Compressed Air Assessment Basics
Housekeeping

• Please Mute your Telephone or Mic
  – Use Grab Bar or manual button on your handset
  – Do Not Use “HOLD”

• For better connectivity
  – Remove wireless devices from viewing area
  – Close unnecessary applications

• Training is being recorded
• Slides will be provided
• Course evaluation = 2 PDHs
• Federal Energy Management Program (FEMP) Headquarters Sponsor
  – Technology Deployment
  – Data Center Energy Efficiency
  – Labs21 (Laboratories for the 21st Century)
  – Water Efficiency
  – New Technologies
  – Sustainability

The Office of Energy Efficiency and Renewable Energy (EERE) works to strengthen the United States' energy security, environmental quality, and economic vitality in public-private partnerships.

http://www.eere.energy.gov/
It supports this goal through:

- Enhancing energy efficiency and productivity;
- Bringing clean, reliable and affordable energy technologies to the marketplace; and
- Making a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life.
Program collaboration

• Federal Energy Management Program
  • Technology Deployment Program
    – Technical Assistance
    – Training Opportunities
    – For More Information
      » http://www1.eere.energy.gov/femp/program/industrial_facilities.html
      » Thomas Wenning, wenningtj@ornl.gov, 865-241-8676

• Industrial Technologies Program
  • BestPractices
    – R&D for industrial sector energy efficiency technologies
    – Technical Publications
    – Software Tools
    – For More Information
      » http://www1.eere.energy.gov/industry/bestpractices/index.html
Facilitate the Federal Government’s implementation of sound, cost-effective energy management & investment practices to enhance the nation’s energy security & environmental stewardship
Stewardship is required and smart

• Industrial motor systems:
  – Are the *single largest electrical end use* category in the American economy
  – Account for 25% of U.S. electrical sales

• Over 60% of that electricity goes to fluid handling

http://www1.eere.energy.gov/femp/regulations/regulations.html
Today

- Look at how we get started on the path to savings
  - Major components of an assessment
  - A useful tool to help quantify potential savings
    - AirMaster+
    - LogTool
Tom Taranto – Data Power Services

- Qualified AirMaster+ Compressed Air Assessment Tool (AirMaster+) Specialist
- Teaches 1-day end-user AirMaster+ Workshop
- Co-instructs 3-day Qualified Specialist Workshop
- Does plant assessments for the Save Energy Now program

Contact Information:
- TomTar@aol.com
- 315-635-1895
Industrial Facilities Initiative
Compressed Air System Assessment Basics
Featuring the AIRMaster+ Software Tool
Technical Topics Agenda

• Overview – Why it’s Important
• Planning for the Assessment
• Baseline Measurement
• Compressed Air Energy Opportunities
• Software Tool – LogTool
• Software Tool – AIRMaster+
• Case Study
Why it’s Important: Cost of Ownership

- Equipment cost and maintenance cost represent only a small part of the total cost of operating a compressed air system.

- Electrical cost usually exceeds 75% of the total operating expense.
Why it’s Important: Energy Flow

- **Energy Input**: 100 kW
- **5% Motor and Drive Efficiency**
- **80% Heat of Compression**
- **5% to 10% Waste**: Irrecoverable Pressure Loss, Leakage, Artificial Demand, Inappropriate Use
- **10% to 5% Productive use**
Why it’s Important: Reported Air System Problems

Percent of Plants Reporting the Problem

Type of Problem

- Don't Know
- No Problem
- Low System Pressure
- Low Local Pressure
- Oil in the Air
- Plugging Filters
- Water in the Air

Why it’s Important: Reported Air System Problems

15 | Federal Energy Management Program (FEMP)
eere.energy.gov
Planning for the Assessment

1. System Approach
2. Block Diagrams
3. Key Issues
4. Energy Costs/ Assessment Costs
Systems Approach

plant efficiency: energy \(\Rightarrow\) product

- **Energy**
  - Supply
    - Compressors
    - Filters / Dryers
    - Piping
    - Primary Storage
  - Power House / Compressor Room
  - Producers of Compressed Air
  - Produce Compressed Air More Efficiently

- **Transmission**
  - Pipelines
  - Filters / Dryers
  - Secondary Storage
  - Eliminate Irreversible Pressure Loss

- **Product**
  - Demand
    - Machines / Process
    - Point of Use Piping
    - Filters / Dryers
    - Storage Tanks
  - Manufacturing Plant / Production Floor
  - Consumers of Compressed Air
  - Consume Less Compressed Air

- **Total Energy Reduction**
• Graphic representation of compressed air system and the relationship of individual components
Key Issues

• Gather pre-assessment information
  – Block Diagrams
  – Compressor Information
    • Rating (flow & pressure), Horsepower, Operating Hours
  – Estimate of annual energy use
  – Review end use applications
    • Potentially inappropriate use of compressed air
    • Perceived high pressure applications
    • High volume intermittent applications
    • Largest compressed air energy uses
  – Compressed air related problems
    • Low air pressure
    • Water in the compressed air
    • Unreliable operation
Baseline Measurement

- Measurement Plan
- Identify Opportunities

![Diagram showing baseline measurement and power usage over time with labels for cycling with 1000 gal and 2000 gal, and time in seconds from 0 to 300.](image-url)
Compressed Air Energy Opportunities

1. Produce Compressed Air More Efficiently
   • Control Strategy

2. Eliminate Irrecoverable Pressure Loss
   • Reducing System Pressure
   • Pressure Profile

3. Consume Less Compressed Air
   • Leakage,
   • Artificial Demand
   • Inappropriate Use
Control Strategies

Source: Compressed Air Challenge®
Rules of Thumb for Relating Discharge Pressure to Energy Consumption

For systems in the 100 psig range, for every 2 psi increase in discharge pressure, energy consumption will increase by approximately 1 percent at full output flow (check performance curves for centrifugal and two-stage lubricant injected rotary screw compressors).

There is also another penalty for higher-than-needed pressure. Raising the compressor discharge pressure increases the demand of every unregulated usage, including leaks, open blowing, etc.

Although it varies by plant, unregulated usage is commonly as high as 30-50% of air demand. For systems in the 100 psig range with 30%-50% unregulated usage, a 2 psi increase in header pressure will increase energy consumption by about another 0.6-1.0 percent, because of the additional unregulated air being consumed (in the worst-case scenario, the extra flow could cause another compressor to start).

The combined effect results in a total increase in energy consumption of about 1.6 to 2 percent for every 2 psi increase in discharge pressure for a system in the 100 psig range with 30-50 unregulated usage.
Simple Pressure Profile

- Pressure profiles describe the system’s operating pressure from the supply to end use applications.

- Pressure profiles are created by taking a group of pressure measurements at key points throughout the system.

- Key points to measure pressure might include, the compressor discharge, upstream and downstream of treatment equipment, in the distribution piping, and at selected end use applications.
The combined effect results in a total increase in energy consumption of about 1.6 to 2 percent for every 2 psi increase in discharge pressure for a system in the 100 psig range with 30-50 unregulated usage.
GOT PRESSURE?
Irrecoverable Pressure Loss

GOT HOSES?
Compressed Air Waste

Leakage - Compressed air leaks exist in every compressed air system. It is not unusual for 25% to 35% of compressed air produced to be wasted to leakage. In some systems leakage is 50% or more of the air produced.

Artificial Demand - Artificial demand is the increased compressed air consumption of the system due to operating at higher than necessary operating pressure. Unregulated compressed air use; leakage, blowing applications, tools, air motors, pneumatic cylinders all consume more compressed airflow as system pressure increases. Air demand increases by 2% for each 2 psi increase.

Inappropriate Use of Compressed Air - Inappropriate use of compressed air is any use of compressed air that is wasteful; or use of compressed air where there is an alternative, more efficient, method or energy source that can be used to accomplish the production task.
Condensate Drainage Wastes Compressed Air
Potentially Inappropriate Use of Compressed Air

- Personnel Cleaning Station w/ Low Pressure Blower
  - Replaces compressed air hose previously used

- Air motors driving ink pumps
  - Latex ink no longer requires explosion proof construction
Potentially Inappropriate Use of Compressed Air

- Lime Tank Sparging w/ Compressed Air
  - Replace with a Low Pressure blower

- HP Blowing Tubes – vs – LP Blower
  - Reduction of Eye Injuries from Flying Debris
Look from the System Level Approach

- Improve Compressor Control
- Reduce System Pressure
- Reduce Air Demand
Quantifying Opportunities – Tools to Help

• Software Tool – AIRMaster+
  – Baseline Measurement & Annual energy use
  – EEM’s (energy efficiency measures) and savings

• Software Tool – LogTool
  – Charting trend performance
  – Assess dynamics, and Compressor Control Response
  – Daily System Profiles Define Day Types
AIRMaster+ a Windows based software tool used to model and analyze industrial compressed air systems:

- Measure / Calculate Annual Baseline Energy & Cost
- Input 24-hour metered airflow or power data
- Assign electrical utility energy schedules
- Simulate compressed air system operation
- Model system operation at various loads
- Estimate Savings of Energy Efficiency Measures
- Is not a substitute for an experienced auditor!
AIRMaster+
System Profile – Data
AIRMaster+
System Profile – Power (kW)
1. Reduce Air Leaks
2. Improve End Use Efficiency
3. Reduce System Air Pressure
4. Use Unloading Controls Adjust Cascading Set Points
5. Use Automatic Sequencer
6. Reduce Run Time
7. Add Primary Receiver Volume
LogTool v2

- LogTool is a public domain tool available from SBW Consulting, Inc.
  - Import data from different types of data loggers
  - Display trend plots with one or two Y axes
  - Assist in the analysis of compressed system performance measurements
  - Display DayType plots
  - A companion tool for AIRMaster+, also available from the Compressed Air Challenge
The import screen gives you tools to import data from different types of data loggers.
Select Channels to Plot
Create Day Types for AIRMaster+ System Profile
View DayType Profiles in Excel
We will step through:

1. Pre-assessment info
   • Plant Background
   • System/Plant Layout
   • System Issues

2. Demo of AirMaster+

3. Demo of LogTool v2

Note: Case demo is based on a real plant assessment
The plant produces cutting edge products made from synthetic materials that add functional advantage when compared to traditional materials.

The plant operates a highly automated manufacturing process; from the custom blending of resins, to extruding and compression molding sheets, to finishing and loading operations.

Products include highly engineered building materials using custom, proprietary, synthetic blends and user focused fabrication operations.

A streamlined and efficient manufacturing process permits flexible expansion to meet growing customer demands.

Present production operations at 40% of capacity.

Four production buildings

Eight air compressors supply three separate systems
Case Study: System Approach

- Systems engineering focuses on defining stakeholders’ needs and required system functionality early in the development cycle, documenting system requirements, and then proceeding with system design while considering the entire system. From energy input to air compressors to work performed in the production process.

  - Understand compressed air point of use as it supports critical plant production functions.
  - Correct existing poor performing applications and those that upset system operation.
  - Eliminate wasteful practices, leaks, artificial demand, and inappropriate use.
  - Create and maintain an energy balance between supply and demand.
  - Optimize compressed air energy storage and air compressor control.
Plant Site Plan

Bldg. 1

Bldg. 2

Bldg. 3

Bldg. 4

Silos

Blending

200 ft
Case Study: Building 1
Block Diagram

- Simple Diagram
- Major Components
- Significant End Use Applications
- TA = Test Amperage
- TP = Test Pressure
**Compressed Air System Assessment**

**Information from Facility Specialists** *(Appendix 1.2c.1-5)*

<table>
<thead>
<tr>
<th><strong>Comment on overall system operation, supply pressure, reliability, air quality, etc.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Operation:</strong> The compressors are old and worn. One 25 HP compressor is enough to run the presses and saw. When extruder 2 is started the 60 HP or 75 HP compressor needs to run. The air quality is fair. There has been moisture collecting in the unused air lines.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Describe routine operation of the compressed air related equipment that you work with.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal Operation:</strong> Normally the smallest air compressor that can run production is operated. The larger compressors are started based on demand.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>For the compressed air related equipment that you work with, what problems exist; how often does it happen? What is the impact on energy efficiency, performance, and reliability?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problems:</strong> Oil leaks on the old compressors have been the main problem in this building.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>How can the compressed air system best support production operations? Please identify specific operations, or pieces of equipment that are of concern.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supporting Production:</strong> There is little production in this building. Press 1 &amp; 4 run Monday to Thursday and the saw is only run on 2nd shift Monday to Friday. Extruder 2 runs only a few times a year. The GA 230 compressor should be replaced and new dedicated air lines run to the existing equipment.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Have there been problems in the past? What has been done to deal with the problems?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Historical Problems:</strong> Yes. There was a 125 HP compressor in use that was too large for the existing equipment on was short cycling causing excessive wear over heating and oil leaks. It was changed out for the 75 HP compressor.</td>
</tr>
</tbody>
</table>
Resources for More Information

• Visit the DOE BestPractices Web site:
  – www.eere.energy.gov/industry/bestpractices/

• Training Information & Calendar:
  – www.eere.energy.gov/industry/bestpractices/training_compressed_air.html
  – www.eere.energy.gov/industry/bestpractices/events_calendar.asp

• Download AIRMaster+ & LogTool:
  – www.eere.energy.gov/industry/bestpractices/software_airmaster.html

• Become a Qualified Specialist:
  – www.eere.energy.gov/industry/bestpractices/qualified_specialists/
FEMP’s GHG Emissions

• Inventory and Manage Greenhouse Gases
  – \textcolor{red}{http://www1.eere.energy.gov/femp/program/greenhousegases.html}
  – Assistance
    • Federal Requirements
    • Guidance
    • EPA’s Climate Leaders
    • Greenhouse Gas Protocol Initiative

• Federal Greenhouse Gas Accounting and Reporting - On Demand Training
  – \textcolor{red}{http://apps1.eere.energy.gov/femp/training/course_detail_ondemand.cfm?CourseId=14}
EPA’s Simplified GHG Emissions Calculator

EPA Climate Leaders Simplified GHG Emissions Calculator (SGEC)

This calculator is designed as a simplified calculation tool to help organizations in estimating their greenhouse gas (GHG) emissions for reporting to the EPA’s Climate Leaders program. All methodologies and default values provided are based on the most current Climate Leaders Greenhouse Gas Inventory Protocol guidance.

The calculator will determine the direct and indirect emissions from all sources at a company when activity data is entered into the various sections of the workbook.

Tool Instructions:
(A) Click on the grey boxes below to go to the appropriate Tool Sheet.
(B) Enter data in Tool Sheet in ORANGE cells only. Final GHG emissions will be provided in CO₂ equivalent emissions in BLUE or GREEN cells. If data is not known or applicable, leave default value (blank, zero or other) in cell.
(C) Enter data in appropriate units; if needed convert units prior to entering into tool.
(D) Guidance for each calculation method is provided in the references at bottom of each sheet.

<table>
<thead>
<tr>
<th>Tool Sheets</th>
<th>Direct 1.0</th>
<th>Direct 2.0</th>
<th>Direct 3.0</th>
<th>Direct 4.0</th>
<th>Direct 5.0</th>
<th>Indirect 1.0</th>
<th>Indirect 2.0</th>
<th>Optional 1.0</th>
<th>Optional 2.0</th>
<th>Optional 3.0</th>
<th>Conversion Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct Emissions from Stationary Combustion Sources - Traditional Sources</td>
<td>Direct Emissions from Mobile Sources</td>
<td>Direct Emissions from Refrigeration and Air Conditioning Equipment</td>
<td>Direct Emissions from Fire Suppression Equipment</td>
<td>Direct Emissions from Stationary Combustion Sources - Gas Waste Streams</td>
<td>Indirect Emissions from Purchase of Electricity</td>
<td>Indirect Emissions from Purchase of Steam</td>
<td>Optional Emissions from Business Travel</td>
<td>Optional Emissions from Employee Commuting</td>
<td>Optional Emissions from Product Transport</td>
<td>Useful Conversion Factors</td>
</tr>
</tbody>
</table>

EPA’s Carbon Footprint
http://www.epa.gov/climateleaders/smallbiz/footprint.html
EPA’s Simplified GHG Emissions Calculator - continued

• Free download at:
  – Excel-based
• Calculates equivalent Carbon Dioxide emissions
  – By region
• For Direct Combustion Sources
  – Stationary or Mobile Combustion
  – Refrigeration and Air Conditioning
  – Fire Suppression Equipment
  – Gas Waste Streams
• For Indirect Sources
  – Purchased Electricity, Fuels
• For Travel Activities
  – Transportation
Using the EPA Equivalent Tool…

- [http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results](http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results)
• Please visit FEMP's Greenhouse Gases website for additional resources to help you with your inventory and management of Greenhouse Gases.
  - [http://www1.eere.energy.gov/femp/program/greenhousegases.html](http://www1.eere.energy.gov/femp/program/greenhousegases.html)

• The EPA website is also a good resource for more information about Greenhouse Gas Emissions
  - [http://www.epa.gov/climatechange/emissions/index.html](http://www.epa.gov/climatechange/emissions/index.html)
For your Future Needs...

• FEMP’s Technology Deployment
  – Industrial Energy Resources and Training
    • http://www1.eere.energy.gov/femp/program/industrial_facilities.html
    • Thomas Wenning, wenningtj@ornl.gov, 865-241-8676

• ITP’s BestPractices
  – Technical Publications and Software Tools
    • http://www1.eere.energy.gov/industry/bestpractices/resources.html
Thanks for Attending!

• Slides will be Available
• Training Archived
• Course Evaluation for PDH Certificate

Questions?
Tom Taranto
TomTar@aol.com
315-635-1895