Total Solutions
Hot Topic Hour August 20

Foundation for hot topic hour revised
August 13, 2015
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 for operators.
• There are many partial solutions as well as total. Each needs to be evaluated.
## 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>
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<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>
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<tr>
<td>Safety</td>
<td>Explosive gases</td>
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<tr>
<td>health</td>
<td>Semiconductor toxic fumes</td>
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<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>
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## Total Solution Options

<table>
<thead>
<tr>
<th>Options</th>
<th>example</th>
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<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>Megtecs 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>
</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.
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%.
Marsulex will furnish SO2 removal system for a fee based on tons of SO2 captured

• In the Ammonia Sulfate (AS) process, the absorption of SO\textsubscript{2} is accomplished with either anhydrous or aqueous ammonia and converts the captured SO\textsubscript{2} into a high value crop fertilizer.

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

• 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.
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 CECO to advise on reagent adjustments to the scrubber to 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. Flex-Kleen example where the size of the existing collector was doubled has been provided.
- CEMS monitoring. The results are generated continuously and provide a basis for CECO 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. The experts to help CECO do this is already known to Jeff Lang.
### 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>
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<tbody>
<tr>
<td>Raw materials</td>
<td></td>
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<td>Operations (incl. responsibility for production output)</td>
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<td>Plant maintenance</td>
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<td>Technical management</td>
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<td>Employees (recruitment, payroll and management)</td>
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<tr>
<td>Training and development of local staff</td>
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<tr>
<td>Office, warehouse and canteen facilities</td>
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<td>Office equipment (incl. computer hardware and software)</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>
<td></td>
<td></td>
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<td>Utilities (power, fuel and water)</td>
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<tr>
<td>Security (guards, equipment, fencing, etc.)</td>
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<td></td>
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<tr>
<td>Plant, property, liability and equipment insurance</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
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.
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 manufacturers 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
# 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. Lots of time is saved by the purchaser if CECO coordinates it all</td>
</tr>
<tr>
<td>Scrubber wastewater</td>
<td>CECO /others</td>
<td>Replacement filter media, belts, agitator parts, motors etc can be part of the contract</td>
</tr>
<tr>
<td>treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reagents and reagent</td>
<td>Reagent supplier such as</td>
<td>Why let Nalco turn around and buy basic chemicals and package them as tailored reagents for scrubbers. CECO can buy from the basic chemicals companies such as Kemira and supply the reagents and treatment. Reagents can generate more revenue than the original scrubber purchase over the lifetime of the system</td>
</tr>
<tr>
<td>supply system</td>
<td>Nalco</td>
<td></td>
</tr>
</tbody>
</table>
Services in APC

- Inspection*
- Installation
- Troubleshooting
- Repair and replacement
- Rebuilds
- Fan balancing
- Equipment relocation
- Performance improvement
- Catalyst replacement
- Engineering studies
CONDENSING BOILER OPERATION

SO₂ Conversion > 80%

2,700°F

Convection sections & economizer

Furnace

FSI

Coal Feed

CaO

CaCO₃

SO₂

Ca(OH)₂

DSI

750°F

Ammonia injection

catalytic hot gas filter

SO₂ < 1%

SO₃ < 1 ppm

320°F

< 150°F

Boiler feed water

Air preheater & HRSG

Ash removal

to stack

CaO

Ca(OH)₂

CaSO₃
Longking combines dry scrubber, scr, and DSI with brick making for multi-pollutant solution.
Complex system designs can include unique alternatives such as splitting particulate collection into two devices.

Possible Alternative = WFGD + Wet ESP