

FGD Oxidation Blower Hot Topic Hour

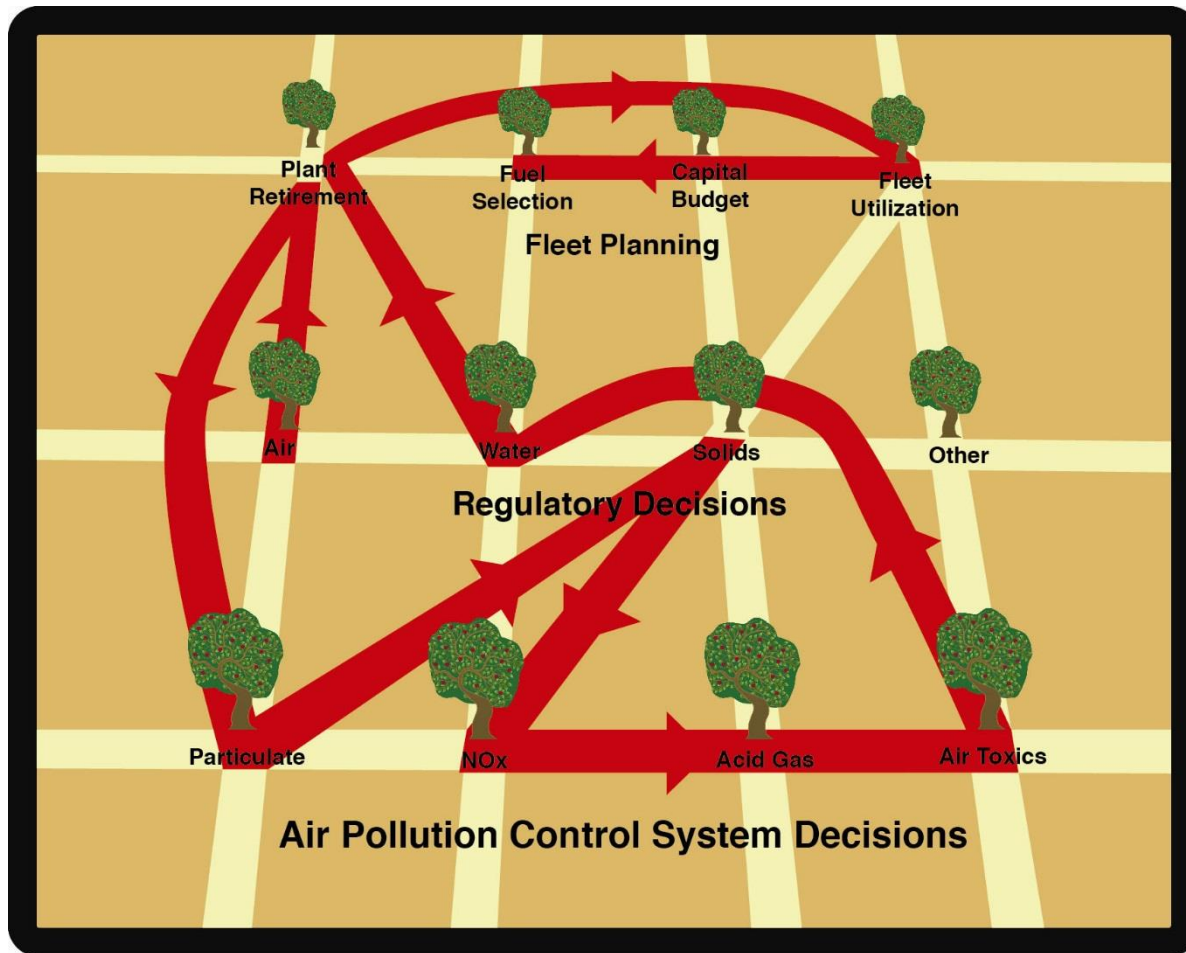
January 22, 2015

Speakers

Bob McIlvaine, McIlvaine Overview plus agitator/blower analysis

Keith Collins, Gardner Denver: FGD Oxidation Blowers

McIlvaine Global Decisions Positioning System (GdPS™) includes agitators and blowers as part of a complex requirement to travel back and forth between decision trees and revise tentative conclusions.



System to select blowers and agitators is part of a new wikinomics approach

- Now the McIlvaine Power Plant Air Quality System is free of charge to power plants around the world.
- This includes access to recordings such as this one.
- One segment of this system which is free to everyone is [Wet Calcium FGD - Continuous Analyses](#).
- The approach is to clearly present all options and the advantages and disadvantages of one route vs. another.
- This includes analysis of all the options relative to FGD oxidation.
- The SO₂ GdPS™ is fortified by cross pollination from GdPS systems relative to coal combustion and others on blowers for similar service e.g., aeration for biological wastewater treatment.

Oxidation options impacting blower design

Options

Forced oxidation	Natural oxidation or inhibited
Limestone reagent	Lime reagent
Spray tower scrubber	Turbulent sump scrubber (Chiyoda)
Combination agitator and lance	Separate agitator and lance
Multi stage blowers	Lobe blowers or single stage compressors

Factors influencing blower choice

Cost of energy	Payback period
Specifications of design institute	Equipment already installed (inventory reduction for repair parts)
Continuous hours of operation needed	Amount of sulfur to be oxidized
Cost	Bundling all blowers in one purchase package
Engineering support	Maintenance and service
Voltage (medium or low)	Drive (direct?)

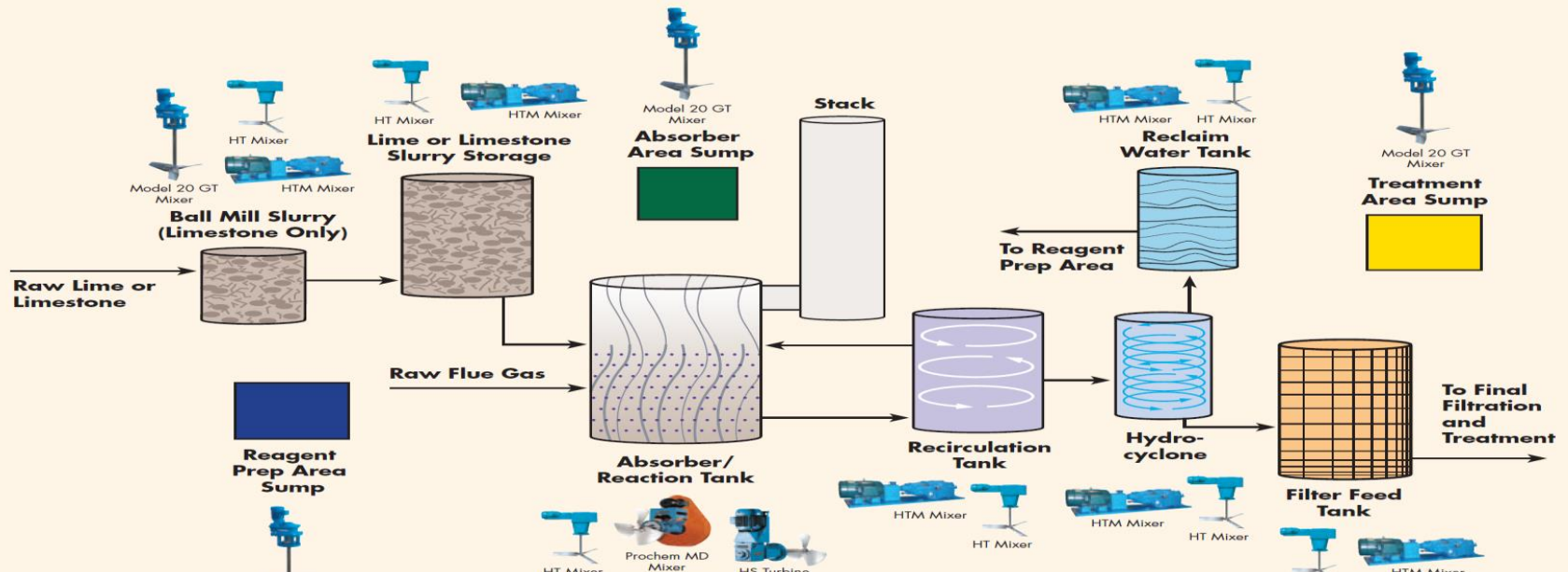
Chemineer agitators

Reliable FGD Mixing Solutions

Chemineer is a leading supplier of mixing solutions and products for Flue Gas Desulfurization (FGD) systems throughout the world for over 60 years. By utilizing laboratory testing and industry-leading technology, Chemineer can design the ideal mixing system for your process. Chemineer distinguishes itself from the competition through the use of rugged agitators that are highly efficient and extremely reliable. Thousands of Chemineer agitators are currently operating in FGD service and many of these have been in service for decades. Chemineer's experience in evaluating FGD applications and supplying equipment specifically engineered for harsh FGD service ensures efficient plant operation and long, reliable service with minimal maintenance.



FGD Process Flow



Chemineer-U.S.

startup	plant name	unit id	utility name	state	reagent	process	size MW
2008	J M Stuart	1	Dayton Power & Light Co.	OH	limestone	wet	610
2008	J M Stuart	2	Dayton Power & Light Co.	OH	limestone	wet	610
2008	J M Stuart	3	Dayton Power & Light Co.	OH	limestone	wet	610
2008	J M Stuart	4	Dayton Power & Light Co.	OH	limestone	wet	610

EKATO Wing Jet

EKATO Agitators

Worldwide 7000 EKATO agitators prove their reliability every day in more than 700 Flue Gas Desulfurization plants.

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 www.ekato.com

FGD AGIT

EKATO HWL 2000-N Side Entry Agitator

The most common side entry agitator drive for FGD absorbers. Motor powers up to 90 kW are available.



EKATO WINGJET

offers increased pumping rates, power savings, integrated wear resistance, a long lifetime and reduced maintenance costs.

EKATO Air-dispersion System

The patented and most efficient air dispersion system O_2 especially permits high air flow rates.

EKATO ESD 42

This cartridge type mechanical seal especially designed for FGD side entry agitators features long lifetime and easy maintenance on-site. This seal does not require a seal supply system or flushing.

EKATO Shut-off Device

The shut-off device guarantees a quick, reliable and safe mechanical seal change without leakage.

Advanced Process Solutions

Ekato FGD Installations-U.S

startup	plant name	unit id	utility name	state	reagent	process	size MW
2005	Asheville	1	Duke Energy	NC	limestone	wet	207
2006	Asheville	2	Duke Energy	NC	limestone	wet	207
2008	Cholla	4	Arizona Public Service Co.	AZ	lime	wet	414
2011	Milton R Young	B1	Minnkota Power Coop Inc.	ND	lime	wet	257

Ekato Installations - China

startup	plant name	unit id	utility name	reagent	method	size MW
2006	Jiangyin Xiagang	1	Jiangyin Sulong Electric Power			
2006	Jiangyin Xiagang	2	Jiangyin Sulong Electric Power			
2006	Taicang	1	Huaneng Power International	limestone	wet	300
2006	Taicang	2	Huaneng Power International	limestone	wet	300
2006	Tianshenggang	1	Guodian Nantong Tianshenggang Power Plant	limestone	wet	330
2006	Tianshenggang	10	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	11	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	2	Guodian Nantong Tianshenggang Power Plant	limestone	wet	330
2006	Tianshenggang	8	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	9	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2007	Jianbi	9	Guodian Suyuan-Jianbi Power Generation Co.	limestone	wet	330
2007	Taicang	3	Huaneng Power International	limestone	wet	600
2007	Taicang	4	Huaneng Power International	limestone	wet	600
2009	Jianbi	7	Guodian Suyuan-Jianbi Power Generation Co.			330

Mixing Solutions Comparison of Lance to combined lance/agitator

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Flue Gas Desulfurization(FGD) 



Research & Development Laboratory

Making the Unknowns - Known

Mixing Solutions Limited operates the largest, most comprehensive, full service industrial mixer laboratory in the world, including a 750,000 gallon test tank. In our R&D Lab we have the ability to model, design, test, and evaluate agitator configurations from scale model to full scale to meet your specific needs.

Make unknowns known without risk and remove any doubt. Using cutting edge technology and equipment we can accurately test and compare competing FGD solutions side by side.

- **Analyze** solutions before they are installed in your facility.
- **Optimize** your process, maximize your profit, reduce chance of fines.
- **Eliminate** costly surprises, upset conditions, and "what ifs?"

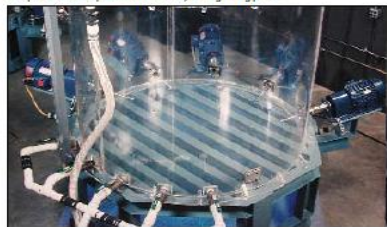
Shaft run-out test at bottom of 750,000 gallon test tank.



Agitator Test Facility, scale-up lab with research & design analysis tank.

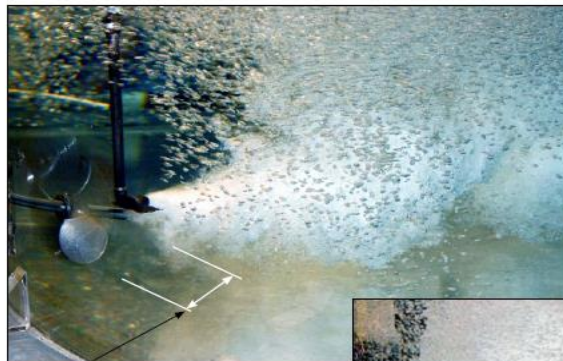


Comparative FGD impeller and O₂ delivery testing taking place.



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Flue Gas Desulfurization(FGD) 



AirWing™ undergoing comparative testing in the world's largest fluid mixing lab. Note the gap between impeller and air jetstream - no flooding is evident behind the impeller. This translates to less air required to fulfil your process.



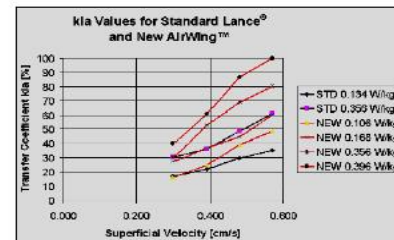
The same cannot be said for the standard air delivery lance. Significant flooding is evident here, resulting in process failure.

Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) Proven design.

Consistently outperforms the closest competitors' offerings in actual lab tests.

Actual Test Data Analysis proves that AirWing™ is the superior solution by up to 30%!

Revolutionary design demonstrates Mixing Solutions Limited's application understanding and expertise. Agitator Drive & Impeller combo make the Phoenix™ System your smart choice!



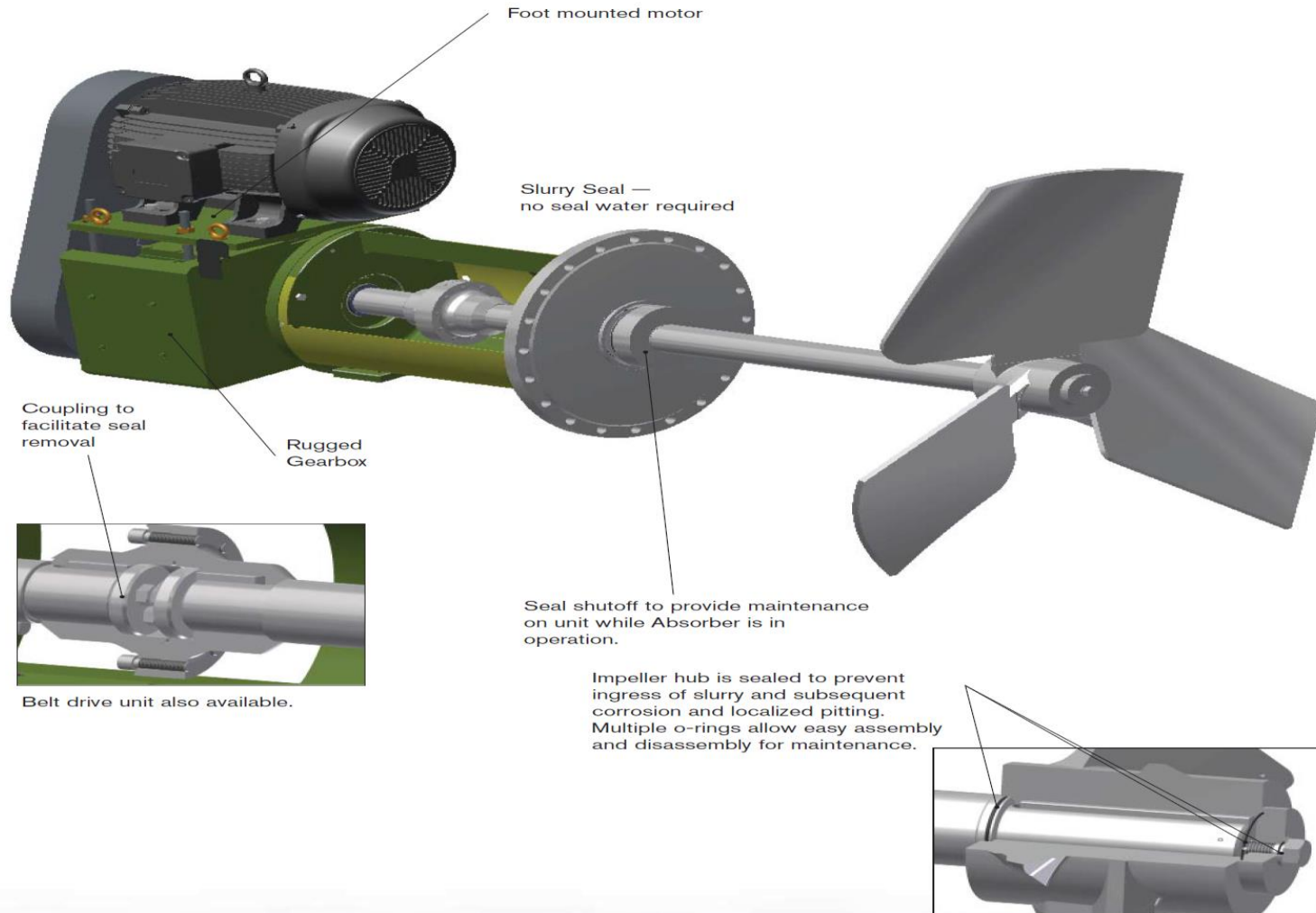
Philadelphia Mixing Solutions-U.S.

startup	plant name	unit id	utility name	state	reagent	process	size MW
2009	Coffeen	1	Ameren Illinois	IL	limestone	wet	390
2010	Coffeen	2	Ameren Illinois	IL	limestone	wet	617
2010	Oak Grove	2	Luminant Energy	TX	limestone	wet	796
2010	Sioux	1	Ameren Missouri	MO	limestone	wet	549.8
2010	Sioux	2	Ameren Missouri	MO	limestone	wet	549.8
2010	Oak Grove	1	Luminant Energy	TX	limestone	wet	796

SPX Lightnin mixer

THEORY OF OPERATION:

VSF Side-Entry Mixer Designed for FGD Absorber Service



Zhejiang Great Wall Reducer Co.



BHEL teamed with MHPS-agitator spec for Indian market



BHEL: BAP: RANIPET

AGITATORS – TECHNICAL POINTS CONFIRMATION FROM VENDOR

Sl. No	Clause no.	Description	As per specification	Bidder to confirm
1.	NUMBER OF AGITATORS			
	3.4.0 (Table-1)	Limestone Slurry Tank	4 no's	
		Auxiliary Absorbent Tank	2 no's	
		Filtrate Tank	2 no's	
		Secondary Hydro cyclone Feed Tank	2 no's	
		Waste Water Tank	2 no's	
		Lime Feed Tank	2 no's	
		Absorber Drain Pit	6 no's	
		Ball Mill Area Drain pit	2 no's	
Gypsum Area Drain pit	2 no's			
2.	MATERIALS OF CONSTRUCTION			
	3.8.0	Impeller Blade	Stainless steel or Nickel alloy. If Bidder offers rubber lining, the minimum life of rubber lining shall be 2 years.	
		Impeller Hub	D2B, ASTM A-439 or similar corrosion resistant material with rubber lining.	
	3.8.2	Shaft	Stainless steel or Nickel alloy.	
	3.8.3	Shaft Sleeve	Duplex Stainless steel CD4MCu or ASTM A-743 or 940L type nickel alloy with a minimum hardness of 240BHN	
3.8.1	Seal	Stuffing box or any proven equivalent or superior sealing type.		
3.	DYNAMICS			
	3.10.0	Critical Speed		
Operating speed of the Agitator motor shall be at least 25% below the first critical speed				
4.	SPECIFICATION OF MOTOR			
	6.0.0	Degree of Protection		
Degree of protection for various enclosures shall be as follows:				
	a)	Outdoor motors	IP 55	

5 new Hitachi Systems with separate lance and agitator

HITACHI
Inspire the Next

Figure 7 shows two spray header levels with nozzles trussed together with direct bonding of the SiC spray nozzles. Figure 8 displays the overlapping high density spray patterns resulting in the generation of fine droplets.



Fig. 7 Typical Spray Headers



Fig. 8 Overlapping High Density Spray Patterns

The design of the absorber reaction tank is also important when coupled with in-situ forced oxidation employing side mounted agitators and air lances. The result being a high level of solids for enhanced SO_2 removal and better dewatering coupled with sufficient residence time to ensure good gypsum crystal growth. Figure 9 shows a typical agitator and air lance arrangement which are spaced at the appropriate locations around the tank, while Figure 10 displays the dispersion of air bubbles to allow forced oxidation.



Fig. 9 Agitator and Air Lance



Fig. 10 Dispersion of Air Bubbles to Allow Forced Oxidation

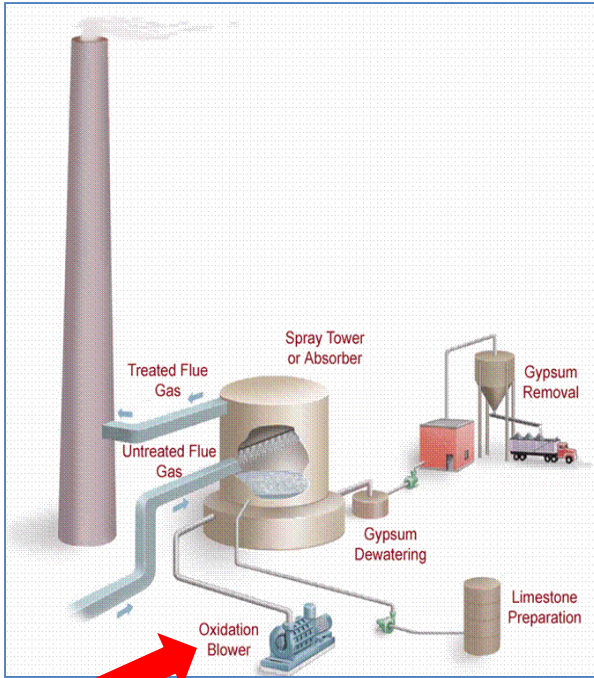
Continuing analysis of FGD for power plants around the world

- The huge FGD program in China is now being supplemented by activities in other Asian countries.
- India is using wet FGD with gypsum oxidation when using imported coals.
- Asian countries will install wet limestone FGD systems with forced oxidation on new units.
- The Chinese retrofit program continues.
- A number of existing Chinese plants will be upgraded.
- U.S. power plant FGD systems have expended their useful life resulting in new agitator and blower demand.
- Plants in China as well as elsewhere are now willing to spend more initially for higher efficiency and lower life-cycle cost.

A Special Opportunity: Electric Utility FGD Oxidation Blower Market in China

- **Utility Power in China**
- Size of installed fleet of coal-fired plants:
 - GWs: **1,146**
 - No. Coal-Fired Plants: **~ 650**
 - Retrofit FGD for unscrubbed plants: **18,000 MW/Year (~ 18 plants/Year)**
- Size of Greenfield opportunity
 - New MWs/Year: **50,000**
 - New Plants/Year: **50**
 - New FGD installations/Year: **50**
 - No. Blowers/FGD: **3 (2 operational, 1 standby)**
 - Typical Blower Specs: **12 psi, 5,000 cfm, 3600 rpm, 500 hp**
 - Total FGD Blowers: **18 + 50 plants @ 3 blowers per plant = 204 blowers**
 - Price Ea. **\$250,000 (could be \$100,000 in China market)**
 - Total Revenue for Utility Power FGD blowers: **\$20-million to \$50-million**
 - Legacy FGD blowers in China: **PD Roots Blowers**

Major Blower Technologies



PD Roots Lobe Blower: Lowest efficiency (45-65%), lowest capital cost



Single Stage Centrifugal: Highest efficiency, (70-80%), highest capital cost



Multistage Centrifugal Blower: Higher efficiency (50-70%), higher capital cost



One of three Siemens Turblex KA44-GT315 flue gas desulfurization oxidation air compressors, each 18,000 scfm, 30 psig, 2500hp.

Model	KA2	KA5	KA10	KA22
Flow (cfm)	500 - 2150	1800 - 6000	4500 - 9000	8000 - 14000
Pressure (psig)	4 - 22	4 - 28	4 - 25	4 - 23
HP	50 - 200	100 - 600	150 - 1000	200 - 1500
Model	KA44	KA66	KA80	KA100
Flow (cfm)	13000 - 21000	18000 - 33000	22000 - 44000	30000 - 70000
Pressure (psig)	4 - 23	4 - 23	4 - 20	4 - 17
HP	300 - 2000	450 - 3000	600 - 4000	800 - 5000

Siemens Turbo installations in U.S.

startup	plant name	unit id	utility name	state	reagent	process	size MW
2007	Roxboro	4A	Duke Energy	NC	limestone	wet	745
2008	Mountaineer	1	American Electric Power	WV	limestone	wet	1300
2008	Winyah	1	Santee Cooper	SC	limestone	wet	315
2008	Winyah	2	Santee Cooper	SC	limestone	wet	280
2009	Brunner Island	1	PP&L Inc.	PA	limestone	wet	363
2009	Brunner Island	2	PP&L Inc.	PA	limestone	wet	405
2009	Brunner Island	3	PP&L Inc.	PA	limestone	wet	790
2009	Cross	4	Santee Cooper	SC	limestone	wet	600
2009	Montour	1	PP&L Inc.	PA	limestone	wet	806
2009	Montour	2	PP&L Inc.	PA	limestone	wet	819
2009	Roxboro	1	Duke Energy	NC	limestone	wet	411
2010	Oak Creek (Elm Road)	1	We Energies	WI	limestone	wet	600
2010	Oak Creek (Elm Road)	2	We Energies	WI	limestone	wet	600

Siemens-China

startup	plant name	unit id	utility name	reagent	method	size MW
2006	Tianshenggang	1	Guodian Nantong Tianshenggang Power Plant	limestone	wet	330
2006	Tianshenggang	10	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	11	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	2	Guodian Nantong Tianshenggang Power Plant	limestone	wet	330
2006	Tianshenggang	8	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2006	Tianshenggang	9	Guodian Nantong Tianshenggang Power Plant	limestone	wet	137.5
2007	Jianbi	9	Guodian Suyuan- Jianbi Power Generation Co.	limestone	wet	330
2007	Taicang	3	Huaneng Power International	limestone	wet	600 ²⁰

Siemens ROW

startup	plant name	unit id	utility name	country	reagent	method	size MW
2000	Tangjin	3,4		South Korea	limestone	wet	1000
2001	Avedore	2	SK Energi	Denmark	limestone	wet	325
2001	Sostanj	5	ELES	Slovenia	limestone	wet	335
2002	Yongnam	1,2	Korea Electric Power Corp.	South Korea	limestone	wet	380
2004	Eggborough	4	British Energy	United Kingdom	limestone	wet	450
2004	Eggborough	3	British Energy	United Kingdom	limestone	wet	450
2005	Voerde	4	STEAG	Germany	limestone	wet	760
2005	Voerde	3	STEAG	Germany	limestone	wet	760

Ingersoll Rand-Hibon multistage blowers at Tanjunglati, Indonesia

- Two units of Hibon Multistage Centrifugal Blowers Model 450.06
- Flow: 15000 Nm³/h
- Differential Pressure: 850 mbarg
- Motor size: 700 kW
- Customer: Babcock&Wilcox

Gardner Denver Success in China

- There were 9 bidders for the Shandong Chiping Xinyuan Aluminum Co. Ltd's 6 * 660 MW supercritical unit power station project. Gardner Denver Nash China won the project with the highest price!
- The project includes 12 sets of CF2007 flue gas desulfurization (FGD) oxidation blowers, 18 sets of TC-11E condenser vacuum pumps and 6 sets of 2BE4 720 FGD vacuum pumps.
- Chiping Xinyuan Aluminum Co. Limited is a subsidiary of Shandong Xinfra Group which is one of China's largest private companies.
- This is the third success in a row, following the Pingwei and the Wanzhou power projects. These have all occurred since Nash China started the "TOTAL SOLUTION" strategy at the end of 2012.
- The original design called for roots blowers. Considerable effort was needed to persuade the Design Institute to change the specifications.
- The "TOTAL SOLUTION" strategy brought Nash orders for 20 sets of blowers, 30 sets of condenser vacuum pump packages and 10 sets of flue gas desulfurization vacuum pumps during 2013.