

# Air Compressor Efficiency Opportunities

Industrial Energy Efficiency Workshop

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City of Boulder  
Office of Environmental Affairs

# 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

# AIR COMPRESSORS

## 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)

# AIR COMPRESSORS

## 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

## AIR COMPRESSORS

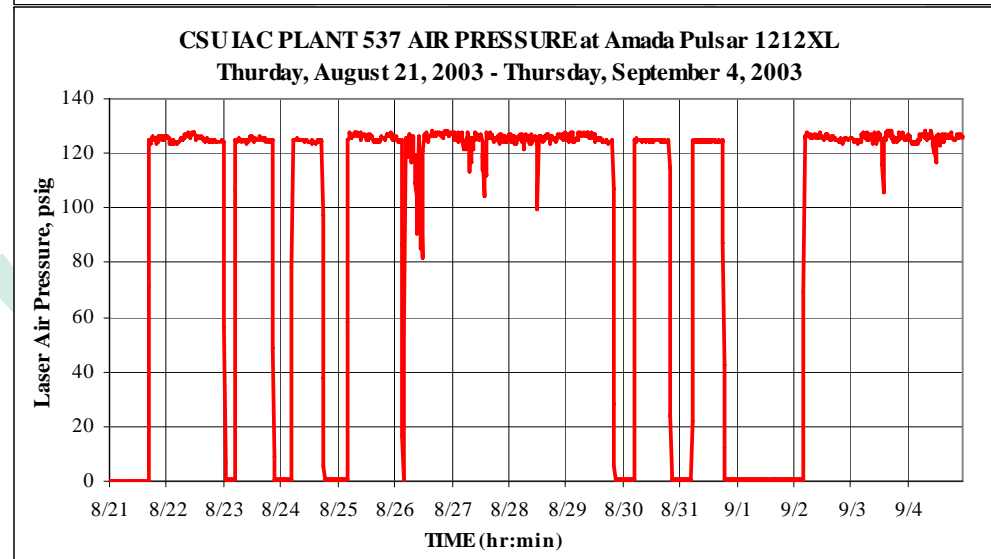
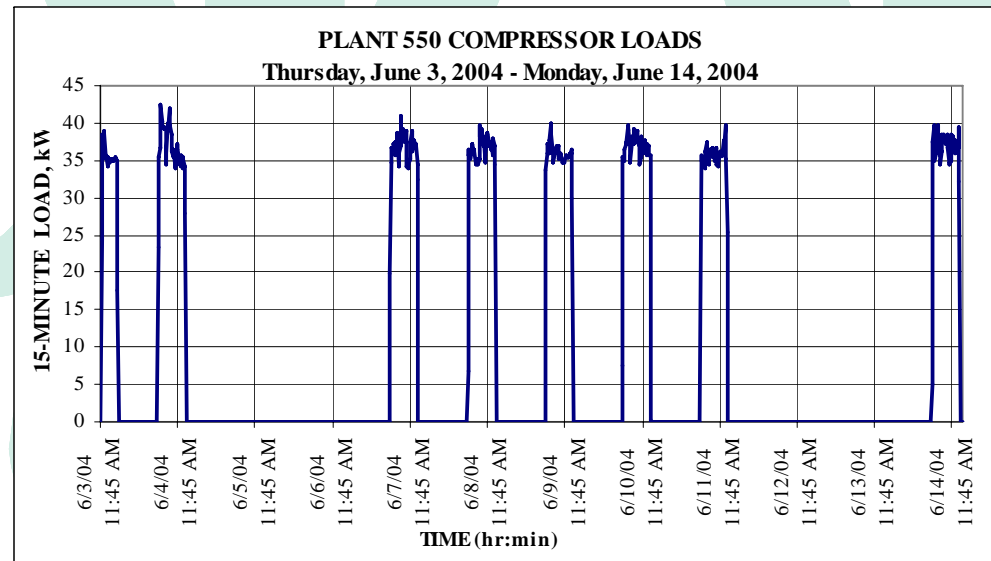
### Typical System at a Plant

- 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

## Plant System Operation:

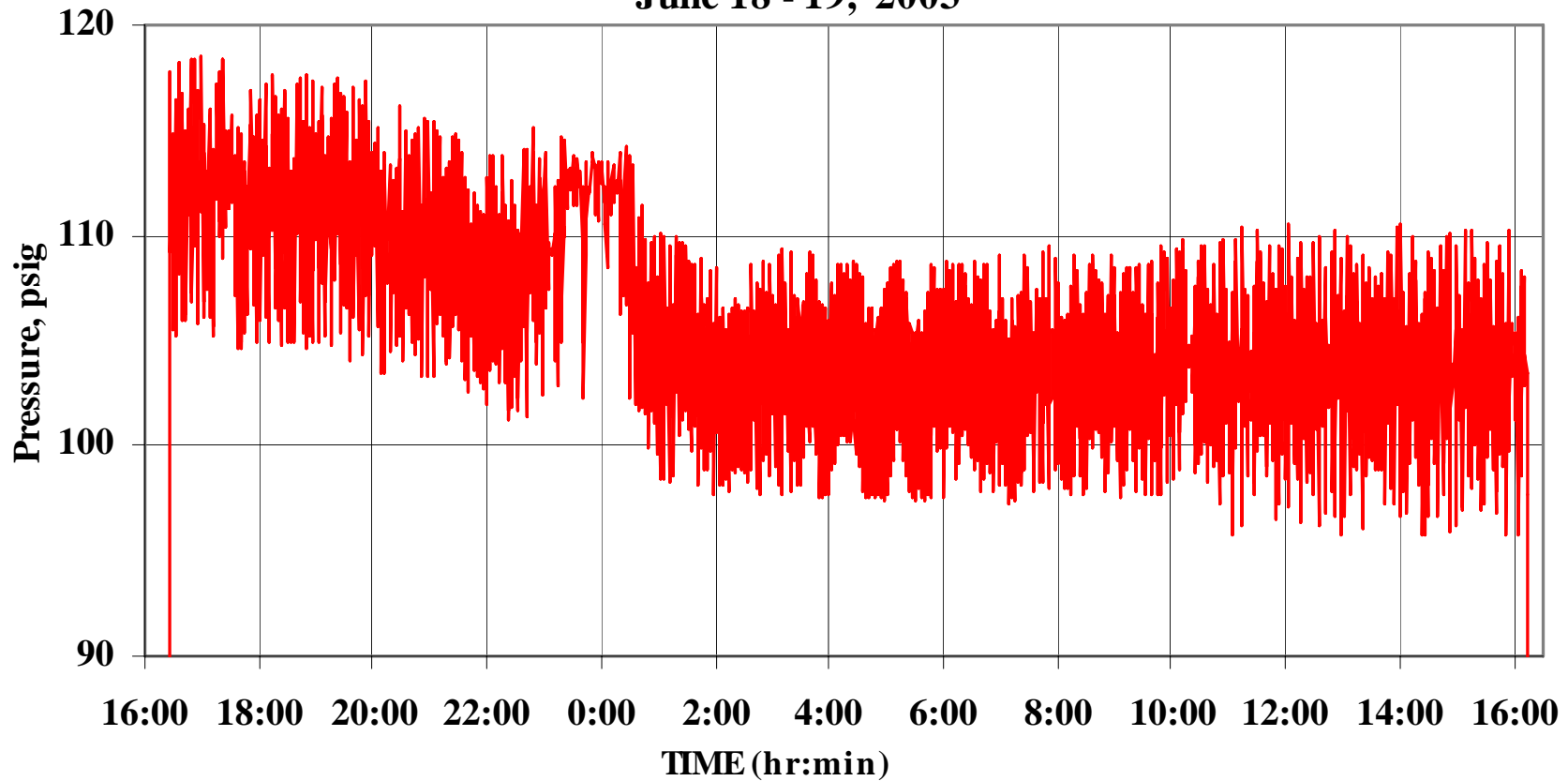
### Power Used

- Operate with Production
- Possibly shut off at night



## Pressure Variation

**IAC 531: Cooper Turbocompressor 250 hp Air Compressor  
June 18 - 19, 2003**



# AIR COMPRESSORS

## 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

# AIR COMPRESSORS

## 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

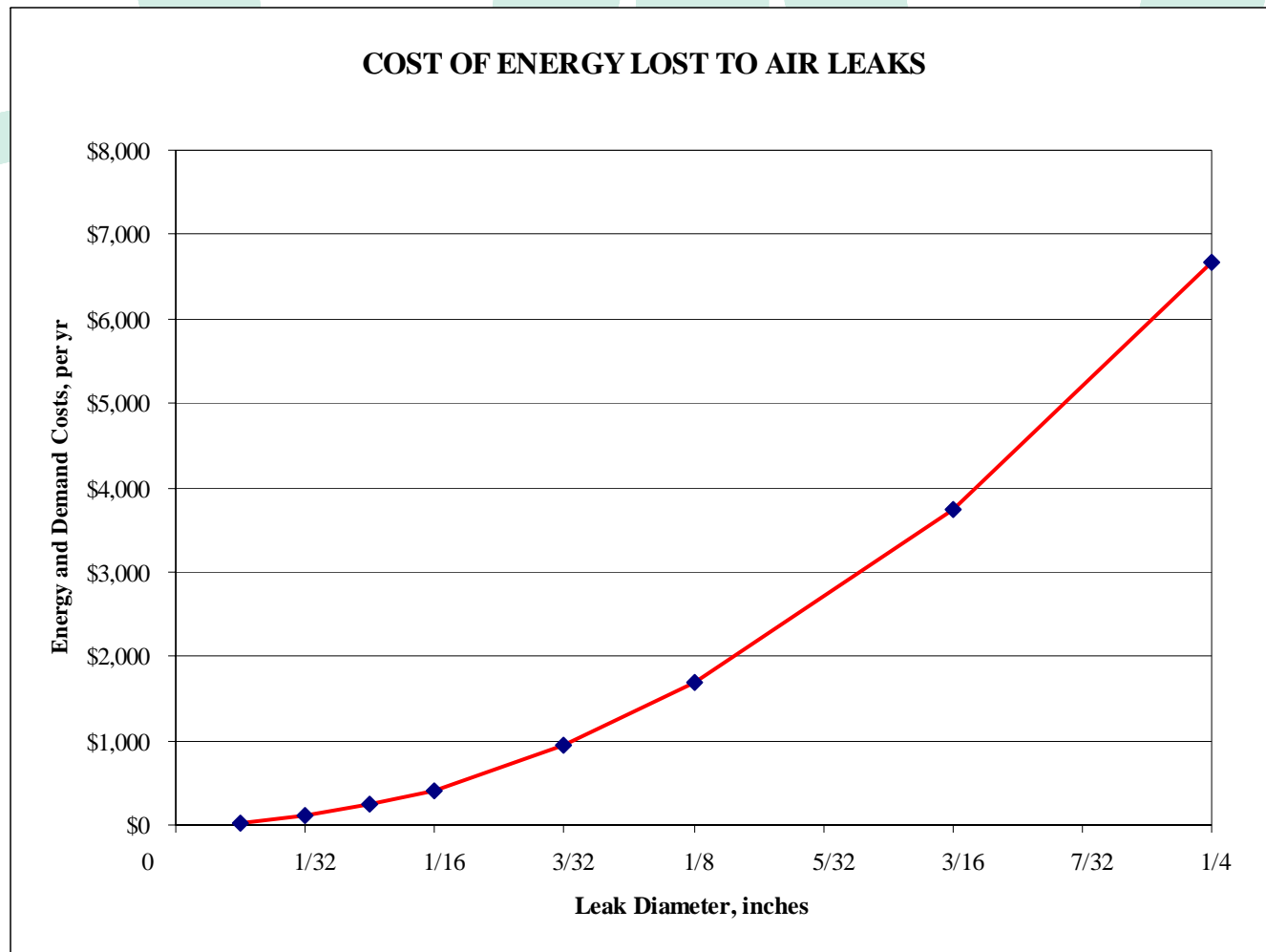
## AIR COMPRESSORS

- 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

## AIR COMPRESSORS

- 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

## Cost of Air Leaks vs. Hole Size



## AIR COMPRESSORS

- 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

## AIR COMPRESSORS

- 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

## AIR COMPRESSORS

- 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

## AIR COMPRESSORS

- 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

# AIR COMPRESSORS

- 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