Solutions for Energy Savings & Environmental Compliance Leading to Cleaner & Lower Cost Production

Arun J. Basu
JNE Consulting Ltd.
Hamilton, ON, Canada
e-mail: abasu@jne.ca

Vivek B. Dutta
JNE Group - Energy and Environment
Cupertino, CA, USA
e-mail: vdutta@jne.ca
Presentation Outline

- Background (Rationale for this work)
- Current Industry Scenario & Key Issue
- Engineering solutions
- Industry in Focus & Applications
- Methodology with Examples (Case Studies)
- Typical Results & Benefit
- Concluding Remarks
Cleaner Production in terms of Sustainable Development Framework
POSITIVE Proof of Global Warning

DO YOU WANT TO SEE YOUR KIDS THERE?


Engineering Solutions for Tomorrow’s Problems
Current Industry Scenario

MAJOR CONTRIBUTORS TO GLOBAL WARMING:

- Petroleum & Coal
- USA & Canada
Energy Initiatives

Alternate Energy
- Solar
- Wind
- Bio-Fuel
- Fuel Cells

Conventional Energy
- Management
- Conservation
- Efficiency
- Storage
Conflicting Issues in Heavy Industry

• “Conventional Dirty Manufacturing” is linked with
  ► Old Technology
  ► Inefficient (i.e. higher) Energy usage
  ► Poor Environment & Health conditions

• Developed countries have already accumulated wealth using conventional practice

• Global Competition & Quick ROI are discouraging Corporations to go environmentally friendly
Industry Challenges

1. Energy Conservation and Operational Efficiency
   “Higher Productivity while consuming lesser energy”

2. Health and Safety – Noise Pollution
   “Restraining existing power and process plants”

3. Environmental Compliance
   “Plant modernization with constraint capital budget”

Smart Energy Management
Engineering Solution

• Energy Savings:
  – Identify areas with air as process media for immediate application
  – Lowering system resistance of the plant draft (air / flue gas) systems including flow through pollution prevention equipment
    • Primarily forced draft and induced draft fan systems
    • ESPs, Baghouses, Scrubbers

• Improve Environment & Health:
  – Noise and Vibration reduction (airflow induced)
Energy Savings Approach

- Noise and Vibration are indications of turbulent airflow and wasted energy.
- Uses “aero-acoustics” optimization techniques while integrating aerodynamics with fluid mechanics to manage air flow and minimize turbulence.
- Experience & knowledge in the area of air/gas flow behavior, fan operations & discharge profiles are used to retrofit & upgrade Legacy Programs, resulting in smoother flow.
- End result is reduced energy consumption, noise attenuation and minimize vibration in manufacturing environment, while maintaining similar productivity.

Helping in Global Energy Conservation
Energy Savings & Cleaner Production

- **Savings** in kWh is obtained by
  - Optimization and lowering system resistance of a fan or pump system (industrial operations), where process media is air or flue gases
  - **Focusing on energy savings and noise attenuation in fan systems**, handling air (fresh or exhaust) and flue gas
  - *Energy savings (e.g., consumption of less fuel) through process optimization is beyond the scope of this paper*
Energy Guzzling Industries Served

- Iron & Steel
- Power Plants
- Refineries
- Tunneling
- Cement
- Mine Ventilation
- Other Industries handling mass Air & Gas flow

Energy Efficient Industry.........A global challenge
Application Areas

Industrial Operations with air as process media and flue gas cleaning

- Power Plants (FD and ID fan systems including ESPs, Bag Houses, FGDs)
- Steel Plants (Primarily ID fan systems including ESPs and Bag Houses, captive power plants)
- Refineries (cooling tower fan systems, captive power plant)
Application Areas (....continued)

Infrastructure related (Health and Safety) is of primary interest, e.g., airflow requirement is governed by

1. keeping methane level diluted enough to have no explosions in gassy mines, and
2. keeping diesel emission diluted for safe working in metal mines and tunnel construction (100 cfm per bhp)

- Mine ventilation (intake and exhaust fan systems on surface and auxiliary fans underground)
- Tunnel ventilation (during development and also permanent ventilation)
Power Plants

Typical Air/Gas Flow Schematic in a Coal Fired Power Plant

- Potential areas of application

SCAH – Steam Coil Air Heater
ESP – Electrostatic Precipitator
FGD – Flue Gas Desulfurization
Steel Plants

Potential areas of application
Basic Oxygen Furnace
(A key area for energy conservation)

Typical area of improvement in airflow conditions
Impact on CO₂ emission

- **Savings** in kWh ➔ **Reduction** in CO₂ emission

### STEEL INDUSTRY
Energy & Eqv. CO₂ Factors

<table>
<thead>
<tr>
<th>Energy/Carbon Source</th>
<th>Energy Value</th>
<th>CO₂ Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler or Steam Coal</td>
<td>25 million BTU/ton</td>
<td>5.130 lb/ton</td>
</tr>
<tr>
<td>Coking or BF Injection Coal</td>
<td>27 million BTU/ton</td>
<td>5.540 lb/ton</td>
</tr>
<tr>
<td>Coke</td>
<td>26 million BTU/ton</td>
<td>6.580 lb/ton</td>
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<tr>
<td>EAF Charge or Insected Carbon</td>
<td>26 million BTU/ton</td>
<td>5.540 lb/ton</td>
</tr>
<tr>
<td>No. 6 Fuel Oil</td>
<td>150,000 BTU/gal</td>
<td>26 lb/gal</td>
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<tr>
<td>Distillate/Diesel Oil</td>
<td>140,000 BTU/gal</td>
<td>22 lb/gal</td>
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<tr>
<td>Gasoline</td>
<td>124,000 BTU/gal</td>
<td>19 lb/gal</td>
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<tr>
<td>Light Oil</td>
<td>140,000 BTU/gal</td>
<td>26 lb/gal</td>
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<tr>
<td>Tar</td>
<td>160,000 BTU/gal</td>
<td>35 lb/gal</td>
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<tr>
<td>Liquefied Petroleum Gas</td>
<td>90,000 BTU/gal</td>
<td>12 lb/gal</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1,000 BTU/ cu ft</td>
<td>0.12 lb/ cu ft</td>
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<tr>
<td>Blast Furnace Gas</td>
<td>90 BTU/ cu ft</td>
<td>0.044 lb/ cu ft</td>
</tr>
<tr>
<td>Coke Oven Gas</td>
<td>500 BTU/ cu ft</td>
<td>0.048 lb/ cu ft</td>
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<tr>
<td>Steam (coal basis)</td>
<td>1,000 BTU</td>
<td>0.06 lb/ton</td>
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<tr>
<td>Electricity (U.S. grid basis)</td>
<td>3,413 BTU/kwh</td>
<td>1.4 lb/kwh</td>
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<tr>
<td>Limestone (12% C)</td>
<td>---</td>
<td>880 lb/ton</td>
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<tr>
<td>Raw Dolomite (12.8% C)</td>
<td>---</td>
<td>940 lb/ton</td>
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<tr>
<td>Carbon Electrodes (99% C)</td>
<td>---</td>
<td>7,260 lb/ton</td>
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<tr>
<td>Pig Iron (4% C)</td>
<td>---</td>
<td>290 lb/ton</td>
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<tr>
<td>DR1 or HBI (5% C)</td>
<td>---</td>
<td>145 lb/ton</td>
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<tr>
<td>Iron Carbide (6.5% C)</td>
<td>---</td>
<td>480 lb/ton</td>
</tr>
<tr>
<td>Carbon Steel (0.04% C)</td>
<td>---</td>
<td>0.0015 lb/ton</td>
</tr>
</tbody>
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#### ELECTRICITY
(U.S. grid basis)

- **3,413 BTU/kwh** ➔ **1.4 lb/kwh**

#### Energy Source

- **Coal**
  - Energy Value: 104 million BTU/ton
  - CO₂ Factor: 22.79 lb/ton

- **BF Gas**
  - Energy Value: 90 BTU/ cu ft.
  - CO₂ Factor: 0.044 lb/ cu ft.

**REF:**
American Iron and Steel Institute: *Principles for a Steel Industry...*
www.climatevision.gov/sectors/steel/pdfs/qhg_protocol.pdf
Examples:
Airflow Improvement for Energy Savings and Noise & Vibration Reduction

Duct Optimization and Fan Inlet & Outlet Condition Modification
Plant Draft System Components: Fans

- Primary Air mover for combustion and exhaust of flue gas through a series of pollution prevention equipment

- Types – Axial and Centrifugal

- Usage
  - Force Draft (FD) – to push air or gases
  - Induced Draft (ID) – to extract the gaseous products
  - Primary Air (PA) – to mix air + solid particles

Design and engineering for reducing air/gas flow resistances, allowing either more air/gas handling capacity (increased generation) or reducing energy loss through the system
Fan performance enhancement improves performance of all key PP equipment (e.g., SCR, FGD, and ESP) including boiler and stack efficiencies.
Example: Axial Fan
Fan (inlet) – Duct – Silencer Interaction

Before

After
Example: ID Fan and duct optimization (Fan outlet to ESP Inlet)

**BEFORE**
Base Case model showing non-uniform airflow and flow separation

**AFTER**
Recommended Solution showing airflow with less turbulence and more uniform velocity distribution
Examples: Duct optimization
Typical Estimated Benefits of Applying CFD Simulated Engineering Optimization

- Performance Improvement of the Pollution & emission control Equipment......10+%  
  - Clean Environment with Carbon Credit
- Noise control Reduction......30+ dBA
- Fan systems Energy efficiency......25%
- Increase power & process units combustibility.......3+%  
- Operational & maintenance Improvements:
  - Higher productivity  
  - Lower wear & tear
- Carbon Credit

Results based on Technology Implementation
Concluding Remarks

- Energy efficient manufacturing has been achieved in existing heavy industry, leading to “cleaner production”.
- Use of aerodynamics with fluid mechanics to optimization and manage air flow, while minimizing turbulence has been demonstrated as successfully engineering solutions.
- CFD simulation is used as diagnostic tool for smart design and energy conservation.
- Besides the ongoing efforts with alternate energy, smart management of conventional energy could further contribute to eco-friendly world.