ladle?________________

8.2 Size of treatment batch?_______________lbs. No. of treatment/hr?_______________

8.3 If **<u>MgFeSi</u>** used: Type______________________ Size_________________% Mg in alloy__________

8.4 Additives in MgFeSi?__________%Ce____________%TRE(________%Ce in TRE)_____%Ca

_____________%Al____other(s)

8.5 Is cover material used? ( ) yes ( ) no. Addition rate__________%

Type of cover material?____

8.6 If **<u>Pure Mg</u>** used: ASTM Spec.__________Size Spec______________(grams/piece or dimensions)

TRE/Ce source: ________________, and typical addition rate:________%________lbs./treatment

8.7 If **<u>Wire</u>** used: Size Wire_____mm dia. Wire Content_______________________________________

TRE/Ce source: ____________________, and typical addition rate: ______%_______lbs./treatment

8.8 Nickel Mag Supplement ( ) yes, ( ) no. Analysis: Ni_____%, Si______%. lbs./treatment

8.9 Typical % Magnesium addition________________________Typical %Mg recovery______________

8.10 Typical treatment temperature?_________________________degrees F

8.11 Typical pouring temperatures? First pour_________________ ° F. Last pour __________ ° F.

Ductile Iron News
DIS
Ductile Iron Society
To Promote the production and application of ductile iron castings *Issue 2, 2003*

FEATURES

DEPARTMENTS

News Briefs

MEETINGS

There will be a **Keith Millis Symposium** on October 20-23, 2003 at the Crowne Plaza Resort in Hilton Head Island, South Carolina.

BUSINESS

Ashland Casting Solutions Enters into Marketing Agreement with Z Corporation

Dublin, OH and Burlington, MA - Ashland Casting Solutions, a business unit of Ashland Specialty Chemical Company, and Z Corporation are pleased to announce today, at GIFA 2003 (Hall 12, Stand No. A 39.40), a marketing partnership designed to create value and provide integrated solutions to the casting industry.

As marketing partners, Ashland Casting Solutions will distribute Z Corp.'s complete line of 3D Printers and ZCast* material systems for use in short-run prototype metal casting. The revolutionary ZCast technology and complementary material systems were developed by ZCorp. to cramatically decrease the time and cost associated with prototype metal casting. The ZCast technology enables creation of cast metal prototype parts directly from CAD data in 24-48 hours.

Ashland Casting Solutions and ESI Group to Offer Casting Simulation Software and Services

Dublin, Ohio (USA) and Paris (France) - Ashland Casting Solutions, a business unit of Ashland Specialty Chemical Company, and ESI Group are pleased to announce today, at GIFA Foundry Trade Fair 2003 in Düsseldorf, their intent to jointly provide casting simulation software solutions and services to the metal casting industry.

The parties will market ProCAST casting simulation software, a fully integrated design tool in the CAD/CAE chain. ProCAST is a completely modular package that can be adapted to the analysis of any shape casting process, for any alloy.

Ashland-ACT launches EZStrip™ Line of Etch Residue Removers

Dublin, OH (USA) - Ashland-ACT is introducing a new line of etch residue removers at SEMICON West (Booth 1015). The products, which are being marketed under the EZStrip brand, are new formulations for common semiconductor industry applications. The first three formulations in the line are being featured at SEMICON West.

EZStrip 1 and EZStrip 2 etch residue removers are HA-containing chemistries formulated using an improved solvent platform which enables these products to quickly and effectively remove etch residue and positive photoresist with minimal impact on critical dimensions of vias and metal lines. EZStrip 1 & EZStrip 2 etch residue removers have shown improved performance in some applications versus existing HA products.

EZStrip etch residue remover is a fluoride-containing formulation developed specifically for etch residue removal. Ashland-ACT specifically engineered this chemistry to provide a wide process latitude and to be

compatible with advanced materials including Cu, low-k and porous low-k materials.
"We are pleased to introduce the new EZStrip product line to the semiconductor industry. These three products and others soon to be released are providing innovative new solvent systems to meet current and future customer requirements," said Eric Tribolet, Product Manager for New Product Development.

All products are currently available through Ashland Specialty Chemical Company.

Ashland's Cleveland Facility Receives Safety Awards

Dublin, OH - The Cleveland (East), Ohio, facility of Ashland Casting Solutions, a business group of Ashland Specialty Chemical Company, has been honored with two awards from the Ohio Bureau of Workers Compensation's (BWC) Division of Safety and Hygiene.

The plant, received a "100% Award" for operating the entire year without a lost-time injury during 2002 and also received an "Achievement Award" for reducing its annual incident rate by 25 percent or more in 2002.

The awards were presented as part of the 2002 Greater Cleveland Safety Campaign, co-sponsored by the Greater Cleveland Safety Council.

"We are honored to receive this recognition from the BWC for these important achievements at our Cleveland East plant," said Mike Swartzlander, vice president, Ashland Specialty Chemical Company, and general manager, Ashland Casting Solutions. "It underscores our company wide commitment to working safely and operating responsibly," he added.

INTERMET TO OPEN SALES AND ENGINEERING OFFICE IN JAPAN

Confirms commitment to support growing base of Asia Pacific-based customers

Troy, Mich., July 30, 2003 - INTERMET Corporation, one of the world's leading manufacturers of cast-metal automotive components, today announced that it will open a Sales and Engineering Office in Japan to support its growing roster of automotive customers based in the Asia-Pacific region. Located in central Tokyo, the new office will further expand INTERMET's engineering and sales support activities and will be networked with the company's other sales and technology centers in the United States and Europe.

INTERMET ANNOUNCES PLANS TO CLOSE RADFORD FOUNDRY

Obsolescence a factor in company's decision to close its last shell-molding plant

Troy, Mich., May 29, 2003 - Citing changes in market conditions and production technology, as well as a substantial investment necessary for continued operation, INTERMET Corporation announced today that it intends to close its Radford Foundry in Radford, Virginia, before the end of this year, with a target date of September 30, 2003.

The facility currently employs 374 people, including hourly and salaried staff, and manufactures gray-iron and ductile-iron castings for the automotive industry. The New River Foundry, located next door to the Radford Foundry, is not affected by this decision.

"We regret the effect that this difficult, but necessary, decision will have on our employees at the Radford Foundry," said Gary Ruff, President and Chief Operating Officer of INTERMET. "However, the INTERMET, as a whole, to remain competitive in an extremely challenging industry environment, we must take this type of action relative to unprofitable operations. Through the first four months of this year, the plant has recorded a pre-tax loss of $1.0 million."

INTERMET TO ACQUIRE REMAINING 50-PERCENT INTEREST IN PORTUGUESE JOINT VENTURE

Move strengthens INTERMET's position in Europe as a leading producer of highly engineered ductile-iron components

Troy, Mich., June 26, 2003 - INTERMET Corporation, one of the world's leading manufacturers of cast-metal automotive components, and Grupo Jorge de Mello of Portugal, announced today that the companies have entered into an agreement for INTERMET to acquire 100 percent of the shares of Fundição Nodular, S.A., a Portuguese foundry company also know as PortCast Foundry. PortCast Foundry expects sales of $35 million in 2003.

INTERMET OPENS EUROPEAN ENGINEERING CENTER

Names Inge Hoegfeldt Technical Director for Europe Operations

Troy, Mich., July 23, 2003 - INTERMET Corporation, one of the world's leading manufacturers of cast-metal automotive components, today announced the establishment of a European Engineering Center based at its European Headquarters in Saarbrücken, Germany.

PEOPLE

Fontana To Head Research & Technology Innovation At Ashland Inc.

DUBLIN, Ohio - **Luca P. Fontana** has joined Ashland Specialty Chemical Company as vice president of Research & Technology Innovation (R&TI), according to Michael J. Shannon, ASCC senior vice president.

In his new role, Fontana will be responsible for technology innovation for ASCC's core resins businesses in both product development and longer term research and development. He will oversee all aspects of the R&TI group including Analytical and Engineering Research Services, the Pilot Plant (used for product testing and development) and Library & Information Services. He will be based in Dublin, Ohio, and report to Shannon.

"Luca brings with him a strong background in product and technology development that will greatly enhance our capabilities in this important arena," Shannon said. "We expect R&TI to continue to thrive under his experienced leadership."

Fontana comes to Ashland from GE Plastics in Pittsfield, Mass., where he served as manager of Global Technology-Business Development. He has been affiliated with various GE operations since 1986 and has served in several different capacities, including manager of Polyester Technology for GE Plastics Europe in The Netherlands and technology manager for the Crystalline Polymer Products business.

A native of Genoa, Italy, Fontana earned a bachelor's degree in chemistry from King College in Bristol, Tenn., and a master's degree and doctorate in organic chemistry from Vanderbilt University in Nashville, Tenn. He holds 25 patents.

Milwaukee, Wisconsin - Grede Foundries, Inc., has named **Todd Sternaman** as Group Vice President - Ductile Iron Operations. He will continue to oversee operations of its Reedsburg foundry in Reedsburg, Wisconsin, but also assume responsibility for the St. Cloud foundry in St. Cloud, Minnesota, the New Castle foundry in New Castle, Indiana, and the Wichita foundry in Wichita, Kansas.

Sternaman received a B.S. in Metallurgical Engineering from the University of Wisconsin-Madison, and an M.B.A. from the University of Illinois-Champaign. Most recently, he served as Vice President of Operations of the Reedsburg foundry in Reedsburg, Wisconsin.

Grede Foundries' facilities include 9 foundries in the United States and a joint-venture operation in Mexico called ProezaGrede. The Company specializes in ferrous metals: gray iron, ductile iron, and steel castings. Grede Foundries works with customers in a variety of industries, providing castings for many products, from automobiles and construction machinery to farm machinery and equipment, and pumps and compressors. For more information, refer to Grede's Web site on the Internet at www.grede.com

---

Back to top