



# Advanced Oxidant Treatment of Foundry Green Sand for Reduced VOC Emissions and Baghouse Dust Recycle

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# What is Advanced Oxidation (AO) as used in the foundry industry ?

**The Sonoperoxone® treatment is a “*non-end of pipe*” pollution prevention process**

- **Advanced oxidants are created in sand system process water with the addition of ozone and hydrogen peroxide in the presence of an intense ultrasonic field. Subsequent reaction in the sand system generates greater micro-porosity and oxidizes adsorbed organics.**
- **AO-Clean Water: sand system process water treatment only**
- **AO-Black Water: bag-house dust recycle, reactivation and return in an AO treated “blackwater” slurry (preferred)**
- **AO-Core Room Odor Scrubbing**

# Reasons Our Customers Have Installed Sonoperoxone® Systems

- The first system was developed to reduce condensable organic particulate, odor and smoke in 1994
- The second was installed to reduce scrap rate caused by a wet collector's oily residue in the conventional blackwater system
- The third was installed to reduce Organic HAPs and to study clay recycle methods
- Reduce neighborhood odor complaints and associated legal costs
- Most are now installed to reduce clay/coal consumption and solid waste costs
- Most achieve scrap rate reductions after the systems are fully implemented and sand properties are re-optimized

# Our Impact On The Foundry Industry as of October, 2005

- 13 systems have been fully implemented and are currently operating at 10 commercial metal casting facilities with a total of 34 production molding lines.
- Two pilot systems are at research foundries with funding from DOE, EPA, NSF, private industry and others.
- Currently in start-up at 1 foundry - 6 production molding lines
- Under construction in 2 foundries – 12 production molding lines
- More than 1 million tons of iron and brass poured per year using Sonoperoxone<sup>®</sup> Advanced Oxidation technology
- Installed in large (>400 tons/day), medium (150-400 tons/day) and small foundries (<150 tons/day).
- Currently producing castings for the automotive, heavy truck, electrical, industrial, agriculture, construction, HVAC, automotive aftermarket (Racing engine) and many other industries.

# Black Water System

Intellution FIX View

File View Alarms Commands Applications Options Window Help

PLT2SONO.ODF

MAIN MENU  CLOSE SCREEN  DRAG CHAIN  OFF

SYSTEM MODE: **AUTO** MANUAL

COOLER TAR 7.7 ACT 0.0

MIXER A TAR 99 ACT 1

MIXER B TAR 103 ACT 1

MIXER C TAR 108 ACT 1

VIBRATE BIN

DUST AUGER  OFF

ACCURATE FEEDER  OFF

DUST CALL TO ENVIRO  NO

SONIC REACT  OFF

FILL MODE  OFF

0.0 0.0 AMPS

OZONE GENERATORS

O<sub>2</sub> FLOW YES

PRIMARY ON 1.80

O<sub>2</sub> FLOW NO

SECONDARY OFF 0.00

SONO PUMP PRESS OFF 1

PRIMARY PUMP  OFF

PUMP PRESS 0

SECONDARY PUMP

PUMP SETPOINT 0

H<sub>2</sub>O<sub>2</sub>

PROBES SCREEN

SUPPLY WATER GPM 0.0

SONOPEROXONE PUMP  START  STOP

BLACKWATER PUMP  START  STOP

ULTRASONIC REACTOR  START  STOP

PRIMARY OZONE ADDITION  START  STOP

SECONDARY OZONE ADDITION  START  STOP

DUST ADDITION  START  STOP

DRAG CHAIN  START  STOP

PLANT AIR BUBBLERS  START  STOP

MULLER A WATER  BLACK  CITY

MULLER B WATER  BLACK  CITY

MULLER C WATER  BLACK  CITY

SAND COOLER WATER  BLACK  CITY

ONE SHIFT EARLY STARTUP  ENABLE  DISABLE

NUMBER OF FAULTS 0

RESET NEXT

0.NO FAULT PRESENT

# Blackwater System

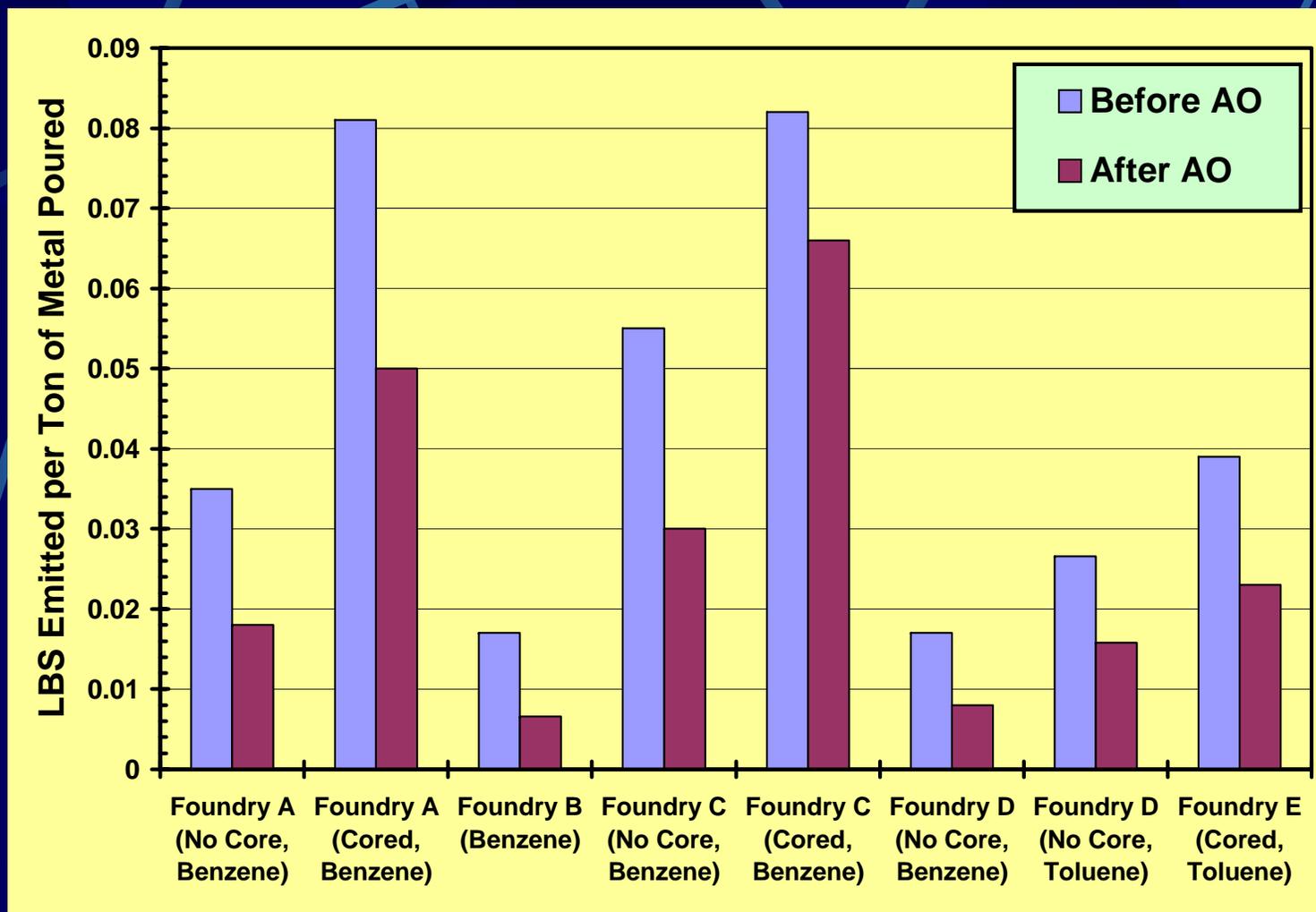
The BLACKWATER systems apply additional acoustic techniques to advanced oxidation treatment concepts in order to recycle the coal and clay from a foundry's dust collection systems to reduce solid waste disposal and to further reduce bond consumption.





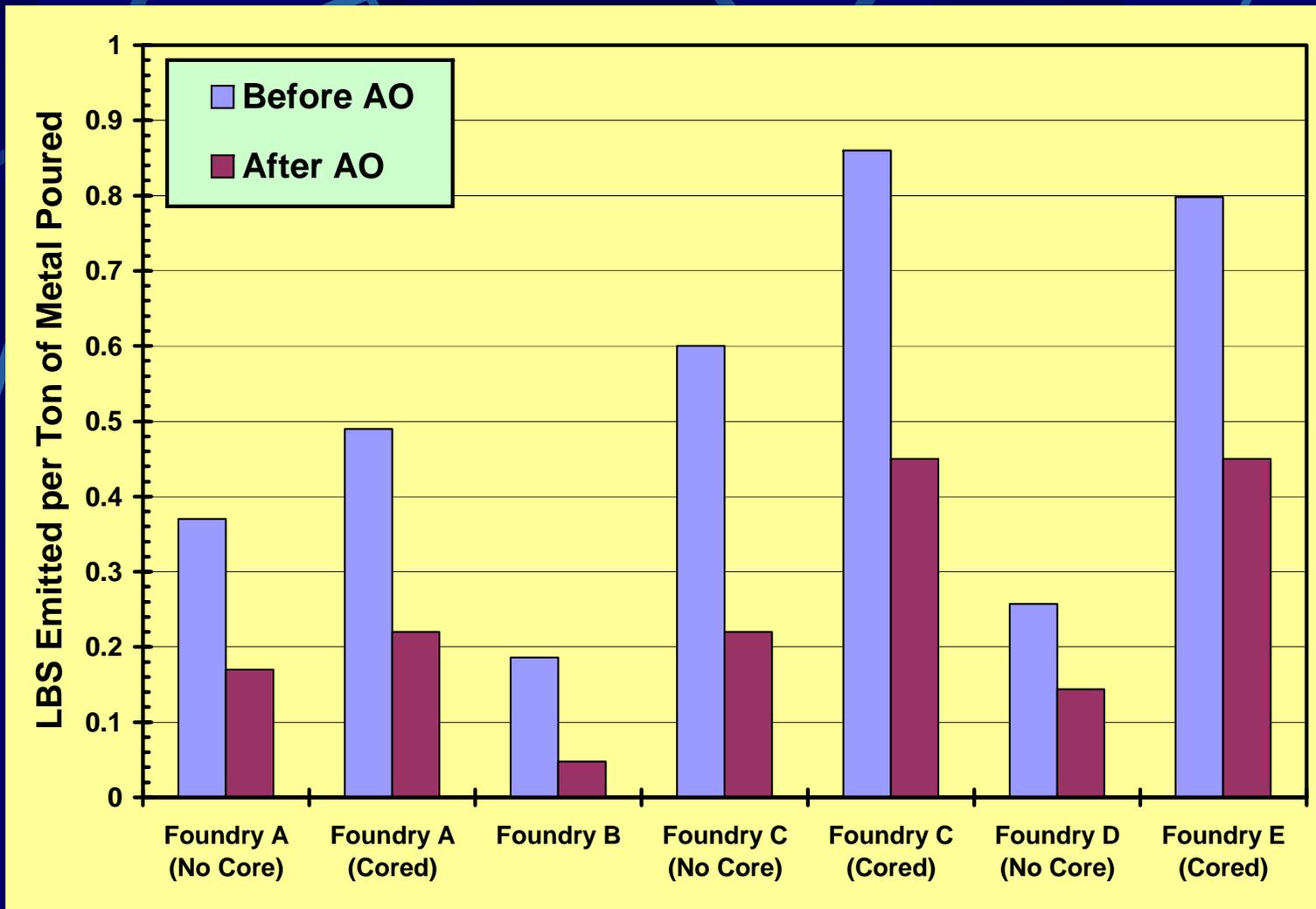
**Sonoperoxone® Core Room Odor Scrubber in operation at a California iron foundry. AAO-Blackwater System treats scrubber water blowdown for pollution prevention in the sand system.**

# Benzene & Toluene Emission Reductions



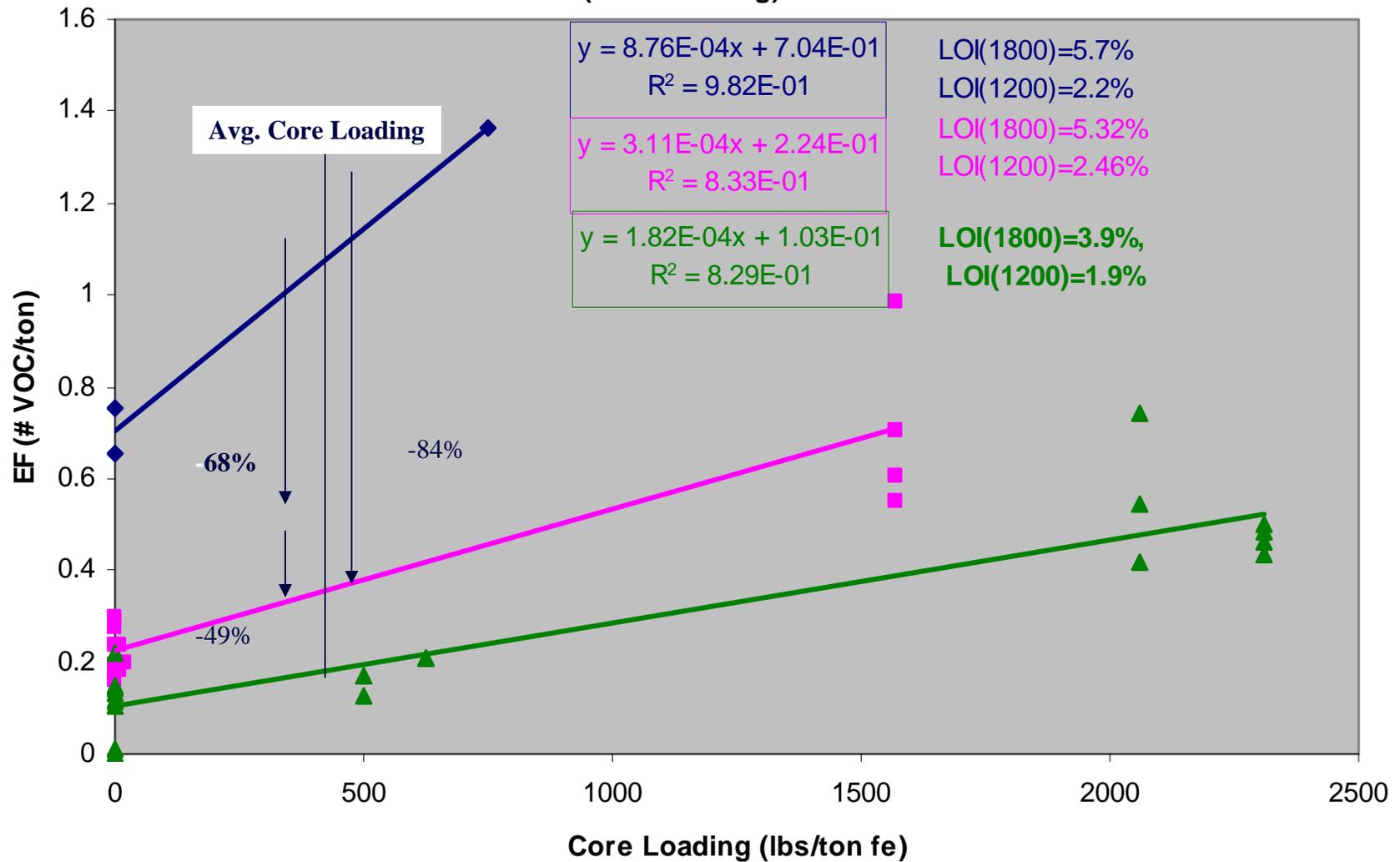
Emission reductions vary with coal and organic content of green sand mixture and with core size and type – just as a foundry's emissions will vary.

# VOC Emission Reductions



Emission reductions vary with coal and organic content of green sand mixture and with core size and type – just as a foundry's emissions will vary.

### VOC Emission Factors (Mold Cooling)



◆ Baseline WCMA Study 1995    ■ Optimized sand system w/o AO    ▲ AO Optimized

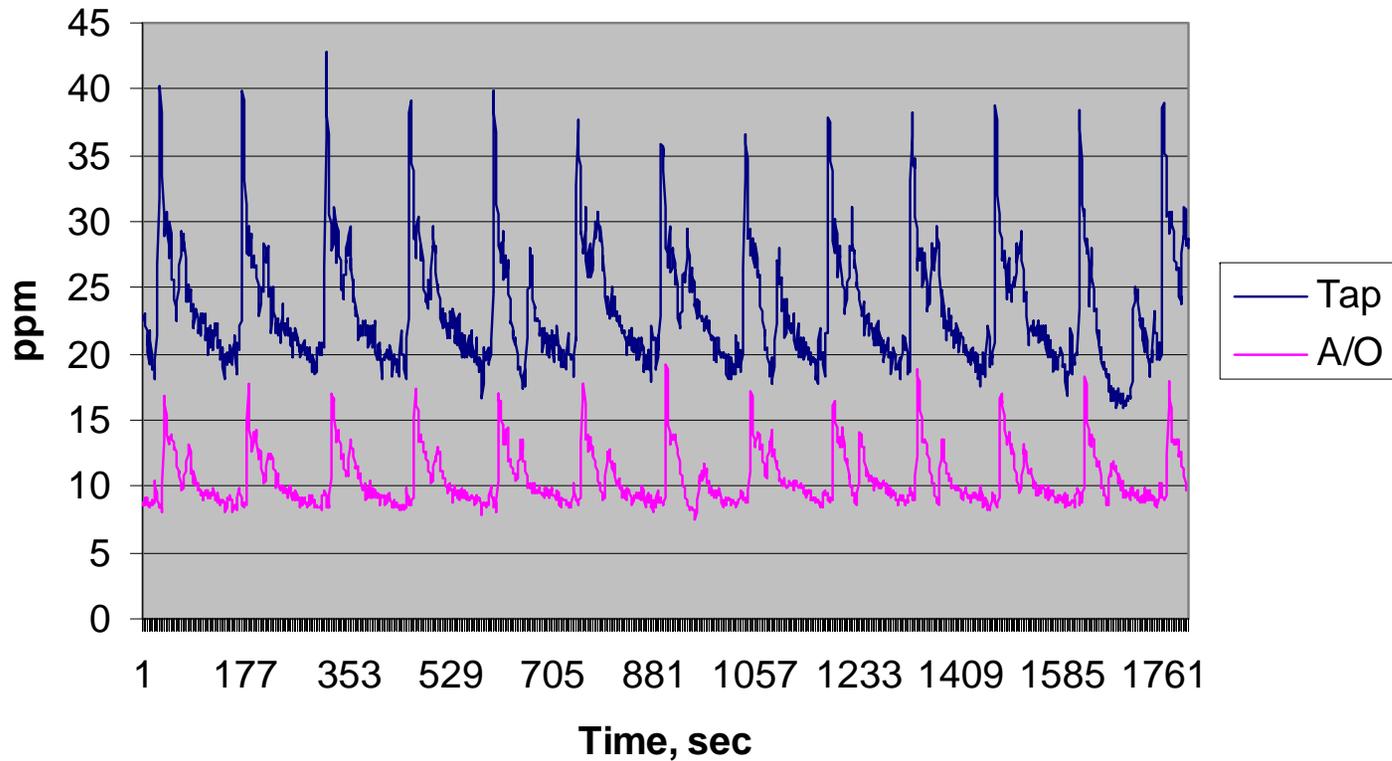
After installation and optimization all foundries that implemented the process and tested their stack(s) have been below the new source MACT Standard of 20 ppmv VOCs:

- A Wisconsin foundry tested less than 18 ppmv on its last certified stack test (Extremely heavy cored)
- A Wisconsin foundry tested 4-10 ppmv with heavy core load (WI Occupational Health Lab)
- A Pennsylvania foundry tested 3.7 to 4.8 ppmv (no core). (Nice3 Final Report available)
- A heavily shell cored California foundry tested less than 14 ppmv.
- A federally funded California research foundry tested 14-16 ppmv via real-time FID of heavily cored engine block tests, lower on high surface area no-core. See graph at next slide.

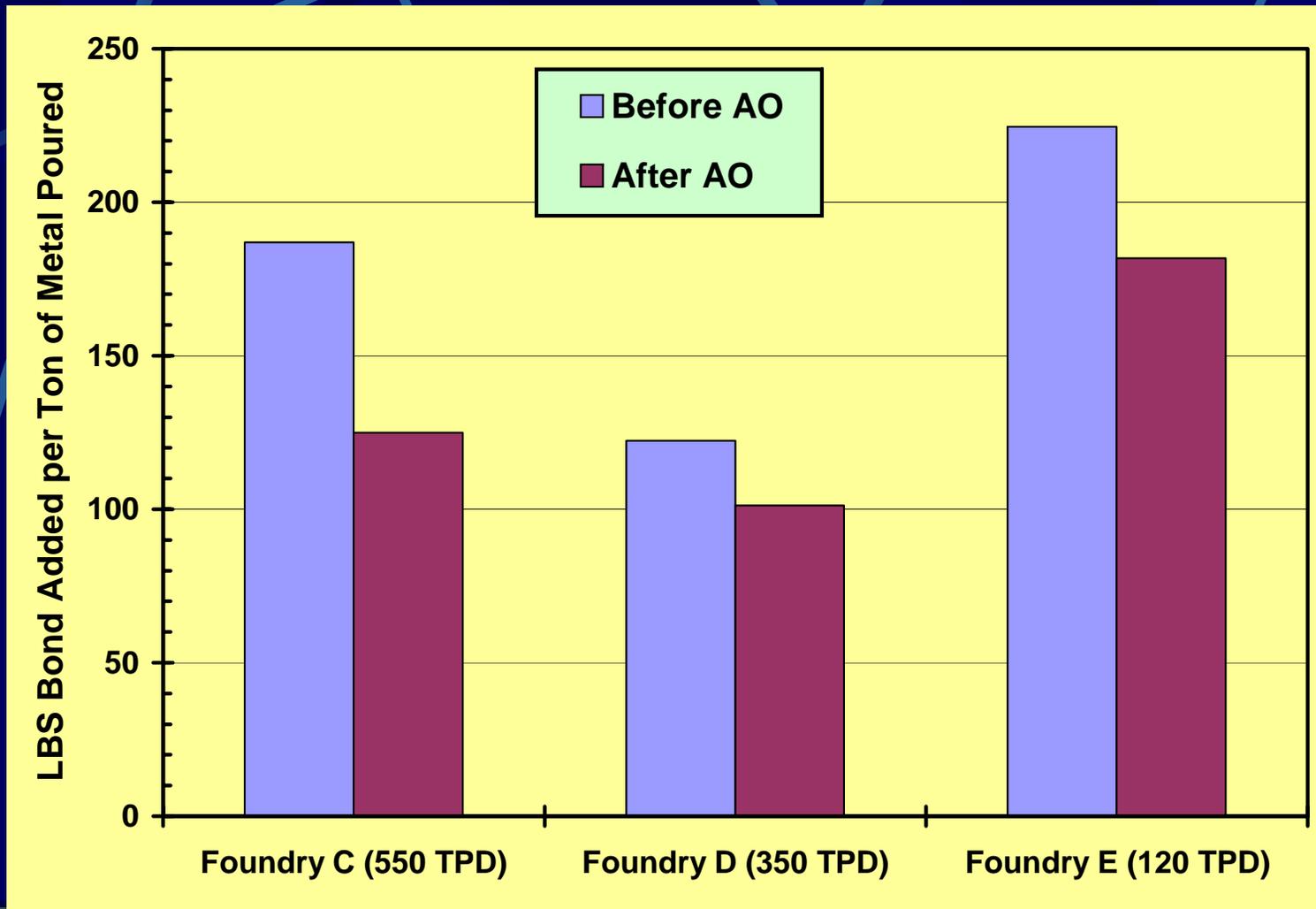
# Real Time Test Results

## Pouring, Cooling & Shakeout in Production Foundry

### Stars Pattern - Tap vs A/O



# Clay/Coal Bond Savings using Sonoperoxone® Blackwater Clay Recycle Systems



## How does the Sonoperoxone® do what it does?

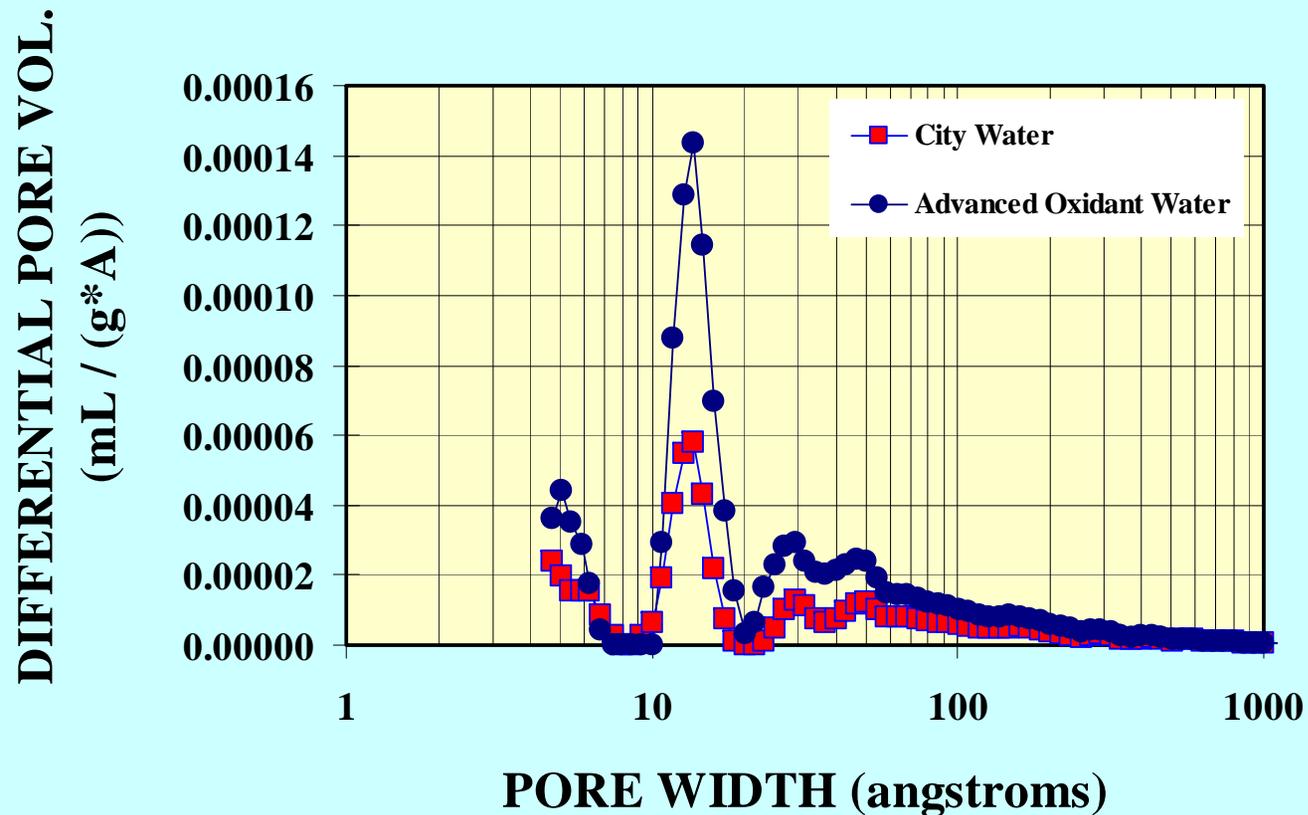
- In production we observe
  - Reduced organic pollutants
  - Higher strength per unit of clay binder
  - Less clay and coal needed to produce quality castings
- Advanced oxidation accomplishes much of this by:
  - Making available greater porosity (especially micropores) in the sand system so pollutants are adsorbed instead of released
  - Oxidation of adsorbed VOCs
  - Altering the surface charge of the clay
  - Better hydration of the clay

Following are a series of slides showing ongoing DOE, EPA and NSF funded research at Penn State

# AAOP - Acoustic Advanced Oxidation Process

## How does it do what it does?

Changes in Pore Structure as determined by Argon Adsorption and DFT\* analysis

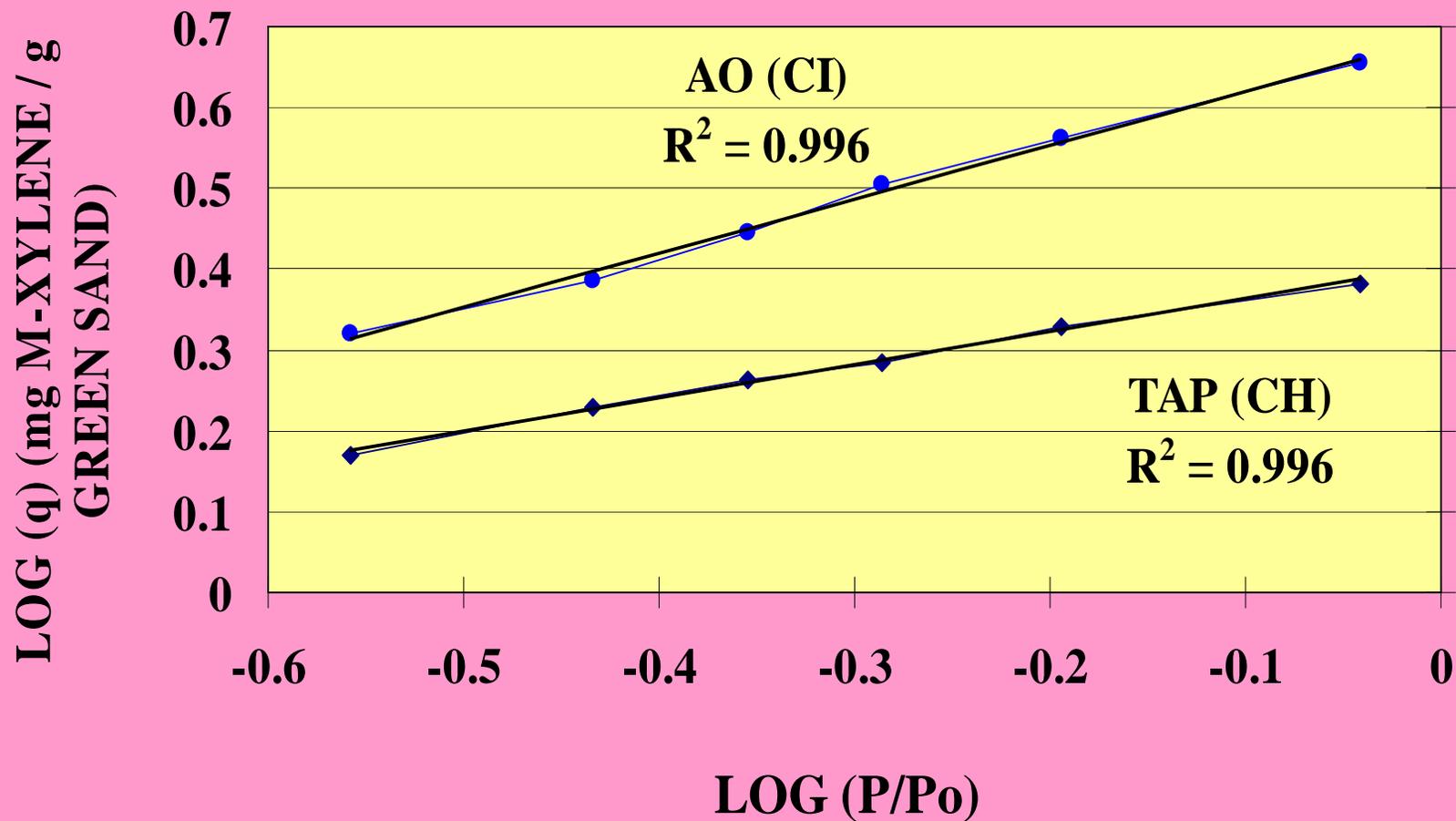


\*Density Functional Theory

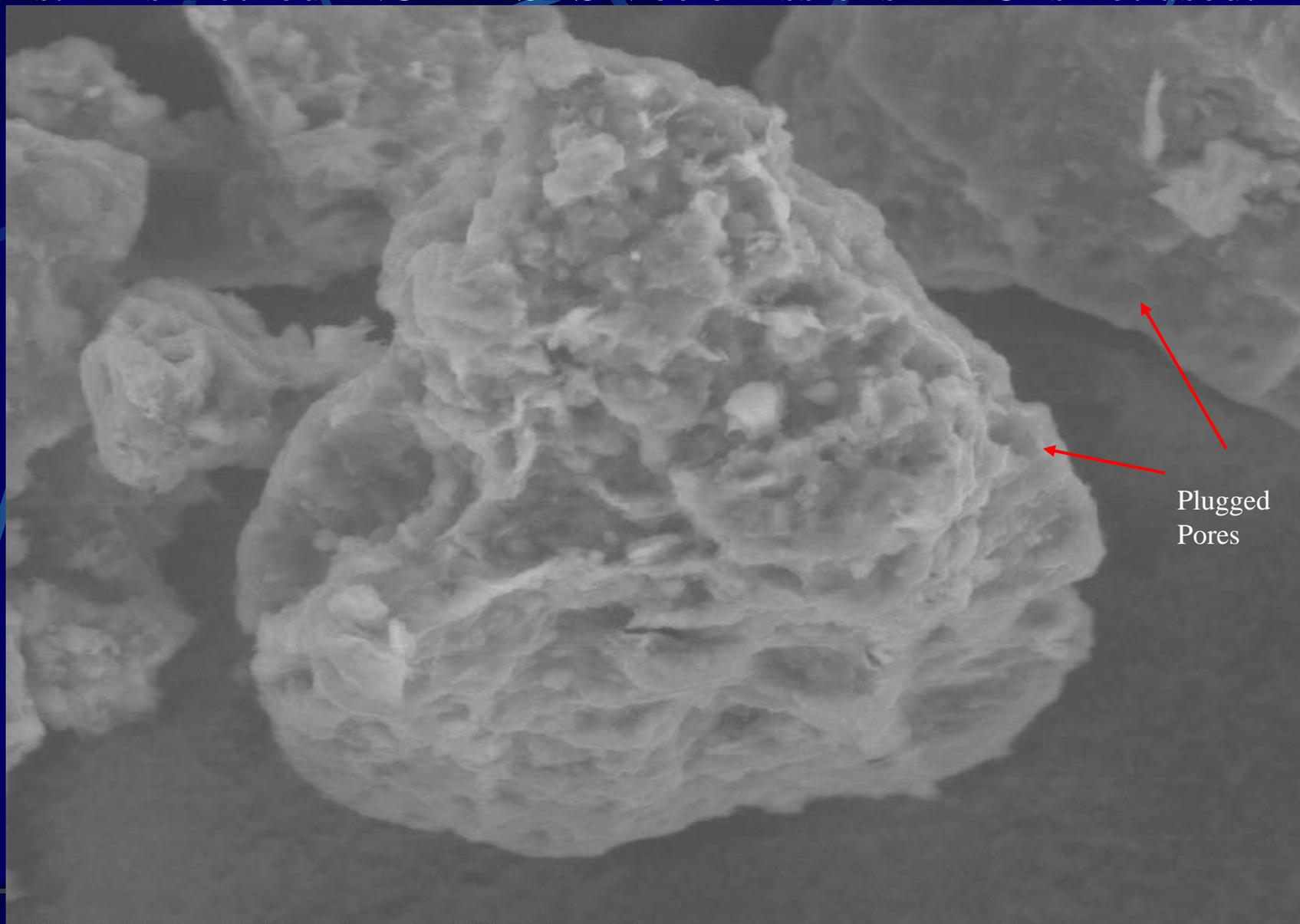
# AAOP System

How does it do what it does?

**Increased Microporosity results in greater capacity to adsorb VOCs: m-Xylene adsorption example:**



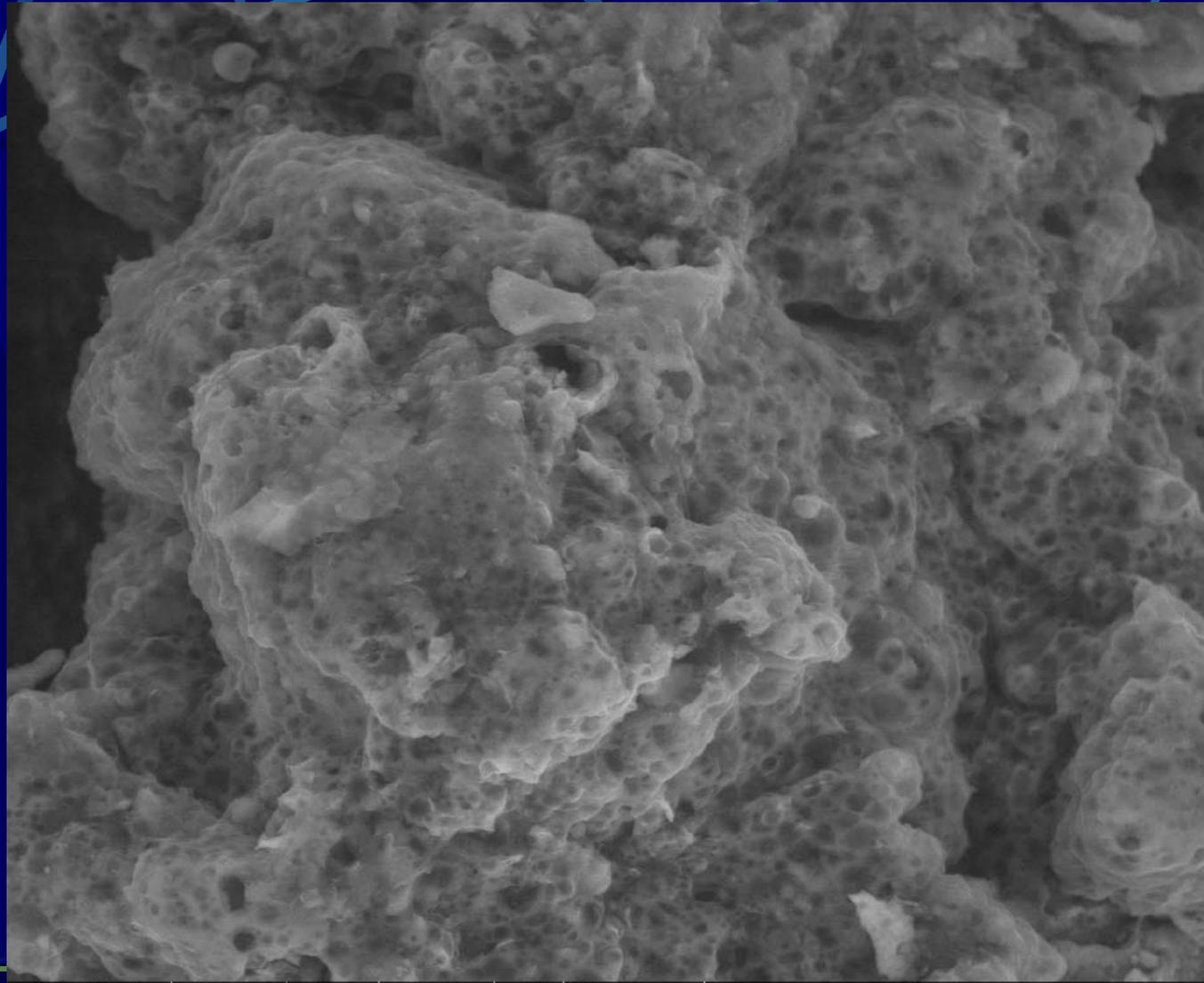
Raw dust stirred in city water to simulate “conventional” dust recycle systems. This method **INCREASES** Voc emissions if AO is not used.



7/1/2003	WD	Mag	HV	Det	Pressure
3:46:15 PM	8.2 mm	3000x	15.0 kV	LFD	0.98 Torr

— 20.0µm —

Peroxide and ozone treatment only to simulate acoustic system failure.  
Pores mostly still plugged but coating is thinner than non-treated.



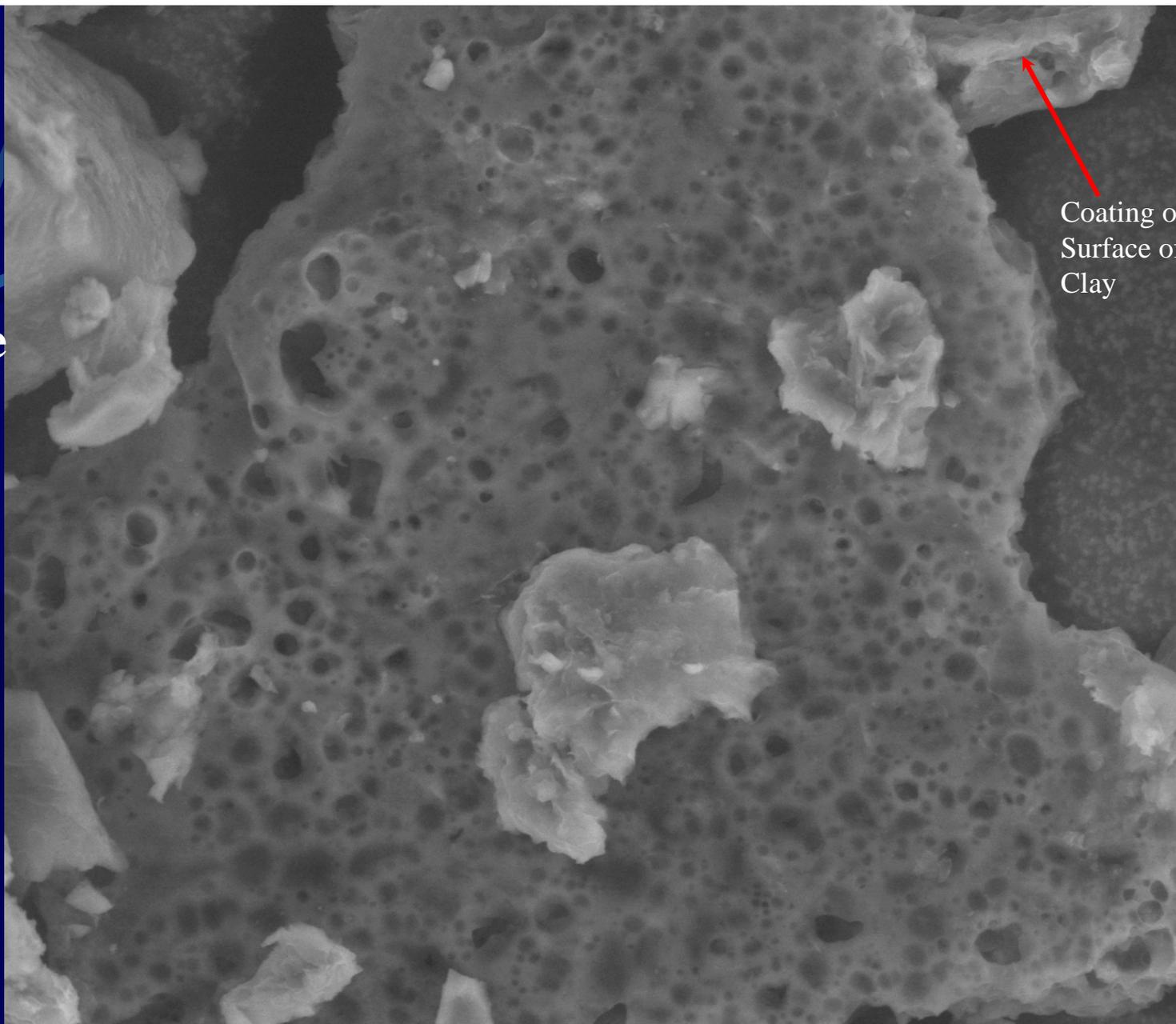
7/10/2003	WD	Mag	HV	Det	Pressure
2:04:11 PM	8.8 mm	3000x	15.0 kV	LFD	0.98 Torr

—20.0μm—

**After  
AAOP**

**Sonication  
plus peroxide  
plus ozone  
treatment.**

**Pores begin  
to open.**



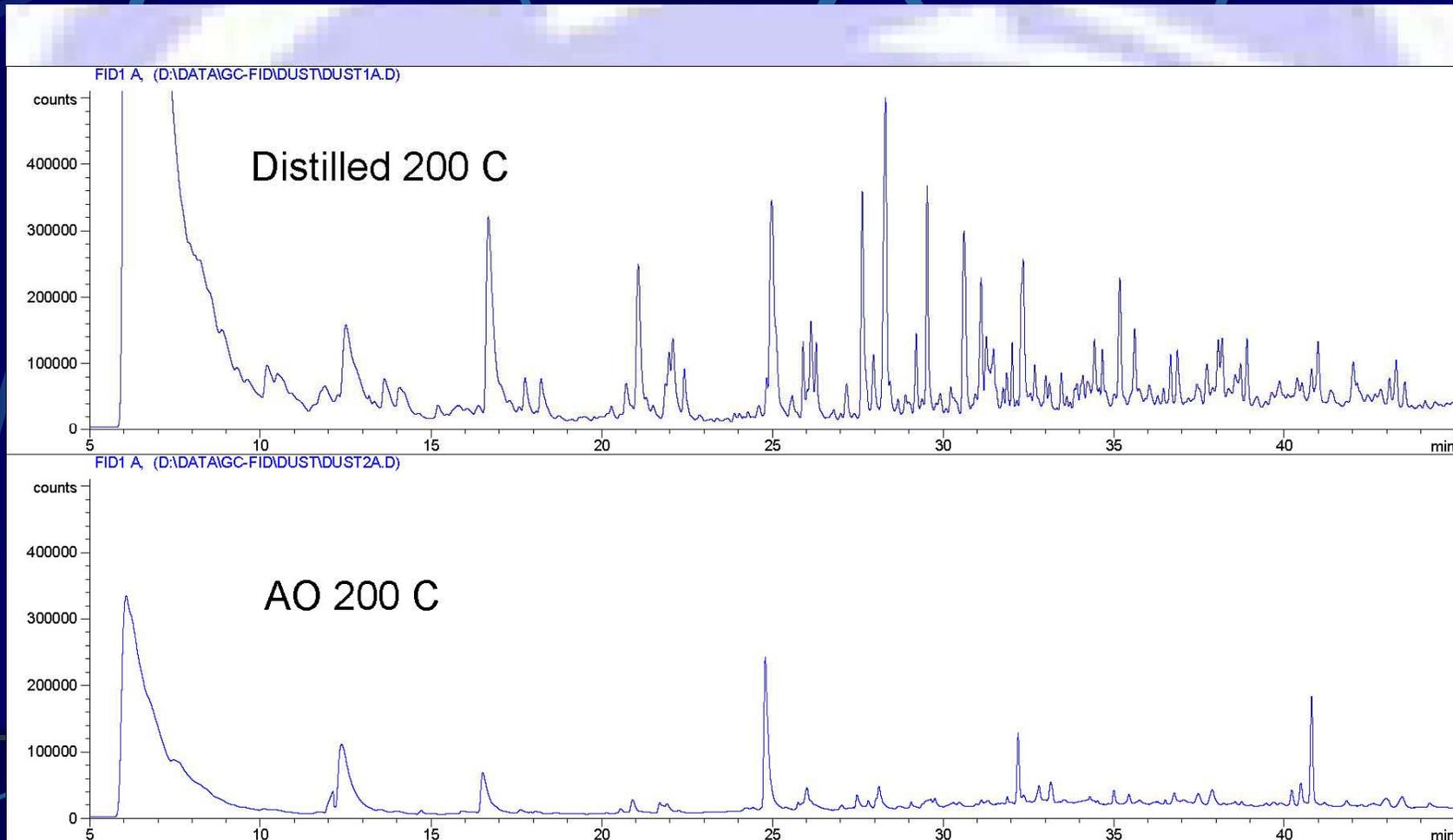
Coating on  
Surface of  
Clay

7/10/2003	WD	Mag	HV	Det	Pressure
11:13:07 AM	8.8 mm	3000x	15.0 kV	LFD	0.98 Torr

20.0µm

Gas Chromatograms of Curie Point Pyrolyzer EPA/NSF funded research at Penn State of a large iron foundry sand system dust sample.

~3% distilled and AAOP water was added to dust. The samples were dried at 200C then flash pyrolyzed up to ~750C in ~.5sec. Emissions were captured and analyzed with GC.



## Summary of clay and coal pore structure ongoing DOE, EPA and NSF funded research –

- Pore structure of foundry sand changes
- The increase in porosity allow the entire greensand system act in a similar way to an activated carbon adsorption bed
- **Acoustic** AO changes the pore structure of foundry clay recycled from air pollution control systems more than standard AO methods
- The pore structure is not available in non-AO systems: fewer pores are created and/or pores are clogged/filled
- Ongoing research has allowed us to continuously improve the process

## Limitations of The Acoustic Advanced Oxidation Pollution Prevention Process and Barriers to Implementation

- Core gases vented directly to atmosphere are not affected.
- While core gases that pass through the green sand mold can be adsorbed, the increased porosity generated from AO treatment is finite. Extremely heavy core loading (> ~1500# of phenolic urethane core per ton of metal poured) could saturate adsorption capacity.
- **Individual Foundry Inertia:** Because this is a process technology, foundries need to be reassured that product quality and productivity will be maintained. Prior to installation, we have to prepare the foundry to adjust its sand system targets. Because mold strength is increased and a greater amount of large hydrocarbons are retained, clay and coal targets and additions will need to be lowered.
- **Industry Inertia:** Concern that any process that reduces pollution may become required *for all foundries*. For this and other reasons, a great deal of false and misleading information about the AO process permeates the industry and into parts of the regulatory community.

QUESTIONS ?