Why Compressed Air Is So Expensive
and
What To Do About It

Presenter

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- 19 years Technical CA Support – POP
- CAC Instructor
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KNOW PRESSURE COMPRESSED AIR CHALLENGE

Coming Up

- Why compressed air is so expensive
- Three secrets of compressed air efficiency
- The effects of system pressure
- Improving how CA is produced
- Transmitting CA more efficiently
- Reducing waste and misuse

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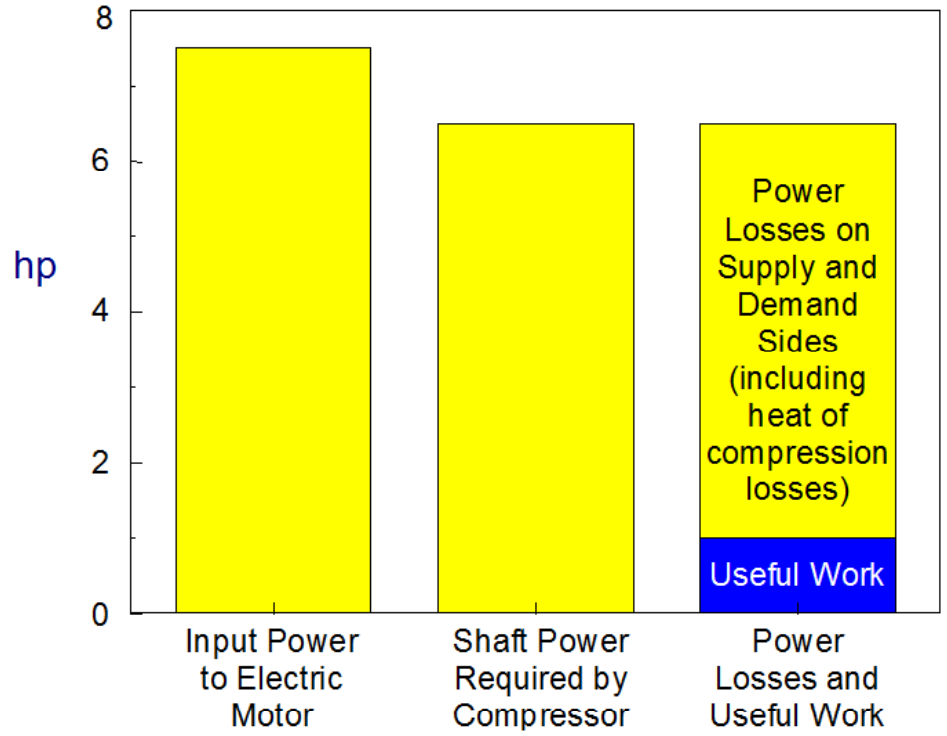
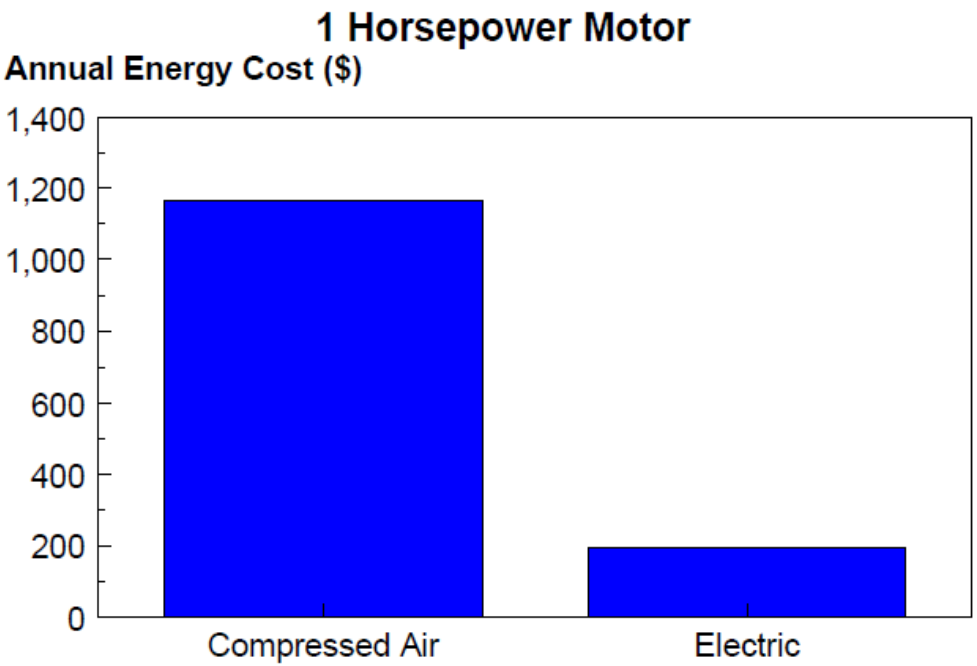
Cost of Compressed Air

- Typical air cooled compressor Specific Power
- 20 to 21 kW/100 cfm at 125 psi
- 18 to 19 kW/100 cfm at 100 psi
- For two shift/ 5 day $7,900 per 100 cfm
- 24 x 7 operation $16,640 per 100 cfm
- 10 cents per kWh, 100% loaded



Poor Production Efficiency

Every 7.5 hp power input to the compressor results in only 1 hp output at the compressed air end use!



Example Air Motor

Compressed Air Motor

- **30 cfm input = 1 HP output**
- **5.7 kW input = 0.8 kW output**

$2,330 (compressed air)
vs. $390 (electric)

7 times more costly

Why Use Compressed Air?

Compressed air systems are used in almost every sector of the economy, and there are thousands of different uses for compressed air. Air operated equipment:

- **Tends to be lighter and more maneuverable than electric**
- **Deliver smooth power and are not damaged by overloading**
- **Have the capability of infinitely variable speed and torque control**
- **Are safer because they do not have the potential hazards of electrical devices, particularly when water and gases are present**

Why Use Compressed Air?

There are many applications where compressed air is the best overall solution

- Whether its pneumatic tools, packaging, automation equipment, conveyors, controls systems, and others
- When compressed air is needed to make a product, it should be used wisely due to the high cost of making the compressed air

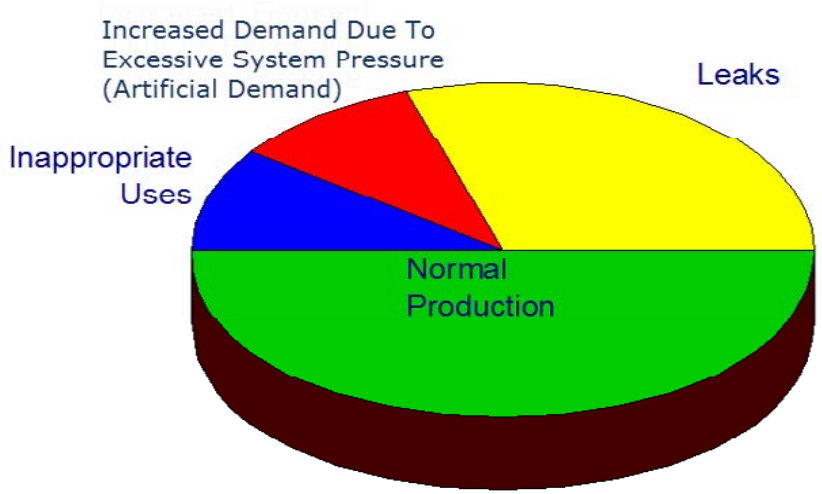
Not real world conditions

Previous calculation assumes lossless system

Real systems have:

- Leaks, artificial demand
- Pressure losses
- Inefficient compressed air production

Real System have losses



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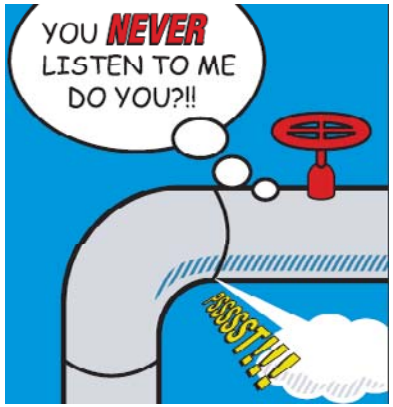
Leaks Add Waste



Source: Carbon Trust

Typical leak level 15 to 30%

Leaked air never makes it to the end use

Size	Air Flow	Cost per year
1/16"	6.49 scfm	$1,050
1/8"	26.0 scfm	$4,190
1/4"	104 scfm	$16,760

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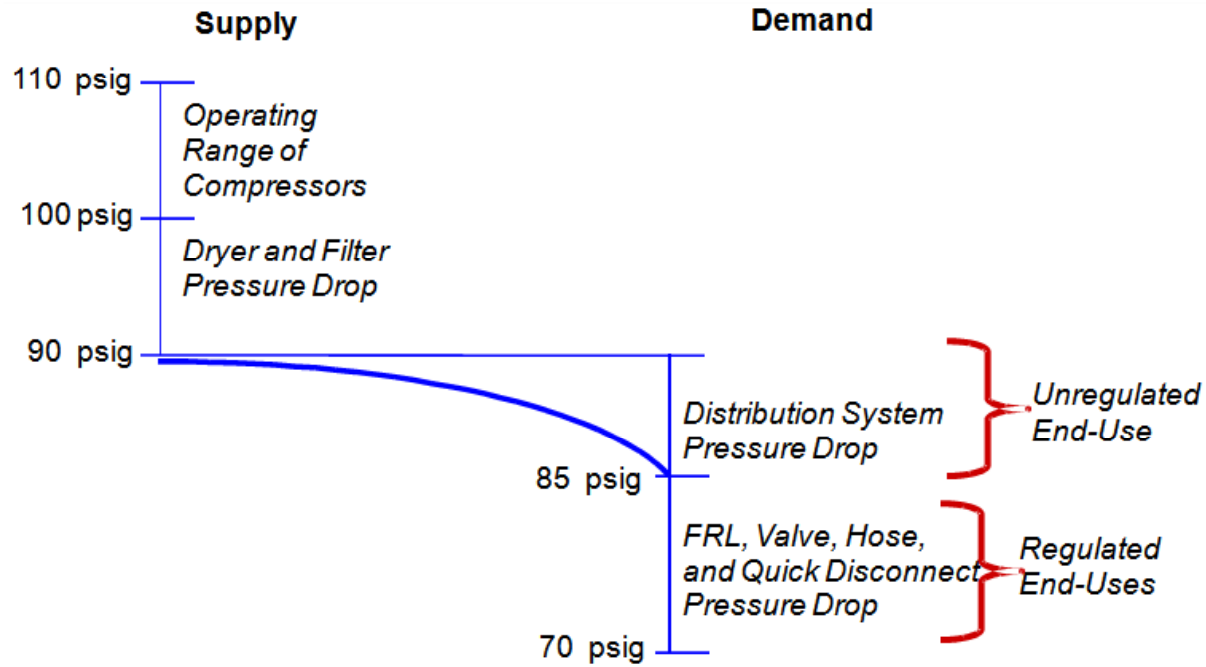
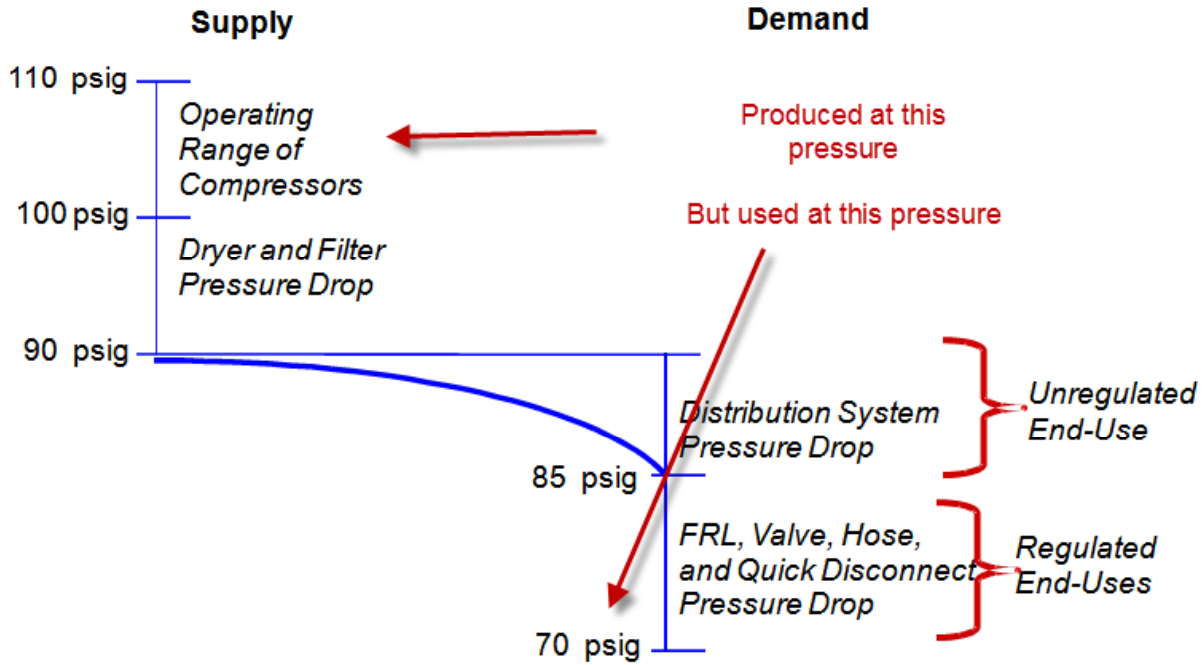
Pressure Drop



Pressure Drop



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Pressure – Rule of Thumb

- Every 2 psi increase in discharge pressure results in 1 percent more energy consumption

(Valid around 100 psi)

- Makes real world compressed air cost more than the perfect system

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CAC COMPRESSED AIR CHALLENGE

Compressor Efficiency

2	Model Number: [redacted]100 [X] Air-cooled [ ] Water-cooled [X] Oil-injected [ ] Oil-free	# of Stages: 1 VALUE	UNIT
3	Rated Capacity at Full Load Operating Pressure [a, f]	434	acfm [a,f]
4	Full Load Operating Pressure [b]	125	psig [b]
5	Maximum Full Flow Operating Pressure [c]	128	psig [c]
6	Drive Motor Nameplate Rating	100	hp
11	Total Package Input Power at Rated Capacity and Full Load Operating Pressure [d]	92.6	kW [d]
12	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure [g]	21.3	kW/100 cfm [g]

At full load

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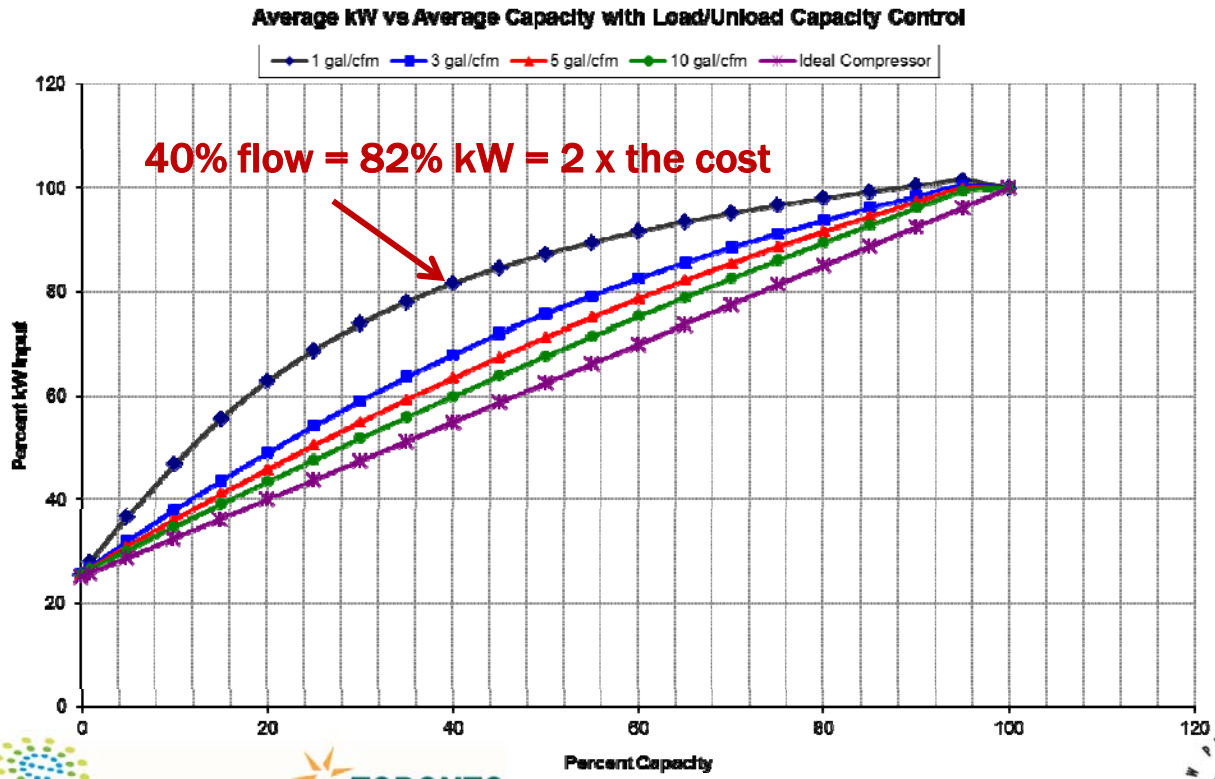
System Average Loading

25 to 40%

Study by Manitoba Hydro

Screw Compressor Characteristics



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Additional Costs

- Air dryers
- Drains and condensate disposal
- Cooling costs (fans, water, water treatment)
- Maintenance
- Equipment replacement

Real World Efficiency

Perfect compressor

- No part loading
- No pressure drop
- No waste

7.5 hp in = 1 hp out

Real world example

- Inefficient part load
- 30% leaks
- 30 psi pressure drop

25 hp in = 1 hp out

This is why compressed air is so expensive

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Things can improve

Many of these additional costs are due to:

- Poorly operating equipment due to improper system design
- Poor maintenance practices
- Use of production equipment with poor energy characteristics at part loads

Secrets to CA Efficiency

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Secrets to CA Efficiency

- Produce compressed air more efficiently
- Use less compressed air
- Use the heat of compression for something useful

Source: ASME EA-4

Pressure Effects

	1/64”	1/32”	1/16”	1/8”	1/4”	3/8”
70 psi	.300	1.20	4.79	19.2	76.7	173
80 psi	.335	1.34	5.36	21.4	85.7	193
90 psi	.370	1.48	5.92	23.8	94.8	213
100 psi	.406	1.62	6.49	26.0	104	234
125 psi	.494	1.98	7.90	31.6	126	284

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10 psi = 10% more flow

Pressure Effects

- Every 2 psi increase in discharge psi increases power by 1%
- Every 1 psi in pressure increases unregulated flow by 1%
- This increased flow further increases the compressor power
- Power increase depends on control mode

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COMPRESSED AIR CHALLENGE

Improving the Supply Side

- More efficient compressor and dryer control
  - Adding storage
  - Operating in a different control mode
- Lower discharge pressure
- More efficient compressors and dryers
- Improved maintenance
- Improved ambient conditions

Improving the Supply Side

Automobile analogy

- Modulation
- Load/Unload
- Start/Stop
- VSD

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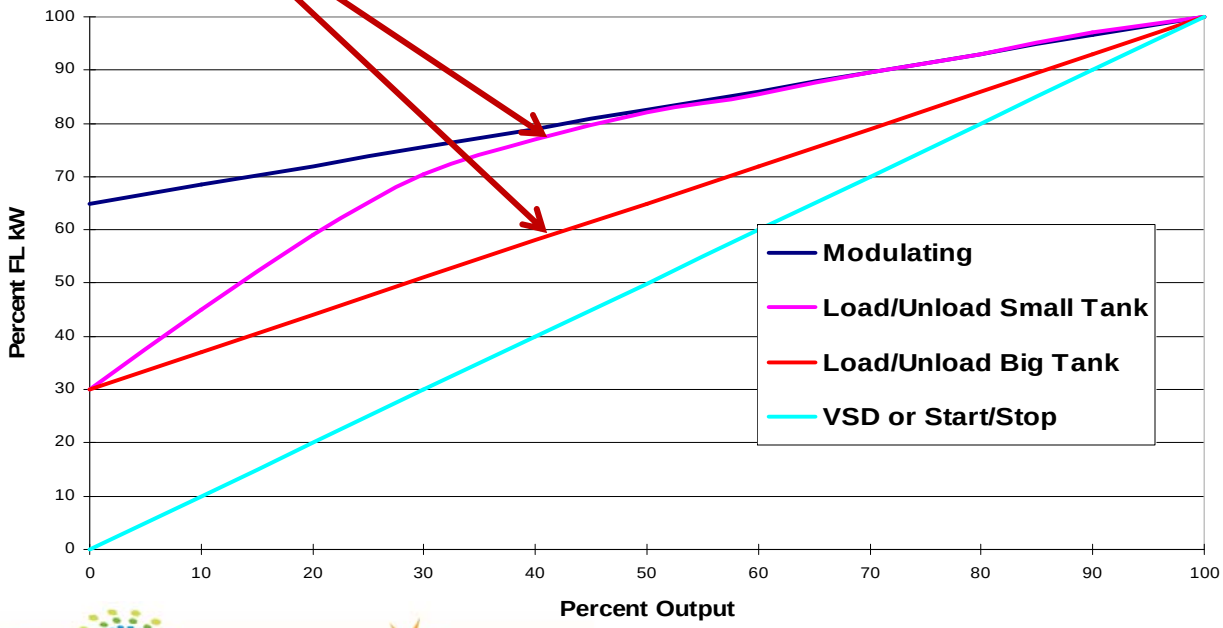
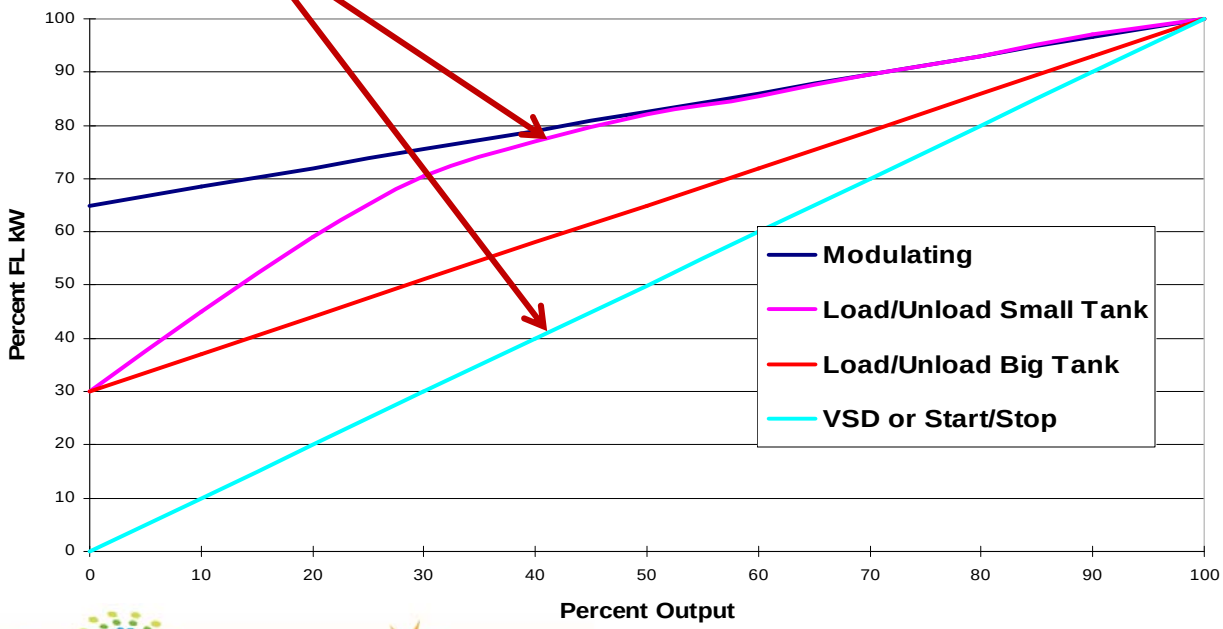
Control Improvements

- Adding storage



Control Improvements

- Control Change



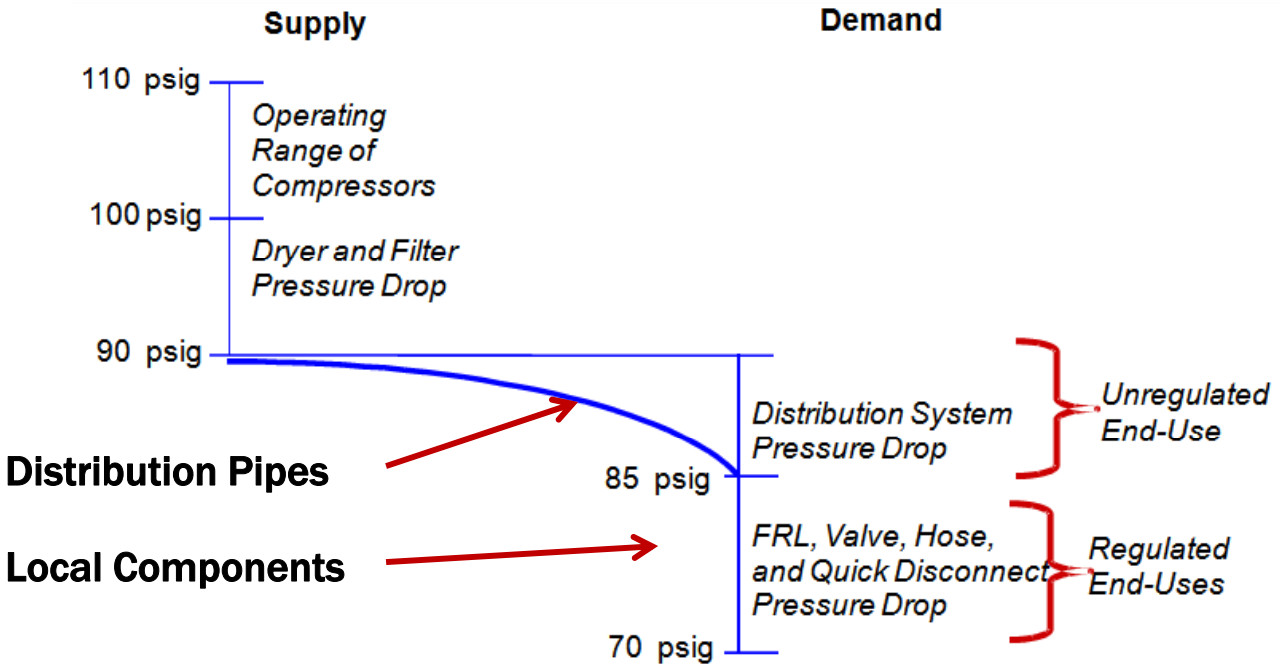
Control Improvements

- Sequencing compressor controls
- Cycling refrigerated air dryers
- Dew point controlled desiccant dryers
- Reduced purge desiccant dryers (externally heated or blower purge)
- Controls that turn off production equipment when not required (nights, weekends)

Maintenance and Ambient

- Clogged filters decreases compressor efficiency
- Clogged coolers causes high temperatures and water problems forcing more compressed air drainage
- Cooler compressors produce more efficiently
- Negative room pressures reduce efficiency
- Heat from compressor rooms can be directed where needed

Transmission Losses



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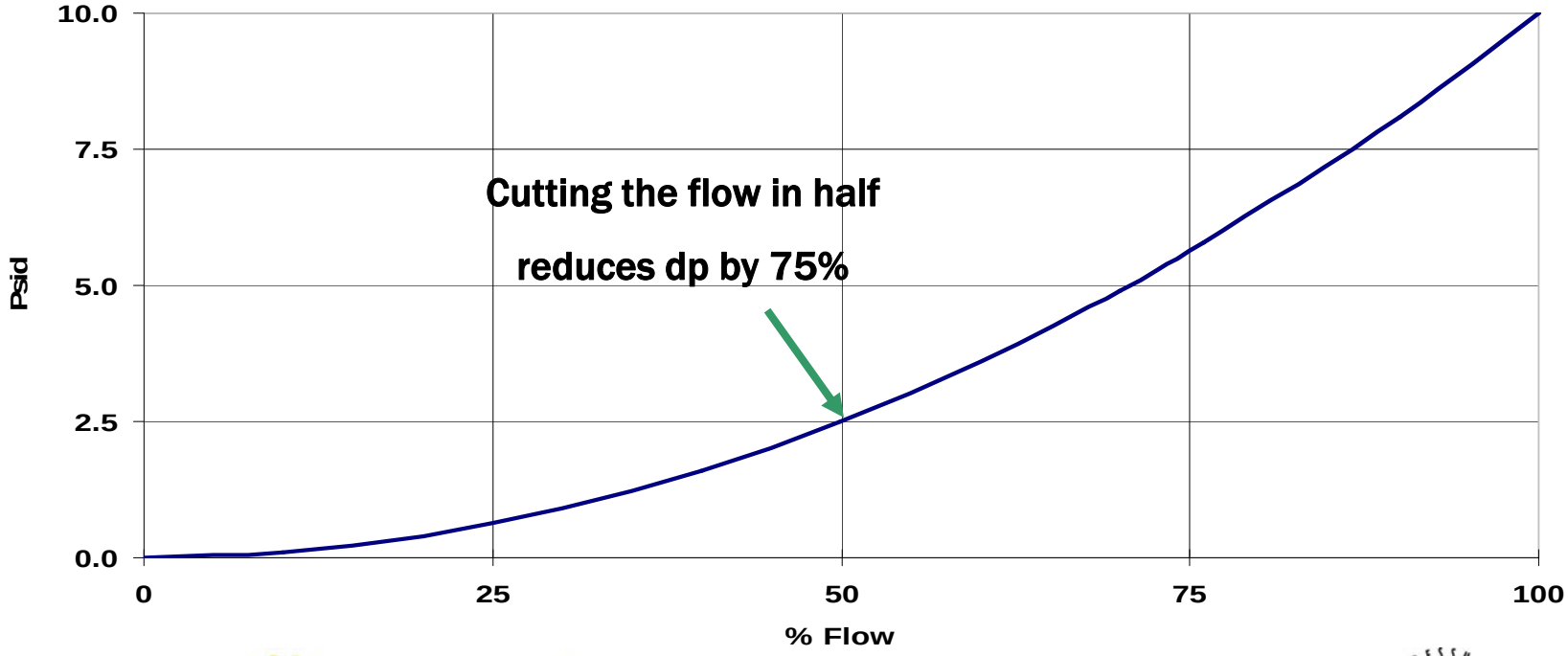
Transmission Losses



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Reducing Transmission Loss

- Pressure drop reduction reduces to the square of the flow reduction
- Loop piping rather than radial feeds
- Increase piping size
- Filters, regulators, lubricators sized for peak
- Hoses, connectors, fittings sized for peak

Peak vs Average

Example:

- Actuator consumes 2 cubic feet per 1 second cycle, 4 times per minute
  = 8 cfm average
- 2 cubic feet in one second is a peak flow rate of 120 cfm
- Components and supply lines sized for average would be grossly undersized
- Resulting pressure drop increases required compressor discharge pressure

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Reducing Transmission Loss

Piping system and hoses DP reduction (almost like magic)

- Upgrade from 1 ½ to 2 inch pipe reduces dp by 73%
- Increase 1/4 inch hose to 3/8 reduces by 88%
- Decreased pressure drop allows lower compressor discharge pressure

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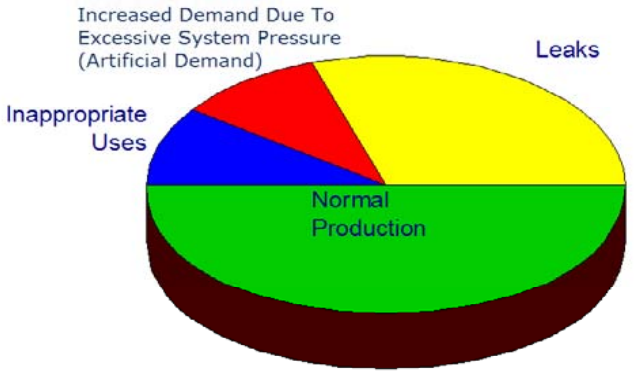
Reducing the Demand Side

- Leakage reduction
- Inappropriate use optimization
- Artificial demand elimination
- Abandoned use reduction
- Regulated end use pressure
- Proper component design



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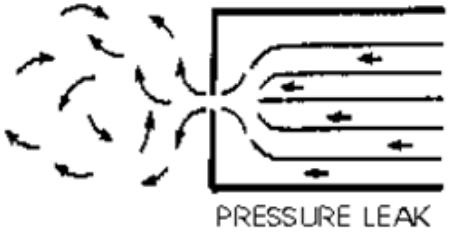
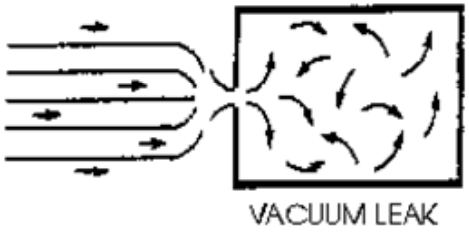
Leakage Reduction

- Find and Fix Leaks
- Use ultrasonic leak detectors to find





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Inappropriate Uses

- Find, replace, eliminate, optimize

- Blowing
- Agitation
- Atomizing
- Cabinet Cooling
- Vacuum
- Transport
- Aspiration
- Personal Cooling

Artificial Demand Reduction

- Reduce the pressure
- Regulate the main system with pressure/ flow control
- Regulate end use
- Flow in unregulated uses reduces 1% per psi
- Compressor power reduces
- May require equipment or component retrofit or redesign if one machine prevents wholesale psi reduction

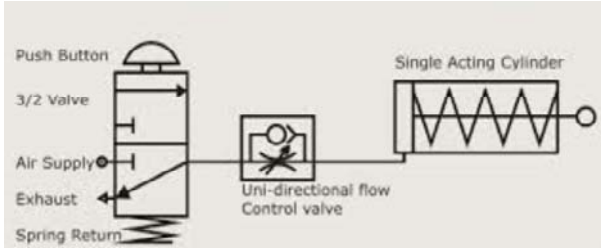
Abandoned Use Reduction

- Turn it off
- Install solenoid control
- Train staff to shut off
- Turn the complete system off if no production at night and weekends
- Flow reduction = energy savings

Lower psi = lower cfm

Example:

- Actuator consumes 2 cubic feet per cycle at 120 psi = 8 cfm
- Reduction to 90 psi consumes 6 cfm
- 22% savings
- Low pressure or spring powered retract stroke saves energy



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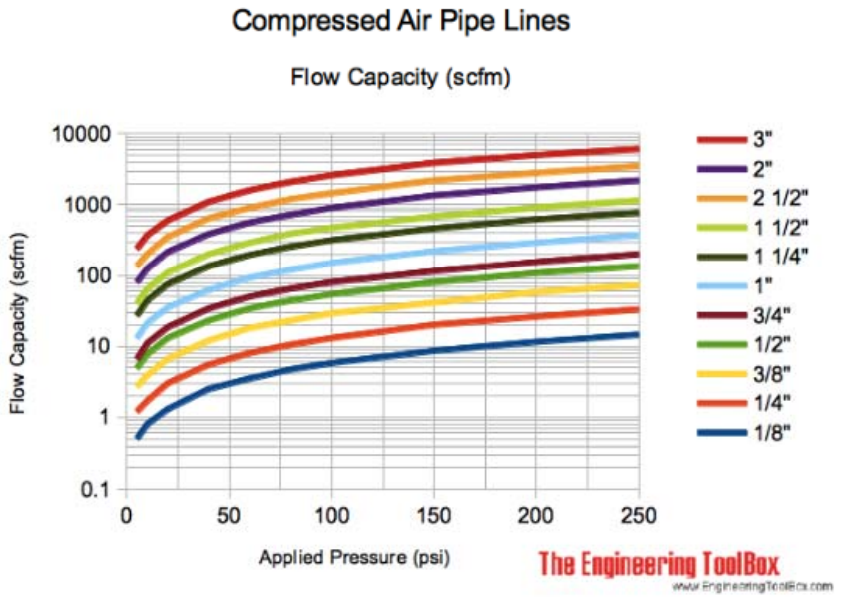
Low psi drop = lower cfm

- Poorly designed components cause discharge pressure increase
- Pressure increase causes artificial demand and higher compressor power
- Properly size components for savings



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Summary

- Compressed air is expensive, more expensive if wasted and produced by inefficient equipment
- Secret to produce efficiently and use less. Keep the heat.
- High pressure costs money
- Production of compressed air can be made more efficent
- Reducing pressure loss in transmission saves energy
- Reducing waste and misuse lowers costs

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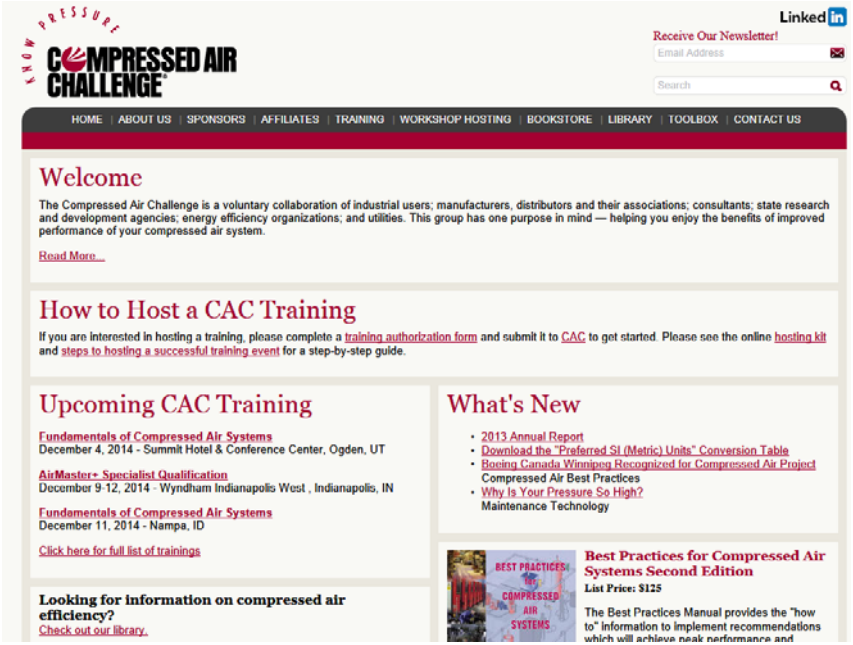
Where to Get Help

- Additional training from CAC
- Compressed Air Best Practices Manual
- Visit CAC website: www.compressedairchallenge.org
  - Tools
  - Articles
  - Training Links
  - LinkedIn Discussion



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