# FURNESS-NEWBURGE, INC.

Advanced Oxidation Systems

Emission Reduction

Water Treatment

- Sonoperoxone ® System
- Consulting and R & D Services
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*"Innovative Compliance Strategies for the 21st Century"*

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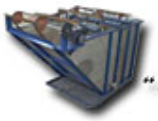

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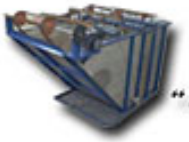

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## Newsletter

- **October 15, 2005**
  Volume1, Number 3
- **July 15, 2005**
  Volume1, Number 2
- **January 28, 2005**
  Volume1, Number 1

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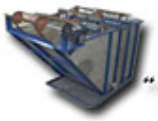

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## About FNI


- **Personnel**
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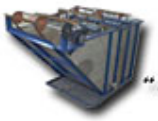
**Furness-Newburge, Inc.** is a small business specializing in for-hire invention of processes and machinery without existing technical solutions.

Furness-Newburge, Inc. routinely takes technologies from concept through prototype to full-scale production. Much of the work performed by Furness-Newburge, Inc. involves water treatment and process optimization for large industrial plants, some of which have more than 1,000 employees.

Furness-Newburge, Inc. also manufactures ultrasonic equipment, ozone generation equipment and electro-hydraulic cavitation devices.



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# Consulting and R & D Services

## CONSULTING SERVICES

Furness-Newburge, Inc. consults with foundries on the use of advanced oxidation techniques for reduction of air pollution, bentonite recycling, and the mathematical modeling of sand system properties that leads to reliable prediction of sand system operations. In addition, it consults on other issues to optimize sand system controls in the foundry industry.

Furness-Newburge, Inc. also consults in many industries on the use of advanced oxidation techniques for amine odor destruct, phenolic sand coating odor destruct and bio/scale control in water towers.

## R & D SERVICES

Furness-Newburge, Inc. has privately funded or participated in government funded R & D in the following areas:

- Gas storage well remediation
- Crude oil viscosity reduction
- Animal waste treatment and recycle
- Groundwater treatment
- Defense/personal protection with emphasis on indoor environment
- Energy reduction through use of acoustically stimulated metal to create hollow risers and thin wall castings
- Acoustic Advanced Oxidation treatment of critical military aircraft components
- Acoustic Advanced Oxidation destruction of dioxin and related by-products
- Acoustic Advanced Oxidation modification of as-mined minerals
- Ultrasonic and Advanced Oxidation processing for foods

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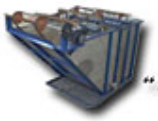

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## Sonoperoxone ® System


- Why Every Green Sand Foundry Needs Sonoperoxone ®
- How Sonoperoxone ® Works
- Pollutant Emission Reductions
- Bond Reductions / Cost Savings
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# SONO WAVES

**A Publication of**

***FURNESS-NEWBURGE, INC.***

***Innovative Compliance Strategies for the 21st Century***

***376 Crossfield Drive, Versailles, Kentucky 40383***

**VOLUME I, NUMBER 3** **OCTOBER 15, 2005**


## MUSES KICKOFF MEETING HELD IN WISCONSIN

Neenah Foundry Company hosted the kickoff meeting for the Muses grant participants on October 3, 2005. During the meeting the participants discussed details for implementation of the research funded by NSF GOALI. The research team includes faculty from economics, engineering, industrial ecology, material science and sociology.

The collaborators will work across disciplines to further understand and model the materials handling in the metal casting industry with a focus on iron foundries. They will also develop and assess innovative casting technologies to enable reductions in costs and life cycle impacts. In addition, the team members will evaluate the socio-economic impact of the U.S. metal casting industry on local, U.S. and world economies.

As the Muses grant research progresses, updates will be posted on this web site.

## R&D

Dr. Paulsen presented a paper entitled "Field Trials for Sonic Treatment of Natural Gas Storage Wells and Stripper Oil Wells for Well Remediation and Increased Productivity" at the 2005 SPE Eastern Regional Meeting held in Morgantown, WV September 14-16.

The paper described DOE sponsored research from 2000 through 2004 performed by the project team of Furness-Newburge, Inc., TechSavants, Inc. and Nicor Gas to develop a sonic tool to treat underground gas storage wells. The sonic treatment concept is to apply high intensity sound waves to help dissolve and break-up scale that forms at the perforations or the sand face and thereby improve gas/fluid flow. Similarly, the project team tried the sonic treatment concept in a stripper oil well to see if the sonic stimulation would increase oil production through viscosity reduction and opening up blockages in the pores.

Deployed in three separate natural gas storage wells in northern Illinois and a stripper oil well in central Alabama, the sonic tool proved successful in improving productivity in both settings. Additional field trials with varied well geologies need to be conducted with single day deployments to meet the commercial goals of this tool in the natural gas arena. Conversely, oil well deployments trials need to be greatly extended to evaluate the effects of continual well stimulation to prove commercial viability.

## News and Notes

### FNI INVITED TO USEPA FOUNDRY MEETING

On October 26, 2005, Jim Furness and Dr. Dave Paulsen will participate in a meeting at USEPA in Research Triangle Park, North Carolina. The meeting will focus on ways to reduce emissions of hazardous air pollutants with the use of innovative technologies and binders. After a presentation on Sonoperoxone(R), Jim and Dave will answer any questions from EPA staff as well as other meeting attendees.

Watch for recommendations from the meeting on this web site before the end of the year.


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**VOLUME I, NUMBER 2** **JULY 15, 2005**


## MACT ACHIEVED WITH FNI EXPERTISE

**Chances are you don't have to install baghouses in order to comply with MACT standards for metal HAP emissions: use water treatment principles to upgrade your cupola wet scrubber system. FNI worked closely with two major iron foundries and achieved MACT with minimal capital outlay. Please call us and bring your foundry into MACT compliance easily and economically.**

## News and Notes

**Two additional iron foundries, one in IN and one in WI, recently joined the Sonoperoxone(R) family. Both start-ups are expected to take place during the fall of 2005.** ***Why not give us a call and have your foundry reap the financial and environmental benefits of Sonoperoxone(R)?***

During April 2005, the State of California accepted FNI technology of combined Sonoperoxone(R) Blackwater and Core Room Odor Scrubber as state of the art. This first-of-its-kind system has been running at Gregg Industries in El Monte, CA since summer 2003, successfully reducing odors from the core room and VOC emissions from the sand system. The Final Report has been submitted and approved and we expect publication by the State of California soon.

## NATIONAL SCIENCE FOUNDATION AWARD PARTICIPANT

Furness-Newburge, Inc. will participate with Penn State University and MIT in an NSF award under the Materials in Metal Casting Industries category. Under this award, we will look at improving and valuing the materials flow of the metal casting industry. The research will focus on developing and characterizing the impacts of innovative iron casting technologies while gaining understanding of how potential improvements in energy and material efficiency of metals casting production affect both industry and society at large.

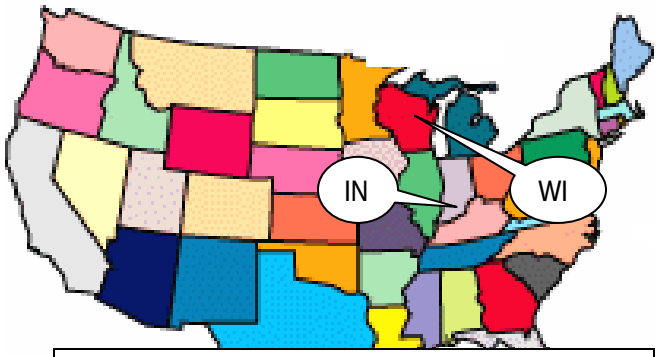
The research team includes faculty from economics, engineering, industrial ecology, material science and sociology. The team's collaborative efforts will foster innovation and learning across disciplines to further the goals of environmental improvement, energy efficiency and material efficiency in the metal casting industry.

## R&D

...FNI continues to experiment with Penn State University and University of WI-Platteville to improve techniques for acoustic stimulation and degassing of molten metal.

...Watch for the next newsletter that will feature a summary of a paper for the Society of Petroleum Engineers to be presented by Dr. Paulsen in Sept 2005 at Morgantown, WVA.

## *Where in the World is Sonoperoxone®?*




Two new Sonoperoxone(R) Systems Fall 2005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**VOLUME I, NUMBER 1** **JANUARY 28, 2005**


## News and Notes

…New alternatives to high-powered acoustics have been successfully tested for use in Sonoperoxone® and other applications. Contact FNI to learn more.

## R&D Corner

…FNI is working in conjunction with academic and foundry industry partners researching various acoustic stimulation and degassing techniques for molten metal.

…***Read our latest papers!*** Call us to receive a copy of Advanced Oxidation research updates presented at the 16th AFS EHS conference, and a paper on the melt energy savings potential of high-powered acoustics.



# Dr. Paulsen Returns from Sonoperoxone® Start-up in Europe

**Dr. Paulsen (third from left in back) visits with NovaCast AB**

Dr. David Paulsen, the Vice President and Technical Director of Furness-Newburge, Inc., returned from Europe after consulting on a successful first installation of the Sonoperoxone® system outside of North America. The new Sonoperoxone® system was installed in a large Swedish foundry. Dr. Paulsen met with FNI's European foundry representative, the NovaCast AB team of Ronneby, Sweden. FNI and NovaCast worked closely with European manufacturers to meet EU standards for Sonoperoxone®.

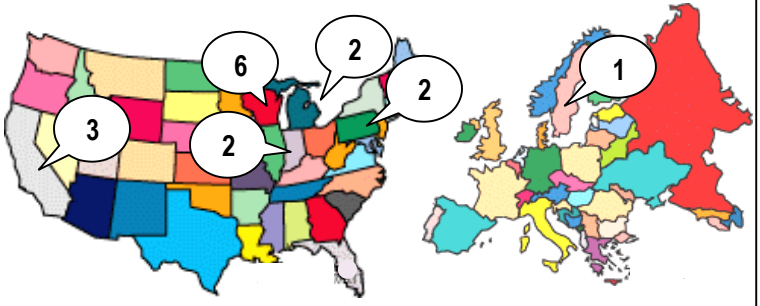
Tests are now being performed by the Swedish foundry to evaluate the benefits of using Sonoperoxone®. FNI expects this European version of Sonoperoxone® to reduce bond consumption by 15-20% and VOC and benzene emissions by 50-60%, very much like its American counterpart.

While in Europe, Dr. Paulsen and NovaCast also visited three other foundries interested in using this technology. Based on his visits, Dr. Paulsen has developed concepts for systems that might be installed by these foundries. Many of the new concepts involve a Sonoperoxone® Blackwater system which adds dust, wet or dry, into the Advanced Oxidation and high-powered acoustic treatment of green sand molding process water. The Blackwater system enhances the environmental and economic benefit of the Clearwater system, the model installed by the Swedish foundry, by allowing direct treatment of the dust itself, not just the process water. American foundries that use a Blackwater system experience 20-30% bond reclamation and 60-70% VOC and benzene reductions.

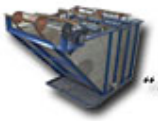
## California Foundry Shows Improvements with Sonoperoxone® Scrubber

Gregg Industries, Inc. in California, a member of the Neenah Foundry Group, has experienced odor and emission reductions since it installed a Sonoperoxone® Core Room Odor Scrubber and Blackwater System. The odor scrubber uses a wet phase scrubber section with sonocatalytically reacted water, ozone, and hydrogen peroxide and an ultraviolet oxidation chamber. The Blackwater portion interacts with the foundry's sand system to reclaim costly mold materials, reduce scrap, and improve overall casting quality. Stack testing showed both a removal of odors usually associated with core-making operations and reductions in volatile organic compound (VOC) emissions from the foundry's sand system. The system, which began as a research project, is the first of its kind, combining both sand system and core-making operations emission control.

## *Where in the World is Sonoperoxone®?*




**In addition to the sixteen Sonoperoxone® systems already in operation worldwide, Furness-Newburge is currently designing five more systems in the United States and Canada and three more systems in Europe.**



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## Personnel

### James C. Furness, Jr.

Mr. Furness founded Furness-Newburge, Inc. in 1983 and remains its President. Mr. Furness began his training and experience in ultrasonic/acoustic cavitation with the U.S. Navy during the Vietnam War.

Mr. Furness invented the Sonoperoxone® technology currently being used at ten sites in eight foundries in the U.S. and Canada. Mr. Furness and faculty at The Pennsylvania State University continue to study Sonoperoxone® through a project pertaining to air pollution reduction using advanced oxidation technologies. This project is funded by grants from the National Science Foundation and the U.S. Department of Energy.

For thirty years, Mr. Furness has designed machinery that he installed and implemented to reduce pollution and to improve foundry processes. For example, he developed vertical blast furnace chemical injection systems to prevent the formation of soluble/hazardous heavy metals and machinery to recycle industrial sand used in the foundry industry.

Mr. Furness holds patents in advanced oxidation water treatment and perfected inventions in various industries. He developed experimental systems for the deodorization of large-scale agricultural operations and also implemented large-scale scrubber operations to deodorize fumes from phenolic resin coatings. In the 1980's, Mr. Furness devised a chemical stabilization process in conjunction with the California Department of Health Services (now the California EPA) to stabilize lead, cadmium, zinc and copper. This unique stabilization process successfully passed federal TCLP and the more stringent leaching requirements of the State of California. During the mid 1990's, his efforts with several Wisconsin foundries and the Wisconsin Department of Natural Resources, Bureau of Air Management, formed the basis of regulations defining air pollution standards for foundries in Wisconsin.

Mr. Furness has published numerous articles and is a member of several professional organizations including the American Foundry Society, the American Chemical Society and the International Ozone Association.

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### Paul David Paulsen, Ph.D., PE, Vice President

Dr. Paulsen has been the Technical Director of Furness-Newburge, Inc. since August 1999. He performs engineering design and research as well as oversees fabrication of advanced oxidation equipment manufactured by Furness-Newburge, Inc. He also serves as project manager for installations of the equipment.

Dr. Paulsen holds a B.S. in Aerospace Engineering from Virginia Tech (1991), an M.S. in Aerospace Engineering from Georgia Tech (1992) where he specialized in combustion, and a Ph.D. in Environmental Engineering from The Pennsylvania State University (1998) where he concentrated in air pollution control. As a graduate student at Penn State, he conducted research on advanced oxidation systems for the removal of HAP's and VOC's generated by paint spraying and coating operations. The processes included air-phase destruction using ozone, water adsorption with regeneration using hydrogen peroxide and ozone, and activated carbon adsorption with ozone regeneration. As a Post-Doctoral Scholar at Penn State, he taught a water transport and treatment course and researched

advanced oxidation systems for benzene and VOC removal at high production iron foundries.

Dr. Paulsen has authored articles for *Carbon*, *Ozone Science and Engineering* and *Foundry Trade Journal*. He has given conference presentations at the ACS Colloid and Surface Science Symposium, the International Carbon Conference, and the International Conference on Advanced Oxidant Technologies for Water and Air Remediation. His professional memberships include the American Foundry Society and the American Chemical Society.

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**Lynn Furness, Chief Financial Officer**

Ms. Furness runs the daily operations of Furness-Newburge, Inc. Her duties include, but are not limited to, purchasing, personnel/payroll, bookkeeping, trademark issues and strategic planning. She also manages travel and other scheduling for staff and projects as well as sales contacts.

Ms. Furness received a B.A. in History from the University of California at Los Angeles (1970) and a J.D. from the Southwestern University School of Law in Los Angeles (1981). She practiced real estate and title insurance law in California before joining Furness-Newburge, Inc. Ms. Furness is a licensed attorney in Kentucky and California maintaining memberships in the Kentucky State Bar and the California State Bar.

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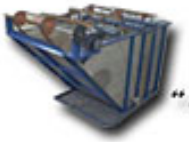

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| **Lynn Furness** | mamanewbs@yahoo.com |
| **Paul David Paulsen** (Dave) | davep01@prodigy.net |

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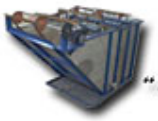

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## Why Every Green Sand Foundry Needs Sonoperoxone ®

**Because pollution costs you money**

High production green sand foundries are under increasing pressure to reduce hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) that are emitted during pouring, cooling and casting shakeout (PCS). Smoke and odor from PCS emissions are a serious concern in the workplace environment and a source of neighborhood complaints. In 1988, the State of Wisconsin established regulatory limits for the HAP benzene at 300 lbs/yr and for the HAP formaldehyde at 250 lbs/yr. The U.S. Environmental Protection Agency in August 2003 established a VOC emission standard of 20 ppm for new PCS lines at iron and steel foundries. Since most end-of-pipe treatment systems such as thermal oxidizers are energy intensive and expensive, the foundry industry clearly needs alternative pollution prevention strategies that economically comply with ever more demanding air quality requirements.

**Our Sonoperoxone ® systems reduce your pollutant emissions to meet the increasingly stringent government regulations and to satisfy your increasingly sensitive neighbors.**

**Complaints = Regulation = Lawyers = Money.**

**Because bond costs you money**

The advanced oxidants generated by our Sonoperoxone ® process interact with the clay and coal in your bond to make them more efficient. Clay activation increases and coal usage drops. Sand strength per unit of clay increases. Foundries with our Clearwater systems have seen their bond consumptions drop by up to 15% [ref. 2]. Foundries with our Blackwater systems have seen their bond consumptions drop by up to 40% [ref. 3,4,6] by combining bag house dust recycle with advanced oxidant activation.

**Our Sonoperoxone ® systems make your foundry more competitive by reducing bond consumption while reducing pollution.**

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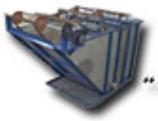

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## How Sonoperoxone ® Works

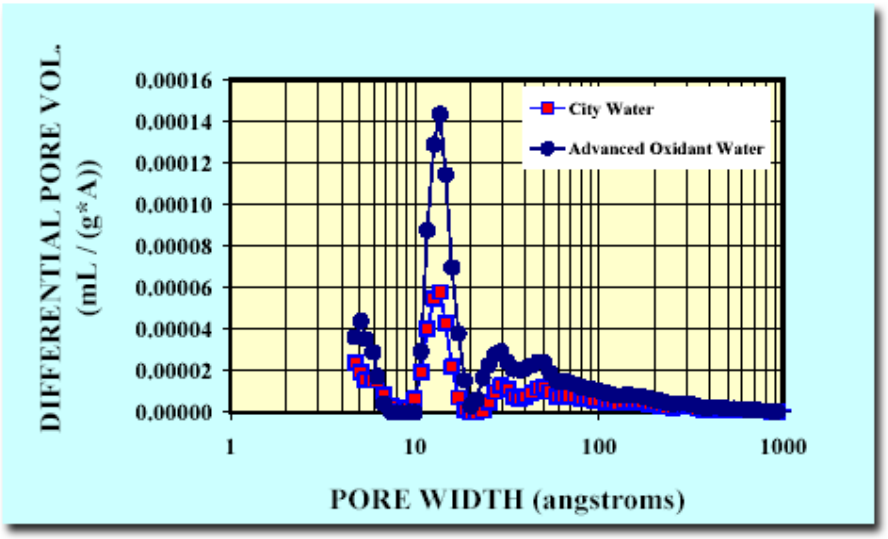

- **Clearwater System Description**
- **Blackwater System Description**


### Green Sand Foundry Emissions and their Prevention

The green sand's coal and the core's resin binder are the primary sources of organic HAP and VOC emissions. The pouring of high temperature molten metal into the sand mold causes the release of organic compounds from the coal and organic resins. These organic compounds are necessary to the casting process because they provide a reducing atmosphere at the casting surface which prevents casting defects and provides good surface finish.

These organic compounds have three fates: they are burned up in the flames of the mold, they condense or are adsorbed in the cooler sections of the mold, or they are released into the atmosphere. Most of these organic compounds belong to the benzene family (benzene, toluene, xylene) and are considered harmful air pollution. The Sonoperoxone® treatment system prevents pollution at its source by improving the ability of the sand mold to adsorb these organic compounds.

Sonoperoxone® combines ozone addition, hydrogen peroxide addition and high-powered acoustics to generate advanced oxidants in the water used by a foundry's coolers and mullers. By treating the water used in a foundry's green sand system, advanced oxidants will destroy some of the organic compounds coating the silica. More importantly, the advanced oxidants clean out the pores of the coal and clay and increase the porosity of these green sand components (See graph [8]). Increasing the porosity of the sand mold allows the mold to retain more of the organic compounds. This results in lower emissions being released and more consumables being retained for the next casting cycle. Even some emissions from the chemically bonded cores are captured in the green sand mold. However, the emissions reduction decreases as core size increases because the process does not treat the core sand. Core sand emissions bypass the green sand mold.




**Effect of advanced oxidation treatment of green sand:**
**Pore volume increase from Glowacki et al [8].**

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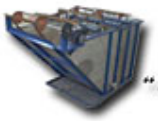

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# Pollutant Emission Reduction

| Emissions Results Table [1,3,4,7] | | | |
|---|---|---|---|
| | | | |
| | | **Emissions** | |
| | City Water | Adv. Oxidant Water | % Change |
| | (lb/ton metal) | (lb/ton metal) | |
| **Sonoperoxone - Clearwater Foundry A** | | | |
| Benzene | 0.017 | 0.0066 | -61% |
| Total VOC | 0.186 | 0.0477 | -74% |
| | | | |
| **Sonoperoxone - Clearwater Foundry B** | | | |
| Benzene, no core | 0.035 | 0.018 | -48% |
| Total VOC, no core | 0.37 | 0.17 | -54% |
| Benzene, cored | 0.081 | 0.05 | -38% |
| Total VOC, cored | 0.49 | 0.22 | -55% |
| | | | |
| **Sonoperoxone - Blackwater Foundry** | | | |
| Benzene, no core | 0.055 | 0.030 | -45% |
| Total VOC, no core | 0.60 | 0.22 | -63% |
| Methane+Ethane, no core | 0.61 | 0.39 | -36% |
| Benzene, cored * | 0.082 | 0.066 | -20% |
| Total VOC, cored * | 0.86 | 0.45 | -48% |
| Methane+Ethane, cored | 0.65 | 0.45 | -31% |
| | | | |

* -- 3.4 lb phenolic urethane binder per ton metal poured

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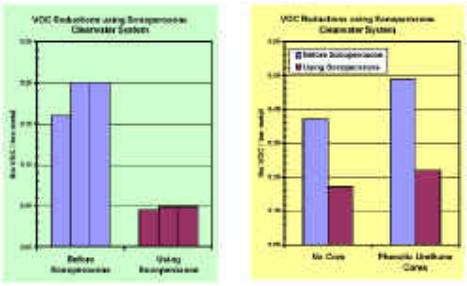

**VOC Reductions using Sonoperoxone Clearwater System**

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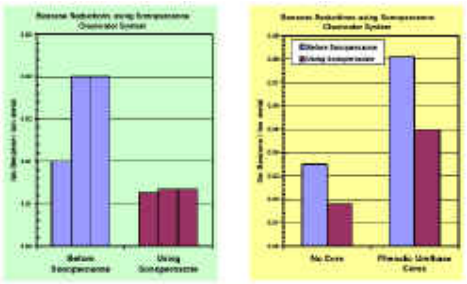

**Benzene Reductions using Sonoperoxone Clearwater System**

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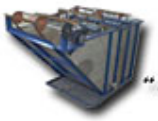

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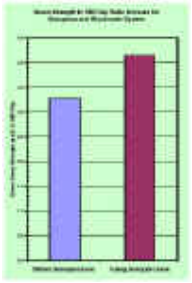
## Bond Reductions / Cost Savings



**Green Strength to MB Clay Ratio Increase for Sonoperoxone Blackwater System**

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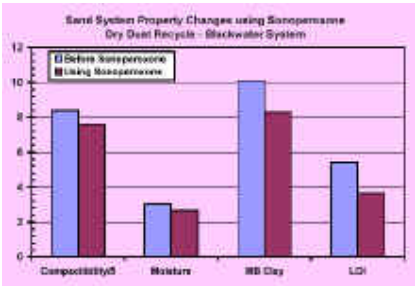


**Sand System Property Changes using SonoperoxoneDry Dust Recycle - Blackwater System**

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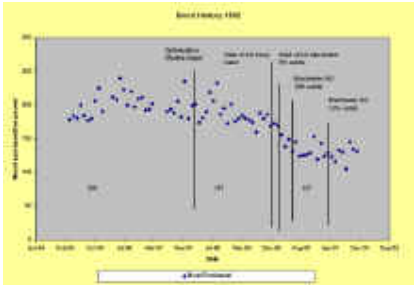

**Bond History 1502**

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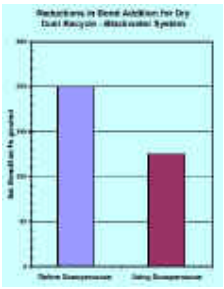

**Reductions in Bond Addition for Dry Dust Recycle - Blackwater System**

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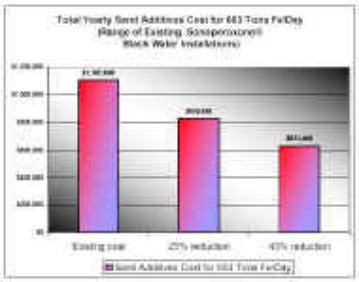

**Total Yearly Sand Additives Cost for 663 Tons Fe/Day (Range of Existing Sonoperoxone® Black Water Installations)**

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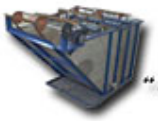

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# Published Articles List

1. "**Emissions Studies at a Test Foundry using an Advanced Oxidation-Clear Water System**," Glowacki, C., G. Crandell, F.S. Cannon, J. K. Clobes, R. C. Voigt, J. C. Furness, McComb and S. Knight, *AFS Transactions* 2003.

2. "**Advanced Oxidants Offer Opportunities to Improve Mold Properties, Emissions**," Andrews, J., R. Bigge, F. S. Cannon, G. Crandell, J. C. Furness, M. Redmann and R.C. Voigt, *Modern Casting*, September 2000, pp. 40-43.

3. "**Foundry Emissions Effects with an Advanced Oxidation-Blackwater System**," Goudzwaard, J., C. Kurtti, F. S. Cannon, J. C. Furness, R. C. Voigt, J. Andrews, and D. L. Sipple, accepted for publication in *AFS Transactions* 2003.

4. "**Performance and Control of a Green Sand System during the Installation and Operation of an Advanced Oxidation System**," Land, J., R. C. Voigt, F.S. Cannon, J.C. Furness and J. Andrews, *AFS Transactions*, Vol. 110, pp. 705-715 (2002).

5. "**2001 Foundry of the Year: Neenah Foundry Co.**," Alfred Spada, *Modern Casting*, July 2001, pp. 24-28.

6. "**Effects of Advanced Oxidants on Green Sand System Performance in a Black Water System**," Neill, D., F. S. Cannon, R.C. Voigt, J.C. Furness and R. Bigge, *AFS Transactions*, Vol. 109, pp. 937-955 (2001).

7. "**Economical Use of Advanced Oxidation Systems for Green Sand Emission Reductions**," Voigt, R.C., F.S. Cannon and J.C. Furness, 12th *AFS International Environmental, Health and Safety Conference,* October 2000, pp. 315-332.

8. "**Emissions Studies at a Test Foundry using an Advanced Oxidation-Clear Water System**," Glowacki, C., G. Crandell, F.S. Cannon, J. K. Clobes, R. C. Voigt, J. C. Furness, McComb and S. Knight, *AFS Conference Milwaukee Transactions* 2003.

9. "**The Use of Advanced Oxidation for the Reduction of Pollution from Green Sand Foundries**, " P.D. Paulsen, *Foundry Trade Journal*, November 2003, pp. 12-14.

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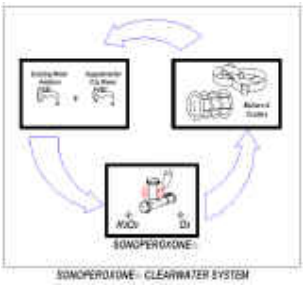
## Clearwater System Description

**Sonoperoxone ® Clearwater System**

Using a combination of advanced oxidation processes, Furness-Newburge, Inc. (FNI) developed its Sonoperoxone ® treatment systems in 1994 to meet the foundry industry need for cost effective pollution reduction. Sonoperoxone ® systems treat water with the combination of ozone addition, hydrogen peroxide addition and high-powered acoustics. The Sonoperoxone ® Clearwater System treats the water used in a green sand foundry's sand mixing/mulling and sand cooling operations. It simply treats the water your foundry is already using in its sand system. At these moisture addition points, advanced oxidants react with the green sand to prevent harmful emissions at their source.



( Click to Enlarge )

VOC reductions of up to 74% and benzene reductions of up to 64% have been reported [1,2] at foundries using this process on their green sand lines (see Pollutant Emission Reductions). Upon operation of the first system in 1995, an ancillary benefit to Sonoperoxone ® treatment was discovered – improvement in sand system strengths. In particular, the ratio of green compressive strength to clay increases when using the system. These sand system effects when employing a Clearwater system allowed foundries to reduce their bond usage by up to 15% [2].

Currently, six Sonoperoxone ® Clearwater Systems in five foundries are operating in the United States and Canada. The green sand lines at these foundries cast different metals (brass, gray iron and ductile iron), use a variety of core types (shell, phenolic-urethane, phenolic, furfuryl alcohol core resin base), employ horizontal and vertical molding lines, and range in size from 50 to 450 tons of castings per day.

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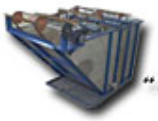

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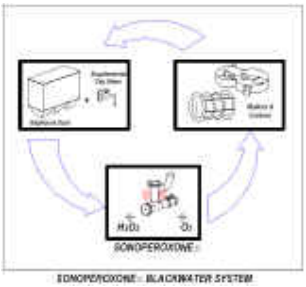
## Blackwater System Description

**Sonoperoxone ® Blackwater System**

The Sonoperoxone ® Blackwater System combines the advanced oxidation processes of ozone addition, hydrogen peroxide addition and high-powered acoustics with a solids separation system in order to recycle the clay and coal from a foundry's dust collection systems.



( Click to Enlarge )

Baghouse dust, which typically contains 20 to 30% clay, is slurried with water. Intense acoustic energy then blasts apart the silica and clay particles. After that, a clarifier can gravity separate the lighter clay and coal from the silica fines. The advanced oxidant treated slurry is then pumped to all the sand system moisture addition points. Control of green sand system fines is achieved through variable removal of the silica from the clarifier. Foundries employing the Sonoperoxone ® Blackwater system have reported 35 to 40% reductions in their bond usage [3,4,6].

As of June 1, 2004, four Sonoperoxone ® Blackwater Systems are operating in four different foundries in the United States. Two more, one in Canada and one in the U.S., have been constructed and are scheduled to start up during the summer of 2004 in two additional foundries.

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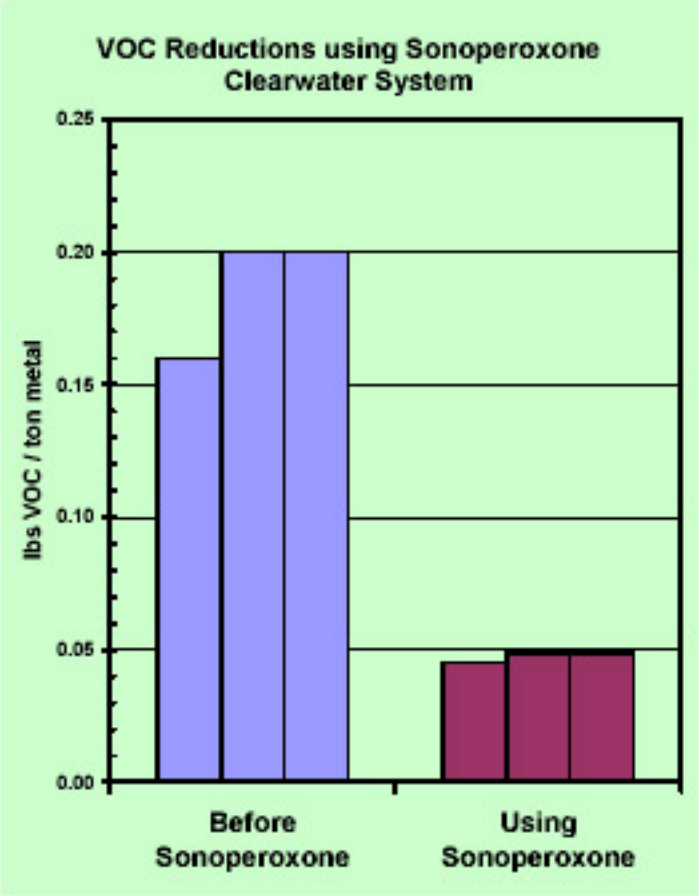
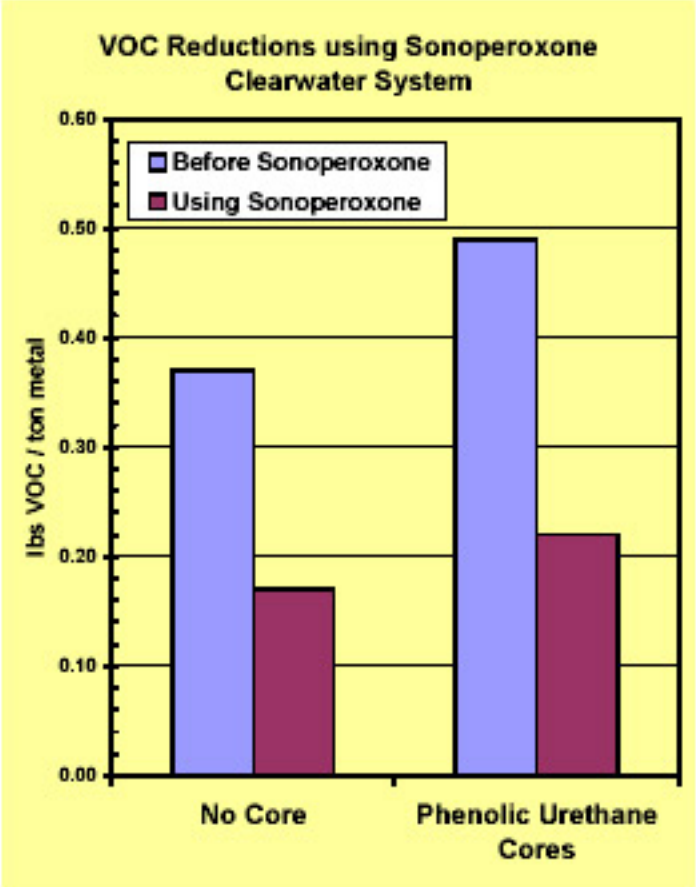
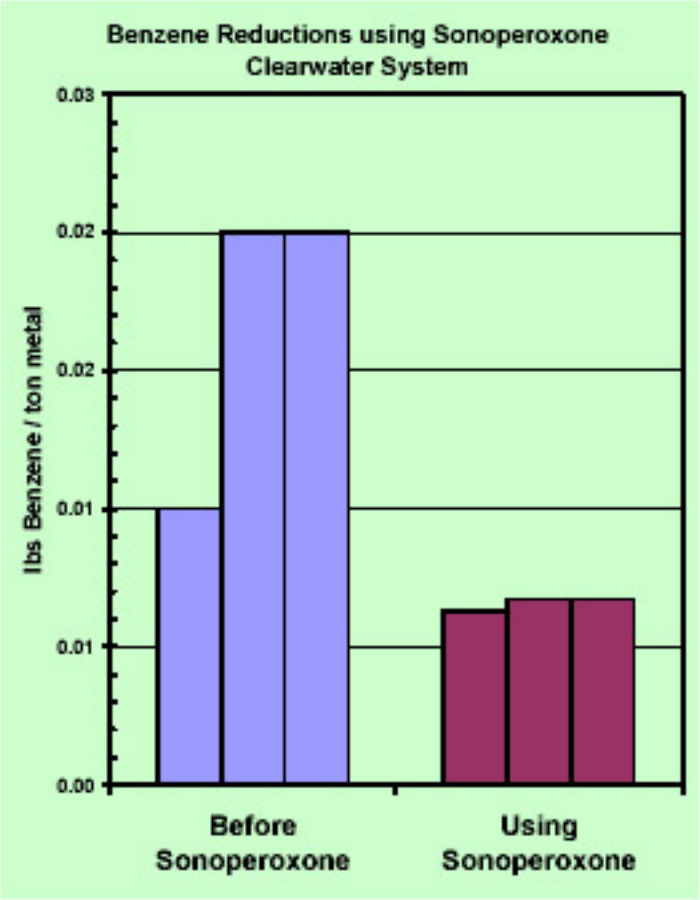
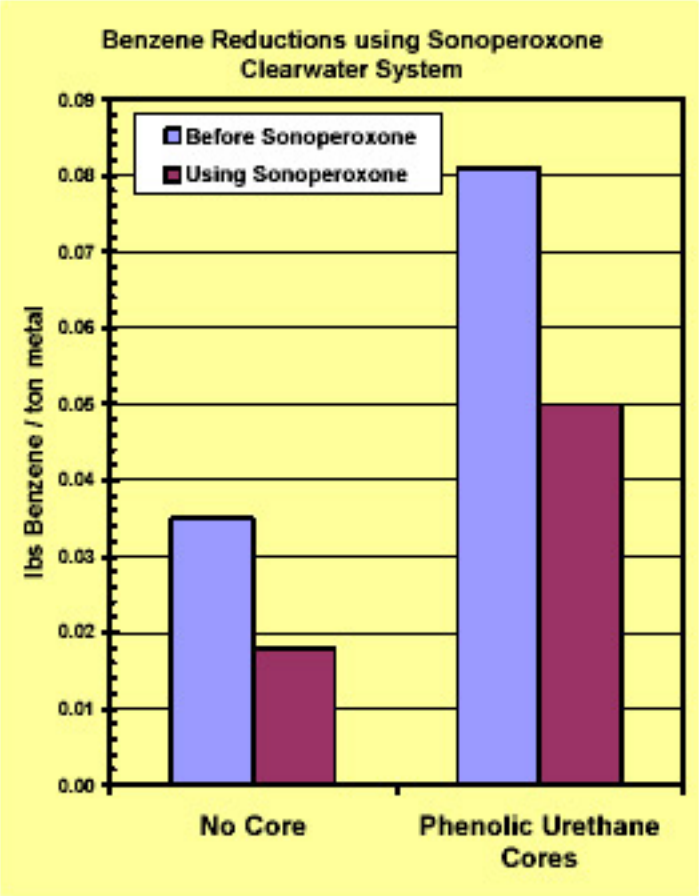
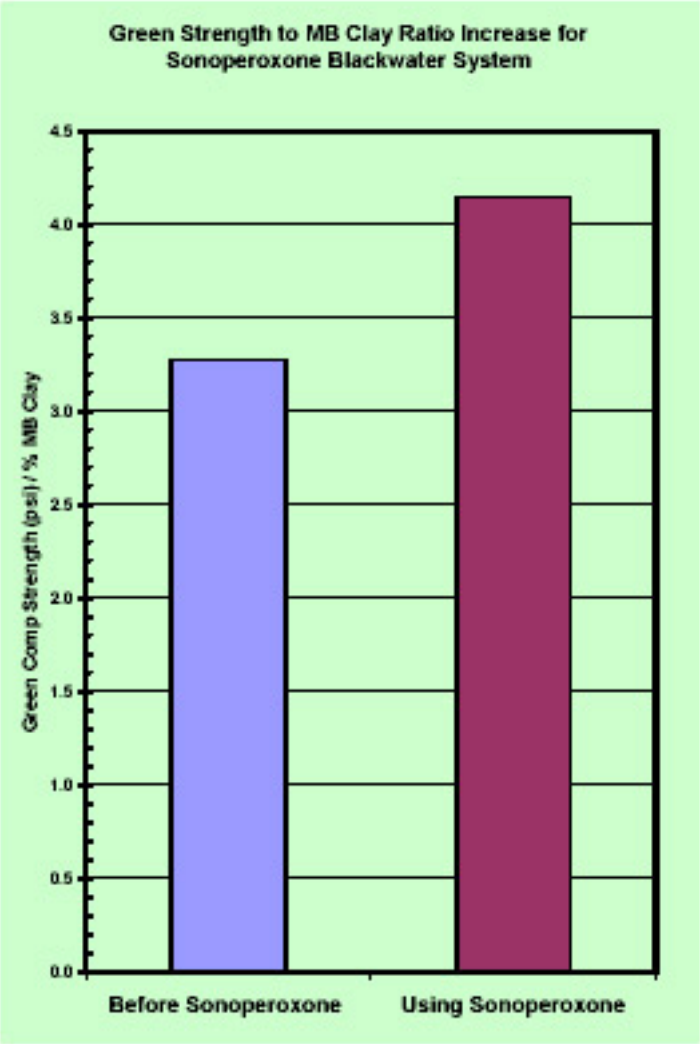
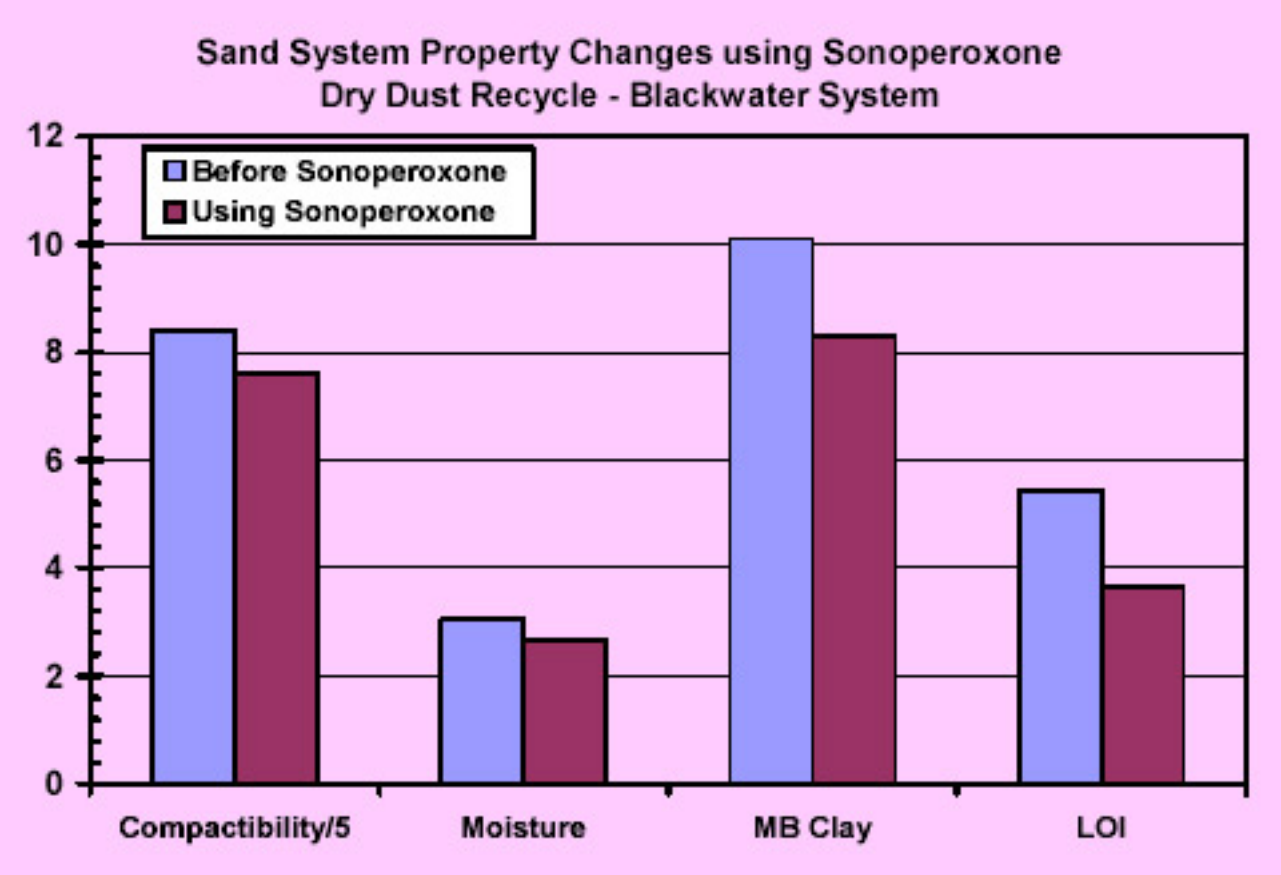

VOC Reductions using Sonoperoxone
Clearwater System
lbs VOC / ton metal
0.25
0.20
0.15
0.10
0.05
0.00
Before Sonoperoxone
Using Sonoperoxone

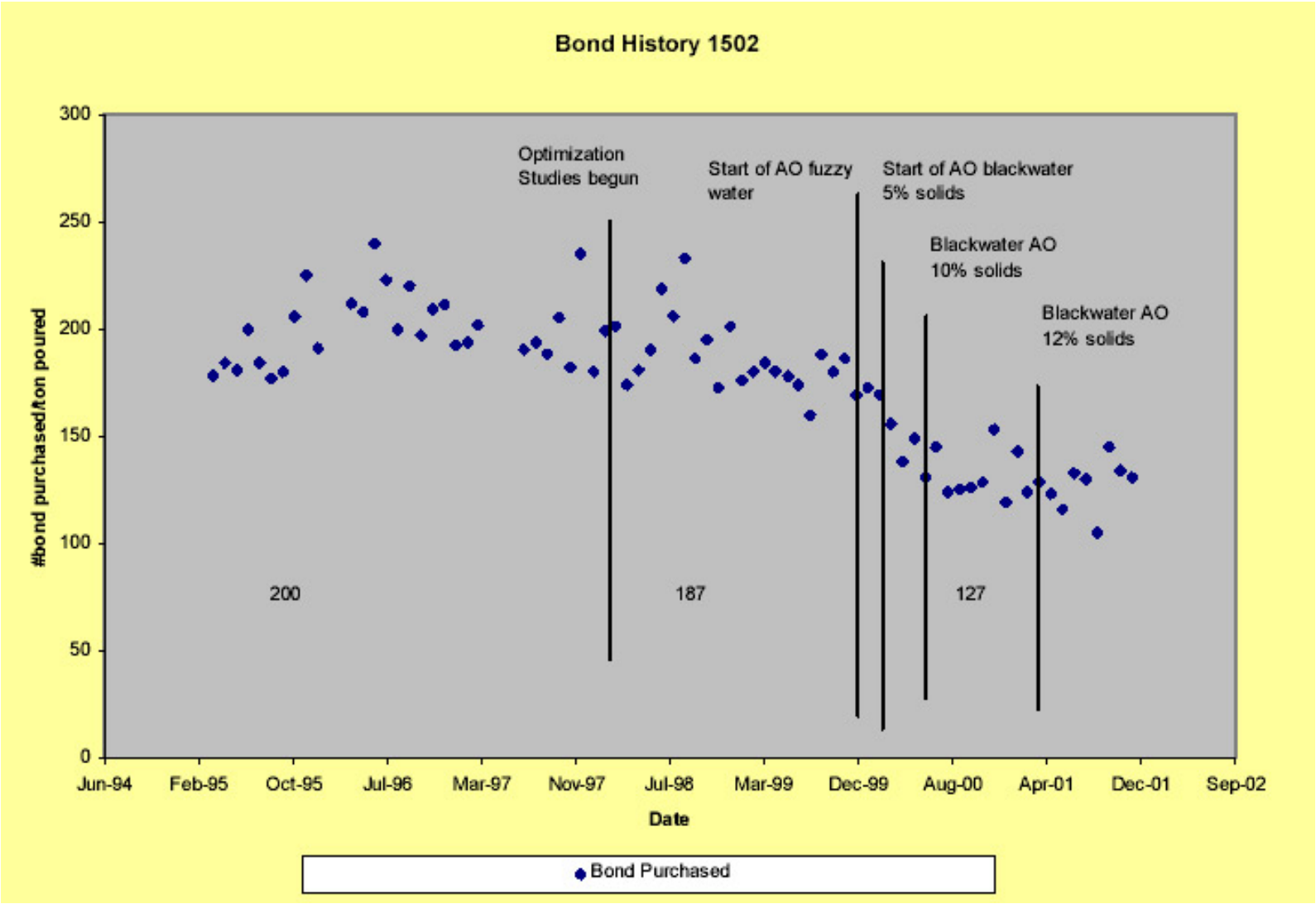

VOC Reductions using Sonoperoxone
Clearwater System
Before Sonoperoxone
Using Sonoperoxone
lbs VOC / ton metal
0.60
0.50
0.40
0.30
0.20
0.10
0.00
No Core
Phenolic Urethane Cores

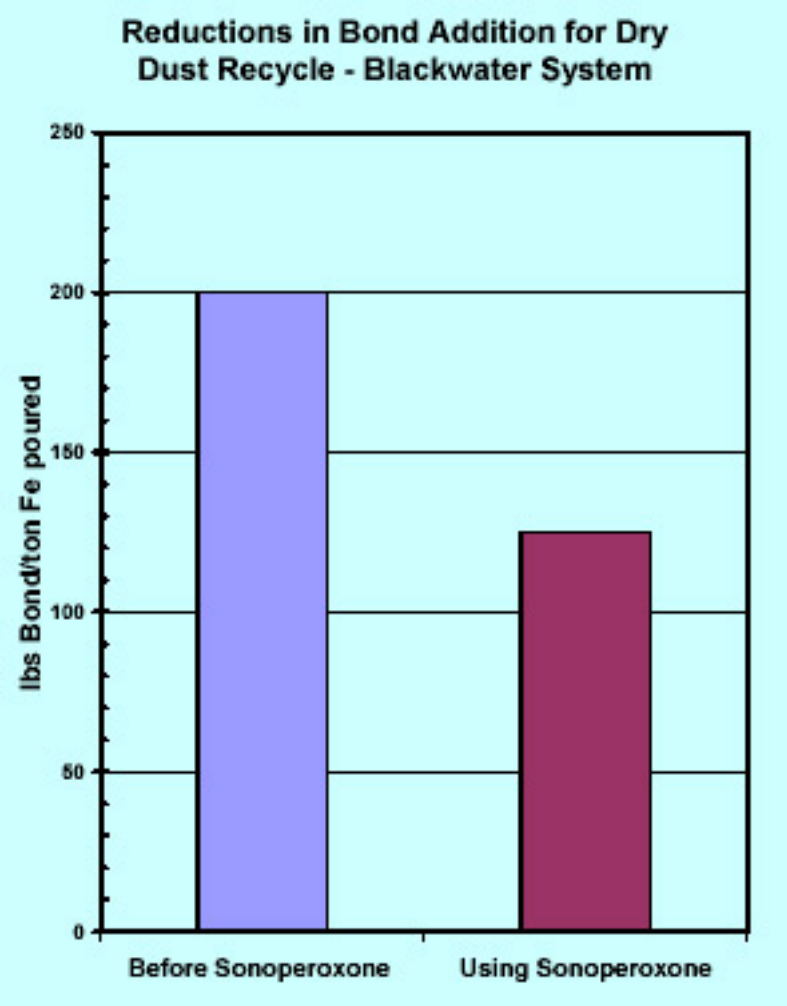

Benzene Reductions using Sonoperoxone
Clearwater System
lbs Benzene / ton metal
0.03
0.02
0.02
0.01
0.01
0.00
Before Sonoperoxone
Using Sonoperoxone

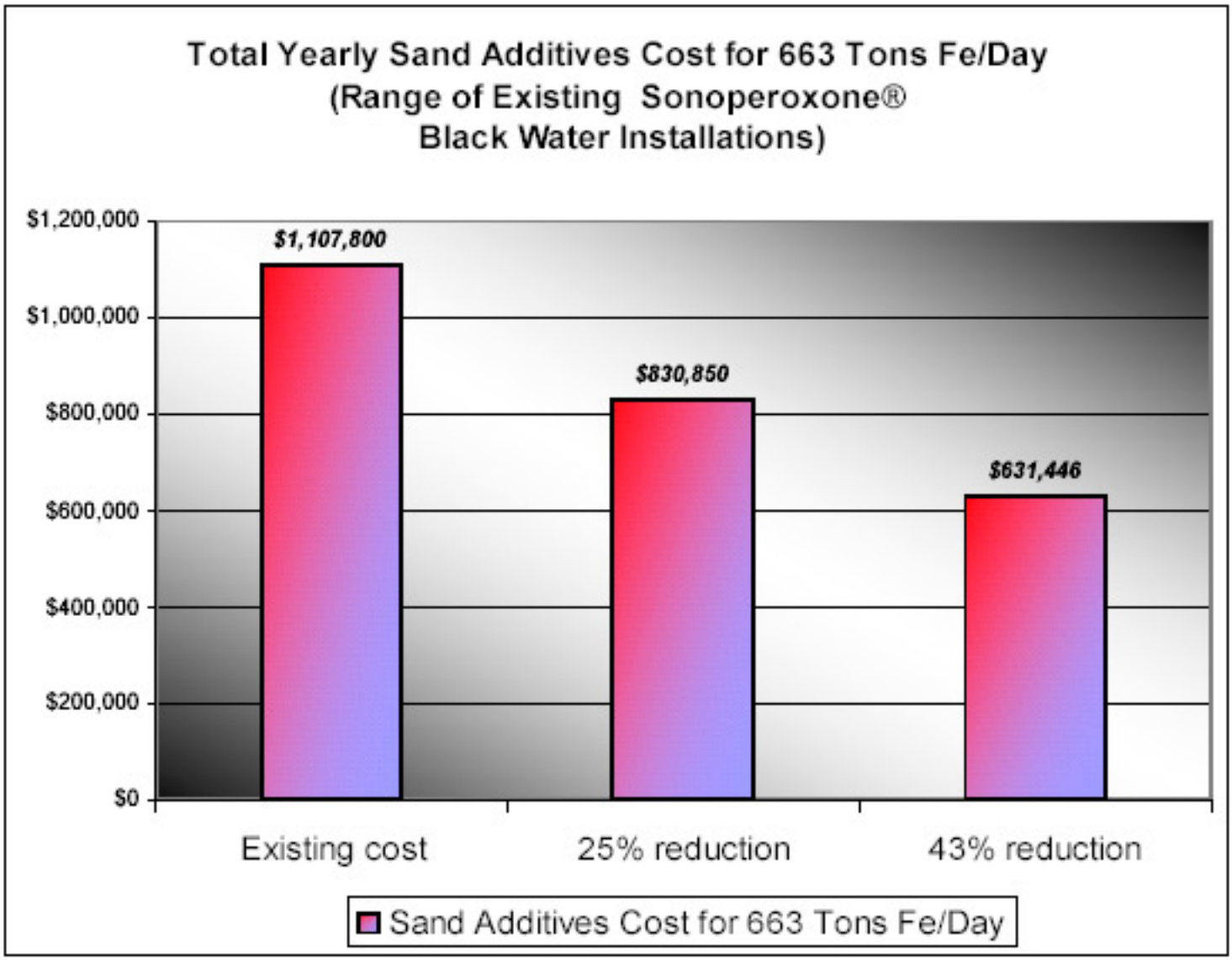

Benzene Reductions using Sonoperoxone
Clearwater System
Before Sonoperoxone
Using Sonoperoxone
lbs Benzene / ton metal
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
No Core
Phenolic Urethane Cores

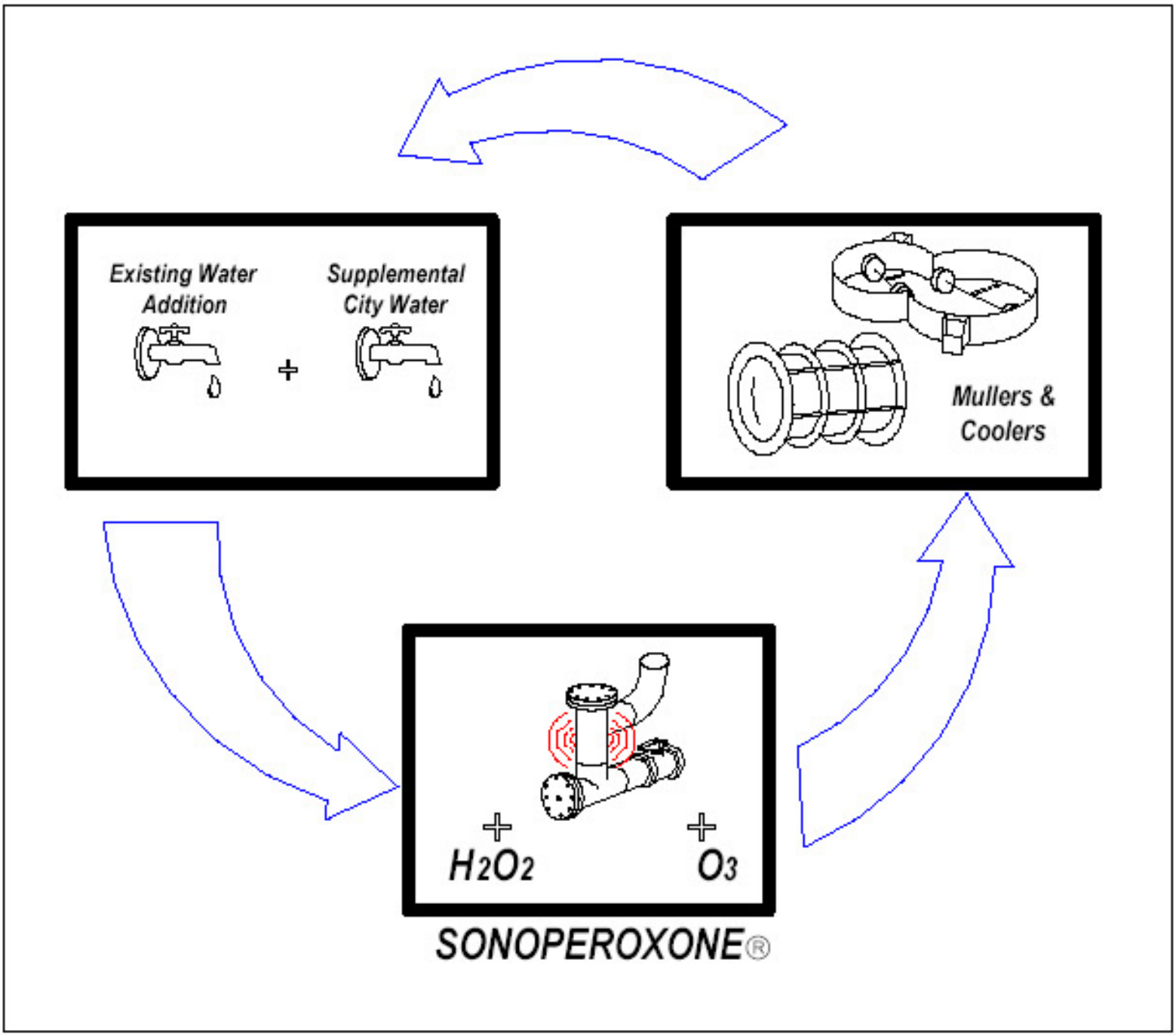

Green Strength to MB Clay Ratio Increase for
Sonoperoxone Blackwater System
Green Comp Strength (psi) / % MB Clay
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Before Sonoperoxone
Using Sonoperoxone


Sand System Property Changes using Sonoperoxone
Dry Dust Recycle - Blackwater System
Before Sonoperoxone
Using Sonoperoxone
12
10
8
6
4
2
0
Compactibility/5
Moisture
MB Clay
LOI

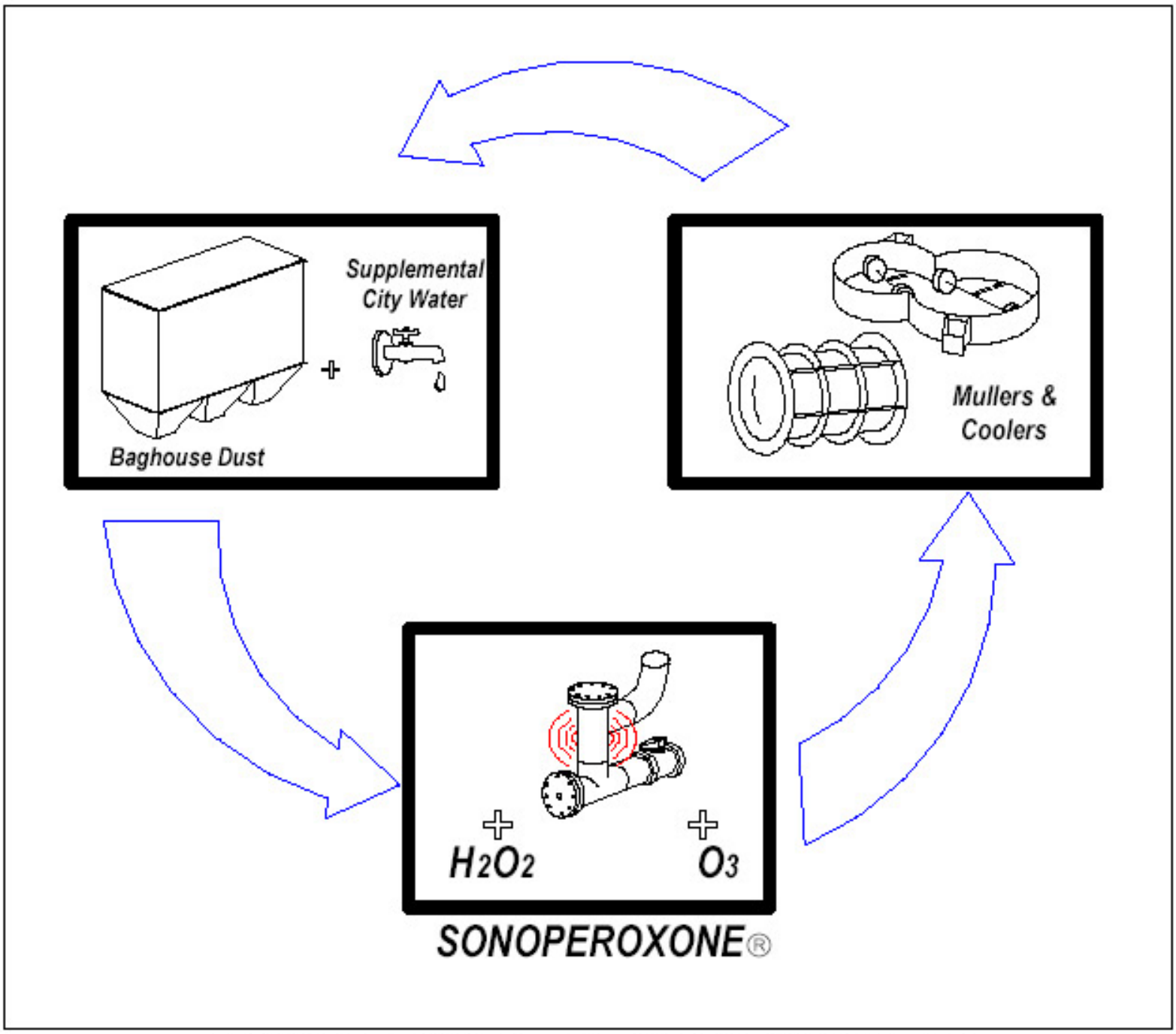

Bond History 1502
#bond purchased/ton poured
300
250
200
150
100
50
0
Optimization Studies begun
Start of AO fuzzy water
Start of AO blackwater 5% solids
Blackwater AO 10% solids
Blackwater AO 12% solids
200
187
127
Jun-94
Feb-95
Oct-95
Jul-96
Mar-97
Nov-97
Jul-98
Mar-99
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
Date
Bond Purchased


Reductions in Bond Addition for Dry Dust Recycle - Blackwater System
lbs Bond/ton Fe poured
250
200
150
100
50
0
Before Sonoperoxone
Using Sonoperoxone


Total Yearly Sand Additives Cost for 663 Tons Fe/Day
(Range of Existing Sonoperoxone®
Black Water Installations)
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
$1,107,800
$830,850
$631,446
Existing cost
25% reduction
43% reduction
Sand Additives Cost for 663 Tons Fe/Day




SONOPEROXONE® CLEARWATER SYSTEM




SONOPEROXONE® BLACKWATER SYSTEM

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Emission Reduction

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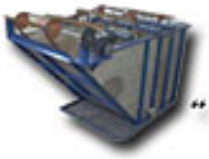

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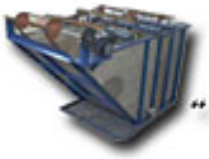

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## About FNI


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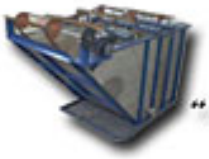
**Furness-Newburge, Inc.** is a small business specializing in for-hire invention of processes and machinery without existing technical solutions.

Furness-Newburge, Inc. routinely takes technologies from concept through prototype to full-scale production. Much of the work performed by Furness-Newburge, Inc. involves water treatment and process optimization for large industrial plants, some of which have more than 1,000 employees.

Furness-Newburge, Inc. also manufactures ultrasonic equipment, ozone generation equipment and electro-hydraulic cavitation devices.



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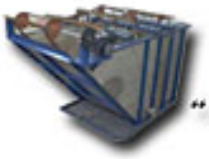

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## Consulting and R & D Services

### CONSULTING SERVICES

Furness-Newburge, Inc. consults with foundries on the use of advanced oxidation techniques for reduction of air pollution, bentonite recycling, and the mathematical modeling of sand system properties that leads to reliable prediction of sand system operations. In addition, it consults on other issues to optimize sand system controls in the foundry industry.

Furness-Newburge, Inc. also consults in many industries on the use of advanced oxidation techniques for amine odor destruct, phenolic sand coating odor destruct and bio/scale control in water towers.

### R & D SERVICES

Furness-Newburge, Inc. has privately funded or participated in government funded R & D in the following areas:

- Gas storage well remediation
- Crude oil viscosity reduction
- Animal waste treatment and recycle
- Groundwater treatment
- Defense/personal protection with emphasis on indoor environment
- Energy reduction through use of acoustically stimulated metal to create hollow risers and thin wall castings
- Acoustic Advanced Oxidation treatment of critical military aircraft components

- Acoustic Advanced Oxidation destruction of dioxin and related by-products
- Acoustic Advanced Oxidation modification of as-mined minerals
- Ultrasonic and Advanced Oxidation processing for foods

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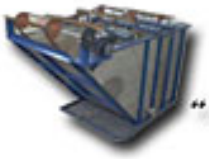

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## Personnel

**James C. Furness, Jr.**

Mr. Furness founded Furness-Newburge, Inc. in 1983 and remains its President. Mr. Furness began his training and experience in ultrasonic/acoustic cavitation with the U.S. Navy during the Vietnam War.

Mr. Furness invented the Sonoperoxone® technology currently being used at ten sites in eight foundries in the U.S. and Canada. Mr. Furness and faculty at The Pennsylvania State University continue to study Sonoperoxone® through a project pertaining to air pollution reduction using advanced oxidation technologies. This project is funded by grants from the National Science Foundation and the U.S. Department of Energy.

For thirty years, Mr. Furness has designed machinery that he installed and implemented to reduce pollution and to improve foundry processes. For example, he developed vertical blast furnace chemical injection systems to prevent the formation of soluble/hazardous heavy metals and machinery to recycle industrial sand used in the foundry industry.

Mr. Furness holds patents in advanced oxidation water treatment and perfected inventions in various industries. He developed experimental systems for the deodorization of large-scale agricultural operations and also implemented large-scale scrubber operations to deodorize fumes from phenolic resin coatings. In the 1980's, Mr. Furness devised a chemical stabilization process in conjunction with the California Department of Health Services (now the California EPA) to stabilize lead, cadmium, zinc and copper. This unique stabilization process successfully passed federal TCLP and the more stringent leaching requirements of the State of California. During the mid 1990's, his efforts with several Wisconsin foundries and the Wisconsin Department of Natural Resources, Bureau of Air Management, formed the basis of regulations defining air pollution standards for foundries in Wisconsin.

Mr. Furness has published numerous articles and is a member of several professional organizations including the American Foundry Society, the American Chemical Society and the International Ozone Association.

---

## Paul David Paulsen, Ph.D., Vice President

Dr. Paulsen has been the Technical Director of Furness-Newburge, Inc. since August 1999. He performs engineering design and research as well as oversees fabrication of advanced oxidation equipment manufactured by Furness-Newburge, Inc. He also serves as project manager for installations of the equipment.

Dr. Paulsen holds a B.S. in Aerospace Engineering from Virginia Tech (1991), an M.S. in Aerospace Engineering from Georgia Tech (1992) where he specialized in combustion, and a Ph.D. in Environmental Engineering from The Pennsylvania State University (1998) where he concentrated in air pollution control. As a graduate student at Penn State, he conducted research on advanced oxidation systems for the removal of HAP's and VOC's generated by paint spraying and coating operations. The processes included air-phase destruction using ozone, water adsorption with regeneration using hydrogen peroxide and ozone, and activated carbon adsorption with ozone regeneration. As a Post-Doctoral Scholar at Penn State, he taught a water transport and treatment course and researched advanced oxidation systems for benzene and VOC removal at high production iron foundries.

Dr. Paulsen has authored articles for Carbon, Ozone Science and Engineering and Foundry Trade Journal. He has given conference presentations at the ACS Colloid and Surface Science Symposium, the International Carbon Conference, and the International Conference on Advanced Oxidant Technologies for Water and Air Remediation. His professional memberships include the American Foundry Society and the American Chemical Society.

---

## Lynn Furness, Chief Financial Officer

Ms. Furness runs the daily operations of Furness-Newburge, Inc. Her duties include, but are not limited to, purchasing, personnel/payroll, bookkeeping, trademark issues and strategic planning. She also manages travel and other scheduling for staff and projects as well as sales contacts.

Ms. Furness received a B.A. in History from the University of California at Los Angeles (1970) and a J.D. from the Southwestern University School of Law in Los Angeles (1981). She practiced real estate and title insurance law in California before joining Furness-Newburge, Inc. Ms. Furness is a licensed attorney in Kentucky and California maintaining memberships in the Kentucky State Bar and the California State Bar.

---

## Daniel C. Hutchens, Mechanical Engineer

Mr. Hutchens joined Furness-Newburge, Inc. as its staff Mechanical Engineer in May 2003. He received a B.S. in Mechanical Engineering from the University of Kentucky, Lexington, Kentucky in August 2002. He has also passed the Fundamentals of Engineering licensure examination for the State of Kentucky.

Building upon Mr. Hutchens' experience at UK as a Research Engineering Assistant in the Advanced

Structures/Emerging Technologies Lab, Furness-Newburge, Inc. utilizes his skills at design, data acquisition and analysis, report writing and inventory control for various projects undertaken by the company. He also assists in fabrication supervision for equipment and systems designed and built by Furness-Newburge, Inc. In addition, based upon his contributions to the system designs, Mr. Hutchens has been instrumental in writing detailed manuals and instruction guides for this same equipment.

Mr. Hutchens is a member of the American Foundry Society, the American Society of Mechanical Engineers, the American Institute of Aeronautics and Astronautics and the Order of the Engineer.

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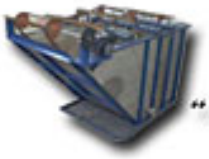

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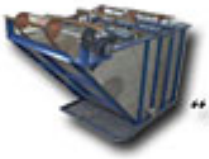
## Contact Us

| | |
|---|---|
| **James C. Furness, Jr.** (Jim) | jimfurness@alltel.net |
| **Lynn Furness** | mamanewbs@yahoo.com |
| **Paul David Paulsen** (Dave) | davep01@prodigy.net |
| **Daniel C. Hutchens** | dchutc0@yahoo.com |



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## Why Every Green Sand Foundry Needs Sonoperoxone ®

**Because pollution costs you money**

High production green sand foundries are under increasing pressure to reduce hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) that are emitted during pouring, cooling and casting shakeout (PCS). Smoke and odor from PCS emissions are a serious concern in the workplace environment and a source of neighborhood complaints. In 1988, the State of Wisconsin established regulatory limits for the HAP benzene at 300 lbs/yr and for the HAP formaldehyde at 250 lbs/yr. The U.S. Environmental Protection Agency in August 2003 established a VOC emission standard of 20 ppm for new PCS lines at iron and steel foundries. Since most end-of-pipe treatment systems such as thermal oxidizers are energy intensive and expensive, the foundry industry clearly needs alternative pollution prevention strategies that economically comply with ever more demanding air quality requirements.

**Our Sonoperoxone ® systems reduce your pollutant emissions to meet the increasingly stringent government regulations and to satisfy your increasingly sensitive neighbors.**

**Complaints = Regulation = Lawyers = Money.**

## Because bond costs you money

The advanced oxidants generated by our Sonoperoxone ® process interact with the clay and coal in your bond to make them more efficient. Clay activation increases and coal usage drops. Sand strength per unit of clay increases. Foundries with our Clearwater systems have seen their bond consumptions drop by up to 15% [ref. 2]. Foundries with our Blackwater systems have seen their bond consumptions drop by up to 40% [ref. 3,4,6] by combining bag house dust recycle with advanced oxidant activation.

**Our Sonoperoxone ® systems make your foundry more competitive by reducing bond consumption while reducing pollution.**

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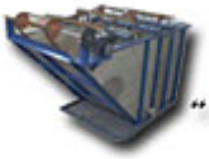

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## How Sonoperoxone ® Works

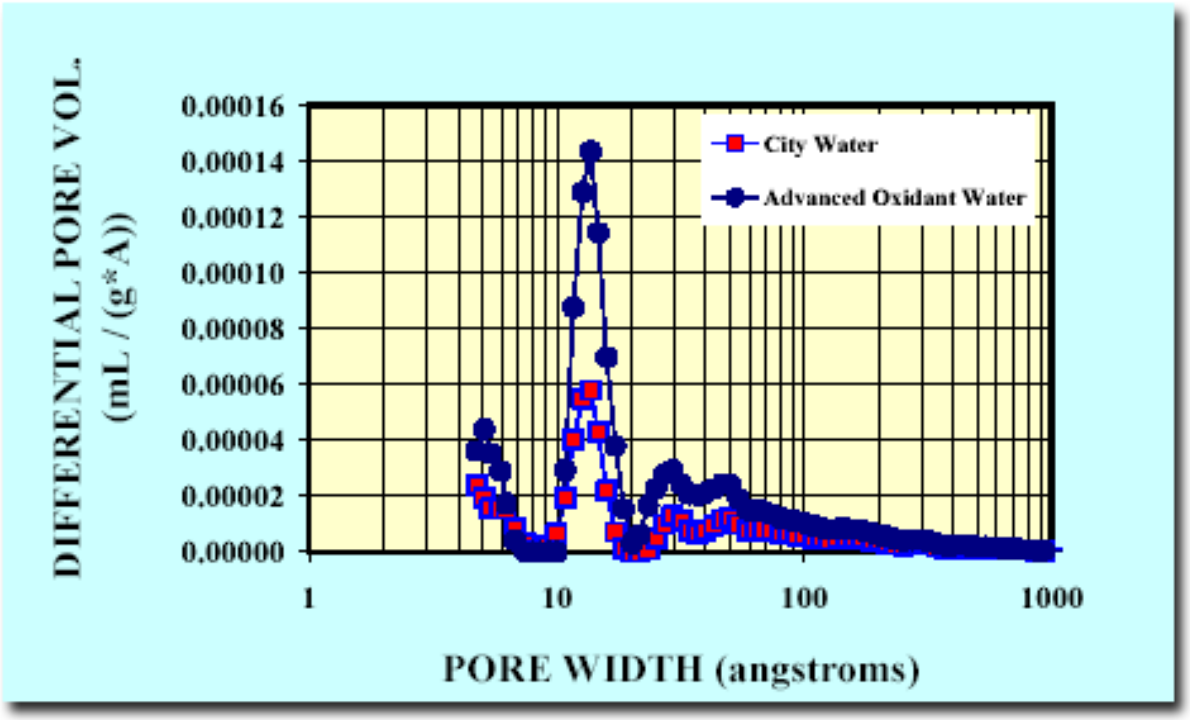

- **Clearwater System Description**
- **Blackwater System Description**


### Green Sand Foundry Emissions and their Prevention

The green sand's coal and the core's resin binder are the primary sources of organic HAP and VOC emissions. The pouring of high temperature molten metal into the sand mold causes the release of organic compounds from the coal and organic resins. These organic compounds are necessary to the casting process because they provide a reducing atmosphere at the casting surface which prevents casting defects and provides good surface finish.

These organic compounds have three fates: they are burned up in the flames of the mold, they condense or are adsorbed in the cooler sections of the mold, or they are released into the atmosphere. Most of these organic compounds belong to the benzene family (benzene, toluene, xylene) and are considered harmful air pollution. The Sonoperoxone® treatment system prevents pollution at its source by improving the ability of the sand mold to adsorb these organic compounds.

Sonoperoxone® combines ozone addition, hydrogen peroxide addition and high-powered acoustics to generate advanced oxidants in the water used by a foundry's coolers and mullers. By treating the water used in a foundry's green sand system, advanced oxidants will destroy some of the organic compounds coating the silica. More importantly, the advanced oxidants clean out the pores of the coal and clay and increase the porosity of these green sand components (See graph [8]). Increasing the porosity of the sand mold allows the mold to retain more of the organic compounds. This results in lower emissions being released and more consumables being retained for the next casting cycle. Even some emissions from the chemically bonded cores are captured in the green sand mold. However, the emissions reduction decreases as core size increases because the process does not treat the core sand. Core sand emissions bypass the green sand mold.




**Effect of advanced oxidation treatment of green sand:**
**Pore volume increase from Glowacki et al [8].**

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## Pollutant Emission Reduction

| Emissions Results Table [1,3,4,7] | | | |
|---|---|---|---|
| | | | |
| | | **Emissions** | |
| | City Water | Adv. Oxidant Water | % Change |
| | (lb/ton metal) | (lb/ton metal) | |
| **Sonoperoxone - Clearwater Foundry A** | | | |
| Benzene | 0.017 | 0.0066 | -61% |
| Total VOC | 0.186 | 0.0477 | -74% |
| | | | |
| **Sonoperoxone - Clearwater Foundry B** | | | |
| Benzene, no core | 0.035 | 0.018 | -48% |
| Total VOC, no core | 0.37 | 0.17 | -54% |
| Benzene, cored | 0.081 | 0.05 | -38% |
| Total VOC, cored | 0.49 | 0.22 | -55% |
| | | | |
| **Sonoperoxone - Blackwater Foundry** | | | |
| Benzene, no core | 0.055 | 0.030 | -45% |

| | | | |
|---|---|---|---|
| Total VOC, no core | 0.60 | 0.22 | -63% |
| Methane+Ethane, no core | 0.61 | 0.39 | -36% |
| Benzene, cored * | 0.082 | 0.066 | -20% |
| Total VOC, cored * | 0.86 | 0.45 | -48% |
| Methane+Ethane, cored | 0.65 | 0.45 | -31% |
| | | | |

* -- 3.4 lb phenolic urethane binder per ton metal poured

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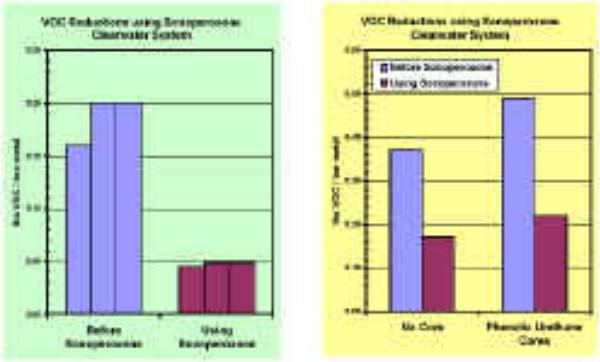

**VOC Reductions using Sonoperoxone Clearwater System**

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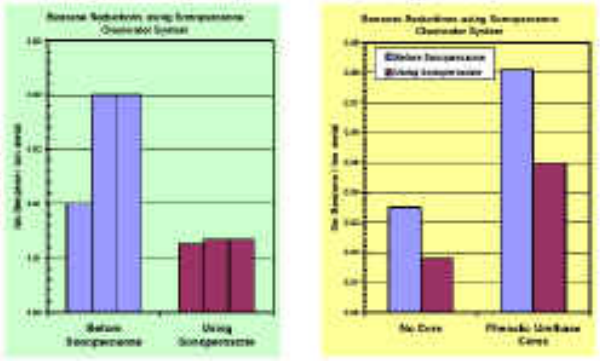

**Benzene Reductions using Sonoperoxone Clearwater System**

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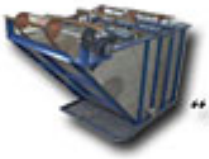

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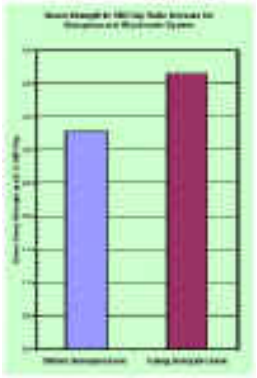
## Bond Reductions / Cost Savings



**Green Strength to MB Clay Ratio Increase for Sonoperoxone Blackwater System**

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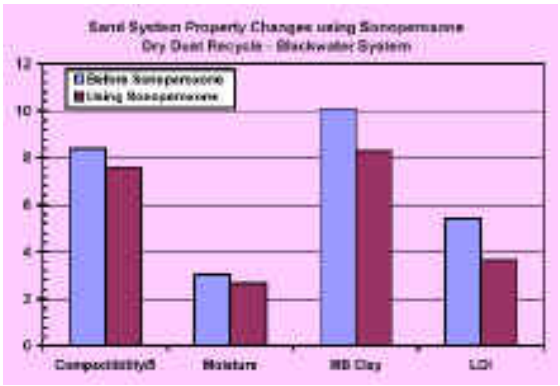


**Sand System Property Changes using SonoperoxoneDry Dust Recycle - Blackwater System**

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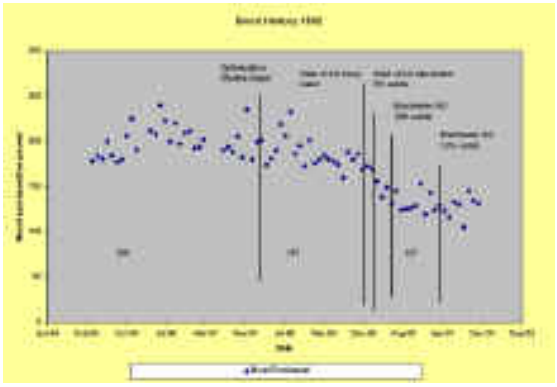

**Bond History 1502**

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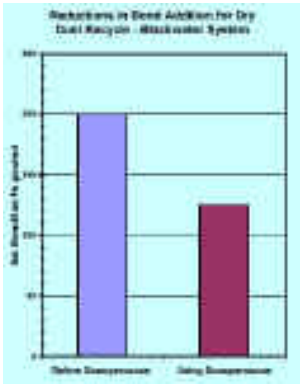

**Reductions in Bond Addition for Dry Dust Recycle - Blackwater System**

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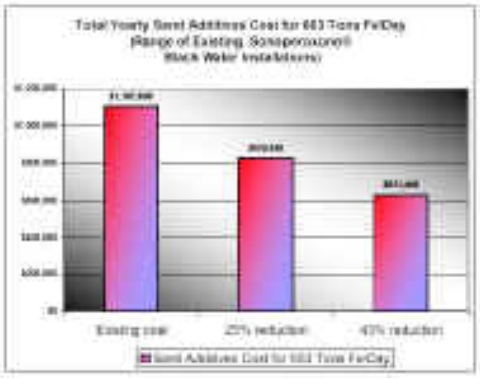


**Total Yearly Sand Additives Cost for 663 Tons Fe/Day (Range of Existing Sonoperoxone® Black Water Installations)**

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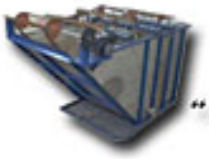

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## Published Articles List

1. "**Emissions Studies at a Test Foundry using an Advanced Oxidation-Clear Water System**," Glowacki, C., G. Crandell, F.S. Cannon, J. K. Clobes, R. C. Voigt, J. C. Furness, McComb and S. Knight, AFS Transactions 2003.

2. "**Advanced Oxidants Offer Opportunities to Improve Mold Properties, Emissions**," Andrews, J., R. Bigge, F. S. Cannon, G. Crandell, J. C. Furness, M. Redmann and R.C. Voigt, Modern Casting, September 2000, pp. 40-43.

3. "**Foundry Emissions Effects with an Advanced Oxidation-Blackwater System**," Goudzwaard, J., C. Kurtti, F. S. Cannon, J. C. Furness, R. C. Voigt, J. Andrews, and D. L. Sipple, accepted for publication in AFS Transactions 2003.

4. "**Performance and Control of a Green Sand System during the Installation and Operation of an Advanced Oxidation System**," Land, J., R. C. Voigt, F.S. Cannon, J.C. Furness and J. Andrews, AFS Transactions, Vol. 110, pp. 705-715 (2002).

5. "**2001 Foundry of the Year: Neenah Foundry Co.**," Alfred Spada, Modern Casting, July 2001, pp. 24-28.

6. "**Effects of Advanced Oxidants on Green Sand System Performance in a Black Water System**," Neill, D., F. S. Cannon, R.C. Voigt, J.C. Furness and R. Bigge, AFS Transactions, Vol. 109, pp. 937-955 (2001).

7. "**Economical Use of Advanced Oxidation Systems for Green Sand Emission Reductions**," Voigt, R.C., F.S. Cannon and J.C. Furness, 12th AFS International Environmental, Health and Safety Conference, October 2000, pp. 315-332.

8. "**Emissions Studies at a Test Foundry using an**

**Advanced Oxidation-Clear Water System**," Glowacki, C., G. Crandell, F.S. Cannon, J. K. Clobes, R. C. Voigt, J. C. Furness, McComb and S. Knight, AFS Conference Milwaukee Transactions 2003.

9. "**The Use of Advanced Oxidation for the Reduction of Pollution from Green Sand Foundries**, " P.D. Paulsen, Foundry Trade Journal, November 2003, pp. 12-14.

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**can provide copies upon request.**

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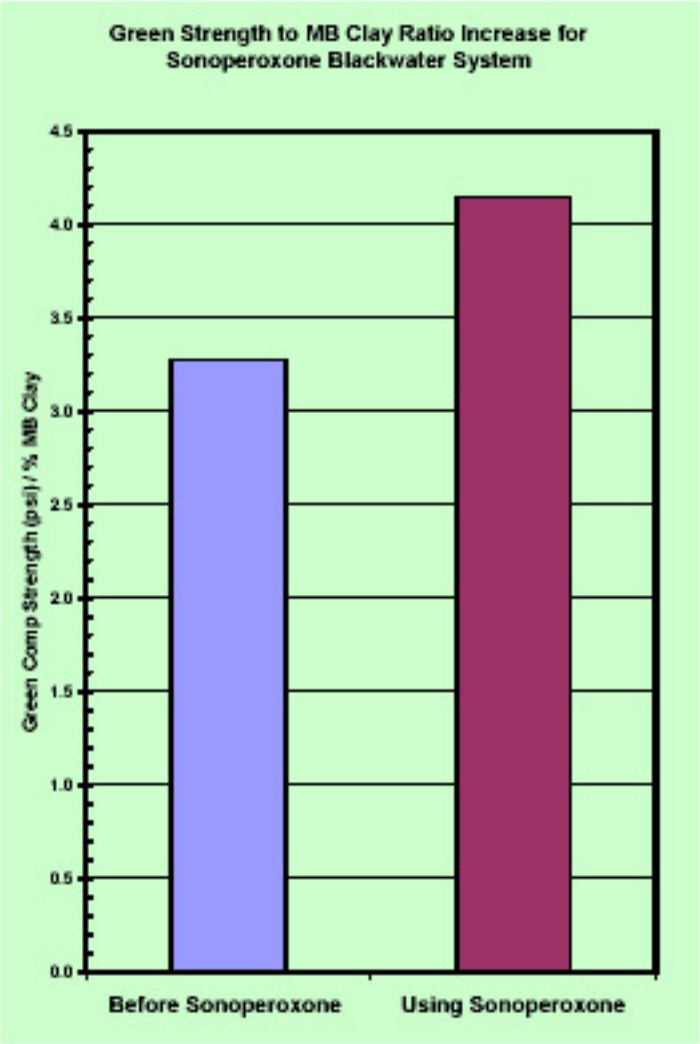
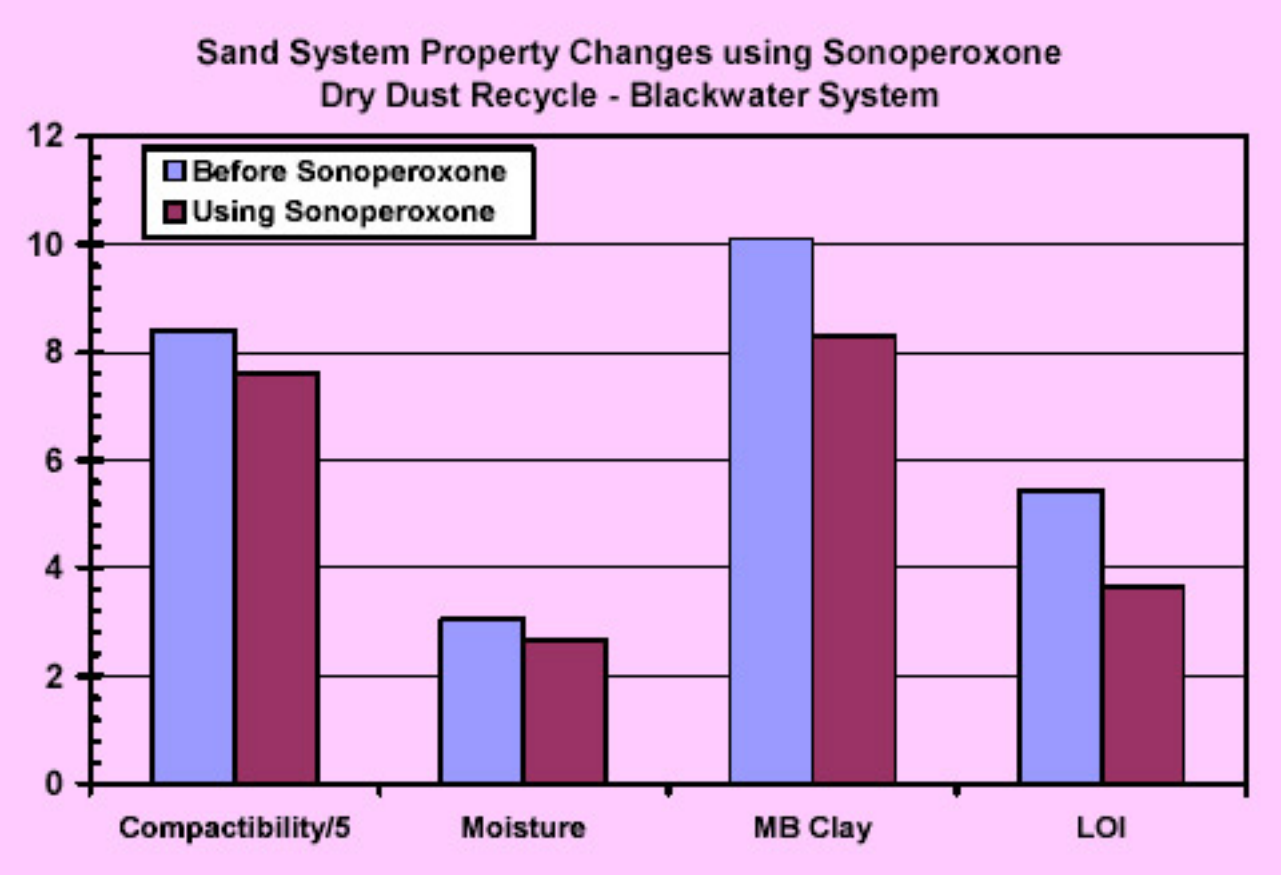
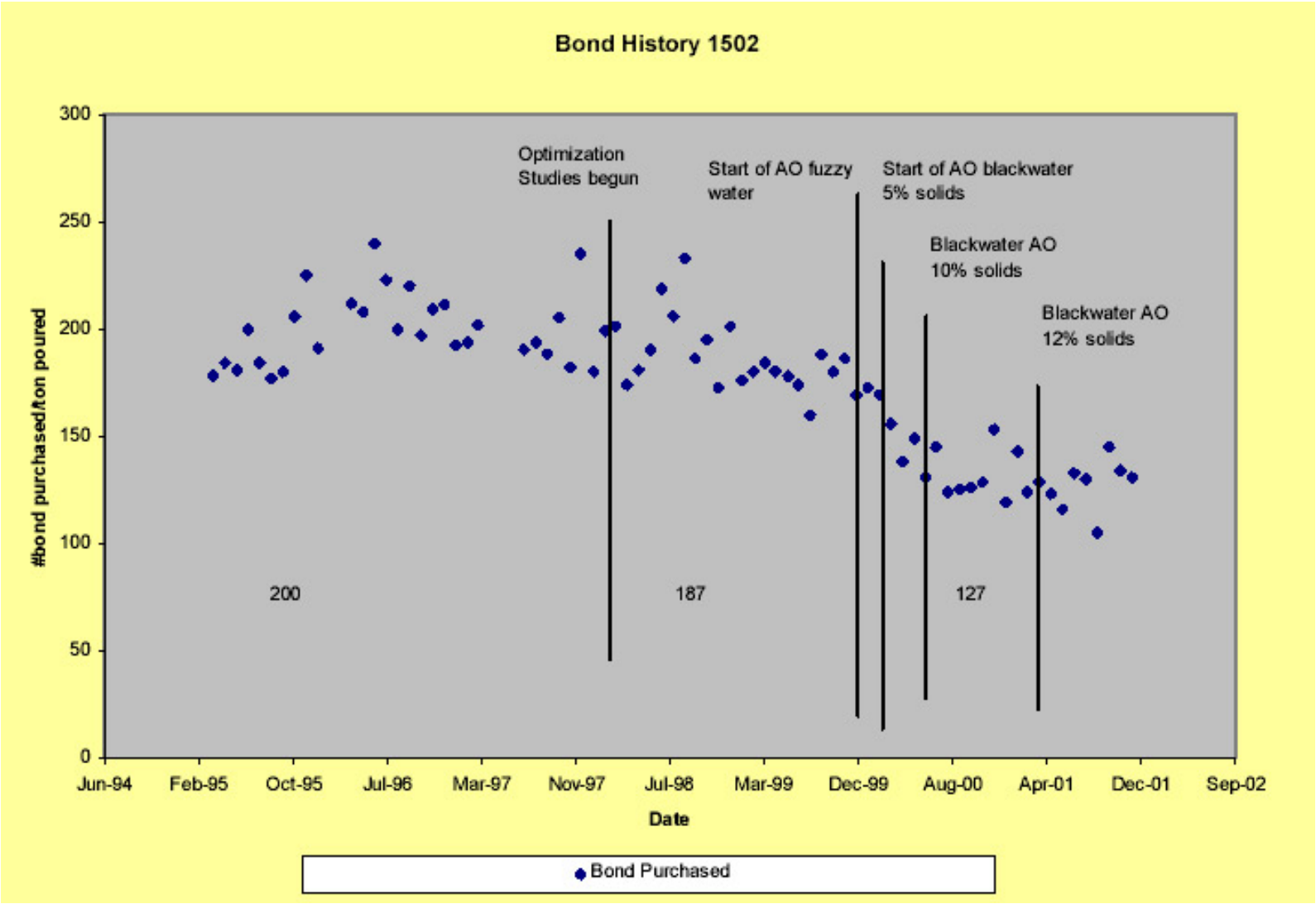
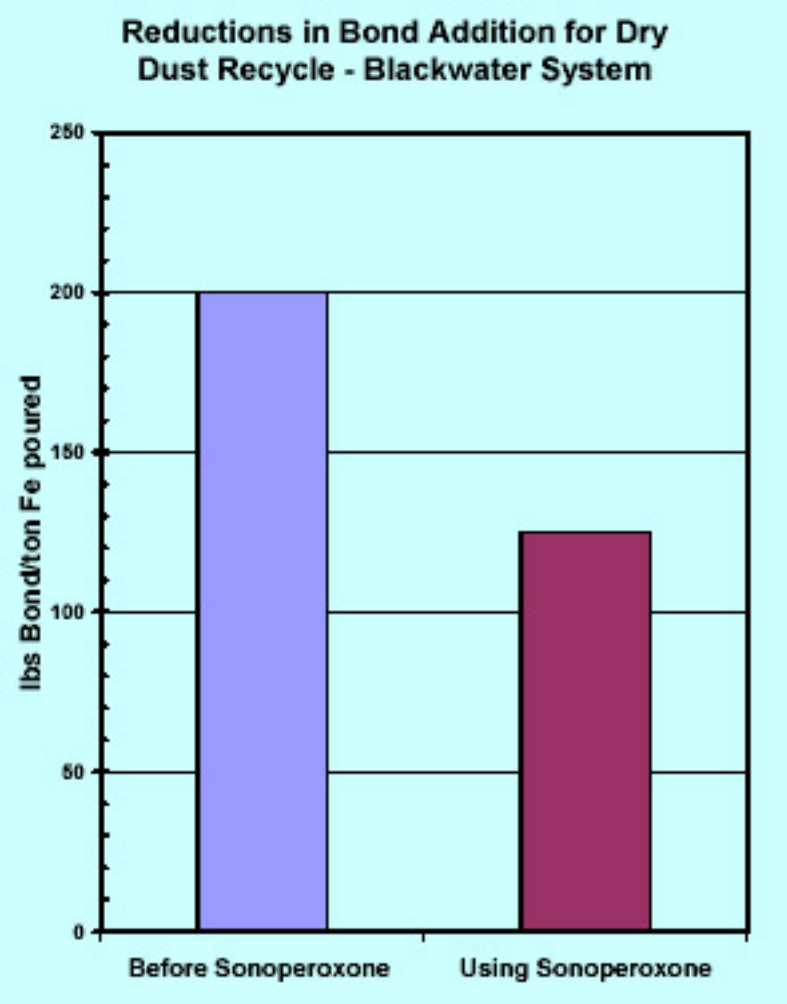
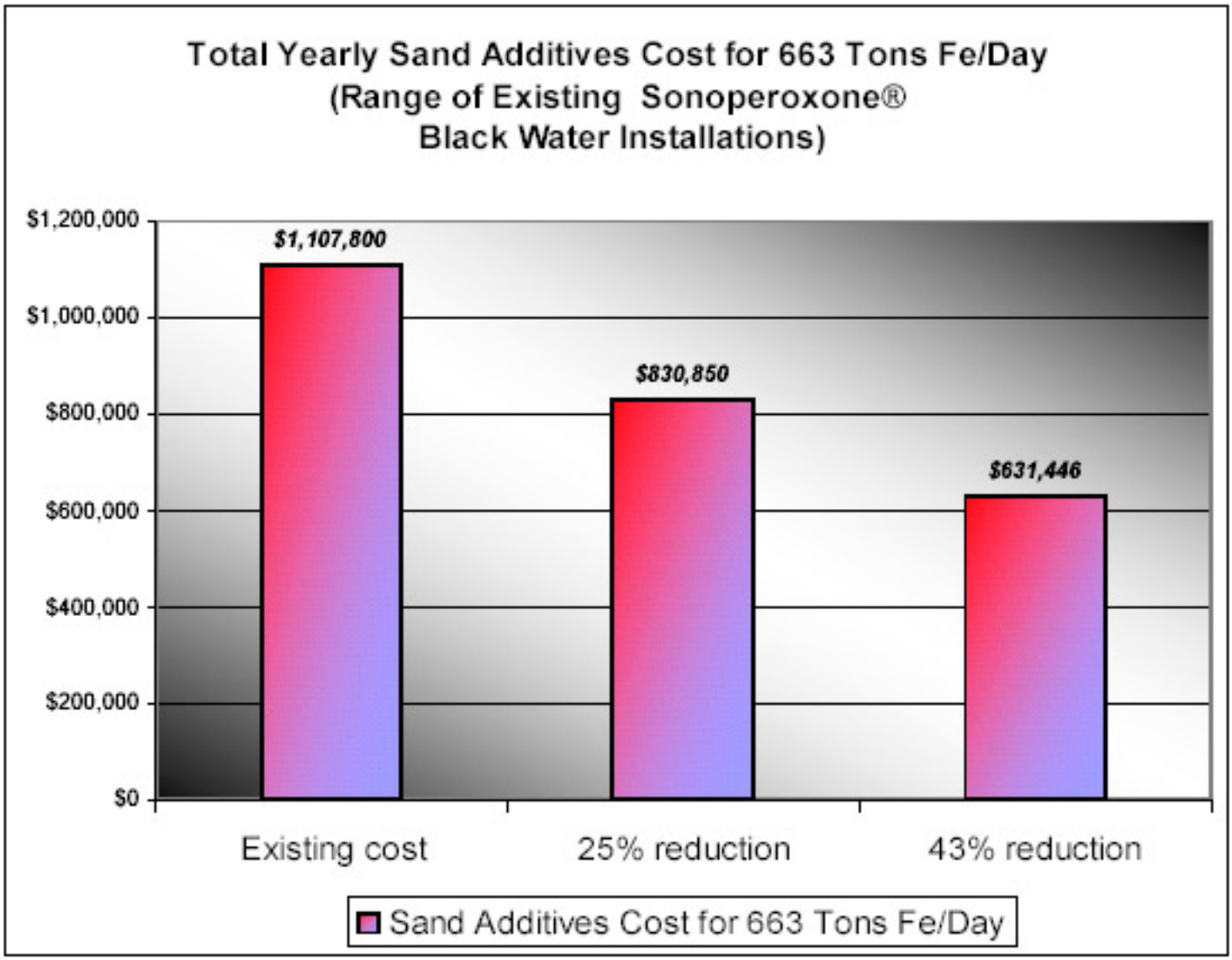
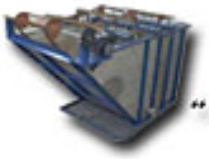

Green Strength to MB Clay Ratio Increase for
Sonoperoxone Blackwater System
Green Comp Strength (psi) / % MB Clay
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Before Sonoperoxone
Using Sonoperoxone


Sand System Property Changes using Sonoperoxone
Dry Dust Recycle - Blackwater System
Before Sonoperoxone
Using Sonoperoxone
12
10
8
6
4
2
0
Compactibility/5
Moisture
MB Clay
LOI


Bond History 1502
#bond purchased/ton poured
300
250
200
150
100
50
0
Optimization Studies begun
Start of AO fuzzy water
Start of AO blackwater 5% solids
Blackwater AO 10% solids
Blackwater AO 12% solids
200
187
127
Jun-94
Feb-95
Oct-95
Jul-96
Mar-97
Nov-97
Jul-98
Mar-99
Dec-99
Aug-00
Apr-01
Dec-01
Sep-02
Date
Bond Purchased


Reductions in Bond Addition for Dry Dust Recycle - Blackwater System
lbs Bond/ton Fe poured
250
200
150
100
50
0
Before Sonoperoxone
Using Sonoperoxone


Total Yearly Sand Additives Cost for 663 Tons Fe/Day
(Range of Existing Sonoperoxone®
Black Water Installations)
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
$1,107,800
$830,850
$631,446
Existing cost
25% reduction
43% reduction
Sand Additives Cost for 663 Tons Fe/Day



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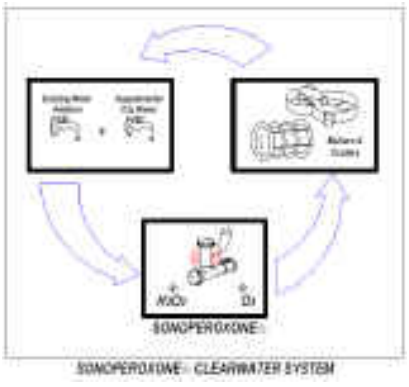
## Clearwater System Description

**Sonoperoxone ® Clearwater System**

Using a combination of advanced oxidation processes, Furness-Newburge, Inc. (FNI) developed its Sonoperoxone ® treatment systems in 1994 to meet the foundry industry need for cost effective pollution reduction. Sonoperoxone ® systems treat water with the combination of ozone addition, hydrogen peroxide addition and high-powered acoustics. The Sonoperoxone ® Clearwater System treats the water used in a green sand foundry's sand mixing/mulling and sand cooling operations. It simply treats the water your foundry is already using in its sand system. At these moisture addition points, advanced oxidants react with the green sand to prevent harmful emissions at their source.




( Click to Enlarge )

VOC reductions of up to 74% and benzene reductions of up to 64% have been reported [1,2] at foundries using this process on their green sand lines (see Pollutant Emission Reductions). Upon operation of the first system in 1995, an ancillary benefit to Sonoperoxone ® treatment was discovered – improvement in sand system strengths. In particular, the ratio of green compressive strength to clay increases when using the system. These sand system effects when employing a Clearwater system allowed foundries to reduce their bond usage by up to 15% [2].

Currently, six Sonoperoxone ® Clearwater Systems in five foundries are operating in the United States and Canada. The green sand lines at these foundries cast different metals (brass, gray iron and ductile iron), use a variety of core types (shell, phenolic-urethane, phenolic, furfuryl alcohol core resin base), employ horizontal and vertical molding lines, and range in size from 50 to 450 tons of castings per day.

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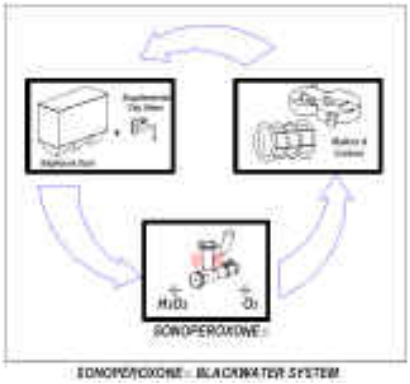
## Blackwater System Description

**Sonoperoxone ® Blackwater System**

The Sonoperoxone ® Blackwater System combines the advanced oxidation processes of ozone addition, hydrogen peroxide addition and high-powered acoustics with a solids separation system in order to recycle the clay and coal from a foundry's dust collection systems.



( Click to Enlarge )

Baghouse dust, which typically contains 20 to 30% clay, is slurried with water. Intense acoustic energy then blasts apart the silica and clay particles. After that, a clarifier can gravity separate the lighter clay and coal from the silica fines. The advanced oxidant treated slurry is then pumped to all the sand system moisture addition points. Control of green sand system fines is achieved through variable removal of the silica from the clarifier. Foundries employing the Sonoperoxone ® Blackwater system have reported 35 to 40% reductions in their bond usage [3,4,6].

As of June 1, 2004, four Sonoperoxone ® Blackwater Systems are operating in four different foundries in the United States. Two more, one in Canada and one in the U.S., have been constructed and are scheduled to start up during the summer of 2004 in two additional foundries.

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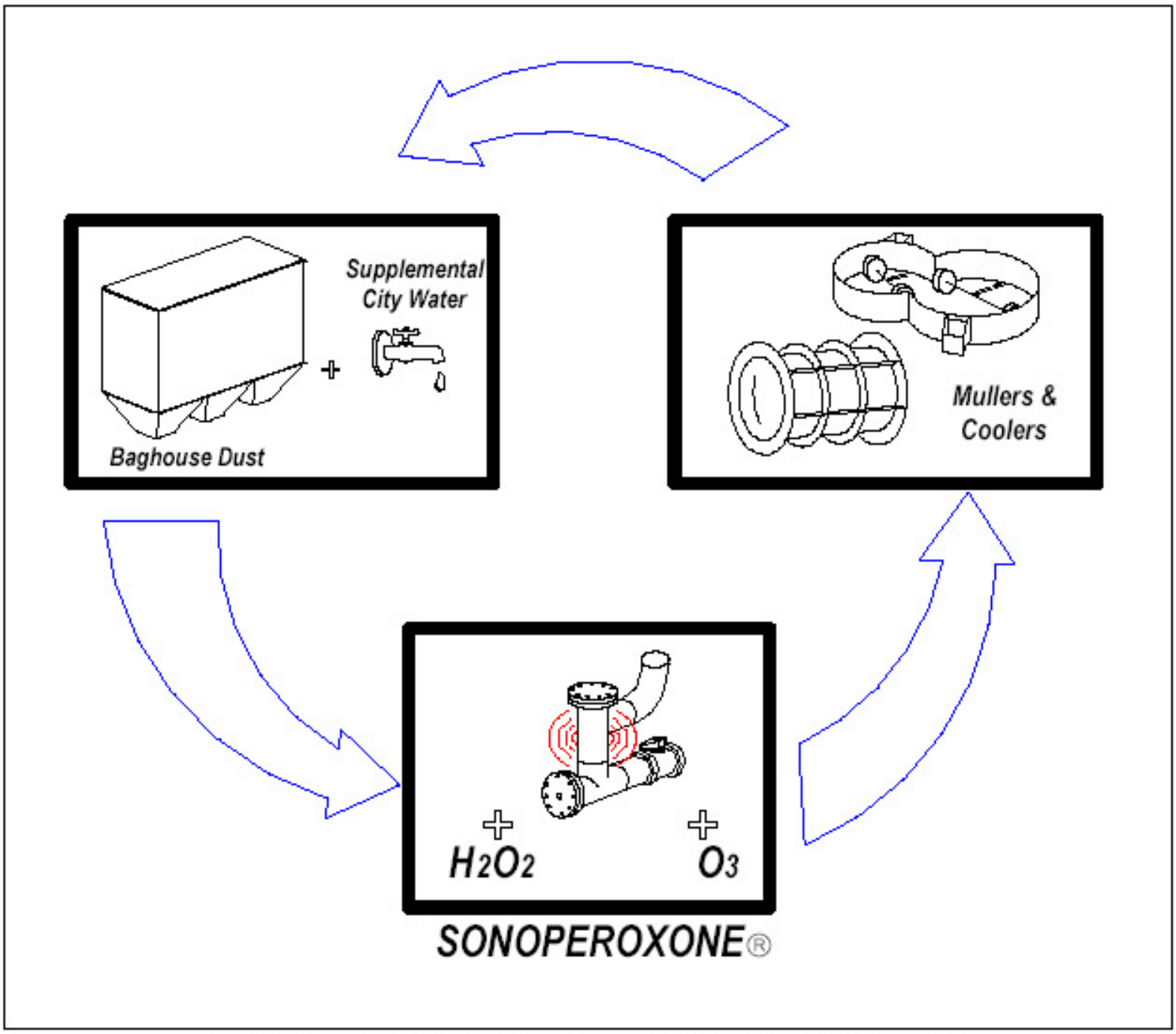
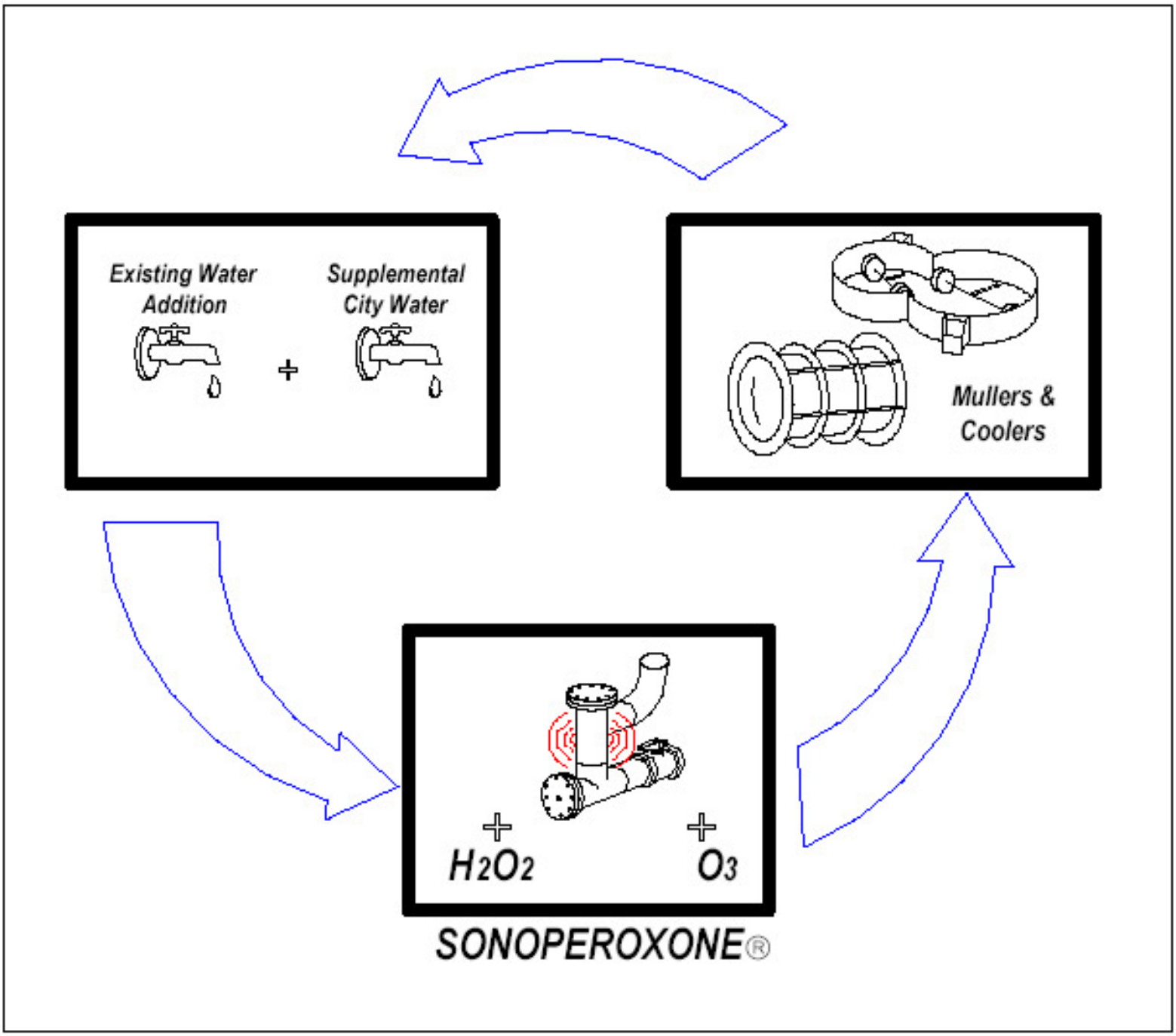
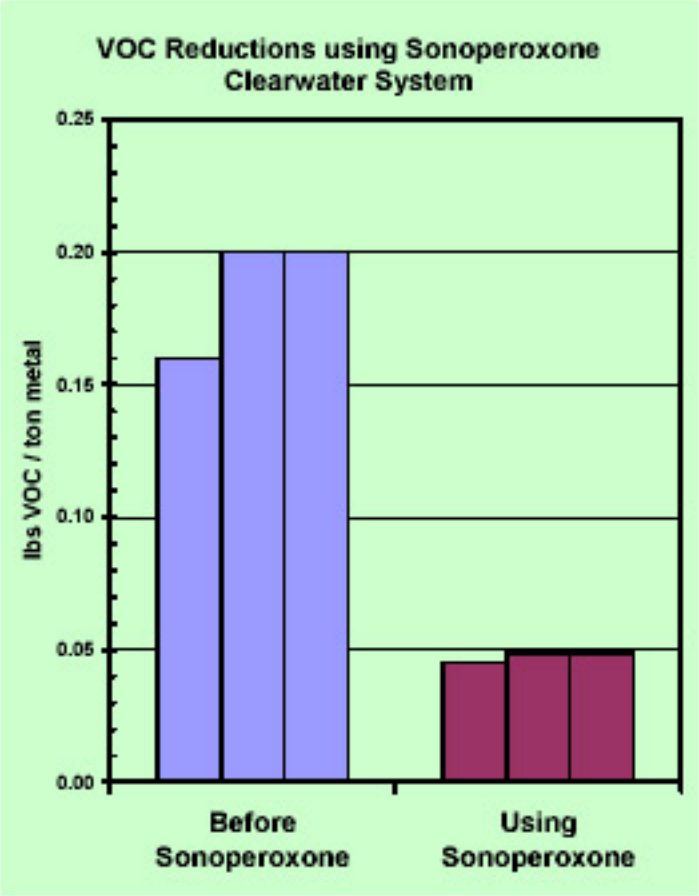
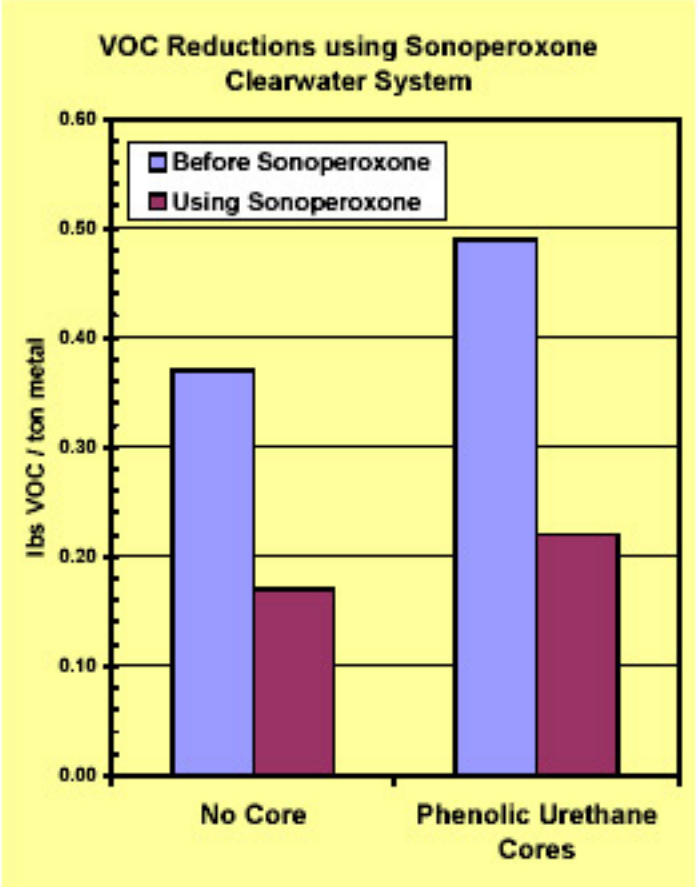


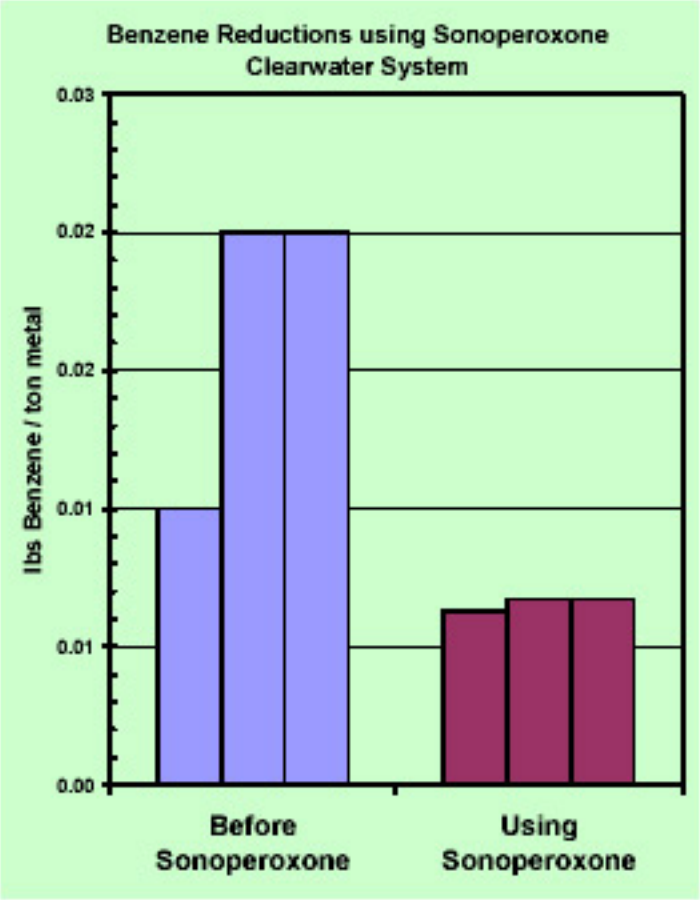

SONOPEROXONE® BLACKWATER SYSTEM

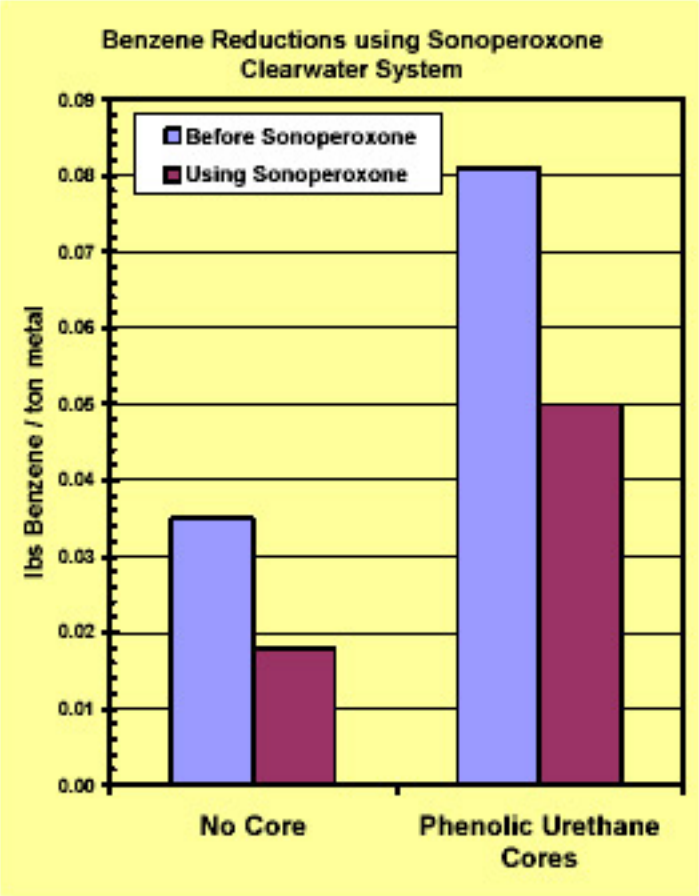



SONOPEROXONE® CLEARWATER SYSTEM


VOC Reductions using Sonoperoxone
Clearwater System
lbs VOC / ton metal
0.25
0.20
0.15
0.10
0.05
0.00
Before Sonoperoxone
Using Sonoperoxone


VOC Reductions using Sonoperoxone
Clearwater System
Before Sonoperoxone
Using Sonoperoxone
lbs VOC / ton metal
0.60
0.50
0.40
0.30
0.20
0.10
0.00
No Core
Phenolic Urethane Cores


Benzene Reductions using Sonoperoxone
Clearwater System
lbs Benzene / ton metal
0.03
0.02
0.02
0.01
0.01
0.00
Before Sonoperoxone
Using Sonoperoxone


Benzene Reductions using Sonoperoxone
Clearwater System
Before Sonoperoxone
Using Sonoperoxone
lbs Benzene / ton metal
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
No Core
Phenolic Urethane Cores