

AIR COMPRESSORS



AIR COMPRESSOR IMPROVEMENTS

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Save Energy Now Workshop

AIR COMPRESSORS



■ Types of Air Compressors

■ Rotary Screw (most common)

- Oil lubricant (or not)
- Most economical

■ Reciprocating (looks like an engine, pistons)

- Oil lubricant (or not)
- Low duty cycle (<50%)

■ Centrifugal (high hp)

- Impeller driven
- No lubricant

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■ System Components

- Air compressor: Motor, Air End, Coolant
- Control Panel: monitoring, set points
- Lubricant/Air Separator (oil contaminant)
- Dryer (desiccant or refrigerant)
- Air storage (receiver, piping, and end use)
- Filters and pressure regulators
- End use equipment (specifications)

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- **Features of Air Systems**
 - **80 to 85% of energy is output as heat**
 - **Higher hp motor is more efficient**
 - **Tend to be oversized for plant expansion**
 - **Roughly 4 cfm per hp rating**
 - **Air storage may be limiting**
 - **Short cycling of compressor**
 - **Leaks at major fittings or equipment**
 - **Employees think it is 'free' air**

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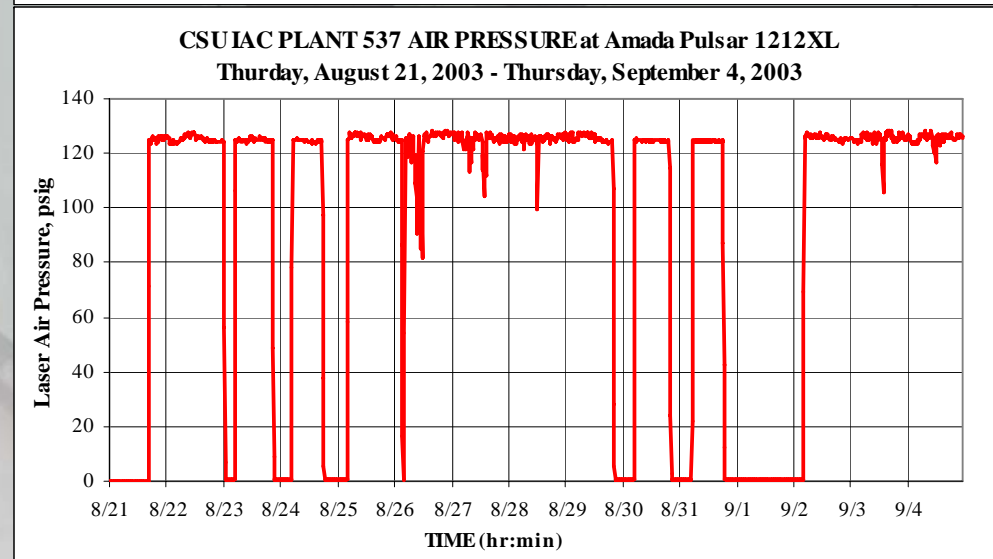
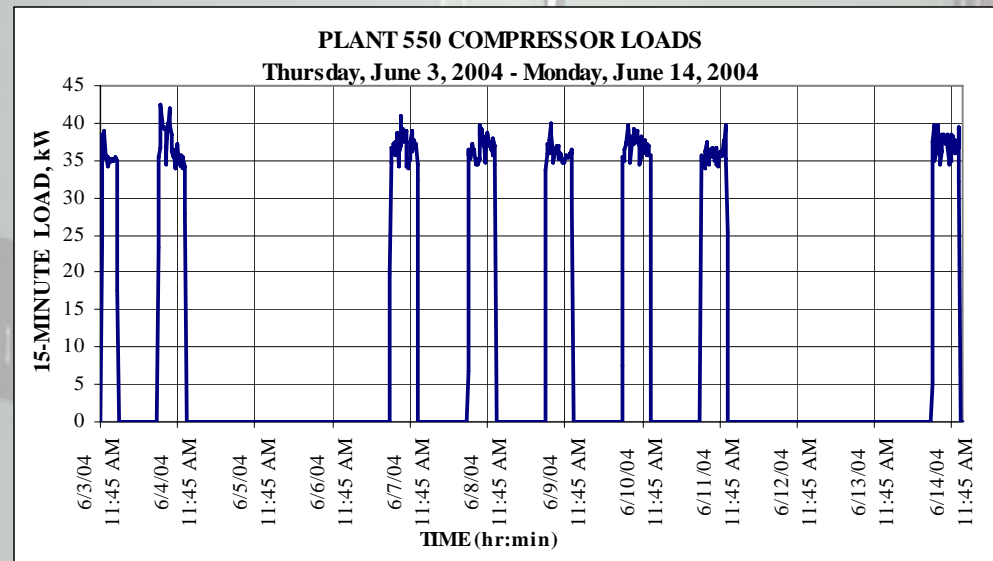


- **Typical System at a Plant**
 - **50 to 200 hp units; 24/5 or 24/7 hours**
 - **Primary unit and a backup unit**
 - **100 psig at the compressor**
 - **Air storage receiver (150 to 1,500 gal)**
 - **Lead/lag or modulating controls**
 - **One dryer (desiccant or refrigerant)**
 - **Vent to outside air (excess heat, inlet air)**
 - **20 to 30% hp lost to air leaks**

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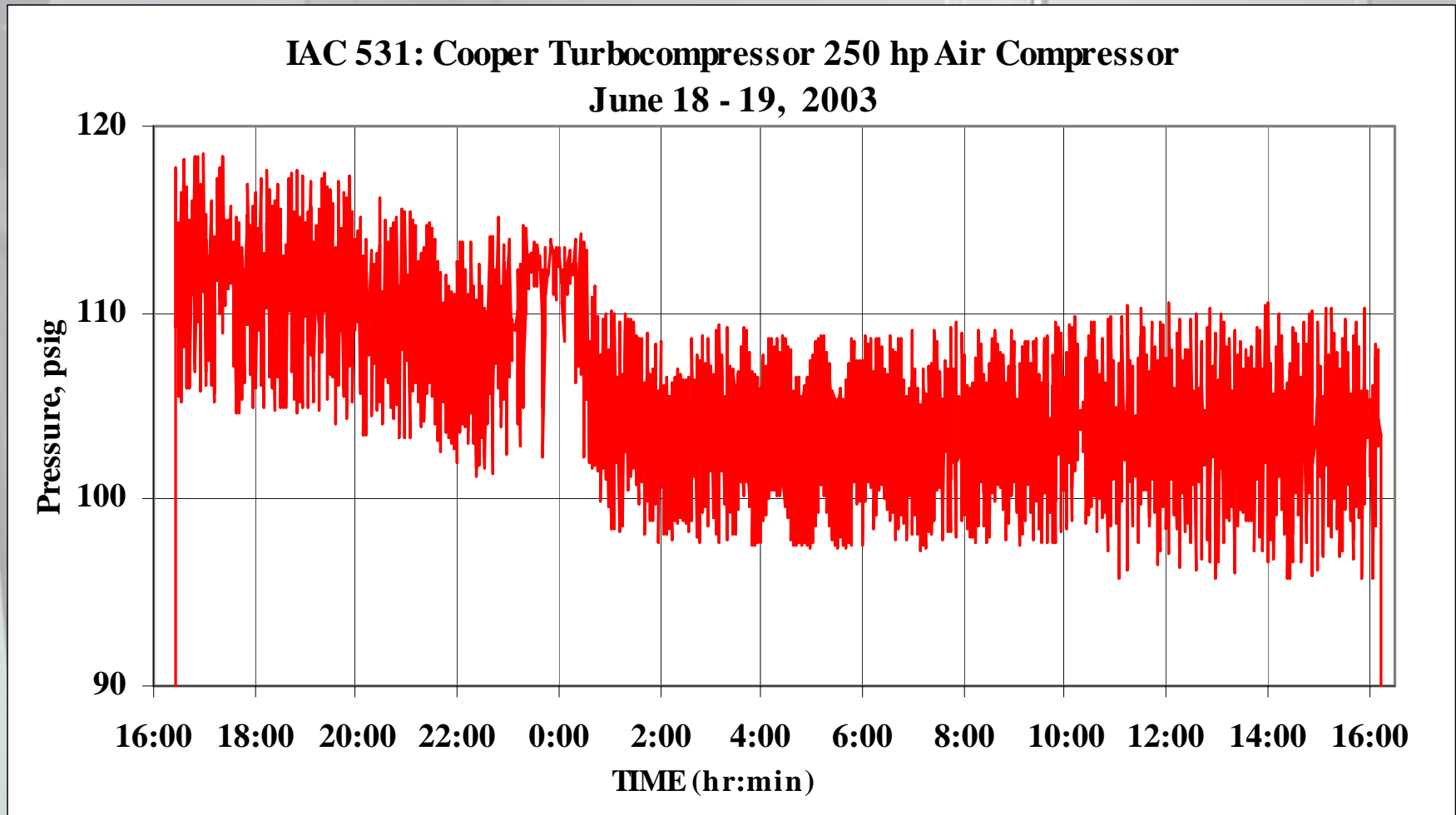
- Plant System Operation: Power Used
 - Operate with Production
 - Possibly shut off at night



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■ Pressure Variation



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- **Control Strategies: Systems Approach**
 - **Match supply with demand**
 - **Avoid short-cycling or blowing off excess**
 - **Individual compressor controls**
 - **Start/stop**
 - **Load/unload (not deliver air in unload)**
 - **Modulating match delivery to demand**
 - **Restrict inlet flow or vary controls**
 - **Variable frequency drive (VFD)**
 - **Reduce speed with low demand**

From: Compressed Air Tip Sheet #7

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- **Control Strategies: Systems Approach**
 - **Multiple compressor controls**
 - **Lead/lag: one compressor is primary**
 - **One fully loaded, others as trim**
 - **System master controller: coordinates all units**
 - **Monitor with trending data**
 - **Pressure/flow controllers**
 - **Separate supply from demand side**
 - **Requires storage**
 - **Deliver air at lowest stable pressure**

From: Compressed Air Tip Sheet #7

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- **Seven Step Action Plan**
 - **Basic Block Diagram**
 - **Measure baseline; calculate use and costs**
 - **Control strategy aided by specialist**
 - **Determine energy, pressures, and leak load**
 - **Schedule preventative maintenance (PM)**
 - **Fix inappropriate uses; adjust controls**
 - **Evaluate performance, inform management**

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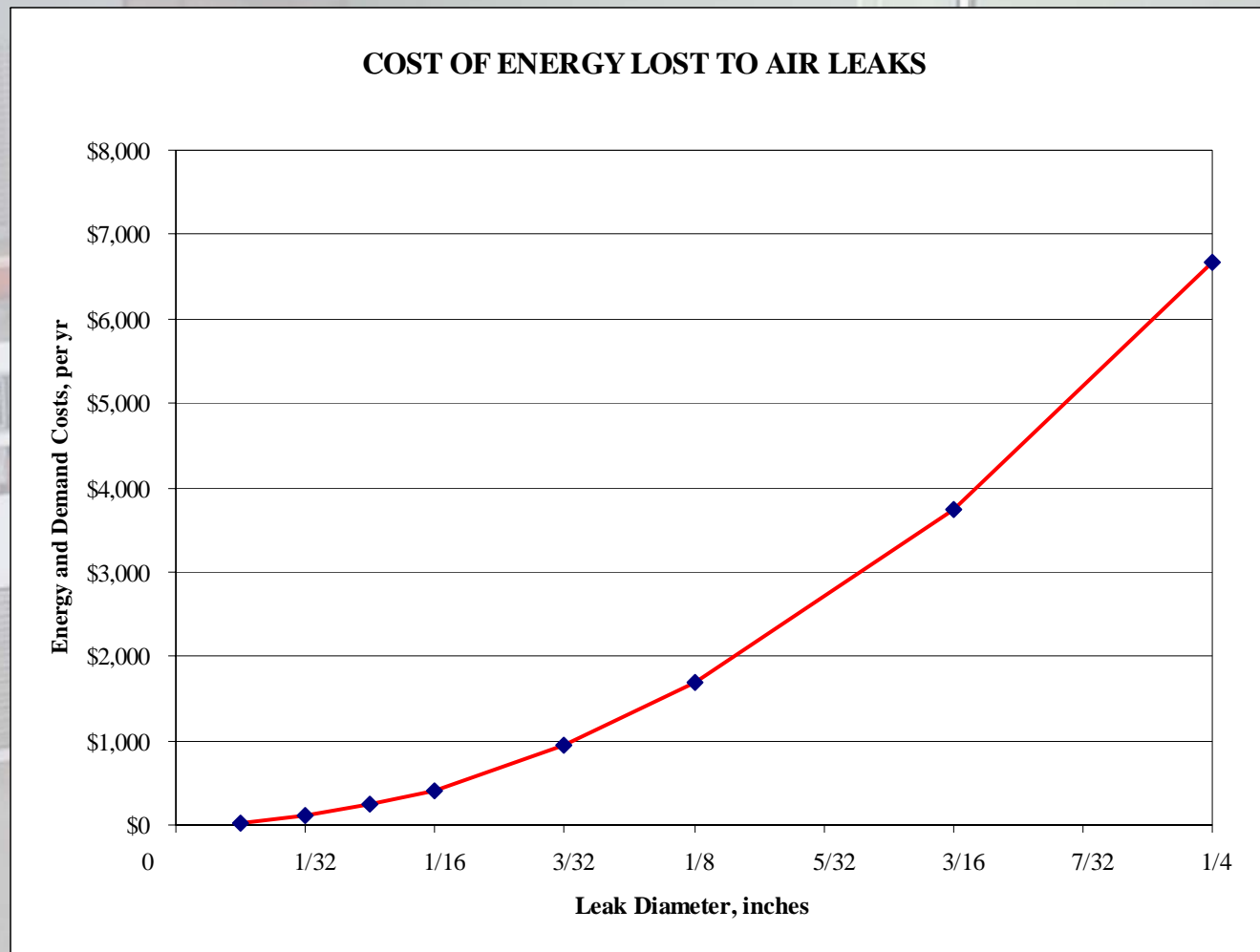


- **Top Recommendations**
 - **Repair Air Leaks**
 - **Shut Off Compressors When Not Needed**
 - **Install a Smaller Compressor**
 - **Use Waste Heat in Another Area**
 - **Use Outside Air for Inlet Air**
 - **Lower Pressure Set Points**
 - **Reduce Inappropriate Uses of Air**
 - **Install a VFD with Control System**

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■ Cost of Air Leaks vs. Hole Size



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- **Uses and Inappropriate Uses**
 - **Pneumatic controls**
 - **Electronic alternatives: microcontrollers**
 - **Equipment actuators**
 - **Electric or hydraulics**
 - **Blowers: lower pressure**
 - **Cooling cabinets or equipment**
 - **Blowers/fans use lower power**
 - **Blow off equipment vs. brushes**

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- **Uses and Inappropriate Uses**
 - **Fluid agitation**
 - Blowers usually as effective
 - **Vacuum creation**
 - Use an actual vacuum system
 - **Pneumatic tools: grinders, drills, wrenches**
 - Electric usually as effective, but heavier
 - Hazardous environment may use air vs. electric

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- **Preventative Maintenance**
 - **Periodic changes of filters/lubricants**
 - **Monitor pressure/power**
 - **Operate/test backup systems**
 - **Maintain dryer, separator, and storage**
 - **Check condensate drain traps**
 - **Repair air leaks; keep records**
 - **Manufacturer representative checkup**

From: Best Practices for Compressed Air Systems

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■ AIRMaster+ Software

- Objective performance assessment
- Model supply side and electrical demands
- Efficient and systematic approach
- Impact of potential changes
 - Control strategy
 - Adding air storage
 - Compressor replacement

from: **Best Practices for Compressed Air Systems**

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■ Summary

- Universal need for compressed air
- Major use of energy at most plants
- 20 to 30% hp lost to air leaks
- Preventative maintenance needed
- Uses and appropriate uses
- Control strategies influence efficiency

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- Questions?
 - Benefits of storage?
 - Air compressor energy efficiency?
 - Oil and condensate removal methods?
- Discussion...

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■ DOE Air Compressor Performance Tools

- Sourcebook available to help designers & operators improve air compressor system performance through better compressor selection and improved operation & maintenance practices.

- AIRMaster+ available on Save Energy Now CD



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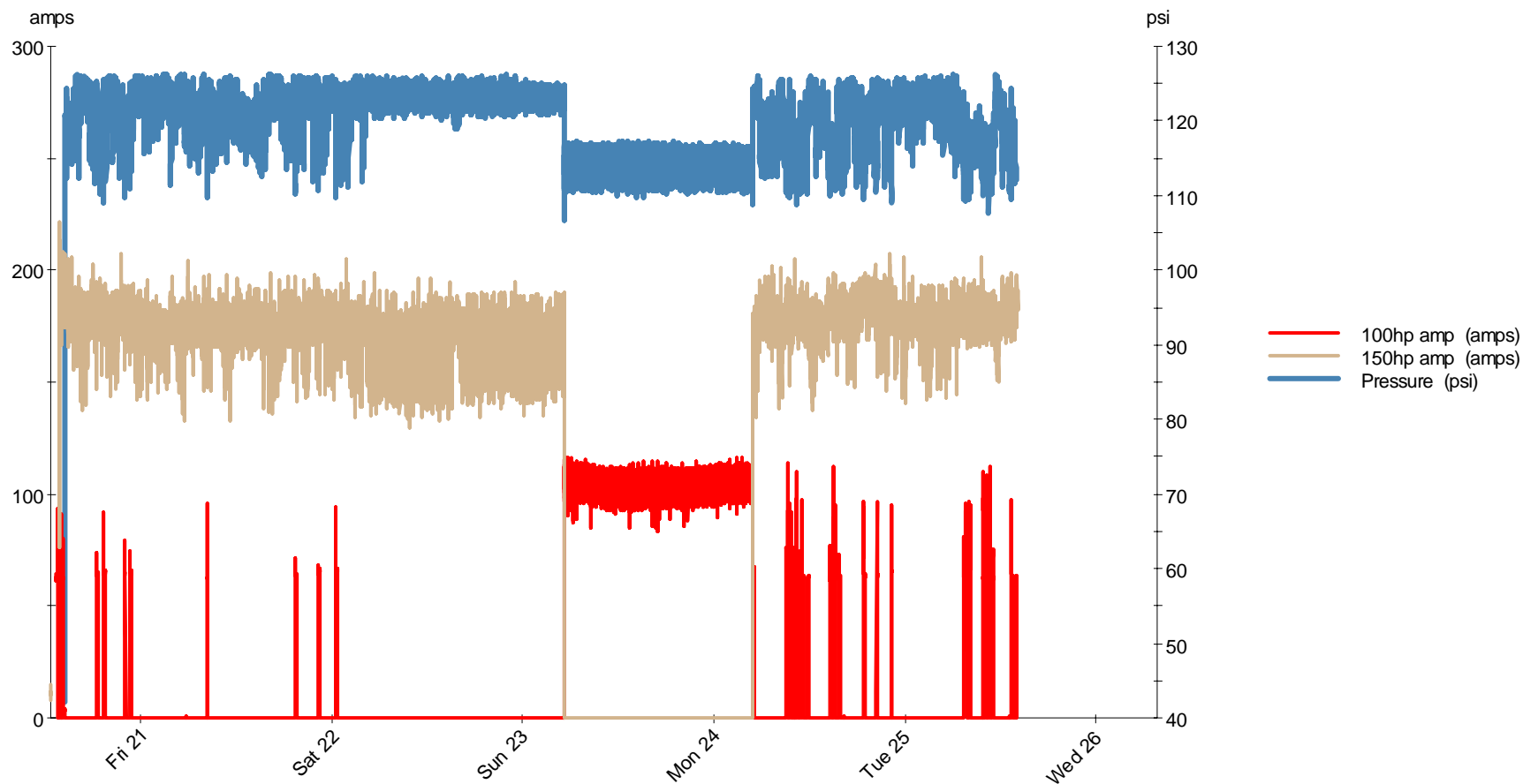


The screenshot displays the AIRMaster+ software interface. The window title is "AIRMaster+" and the menu bar includes "Inventory", "System Enhancements", "Calculators", and "Help". The main area has a teal background with the "AIRMaster+" logo at the top. Below the logo are two columns of buttons. The left column contains buttons for "Company", "Utility", "Facility", "System", "Compressor", and "Profile". The right column contains buttons for "Efficiency Measures", "Maintenance", "Catalog", "Life Cycle", "Print Data Input Forms", and "Exit". The "Efficiency Measures" button is highlighted in red. At the bottom of the window, the taskbar shows the file path "C:\DOCUMENTS AND SETTINGS\MICHAEL\DESKTOP", the version "Version 1.1.1", and the date and time "06/26/06 2:37 PM".

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Interval data (30 seconds) for System (Trim, Baseload, System) and Periods (Baseline)
4/20/2006 12:45:44 PM to 4/26/2006 7:39:04 AM



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System Profiles [Close]

File Calculators Help

[Pencil] [Floppy] [Print] [Help]

Select
 Facility: IAC_586
 System: Plant Air
 Daytype: Production
 System pressure control range: 111.0 - 125.0 psig

Data Entry | Profile Summary | Totals

Cascade Order - click cell to toggle stage#/'off' [Copy Prev Col] [Graph]

Compressor	1	2	3	4	5	6	7	8	9	10
Main compressor	1	1	1	1	1	1	1	1	1	1
Trim compressor	2	2	2	2	2	2	2	2	2	2

Profile data type: Volts/Amps [Paste From Clipboard] [Copy Prev Col] [Graph]

Compressor	Units	1	2	3	4	5	6	7	8	9	10
Main compressor	Volts	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0
	Amps	175.2	177.4	173.0	173.5	173.5	170.3	173.8	172.4	171.3	171.3
Trim compressor	Volts	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0	460.0
	Amps	4.0	0.3	0.3	0.3	0.3	0.3	0.3	7.6	8.3	

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■ Partial Hourly Results – Production Days

150 hp Base Load				
Calc Power, kW	120.8	122.3	119.3	119.6
Calc Airflow, acfm	664	664	664	664
Calc %Capacity	100	100	100	100
Cascade #	1	1	1	1
100 hp Trim				
Calc Power, kW	0.8	0.1	0.1	0.1
Calc Airflow, acfm	4	0	0	0
Calc %Capacity	0.9	0.1	0.1	0.1
Cascade #	2	2	2	2
Total				
Total Power, kW	121.6	122.3	119.3	119.6
Total Airflow, acfm	668	664	664	664
% System Capacity	60.2	59.9	59.9	59.9

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Partial Hourly Results – Non-Production Days

150 hp Base Load				
Calc Power, kW	0	0	0	0
Calc Airflow, acfm	0	0	0	0
Calc %Capacity	0	0	0	0
Cascade #	0	0	0	0
100 hp Trim				
Calc Power, kW	74.1	74.3	74.6	74.8
Calc Airflow, acfm	377	379	380	381
Calc %Capacity	84.7	85	85.3	85.5
Cascade #	1	1	1	1
Total				
Total Power, kW	74.1	74.3	74.6	74.8
Total Airflow, acfm	377	379	380	381
% System Capacity	34	34.1	34.2	34.4

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■ Annual Results

Daytype	Total Operating Hours <i>per yr</i>	Average Airflow <i>acfm</i>	Average Airflow <i>% System</i>	Motor Load Factor <i>% Rated</i>	Annual Energy Consmpt'n <i>kWh/yr</i>	Annual Energy Cost <i>per year</i>
Production	7,488	658	59.3%	58.3%	892,781	\$30,765
Non-Production	1,272	375	33.8%	36.0%	93,633	\$3,227
System Totals	8,760	516	46.6%	47.1%	986,414	\$33,992

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■ AIRMaster+ Features

- Builds a model of compressed air system
- Use the model for “what-if” scenarios
- Helpful calculators to estimate:
 - SCFM to ACFM
 - Air storage capacity
 - Elevation correction
 - Cycle time

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- **AIRMaster+ Limitations**
 - **Fair amount of data required**
 - **Uses hourly performance data**
 - **Doesn't tell full story of compressor operation or compressed air system performance**
 - **Doesn't make user a compressor expert!**
 - **GIGO means WYSIWYG**