

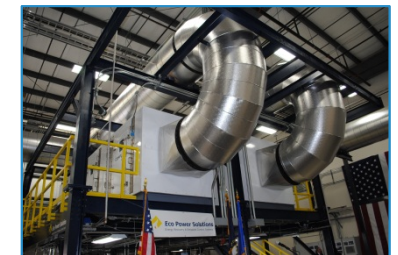
ADDRESSING MERCURY EMISSIONS WITH MULTI-POLLUTANT CONTROL TECHNOLOGY

BY

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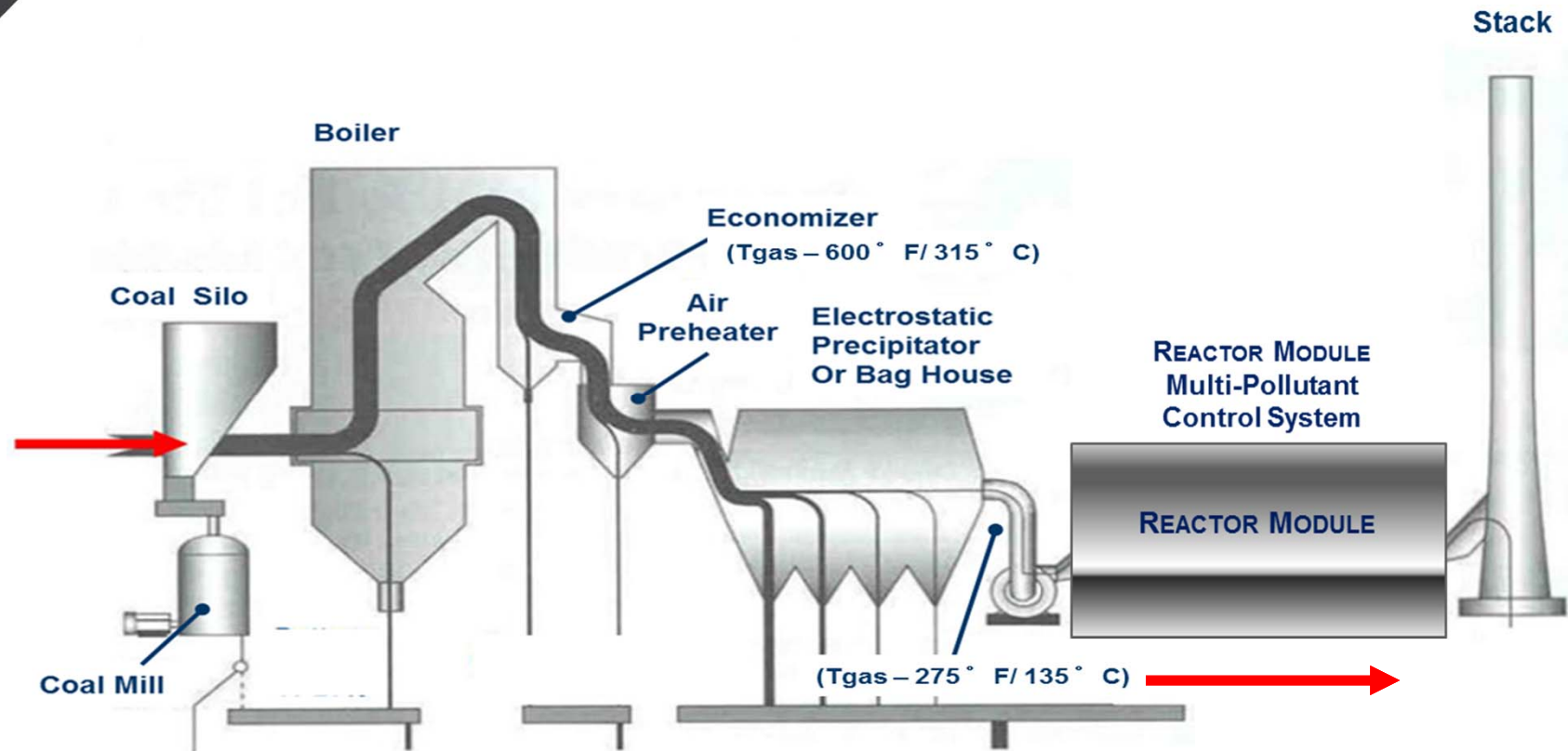
**SESSION: MERCURY MEASUREMENT &
CONTROL PART 2**

ECO
POWER
SOLUTIONS



PRODUCT INTEGRATION— “COLD END”

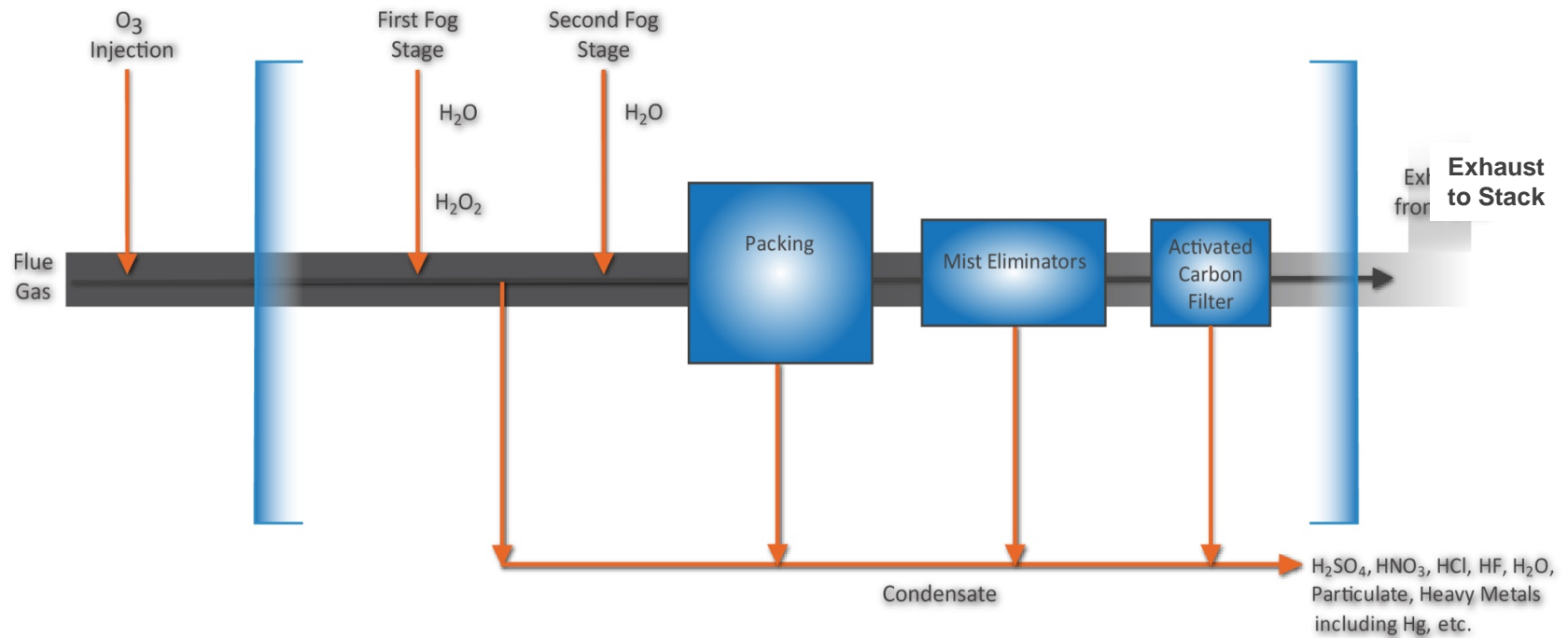
Reactor Module fully integrates into current plant operations downstream of primary particulate collection device



Avoided Costs: No modifications to boiler and/or 'hot flue gas' equipment
Preserved Flyash Treatment: No flyash impact thereby preserving current disposal options and revenue streams
Integration Advantage: Cold application means less gas volume translating to compact footprint

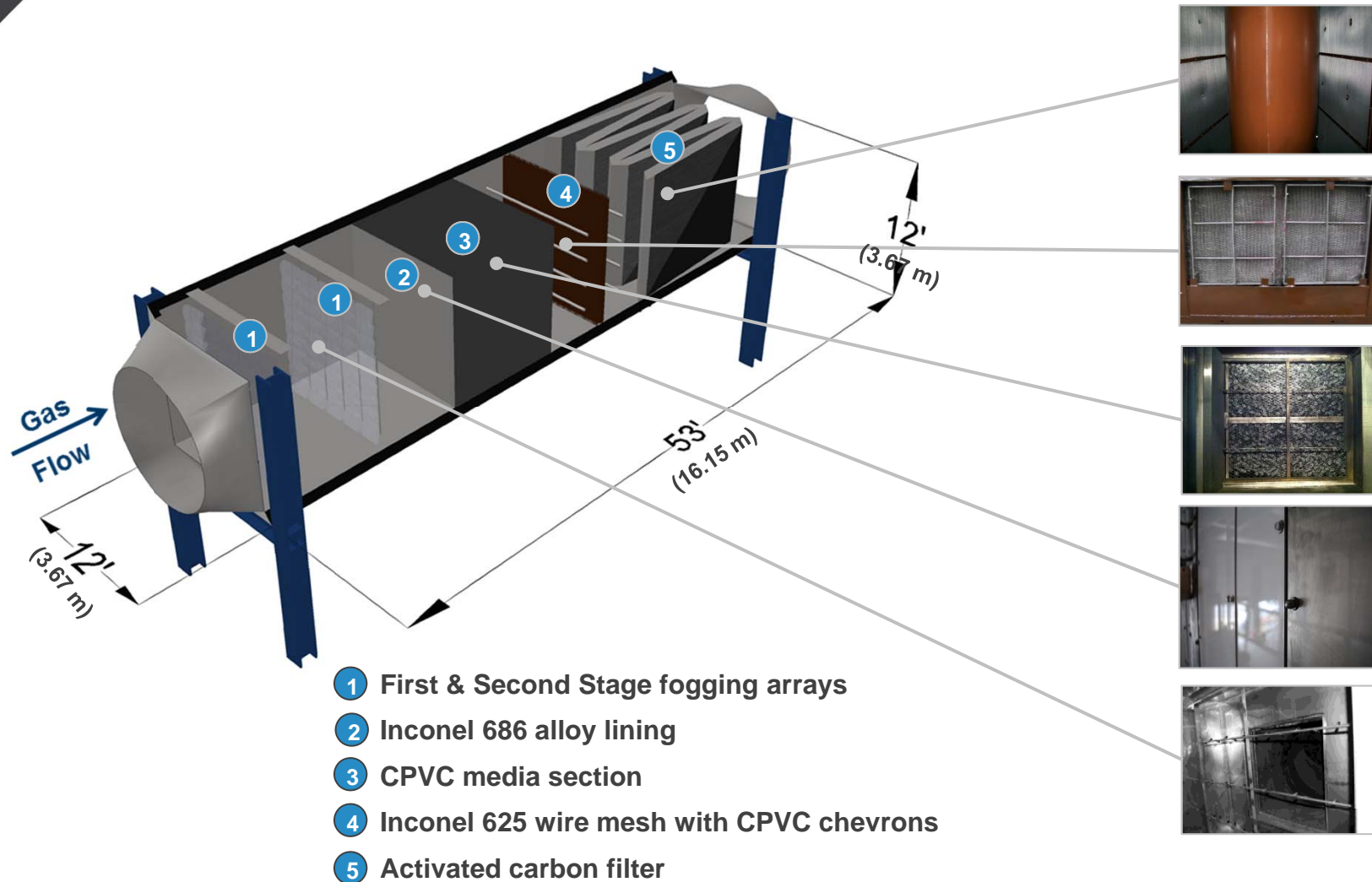
PROCESS SCHEMATIC

Simple, cost effective, and patented



REACTOR MODULE - LAYOUT DIAGRAM

Straightforward and functional design allows for ease of operation and maintenance of modules.



MERCURY (HG) & HEAVY METALS CONTROLS

Mercury exists in three forms in exhaust flue gases:

- Elemental mercury
- Mercury oxide
- Particulate mercury

Chlorine in the fuel converts elemental mercury to mercuric chloride. Conversion rates can vary from a few percent to 90%.

Ozone and peroxide injection promote the conversion of elemental mercury to oxide.

Particulate mercury is the result of gas-solid, surface catalyzed reactions. It is adsorbed into fly ash and unburned carbon and can be captured in a particulate removal device.

Mercury oxide is water soluble and easily removed during the condensation process.

MERCURY (HG) & HEAVY METALS CONTROLS

Other heavy metals removed include: arsenic, cadmium, chromium, selenium, barium, lead, silver.

Mercury re-emissions suppressed:

- Presence of strong oxidizers – ozone and hydrogen peroxide
- Presence of acids – sulfuric, nitric, hydrochloric, etc. pH < 2.0
- Lack of reducing agent unlike sulfites in wet FGD systems

TECHNOLOGY CENTER - COAL & NATURAL GAS

State-of-the-art facility opened in June 2010 to demonstrate the advanced multi-pollutant emission control capabilities of the Reactor Module

Design

- Began Operation – June, 2010
- Coal Fired – Designed for 5 MW equivalent volume
- Natural Gas Units – Designed for 5 MW equivalent volume
- Design Volume - 15,000 SCFM (7.1 N m³/sec)

Measurement & Verification

- Eastern Bituminous Coal (2.2% Sulfur)
- Flue Gas Analysis
- Real time Emission Monitoring
- Sorbent Trap testing for Hg removal



PROVEN, REPEATABLE PERFORMANCE: COAL FIRED

Demonstrated at Eco Power Technology Center
firing eastern bituminous coal

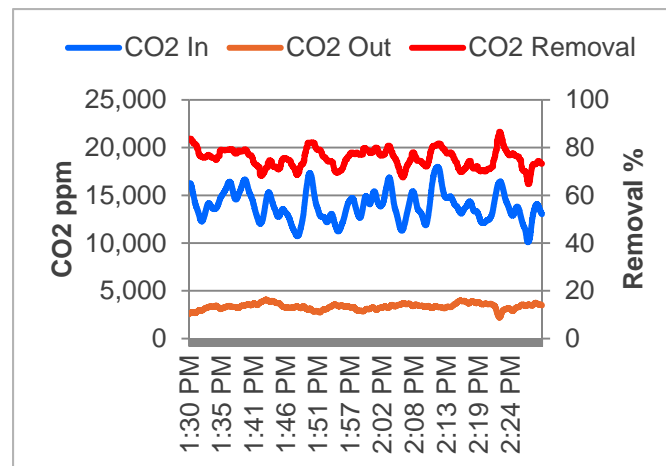
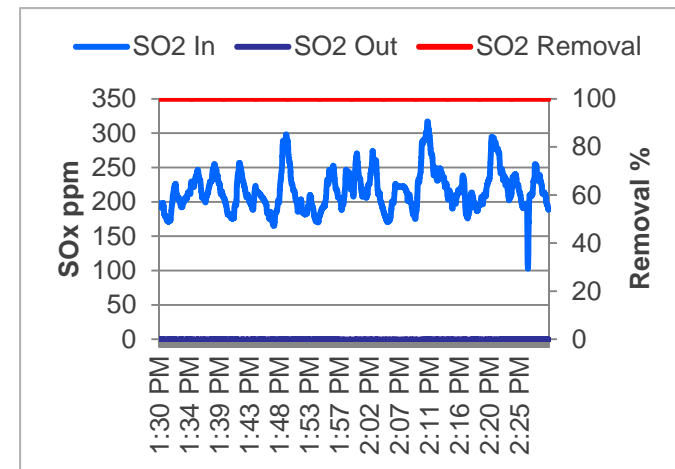
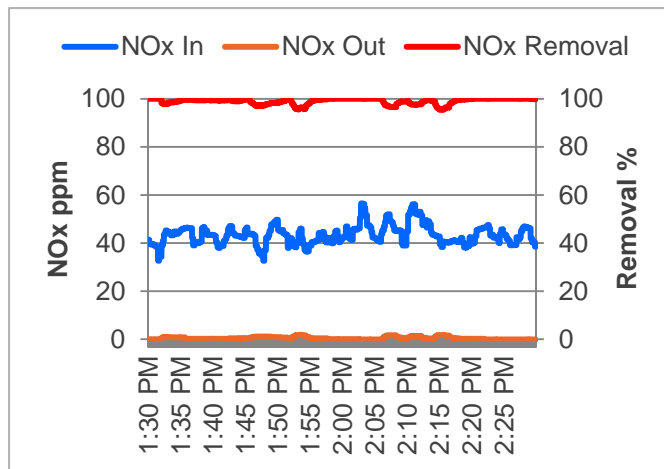
Eastern Bituminous Ultimate Analysis			
Carbon	69.9%	Hydrogen	4.7%
Oxygen	6.4%	Nitrogen	1.2%
Sulfur	2.2%	Ash	13.2%
Moisture	2.4%	Heating Value	12,644 Btu/lb

Outlet Emissions in ppm, FTIR			
HCl	0.0	HF	0.0
SO ₃	0.0	Acid Mist	3.9
Formaldehyde	0.0	CO	78.4
Methane	5.4	Ethane	1.8
Propane	0.0	Ethylene	4.1
Hexane	0.0	Ammonia	0.3

Operating Conditions (8/14/2012)		
	Inlet	Outlet
Gas Temp	257 ⁰ F (125 ⁰ C)	89 ⁰ F (32 ⁰ C)
NO _x	43.36 ppm	0.44 ppm
SO ₂	216.58 ppm	0.00 ppm
CO ₂	13,865 ppm	3,352 ppm

PROVEN, REPEATABLE PERFORMANCE: COAL FIRED

Demonstrated at Eco Power Technology Center
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MERCURY (HG) MEASUREMENTS

Three commonly used methods for mercury testing:

- Sorbent Trap Method
- Ontario-Hydro Method
- Mercury CEMS Analyzers

MERCURY TEST DESCRIPTION

Sorbent Trap Method was used in our case to measure mercury removal rates:

- The sorbent traps were baseline traps similar to 12B Appendix K from Ohio Lumex
- Two sections containing coconut shell carbon
- Tube OD is 10 mm
- Traps placed at the inlet and outlet of reactor module in the ductwork
- Flue gas flow of 0.4 l/min was maintained through the traps
- Test duration = 6 hours



MERCURY TEST

Test Results (June 5, 2012):

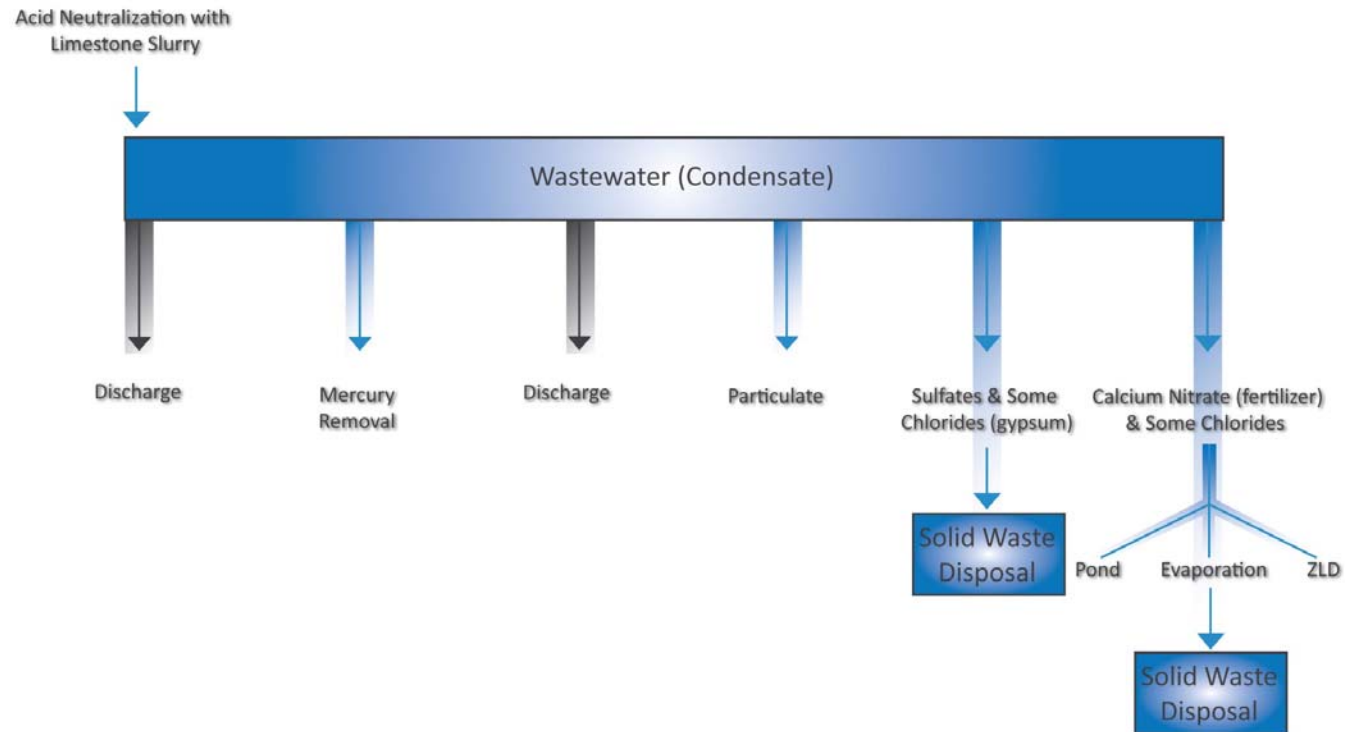
- Traps sent to independent lab to measure deposition rates
- Mercury deposition for both the sections was measured for each trap
- Inlet duct: Section 1 = 95.38 ng; Section 2 = 0.08
- Outlet Duct: Section 1 = 9.87; Section 2 = 0.77
- Removal Rate = 89%

MERCURY TEST

Plan for Improvement:

- Filtration installed upstream of the reactor module
- Mist eliminators installed to reduce water carryover to the outlet duct
- Opacity levels are now in the 4 to 6% range instead of in the double digits
- Expect significant improvement in results

WASTE WATER PROCESS SCHEMATIC

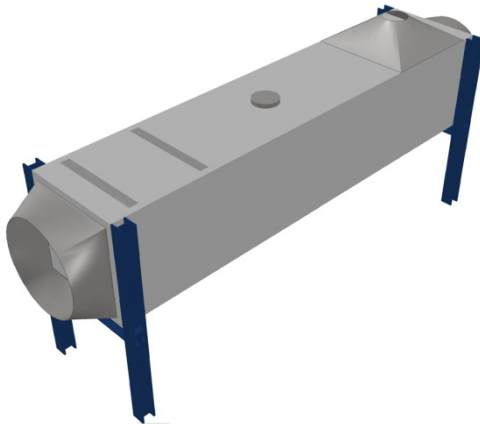


- Condensation primarily consists of strong acids (low pH) and relatively weaker acids
- Quantity of wastewater varies depending on temperature of flue gas entering the units.
- The wastewater streams can be combined or separated for acid resale.
- Byproduct is salt and water.

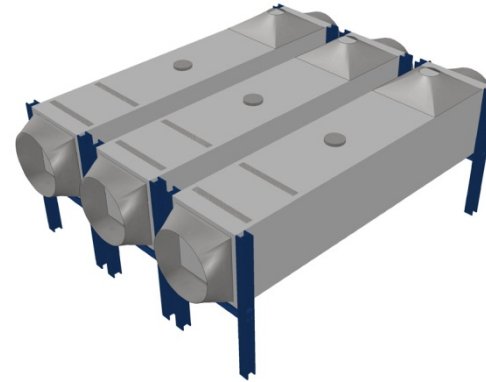
DESIGNED FOR SCALE-UP & FLEXIBILITY

Modular design philosophy provides for short cycle times and scale up capabilities.

25 MW Single Module
(60,000 SCFM/ 28.3 N m³/sec)



75 MW Multiple Modules
(180,000 SCFM/ 85.0 N m³/sec)



- Scale-up achieved through modular design.
- Short cycle time (fabrication through installation)
- Operational flexibility- maximum integration potential for retrofit applications
- Shop assembled module units of 25 MW (projects up to 150 MW)
- Field erected module units for projects > 150 MW.

SUMMARY

- An all-in-one, multi-pollutant AQCS that captures both regulated and unregulated air pollutants
- Over 1,000 hours of operating experience backed by credible third party validation
- Applicable to a broad range of fuel types from fossil fuels to biomass to waste fuel stock
- Flexible design allows the system to be tailored to address specific pollutants
- Cold-end location means less intrusion during the retrofit
- No modification of upstream equipment is required
- Modular and repeatable design speeds implementation and reduces costs
- Favorable capital and operating costs when compared to traditional technologies

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