Total Solutions

Decision guide for the August 20 Mcilvaine hot topic hour

“A rising tide lifts all boats”. This webinar is to help suppliers expand their scope and solve problems not just supply components. It is the route for international suppliers to eliminate local competition.
Some of the participants

- Clark Griffith, Griffith Consulting
- Bruce Galli, Marsulex
- Guisu Liu, Mobotec
- John Albritton, Paragon Air Heater
- Martin Schroter, Durr
- Rod Gravely, Tri Mer
- Nathan White, Haldor Topsoe
- Tom Van Remmen, Verantis
- Mike Gregory, IAC
- Craig Thiry, Montrose
- Joe Porcelli, Sulzer Chemtech
Overview of Total Solutions

• An air polluter can buy components and design, operate and service his pollution control system
• Alternatively he can outsource all these responsibilities.
• The revenue potential for all this outsourcing is defined as the “Total Solutions Opportunity”
• The historical trend is toward greater and greater outsourcing
• The availability of new digital tools will accelerate this trend in the future
• This opportunity promises to deliver higher profits to suppliers and lower life cycle costs and higher value products for operators.
• There are many partial solutions as well as total. Each needs to be evaluated.

• **The reason operators need the knowledge and help is not because the experienced people are retiring but because knowledge is growing exponentially and the human brain is not.**
# Demand Factors for Total Solutions

<table>
<thead>
<tr>
<th>Factor</th>
<th>example</th>
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<tbody>
<tr>
<td>Complex systems with multiple control steps</td>
<td>Coal fired boilers, cement kilns, chemical processes</td>
</tr>
<tr>
<td>Valuable final product recovery</td>
<td>Precious metal mining,</td>
</tr>
<tr>
<td>Valuable process product recovery</td>
<td>Refinery catalyst, solvents in chemical and surface treatment</td>
</tr>
<tr>
<td>Difficult compliance with air permit</td>
<td>Many industries in many countries where even start up and shut down emissions are important</td>
</tr>
<tr>
<td>Safety</td>
<td>Explosive gases</td>
</tr>
<tr>
<td>health</td>
<td>Semiconductor toxic fumes</td>
</tr>
<tr>
<td>Potential for air pollution control system to negatively impact operations</td>
<td>Many industries</td>
</tr>
<tr>
<td>Lack of skilled personnel within the plant</td>
<td>Continuous trend</td>
</tr>
<tr>
<td>Success of remote monitoring</td>
<td>Applicable to all pollutants and operating parameters</td>
</tr>
<tr>
<td>Ability of suppliers to provide a lower cost alternative</td>
<td>Reduction of repairs, downtime, energy consumption etc</td>
</tr>
</tbody>
</table>
# Total Solution Options

<table>
<thead>
<tr>
<th>Options</th>
<th>example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary system design</td>
<td>CECO offers CFD modeling and design for rolling mill fume control including the important industrial ventilation ductwork to reduce air volume</td>
</tr>
<tr>
<td>Turnkey system with unique combination of pollution control devices</td>
<td>Megtec sewage sludge incineration systems with oxidizer, scrubber and wet precipitator. Trimer supplies PM 2.5 Nox reduction and acid gas capture in one device</td>
</tr>
<tr>
<td>Turnkey system with total operational control</td>
<td>FLS offers this option for cement kilns</td>
</tr>
<tr>
<td>System and reagent integration</td>
<td>Durr and ClearChem supply pulverized limestone injection in the furnace followed by a catalytic filter</td>
</tr>
<tr>
<td>BOO and by product sales</td>
<td>MET offers this system to convert SO2 to ammonium sulfate fertilizer</td>
</tr>
<tr>
<td>Remote monitoring of operations</td>
<td>Many examples</td>
</tr>
<tr>
<td>Guaranteed cost bag replacement program</td>
<td>Supplier monitors operations and replaces bags as needed at a fixed yearly cost</td>
</tr>
<tr>
<td>Routine service programs</td>
<td>Replace all parts in system, regular inspections, continuous remote monitoring</td>
</tr>
<tr>
<td>Delivery of all consumables</td>
<td>Clarcor Total Filtration Services supplies all filters for the plant</td>
</tr>
</tbody>
</table>
Initial analysis by system providers-

Gas Turbine exhaust system (Peerless example)

Computational Fluid Dynamics (CFD)
- Fluent Software
- Multi-phase Flow Simulations
- Retrofit Design Evaluation
- 20+ years experience

Air & Water Wind Tunnel
- Performance Confirmation
- Doctorate Level Staff
- 40+ years experience
- Silencer Test System
Total Solutions- Turnkey Systems

• The owner can design his own system, hire an A/E or ask for turnkey bids
• Turnkey bids result in transfer of responsibility, quick delivery and often lower overall costs
• A/E firms argue that turn key bids often include lower quality components and that the performance of major components should be specified. However, owners who sole source turnkey projects are typically assured that their component expectations will be met.
• The requirements to remove many pollutants in one system combined with the negative impact of one removal device on the capture of other pollutants makes the allocation of total responsibility desirable
  – The choice of catalyst influences SO3 generation
  – The choice of burners impacts CO and Nox emissions
  – The choice of scrubber impacts wastewater pollution

• The installation can be turned from a low profit high risk option to a high profit option. PPC sells their precipitators on an installed basis. The units are built in modules and assembled and then disassembled in the shop. Installed costs are typically half that of competitors.
Turnkey systems for power plants

example from SNC Lavalin

• SNC Lavalin joint venture with Skanska is providing engineering, procurement, start-up and commissioning services for the Newark Energy Center in New Jersey. Scheduled to start up in 2015, the 655-MW gas-fired combined cycle power plant will be one of the cleanest of its kind in the United States.

• The new plant will use wastewater and the latest General Electric F-class 5-series combustion gas turbines to generate reliable and efficient power. These gas turbines can switch on quickly, producing fewer emissions at start-up. Ultimately, the plant will reduce the region’s reliance on older, less efficient power plants with higher emissions.

• The Newark Energy Center will provide reliable power to 700,000 homes via the regional grid. The project employs more than 700 construction workers and generates tax revenues for the city of Newark.
Nederman has total solutions for foundries addressing both worker health and plant air purity along with meeting air emission limits.

- **Extraction of fumes at the furnace**
  - Melting furnaces generate dangerous fumes. Extraction and filtration is necessary to make the production efficient, to protect workers from hazardous substances and to comply with statutory emission levels. Nederman has close capture hoods for collecting hot fumes from furnaces during charging, melting and pouring.

- **Extraction of dust at moulding lines and sand management**
  - Wide range of filters, fans and equipment are suitable for everything from single machines to whole processes with multiple extraction points. The company claims to ensure optimum collection of dust with the lowest possible air volume, which is vital for keeping the investment and operation costs to a minimum.

- **Solutions for shot blast machines and casting cleaning**
  - Nederman has solutions for extracting and filtering dust from shot blast machines, fettling tables, machining operations and other downstream operations.
Semiconductor plant buys Duall system combining scrubbers, fans, pumps for critical acidic vapor capture

• In order to comply with Ministry of the Environment emission requirements, Project Engineers at Chartered Silicon Partners, Singapore (CSP) needed gas scrubbers for their FAB-6 expansion. They required six (6) new 40,000 CFM scrubbers with chemical addition and high efficiency mist eliminators to treat acidic process exhaust. CSP also required that each scrubber be supplied with an energy efficient exhaust fan. After thorough analysis of equipment features and benefits, CSP selected Duall model F105 scrubbers complete with redundant recycle pumps and Duall NH fans. All equipment was constructed of UV-PP to provide maximum corrosion resistance and weather protection for outdoor installations subjected to Singapore’s intense sunlight and tropical climate. Duall engineers designed the NH fans with airfoil impellers in order to provide mechanical efficiencies in excess of 85%.
Total Solutions In Action

Clark Griffith, P.E.
Griffith Consulting, LLC. & Generation Combustion, Inc.
Thermal Oxidizer-Related Total Solutions

Equipment Options

- Waste Heat Boilers
- Ductwork
- Used Equipment
- Flow Measurement
- CFD
- Engineering Studies
- Installation
- Thermal Fluid Systems
<table>
<thead>
<tr>
<th>Example 1 – Minnesota T.O./WHB</th>
<th>Example 2 – Ohio Direct-Fired T.O.</th>
<th>Example 3 - New Jersey Regenerative T.O.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prospect’s Existing T.O. Wasn’t Working for Unknown Reasons</td>
<td>• Prospect Didn’t Know His Flow Rate or VOC Loading and Wanted T.O. Installed with Future Heat Recovery Capabilities</td>
<td>• Prospect Considered Our Used Equipment to Save Money</td>
</tr>
<tr>
<td>• Performed CFD Modeling and Engineering Study. Experienced with Boilers</td>
<td>• Went to Site, Took Measurements, Educated Customer, Gained Inside Track</td>
<td>• Due to Excessively Large Crane to Move Already Assembled Used Equipment – Used Equipment Not Viable</td>
</tr>
<tr>
<td>• Prospect Becomes Revamp Customer and Existing Failing T.O. is Totally Overhauled to Perform Exceptionally</td>
<td>• Prospect Becomes New Equipment Customer &amp; Future Expansion Prospect</td>
<td>• Prospect Becomes New Equipment Customer</td>
</tr>
<tr>
<td>• Excellent Reference</td>
<td>• Excellent Reference</td>
<td>• Stay Tuned</td>
</tr>
</tbody>
</table>
Marsulex and Air Products furnish SO2 removal system for a fee based on tons of SO2 captured

• In the Ammonia Sulfate (AS) process, the absorption of SO$_2$ is accomplished with either anhydrous or aqueous ammonia and converts the captured SO$_2$ into a high value crop fertilizer.

• Marsulex can generate enough revenue from fertilizer sales to offer a build, own, operate approach.

• One project (later canceled) would have generated $80 million of EBITA.

• Mitsubishi and Air Products and Chemicals teamed up to offer a BOO to capture SO2 using limestone slurry at the Baily station in Indiana. The project was quite successful and has operated for many ears.
CECO-Busch emission control options

Solve air pollution challenges with BUSCH’s Six Primary Control Options, plus the added efficiency of the Stack Skimmer.

Depending on your operation, each component alone can alleviate emission control problems... combined as a team, BUSCH has no match in the industry in excellence and efficiency.

Busch heavy oil scrubbing systems used in foil mills

- A major aluminum foil manufacturer selected Busch to provide our new Heavy Oil scrubbing system for two foil mills.
- The Busch HOS system is designed to capture both mist and vapor phase emissions. The collected rolling oil is then reclaimed and returned to the mill for reuse.
- The scope of work included a complete fume exhaust system from duct connections at the mills thru the scrubber discharge stack.
- The project was made more challenging by the fact that the entire system was required to fit inside of the building in very cramped quarters.
- Busch engineering provided detail arrangement drawings for construction, and installation went very smoothly.
- The system currently reclaims large quantities of rolling oil for reuse which is a major cost advantage. Outlet emissions are well under mandated levels.
Aluminum hot rolling mill with Busch oil capture system

• The system includes Drip Resistant mill hoods which help to improve product quality. The mill enclosure includes a custom curved rollup door to facilitate easier roll changes and lift-out duct sections are included behind the mill to simplify maintenance operations.

• The lift-off hoods incorporate internal fire-protection piping and exterior ladders for access to grated top walking surfaces. The collection technology utilized low maintenance Busch Purifiers to meet emission requirements.

• The client was so pleased with the system’s capture efficiency that they immediately ordered a similar fume exhaust system for a second hot mill at the same facility. This second system has just been completed with similar results

Mobotec’s Capability for Solutions Delivery

**Emissions Compliance**
- Experience in high performance solutions for NOx, SO2, SO3, CO & HCl reduction

**Fuel Flexibility and Switching**
- Solutions can be applied to wide range of boilers configurations & fuels
- Capability to covert from coal-only to co-firing or to 100% conversions

**Enhanced Performance**
- Layered approach
- Integrated solutions
- Guaranteed performance
- Technology agnostic

**Cost Reduction**
- Low Operational Cost
- Sorbent reduction
- Low ammonia slip
Mobotec’s Global Solutions for Power Plants

<table>
<thead>
<tr>
<th>Boiler Configuration</th>
<th>No.</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall-Fired</td>
<td>37</td>
<td>25 – 570 MWe</td>
</tr>
<tr>
<td>T-Fired</td>
<td>28</td>
<td>70 – 705 MWe</td>
</tr>
<tr>
<td>Stoker/Grate</td>
<td>22</td>
<td>16 – 32 MWe</td>
</tr>
<tr>
<td>Fluidized Bed</td>
<td>7</td>
<td>80 – 235 MWe</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
<td>8 – 15 MWe</td>
</tr>
</tbody>
</table>

References

- Sorbimix for SO2, SO3, HCl, Hg
- SNCR
- OFA/ROFA®
- Biomass Co-Firing/conversion
- LNB, Combustion Optimization
- In-Duct SCR
Total Solutions - Operation

- Process advice: Megtec, advises the chemical company on whether to destruct or capture solvents based on the current price of the solvent. This is an example of the process advice that can be supplied.

- Operational tuning: Remote monitoring can allow vendor to advise on reagent adjustments to the scrubber or trigger the order for bags for the collector (each bag can be monitored with an online broken bag detector).

- Fine tuning ventilation systems is a continuing need. The quality of the in plant air affects health and is a high priority for many plants.

- Advice on upcoming regulations (safety, pollution control) can allow operators to start planning the needed actions. This also leads to sole sourcing the solution.

- CEMS monitoring. The results are generated continuously and provide a basis for the supplier to advise its clients relative to needed changes.

- A high profit but possibly high risk area would be to guarantee or share in recovery of precious metals, catalyst, etc. This is a big opportunity in refining.
Airheater Performance – Key Points by Paragon

• The Airheater supplies hot pre-heated combustion air to the wind-box and the mills. The airheater accounts for over 10% of the Units thermal performance. Heat rate effects Coal Usage and CO₂ Emissions.

• Supply of hot air to drive the moisture from the fuel and assist with mill capacity. Dryer coal means improved coal fineness and flame stability.

• Improved air supply to the unit yields improved Combustion, LOI, Efficiency and Reliability.

• Airheater leakage affects: Efficiency, Heat Rate, the Mills, FD & ID fans, Increases Volume and Velocity of Air to ESP, Bag House, Scrubbers.

• ABS and Corrosion due to things like SCRs and Calcium Bromide injections affect the life, health and reliability of the airheater.
Paragon is a Full Service Provider

- Perform Airheater Inspections
- Assess Overall Performance
- Turnkey Installations
- Technical Supervision of Installations
- Analyze Parts Replacement
- Recommend Upgrades
  - High Performance Seals to Reduce Air Leakage
  - Enamel Baskets to deal with ABS / Corrosion
  - Different Basket Configurations to Improve Heat Rate

www.paragonairheater.com
(951) 273-1828
FL Smidth division of responsibilities with owner

<table>
<thead>
<tr>
<th>An example of the division of responsibility</th>
<th>FLSmidth</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations (incl. responsibility for production output)</td>
<td></td>
<td></td>
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<tr>
<td>Plant maintenance</td>
<td></td>
<td></td>
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<tr>
<td>Technical management</td>
<td></td>
<td></td>
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<tr>
<td>Employees (recruitment, payroll and management)</td>
<td></td>
<td></td>
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<tr>
<td>Training and development of local staff</td>
<td></td>
<td></td>
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<tr>
<td>Office, warehouse and canteen facilities</td>
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<td></td>
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<tr>
<td>Office equipment (incl. computer hardware and software)</td>
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<td></td>
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<tr>
<td>Office furniture</td>
<td></td>
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<tr>
<td>Personnel safety equipment</td>
<td></td>
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<tr>
<td>Consumables &amp; operational spare parts (on-going consumption)</td>
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<td></td>
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<tr>
<td>Utilities (power, fuel and water)</td>
<td></td>
<td></td>
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<tr>
<td>Security (guards, equipment, fencing, etc.)</td>
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<td></td>
</tr>
<tr>
<td>Plant, property, liability and equipment insurance</td>
<td></td>
<td></td>
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<tr>
<td>First-aid equipment</td>
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Total Solutions approach can increase plant production and profits.
Total solutions - Maintenance

- There is a big potential to generate profits in the after market - much bigger than the typical service contract and the replacement of hardware
- With the many millions of bags in service the market to replace them is substantial. It is being served by specialized bag companies. However, if the supplier offers lump sum yearly contracts and monitoring operations to extend bag life, the bag revenue can be substantial and the profit high
- The CEMS system requires quarterly audits. GE purchased a stack testing company based on the realization that this was an ongoing revenue producer for every gas turbine installation. A system supplier who sub contracts or owns testing and CEMS companies can insure compliance on a continuing basis.
Inventory management programs are claimed to reduce the overall cost and lead time of obtaining parts and components while maintaining and improving plant equipment reliability and availability. These programs streamline replacement parts purchasing and inventory functions – saving time, money and equipment downtime.

- **Assured Stock Program:** B&W manufactures parts and components based on forecasted needs and supports emergency or unplanned repair requirements.
  - The program is adaptable, easily implemented and can incorporate additional B&W services such as component rebuilds, upgrades and scrap purchase of wear parts.

- **ENVantage℠ Program:** ENVantage Program is a full-service, integrated maintenance and optimization solution designed to improve the reliability and efficiency of utility and industrial air quality control systems.
  - The program includes inventory management and onsite field services for wet and dry flue gas desulfurization systems, wet and dry electrostatic precipitators, fabric filters, SCRs, Multiclone® dust collectors and Turbulaire™ scrubbers, and can be customized.

**Benefits**

- Reduced on-site inventories and associated carrying costs
- Reduced lead times and paperwork
- Reduced risk of obsolete inventory
- Improved asset management
- Improved planning of stock levels to optimize service
- Guaranteed shipments for emergencies within hours of notification, without priority charges
- Operations and maintenance planning support
- On-site field specialist support
Durr

portfolio of services includes: .

- modernization
- expert programming
- tele-diagnosis
- seminars and training sessions at Dürr
Combining FSI with Hot Gas Filtration

APC Control Adding Value to the Process

- **SO₂ Conversion > 80%**
- **2,700°F**
- **Convection sections & economizer**

- **KaCO₃**
- **SO₂**
- **CaO**

- **Coal Feed**

- **DS**
  - **Ca(OH)₂**
  - **750°F**

- **Ammonia injection**

- **SO₂ < 1%**
  - **SO₃ < 1 ppm**

- **Catalytic hot gas filter**
  - **320°F**
  - **< 150°F**

- **Ash removal**

- **Boiler feed water**

- **CaCO₃**
- **CaO**
- **CaSO₃**
- **Ca(OH)₂**

© Dürr company, DSI/CTS, Business Development, McIlvaine, Total Solutions for APC, webinar August 20th, 2015
Tri-Mer offers turnkey systems and services:

- Pollution control system design
- Engineering (mechanical, electrical, civil, structural)
- Site work such as demolition
- Site work up-front construction
- Regulatory agency support
- Controls and integration
- Continuous Emission Monitors
- In-house equipment fabrication
- Installation and start-up
- Aftermarket support services
Catalyst is inside the filter walls, evenly distributed.

Particulate (PM) is captured on the surface of the filter.

Catalyst is protected from blinding and poisoning by particulate.

Very long catalyst life.

Over 90% NOx removal at 400º F.
- Tri-Mer Ceramic

**Non-catalytic ceramic filters**
- Particulate only, temperature above fabric filter range
- Particulate and any combination of SO2, SO3, HCl, and mercury

**Catalytic ceramic filters**
- Particulate and NOx and/or Cement O-HAPS, CO
- Particulate and any combination of SO2, SO3, HCl, and mercury; plus NOx, Cement O-HAPS, CO
Total Emissions solutions for Particulate and Non-Particulate fossil fuels

- New cost efficient solution for removing gas emission along with and without particulate matter
- Saves up to 80% on CAPEX compared to existing technology solutions
- Saves operational cost (OPEX) compared to existing technology solutions
- Saves foot print of the total installation compared to existing technology solutions
- Removal of (separately or combined at the same time):
  - NOx
  - HAP (hazardous air pollutants)
  - VOC (volatile organic compounds)
  - CO
  - Dioxin and Furans
  - NH$_3$
  - Dust and particulate matter (PM)
Total Emission (particulate) - Catalytic Filter Bags

**CataFlex™ Catalytic filter bags**

- Each bag consist of three fabric impregnated layers with little impact to draft loss,
- High filtration efficiency,
- Filter bag up to 464 F (240 deg. C)
- Multiple pollution removal - VOC, CO, ammonia, DeNOx, SOx and others capable across one backend system,
- No poisoning of catalyst

Dimension: standard diameter, lengths up to 40 feet
Total Emission (particulate) - Catalytic Ceramic Filters

TopFrax™ Catalytic ceramic filters

• Each filter consist of a ceramic fiber based filter impregnated with a catalyst in the filter wall
• High filtration efficiency
• Up to 900 F depending on catalyst formulation
• Multiple pollution removal - VOC, CO, ammonia, DeNOx, SOx and others capable across one backend system.
• Long service life

Dimension: lengths up to 3 meter
Total Emissions (Natural Gas) - Dual Function NOx, CO reduction

CO-SCR

Compressor → Air

Turbine → Gas

CO catalyst

SCR catalyst

DNX GTC-802

SCR-CO

Compressor → Air

Turbine → Flue gas

Ammonia injection

SCR catalyst: CO catalyst

SCR-CO

Compressor → Air

Turbine → Flue gas

Ammonia injection

CD and SCR catalyst: Dual Function
Flex-kleen dust collector upgrades

• Flex-Kleen® will inspect existing the shell, hopper and dust handling equipment to assure they're in good repair and recommend replacement of components if necessary.
• Flexkleen will provide a detailed plan and project schedule that will insure completion of the installation with an absolute minimum of down time.
• Flexkleen will remove the existing internal components and install new Flex-Kleen® core-frames, manifolds headers and bag suspension hardware. It can also modify the top, by installing a walk-in clean air plenum, or lift-up doors. The Flex-Kleen® core, with more cloth area will, increase collection efficiency.
• The customer retains the hoppers, steel shell, duct-work, and all discharge mechanisms.
• Flexkleen will engineer the hook-up to the plant compressed air supply necessary to run the Flex-Kleen® pulse jet system. Flex-Kleen® will supply engineering and materials, plus erection supervision, if desired.
• At the 400 MW Big Stone power plant, Flexkleen replaced the precipitator internals with Flex Kleen bags. Pentair provided detailed analysis to insure that bag leaning efficiency would be maximized. Engineering skills were used to make a successful installation despite the space constraints.
Process optimization

• B&W MEGTEC’s experience in air handling, drying, heating, cooling, process and combustion control can help to improve the operating efficiency of a facility and maximize the performance of equipment.
• B&W MEGTEC can help improve operating efficiencies by analyzing current process energy usage and offer solutions to reduce energy consumption.
• Through this process, B&W MEGTEC can:
  • Maintain the equipment to manufacturer specifications
  • Understand the process and obtain baseline energy usage
  • Review the process to reduce airflow and temperature
  • Improve process interface dampers & controls to reduce system demand
  • Investigate energy funding programs and project ROI
  • Investigate system retrofits, controls upgrades, more efficient heat exchangers, new ceramic medias, replace obsolete components
  • Consider secondary heat recovery
  • Investigate potential replacement with new energy efficient system
Total Solutions Approach

• Engineering Solutions
  • Existing system process modeling and optimization
  • Capacity enhancements, improved efficiencies, enhanced on-line availability
  • Turn-key approach to engineering solutions which include complete new systems, fabrication of custom retrofit components, equipment upgrades and control modifications for all types of combustion, thermal treatment and air pollution control technologies
  • Worldwide offices and facilities with the ability to provide custom engineered solutions and systems tailored to the local requirements
  • Global engineering, fabrication, installation and aftermarket parts and service capabilities
Total Solutions Approach

- **Equipment and Systems Supply**
  - Custom engineered, fully integrated incineration and air pollution control systems
    - Thermal Oxidizers, Rotary Kilns, Wet, Dry, Electrostatic and NOx Reduction Air Pollution Control Technologies
    - Waste Heat Recovery and Electrical Generation Options
    - Product Recovery Systems – HCl, SiO², custom engineered alternative scrubbing fluids designed for recovery of specific gas stream components
  - Zero Liquid Discharge Systems
  - Proprietary Tower Packing Materials
Longking combines dry scrubber, scr, and DSI with brick making for multi-pollutant solution.
IAC RECIRCULATION SCRUBBER
SO2; SO3; HCL CONTROL WITH FOR DRY SORBENTS
SLIP STREAM DEMONSTRATION

NOTE:
- Lime Hydrate Injection before Flue Gas Cooling.
- Fresh and Recirculation Sorbents can be pneumatically or mechanically conveyed to Point of Use.
- Fresh Lime delivery by Super Sack.
- Cooling liquid can be done by adding water at the Paddle Mixer.
- Waste tray and convey system not illustrated.

<table>
<thead>
<tr>
<th>Design Fuel Analysis</th>
<th>Coal</th>
<th>Lime Hydrate Injection Upstream of Cooler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Input</td>
<td>6.5</td>
<td>Flow from Boiler Exit Stream 5.118 ACFM</td>
</tr>
<tr>
<td>Fuel HRV</td>
<td>10.62</td>
<td>Temperature 315 °F</td>
</tr>
<tr>
<td>S</td>
<td>3.05</td>
<td>Flow from Multicone 3.733 ACFM</td>
</tr>
<tr>
<td>H</td>
<td>3.10</td>
<td>Temperature 165 °F</td>
</tr>
<tr>
<td>N</td>
<td>1.99</td>
<td>Multicone Exit 36 Lb/HR</td>
</tr>
<tr>
<td>O</td>
<td>5.57</td>
<td>Flow (Gas) 212 Lb/HR</td>
</tr>
<tr>
<td>Ar</td>
<td>2.29</td>
<td>Fresh Hydrate 69 Lb/HR</td>
</tr>
<tr>
<td>N2O</td>
<td>4.5</td>
<td>Recirculation 4.768 Lb/HR</td>
</tr>
<tr>
<td>Ash</td>
<td>22.75</td>
<td>Total 5.097 Lb/HR</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>Mt. Outlet to Baghouse 235 Lb/HR</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reuse. Bin to Waste 63 Lb/HR</td>
</tr>
</tbody>
</table>

Inlet Flow: 3,733 ACFM
Temp: 165 F
Inlet: 255 Lb/HR
Loading: 7.64 Gr/ACF
Cloth Area: 1,015 Sq Ft
AV Ratio: 5.65 FPM
Dty of Bags: 64
Diame: 6.25 ins.
Length: 10 Ft
## Repair parts-Scrubber

<table>
<thead>
<tr>
<th>description</th>
<th>source</th>
<th>changing method of purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrubber nozzles</td>
<td>Nozzle supplier</td>
<td>Offer service and replacement contract and purchase and re-sell nozzles as part of contract</td>
</tr>
<tr>
<td>Scrubber packing</td>
<td>Packing supplier</td>
<td>Offer service and replacement contract and purchase and re-sell packing as part of contract</td>
</tr>
<tr>
<td>Scrubber valves and pumps</td>
<td>Valve and pump Suppliers and others</td>
<td>Offer service and replacement contract and use proprietary products where practical but develop good OEM relationships and partnerships</td>
</tr>
<tr>
<td>Scrubber fan parts</td>
<td>Fan supplier</td>
<td>Work up close partnership with one or two fan suppliers and obtain low prices and include as part of service contract</td>
</tr>
</tbody>
</table>
## Repair Parts – Scrubber -2

<table>
<thead>
<tr>
<th>component</th>
<th>sources</th>
<th>Changing the method of purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>instrumentation</td>
<td>Varied sources</td>
<td>Monitoring scrubber pressure drop, water flows, slurry concentration and gas emissions involves many different vendors.</td>
</tr>
<tr>
<td>Scrubber wastewater treatment</td>
<td>Varied sources</td>
<td>Replacement filter media, belts, agitator parts, motors etc can be part of the contract</td>
</tr>
<tr>
<td>Reagents and reagent supply system</td>
<td>Reagent supplier such as Nalco</td>
<td>Reagents can generate more revenue than the original scrubber purchase over the lifetime of the system</td>
</tr>
</tbody>
</table>
Services in APC

• Inspection*
• Installation
• Troubleshooting
• Repair and replacement
• Rebuilds
• Fan balancing
• Equipment relocation
• Performance improvement
• Catalyst replacement
• Engineering studies
Montrose Environmental has compliance management solutions

**Permitting and compliance management**
- Agency negotiations and expert witness services
- Air toxic investigations associated with the Mercury and Air Toxics Rule (a.k.a. Utility MATC)
- Dispersion / air impact and accidental release modeling
- Emission factor development, emission inventories and toxic release inventory (TRI)
- Environmental Management and Compliance Systems and Audits
- Expertise in use of Selective Catalytic Reduction (SCR) for NO\textsubscript{x} emission control
- Health risk and technology assessments
- Regulatory applicability determinations, investigation of control technology alternatives, and development of most efficient permitting strategies.

**Stack testing**
- Continuous Emissions Monitoring (CEM), Relative Accuracy Test Audit (RATA), Calibration Gas Audits (CGA), Quarterly Relative Accuracy Audits (RAA), and Linearity 40 CFR Parts 60 and 75
- Control equipment performance guarantee testing
- Mercury controls and compliance testing
- Particulate size distribution evaluations
- SCR tuning and optimization
- Ultra-Low Emission Measurements for NO\textsubscript{x}, Particulate Matter and HAPs
- Complete US EPA Reference Method Capabilities

**Laboratory Services**
- Air Analysis
- Organic Analysis
- Metal Analysis
- Microbiology Analysis
- Wet Chemistry Analysis
- Food Analysis
- Soil, Water, Hazardous Waste Analysis
- Fish-Bioassay Analysis
- Radiochemistry, Aquatic Toxicity, Tobacco

**Ambient monitoring, LDAR, Remote monitoring**
- Leak detection
- Fence-line monitoring
- FTIR remote
- Ambient sampling stations
Sulzer has a whole suite of flow control and treatment products including the SCR ammonia mixer.