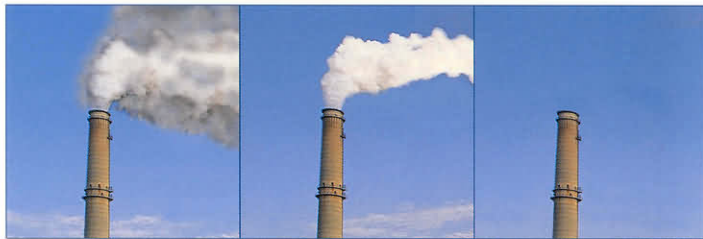


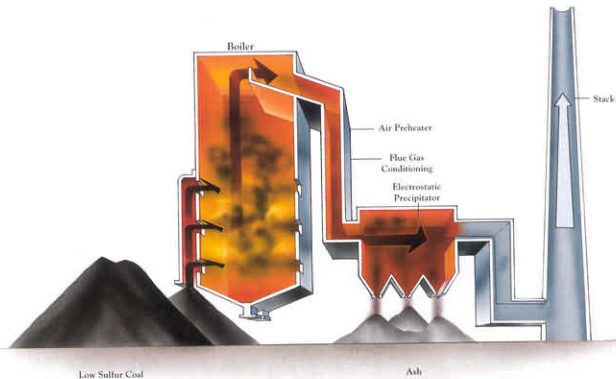
World Leader in Flue Gas Conditioning

WAHLCO



WAHLCO, INC.[®]

Flue Gas Conditioning Basics



Why Is Flue Gas Conditioning Needed?

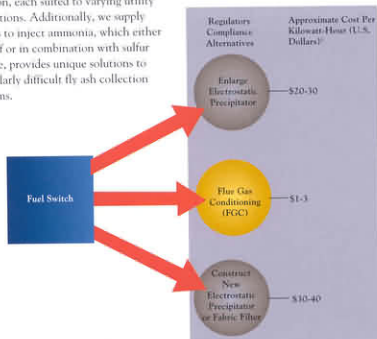
Burning coal to produce electricity causes the emission of sulfur oxides such as sulfur dioxide and sulfur trioxide, or acid gas. This gas is carried into the atmosphere, along with fly ash generated from the combustion of the coal. When these acid gases combine with moisture in the atmosphere, they form dilute solutions of sulfuric acid or "acid rain" which fall back to earth, damaging the environment.

High sulfur coal has traditionally been the standard fuel for coal-fired boilers and the fly ash produced from this fuel is readily collectable in electrostatic precipitators. Regulations restricting sulfur dioxide emissions are being implemented worldwide. In an attempt to comply with these new limitations, the power industry has begun the switch to lower sulfur coals. Low sulfur coal tends to generate more fly ash and flue gas per megawatt. Because of the higher resistivity of this ash, it is difficult to collect in existing precipitators.

Two solutions are to install much larger and more expensive precipitators or fabric filters for collection of the fly ash. Another, more cost-effective alternative, is flue gas conditioning.

Flue gas conditioning restores the collection efficiency of the precipitators to performance levels consistent with the firing of high sulfur coal.

Wahlco offers a wide variety of methods to create sulfur trioxide for injection, each suited to varying utility applications. Additionally, we supply systems to inject ammonia, which either by itself or in combination with sulfur trioxide, provides unique solutions to particularly difficult fly ash collection problems.



*Assumes a 500 MW boiler.

What is Flue Gas Conditioning?

Flue gas conditioning is the controlled injection of small quantities of sulfur trioxide into the flue gas stream, reducing the resistivity of the fly ash and permitting its collection in the existing precipitator. When flue gas conditioning is installed on units that have switched to low sulfur coal, sulfur oxide emissions are significantly reduced, complying with environmental regulations and utility standards.

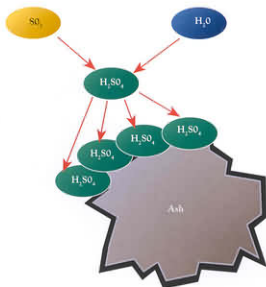
"If regulations tell me to reduce emissions of sulfur oxides, why should I inject them?"

It's a common question. The answer lies in the difference between sulfur dioxide and sulfur trioxide. When high sulfur coals are burned, they yield large quantities of SO_2 , but very small amounts of SO_3 .

This SO_3 , however, is very important, because it naturally combines with moisture in flue gas to create sulfuric acid. This sulfuric acid (H_2SO_4) is deposited on fly ash particles to form a thin conductive film which lowers the electrical resistance of the ash, allowing it to be readily collected by electrostatic precipitation.

When low sulfur coals are burned, natural SO_3 levels are reduced to the point that they no longer can create enough H_2SO_4 to properly "condition" the fly ash and reduce its resistivity. High resistivity ash passes through precipitators sized for high sulfur coal, creating unacceptable emissions.

Sulfur trioxide FGC systems, as developed and patented by Wahlco, inject into the gas stream small quantities of SO_3 . This newly-introduced SO_3 reacts in the same way as naturally-occurring SO_3 , lowering ash resistivity, and allowing easy collection.

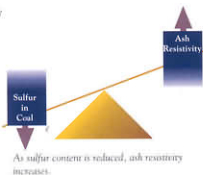


SO_3 and moisture combine to form sulfuric acid, which is deposited on the fly ash surface, forming a conductive film and lowering the electrical resistance of the ash.

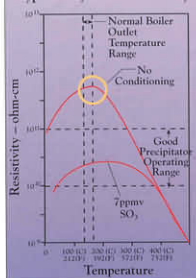
Typical Sulfur Oxide Emissions from Coal-Burning Boilers

Sulfur Oxides PPMV		3.5% Sulfur Content	0.5% Sulfur Content	0.5% Sulfur & FGC
Entering Precipitator	SO_2	2600	370	371
	SO_3	26	4	10
Entering Stack	SO_2	2600	370	375
	SO_3	7	4	4

Flue gas conditioning does not increase emission levels of sulfur oxides (SO_2 or SO_3).



Typical Fly Ash Resistivity

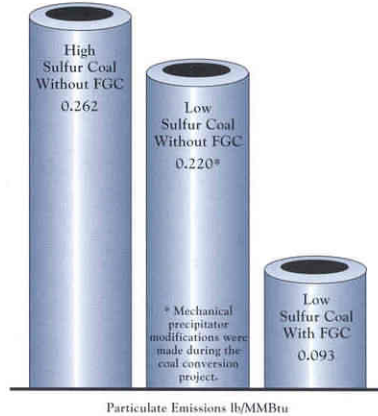


Flue Gas Conditioning Success Stories

"Switching fuels reduced our SO₂ emissions..."

...Wahlco's FGC system provided operational flexibility of particulate emissions control."

– Kansas City Power & Light



Kansas City Power & Light's Montrose Generating Station presented a "classic" fuel switch situation: three boilers, built in the late 1950s and early 1960s, were designed to burn Midwestern 6% sulfur coal. After switching to Western 0.3% sulfur coal, the precipitators required a significant maintenance investment to meet emissions requirements.

Three flue gas conditioning systems were installed on an accelerated

"turnkey" basis, with Wahlco providing system design, construction services, and FGC equipment. The FGC equipment reduced fly ash resistivity and particulate emissions, allowing the plant to operate well within opacity limits.

"Faced with a similar project...we would not hesitate to approach it in the same manner," said KCP&L management.

"Here's visual proof of our Wahlco system's success."

– China Light & Power



Seven of eight units at China Light & Power were using Wahlco FGC systems when this photo was taken. Plume from eighth unit disappeared when conditioning was activated.

All eight units of China Light & Power's Castle Peak A & B employ Wahlco flue gas conditioning. FGC gives CL&P the flexibility to confidently burn a wide variety of imported coals, without regulatory compliance problems.

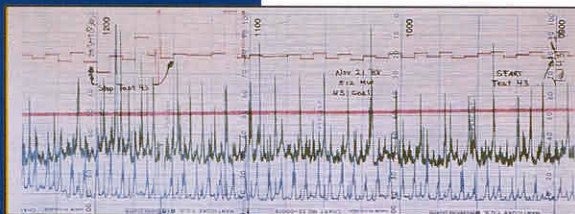
A recent test proved that Australian Hunter Valley coal, with low sulfur but high silica, alumina, and iron content could be burned. This coal's ash has a reputation for poor H₂SO₄ attachment and difficult collection due to its "glassy" surface and very high resistivity.

“Switching to a low sulfur coal blend reduced the efficiency and effectiveness of our electrostatic precipitators.

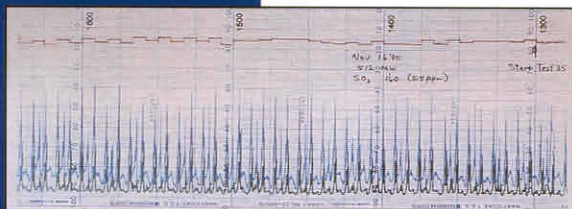
“Dual conditioning solved the problem.”

—Ontario Hydro

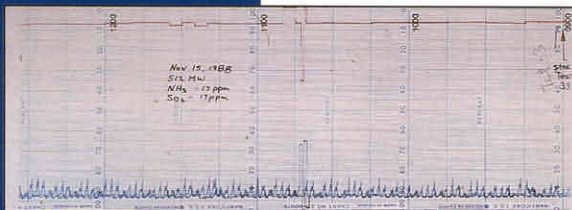
Nanticoke Unit 2 Opacity



Low Sulfur 50/50
SO₂ Off
NH₃ Off



Low Sulfur 50/50
SO₂ 5.5 ppm
NH₃ Off



Low Sulfur 50/50
SO₂ 17 ppm
NH₃ 17 ppm

With carbon carryover levels approaching 25%, SO₂ alone (center graph) was not sufficient. Dual flue gas conditioning (DFGC, bottom graph) solved the problem.

Ontario Hydro switched from operating with a United States/Western Canada coal blend (approximately 1.2% sulfur) to a low sulfur blend (approximately 0.65% sulfur) on its 8x500 MW units at the Nanticoke Generating Station. A significant increase in particulate emissions ensued, resulting in unit deratings due to opacity restrictions. This was caused in part by the abnormally high carbon content of the fly ash.

The low resistivity portion of the ash (carbon) was easily re-entrained during rapping, with little electrical force to

hold particles on precipitator collecting plates, creating opacity “spikes”. The high resistivity ash remained, creating an insulating layer.

SO₂ conditioning prevented the accumulation of high resistivity ash, but dual conditioning (SO₂ and NH₃) was required to completely solve the problem. The SO₂ and NH₃ are injected under controlled stoichiometric ratios, forming ammonium bisulfate, which acts as a binding agent to enhance the cohesive properties of ash on the collecting plates.

Flue Gas Conditioning Success Stories

"A Wahlco upgrade made our old, small precipitators perform like new, large precipitators."

—Electric Energy, Inc.



Joppa Station of Electric Energy, Inc. has six very small (170 SCA) precipitators. Because of their marginal performance, these ESPs demanded an FGC system approaching 100% reliability. Any downtime would translate to a derate. Wahlco acted as the primary partner for air pollution control, delivering a complete "turnkey" rebuild of the existing control equipment with stringent emission guarantees. Today, these

same six "problem precipitators" are well under 15% opacity. All three stacks serving the precipitators are in compliance with State of Illinois standards.

Wahlco upgrades older systems, and those of other FGC suppliers, to provide the latest in collection efficiency and operating economy. We can also help with additional system management services if desired.

"We needed unlimited fuel flexibility. Wahlco's dual FGC helps our precipitators handle whatever we send their way."

—PSI Energy Inc.



PSI Energy is heavily committed to coal blending as part of its \$3.2 billion Clean Air Act compliance program. The Gibson Station requires that its precipitators be able to handle either eastern or western U.S. low sulfur coal, and blends of these coals with local midwestern coals. After an exhaustive evaluation of flue gas conditioning which included site visits to inspect the various suppliers' equipment, PSI Energy elected to purchase a Wahlco

dual flue gas conditioning system. DFGC permits the use of coal with a high content of silica and alumina in the ash, without compromising collection efficiency. This purchase decision was based on Wahlco's wide experience with dual conditioning and our demonstrated capability to accurately predict precipitator performance levels when dealing with a vast range of fuels.

“Dual FGC cost us a fraction of a precipitator rebuild”

—Public Service Company of New Hampshire



Unit 2 of Merrimack Station of Public Service Company of New Hampshire was upgraded to handle low sulfur coal with a dual FGC system. Alternately, Merrimack Unit 1 employed a precipitator upgrade and repair. The successful FGC project cost 1/10th the rebuild.

	% Sulfur	Average Opacity %	Average Mass Emissions lb/MMBtu
Test Burn (no conditioning)	1.26	35	0.464
After Optimization of Dual FGC	1.26	16	0.10
Wahlco Guaranteed Performance	1.26	20	0.12

Dual FGC can solve a variety of exceptionally difficult collection problems, including excessive reentrainment of collected fly ash during plate rapping.

To provide the flexibility to enable it to burn both low sulfur coal in the near term as well as even lower sulfur coal in the future, Public Service Company of New Hampshire selected dual conditioning for its Merrimack Unit #2. Working with PSNH,

Wahlco provided a performance guarantee of 20% opacity and an emission rate of 0.12 lb/MMBtu, well under the state limit of 30% opacity and .233 lb/MMBtu.

Wahlco provided a complete “turnkey” solution, including design, equipment, and construction. After optimizing the system to determine the best combination of NH_3 and SO_2 injection rates, Unit 2 exceeded Wahlco’s performance guarantees.

“Wahlco’s gas conditioning is not just for utilities. Look what it did for our sinter plant.”

—European steel producer



A major European steel maker purchased a Wahlco gas conditioning system to improve collection of sinter dust, without having to enlarge its electrostatic precipitator.

The addition of limestone and dolomite to this plant’s sinter increased the electrical resistivity of the sinter dust. Higher resistivity reduced the electric current in its precipitators, significantly reducing efficiency. An unsightly stack plume was a definite sign of precipitator problems.

Both increasing the size of the electrostatic precipitator and possibly

constructing a wet precipitator were considered.

To avoid the large capital costs of additional precipitator work, a Wahlco SO_2 gas conditioning system was employed. Particulate emissions dropped from 700 mg/Nm³ to less than 50 mg/Nm³.

Scientific Understanding, Engineering Depth, and Manufacturing Expertise

To Really Understand Particulate Collection Problems, You Must Understand the Entire Power Generation Plant

Wahlco does!

Wahlco has accumulated and maintains the leading body of both theoretical and practical flue gas conditioning knowledge anywhere. In the past five years alone, seven United States patents have been issued for improvements to the flue gas conditioning process.

When it comes to performance evaluations, performance guarantees, equipment selection and sizing, test programs or computer modeling, our scientists work from a base of solid scientific knowledge, not conjecture.

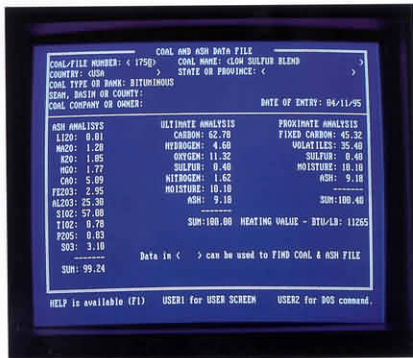
Some of the tools that we employ include:

- the most extensive coal and fly ash database in the world (more than 1700 entries)
- a continuously upgraded ESP model
- predictive capabilities for fly ash resistivity and stack opacity
- models to calculate optimum injection rates
- new control strategies for SO₂ and DFGC
- Computational Fluid Dynamic modeling of complex flows
- models for injected agent distribution and mixing
- a test facility for cold flow modeling.

Our Engineering Strength Provides You With a Reliable System

Wahlco's approach to flue gas conditioning is based on two precepts that have served our customers well since the early 1970's:

- system reliability is critical in a power generation environment
 - simple designs yield reliable systems
- While other FGC system suppliers may tout "bells and whistles" (each one of which increases the probability of downtime), Wahlco has concentrated on system improvements via simplified technology. With over 400 successful installations worldwide, Wahlco customers have learned that our approach means:
- your system will be available when you need it (maximized uptime), and
 - your system will accomplish what we promised.



Our unique coal and fly ash database contains the characteristics of over 1700 fuels, helping us to provide reliable solutions, worldwide.

Rebuilds, Upgrades and System Audits (Even if the System Isn't Wahlco's!)

System obsolescence is not part of the plan at Wahlco. Our service engineers routinely prepare proposals to rebuild and upgrade FGC systems to improve conversion and energy efficiency. We are regularly asked to audit the performance of another supplier's equipment, or even to assume the service of non-Wahlco equipment.

Alternate Feedstocks and More Sophisticated Controls Help Minimize Maintenance Requirements

Many utilities are currently re-engineering and downsizing their operations, reducing the maintenance personnel available to monitor auxiliary systems. Wahlco has responded with a variety of alternatives designed to simplify maintenance and cut staffing needs, while allowing the utility to maximize the usefulness of existing equipment:

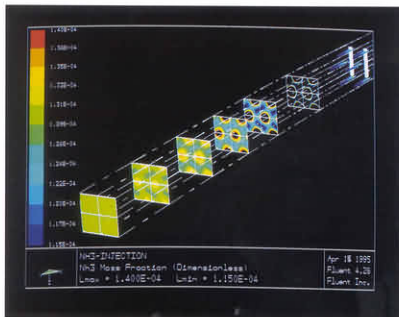
- dry granular sulfur feedstock, which eliminates the need for steam and other molten sulfur handling equipment
- microprocessor-based controls, which provide a new level of reliability and convenience, greatly simplifying trouble-shooting
- for existing customers that have installed low NO_x burners, we can upgrade their FGC system to accommodate the increase in unburned carbon in the ash



Wahlco bases FGC system design on two precepts: system reliability is critical to our customers; and simple designs yield reliable systems.



Upgrades and rebuilds are a popular way for our customers to maintain maximum system efficiencies while minimizing maintenance.



Your Assurance of Worry-Free Particulate Control

Beyond Equipment... True Understanding

A flue gas conditioning system is more than a collection of pumps, a tank and burner...much more. A properly implemented approach to flue gas conditioning incorporates an in-depth understanding of the science of fluid flows and ash electrical properties, the dynamics of the power generation process, and the mechanics of creating simple, reliable equipment.

These disciplines have been successfully combined in Wahlco's more than 400 installations worldwide.

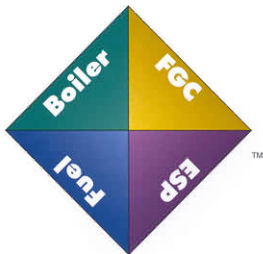
We invite you to take advantage of this expertise to optimize your plant's particulate control program.



Wahlco commercialized the flue gas conditioning process for utilities in 1972, and has over 400 successful installations worldwide. No other company begins to approach this level of experience. No other company offers all proven options you may need for your system.



Ongoing basic and applied research guarantees that your FGC system from Wahlco will be the most advanced and reliable available.



Wahlco employs an integrated approach to particulate collection. This means that our scientists and engineers use an in-depth understanding of fuels, boilers, precipitators, and flue gas conditioning systems to solve problems.

This approach is unparalleled among flue gas conditioning suppliers. It permits us to provide you an added level of assurance and value while providing a reliable solution to optimize particulate control.



WAHLCO, INC.®

Sales Office: 3600 West Segerstrom Avenue, Santa Ana, California 92704
Telephone: (714) 979-7300 (800) 423-5432, Fax: (714) 979-0603