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5 Installation Tips for Flow and kW Meters

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Tim Dugan, P.E., *Compression Engineering Corporation*
Keynote Speaker

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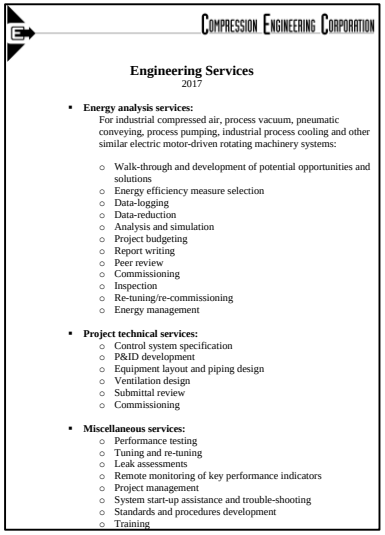

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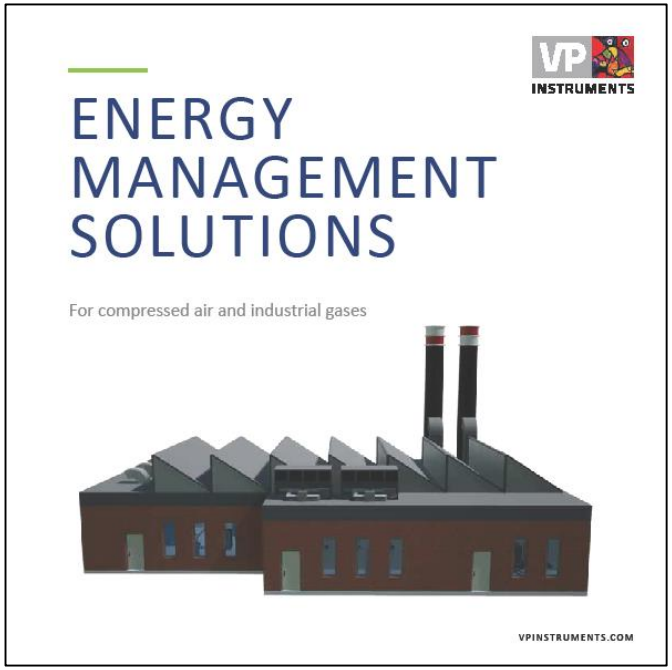

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5 Installation Tips for Flow and kW Meters

Introduction by *Rod Smith*, Publisher

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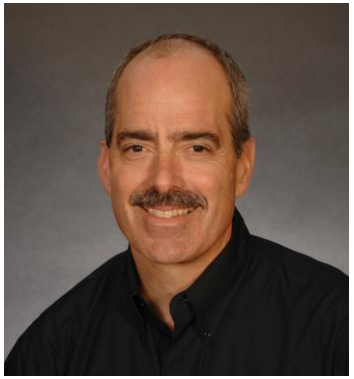

Tim Dugan, P.E.
Compression Engineering Corp.

- President and Principal Engineer of Compression Engineering Corporation

- Over 25 years of experience in the industry

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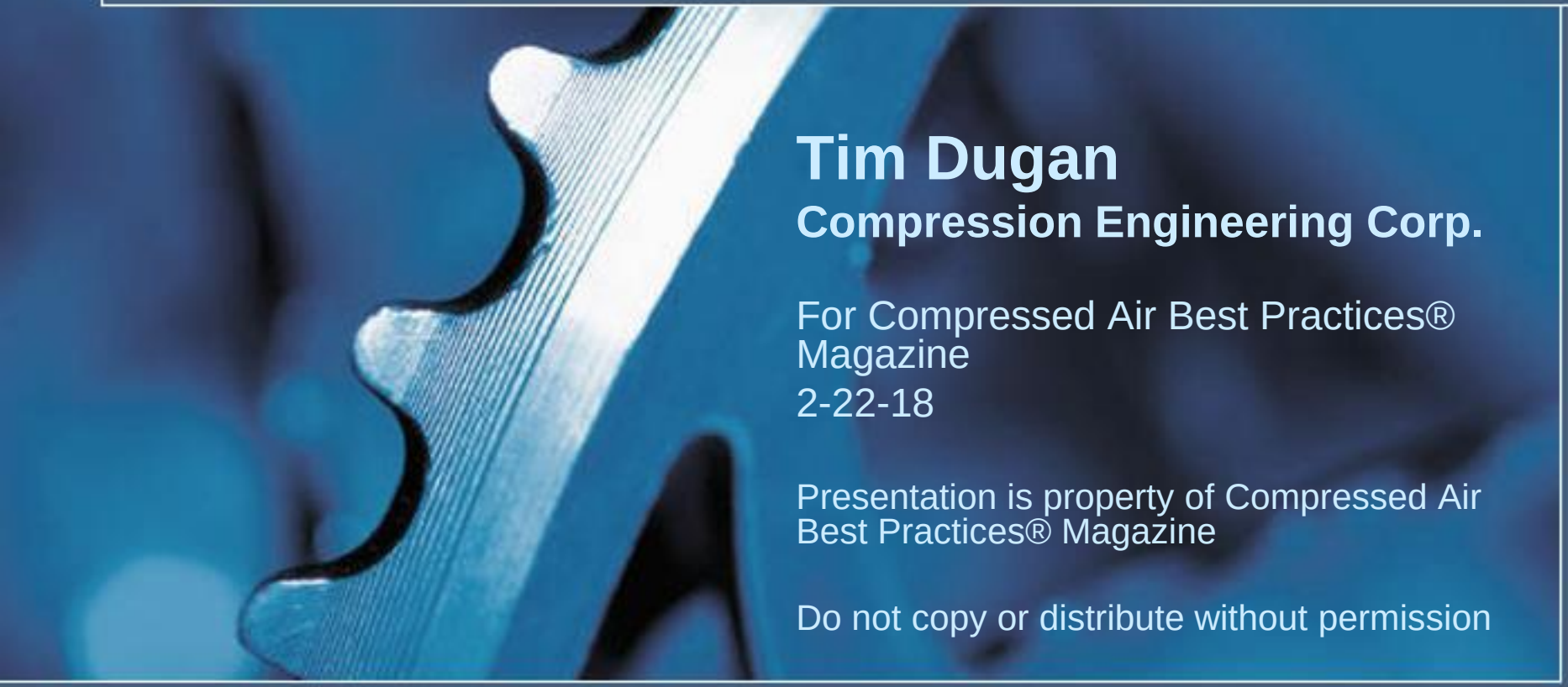
5 Installation Tips for Flow and Power Meters



Tim Dugan
Compression Engineering Corp.

For Compressed Air Best Practices® Magazine
2-22-18

Outline

1. Why Both Flow + Power Metering?
2. Flow Meter Installation Issues
3. Power Meter Installation Issues
4. Tracking Compressor Room Performance
5. Tracking System Usage

Why Install Both Flow and Power Meters?

- Money In: Electricity

- Useful Power Out: Pneumatics

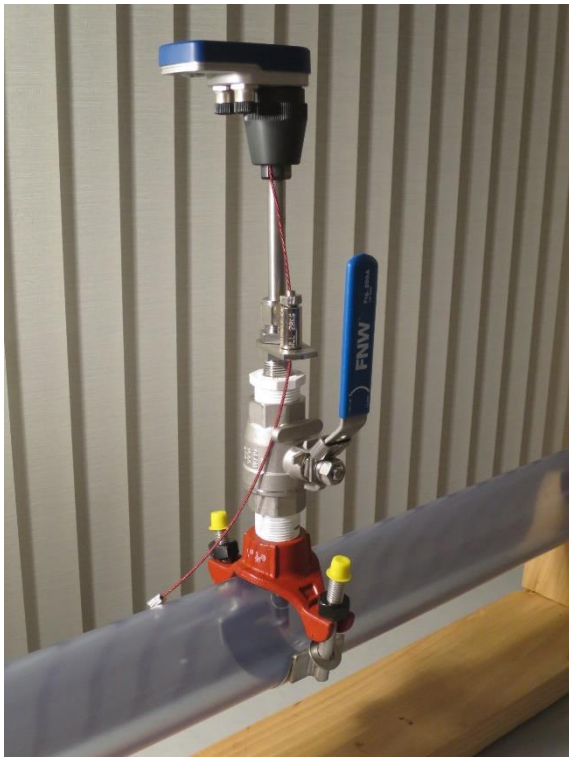
Why Flow & kW Meter Compressor Room?

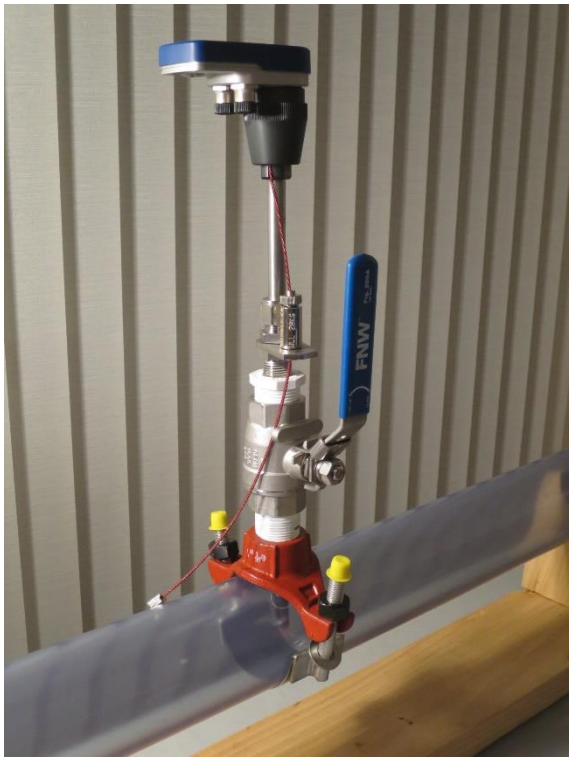
- Track Overall Compressor Room Efficiency:
  - In US: scfm/kW or kW per 100 scfm
  - SI: kWh/nm3
- Why Trend? Is an Audit Enough?
  - Dynamic Issues in Compressor Room:
  - Controls Change, Affecting Efficiency Dramatically
  - False Loads Change, Also Affecting Efficiency

Flow Meter Installation Issues

- **Simple Systems:**
- One Permanent Trending Flow Meter After Dryer
- One Portable Data-logging Meter for Temporary Measurement
- Consider “Hot-tapping”

Installation Methods: Hot Tap

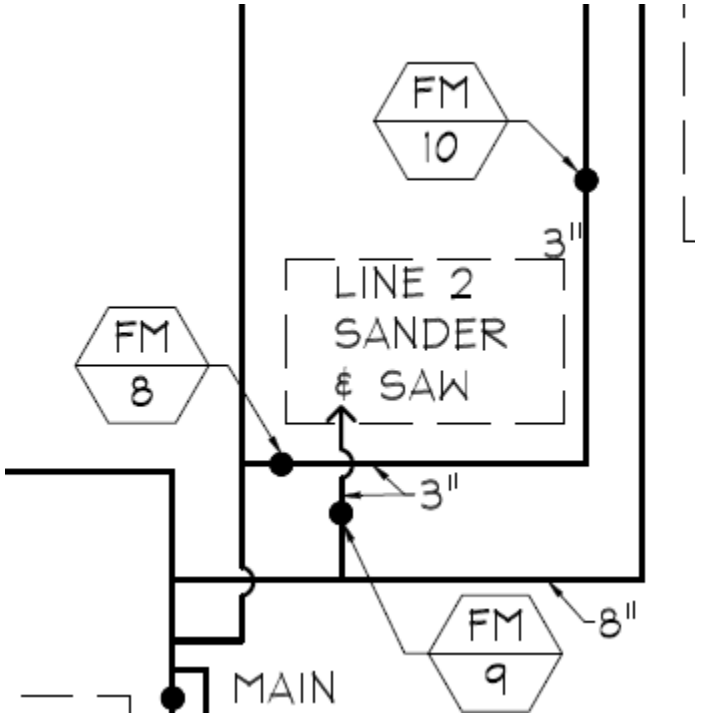




- Slightly loosen fitting
- Open valve
- Push meter to bottom of pipe
- Back meter out ½ of pipe diameter
- Straighten meter
- Adjust cable & tighten fitting

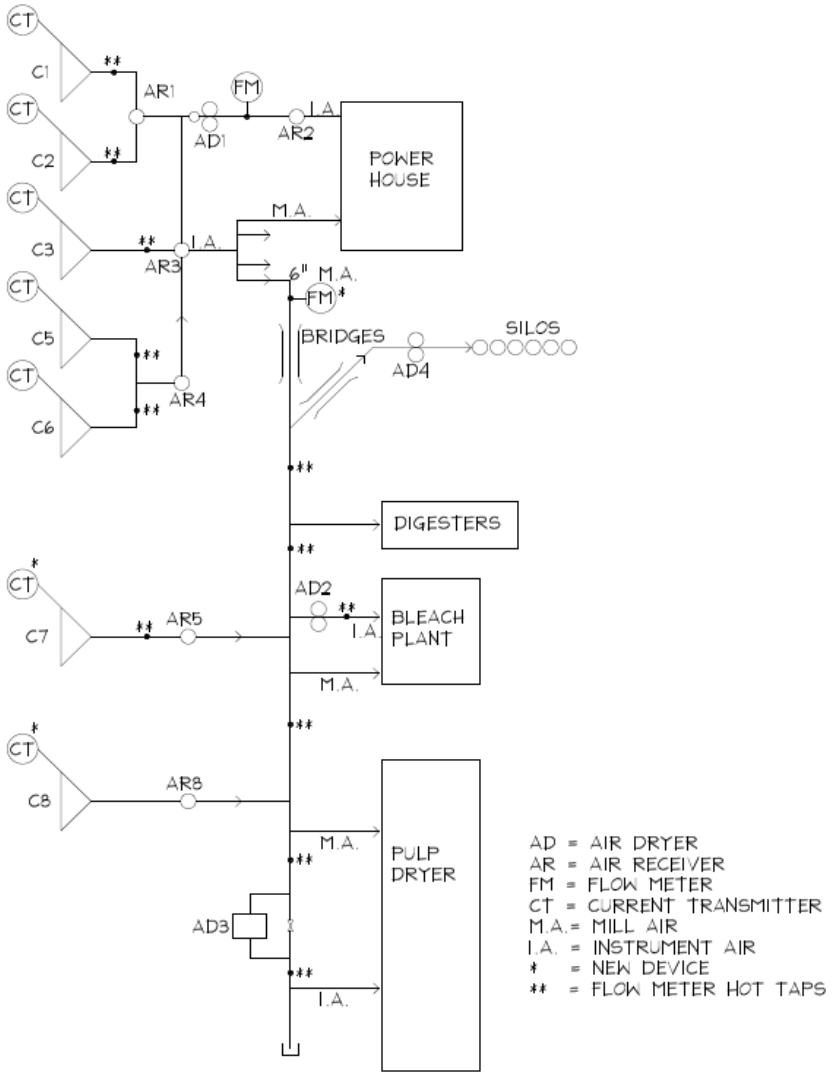
Flow Meter Installation Issues

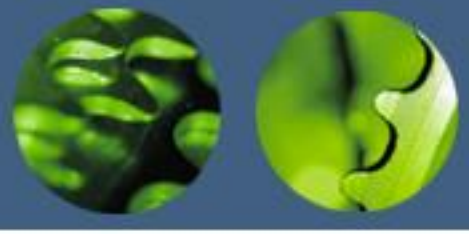
- **Piping Network, “Looped”:**
- “Double tap” metering recommended, bi-directional



Flow Meter Installation Issues

- **Piping Network, "Linear":**
- "Double tap" metering recommended, single-directional





Flow Meter Installation Issues

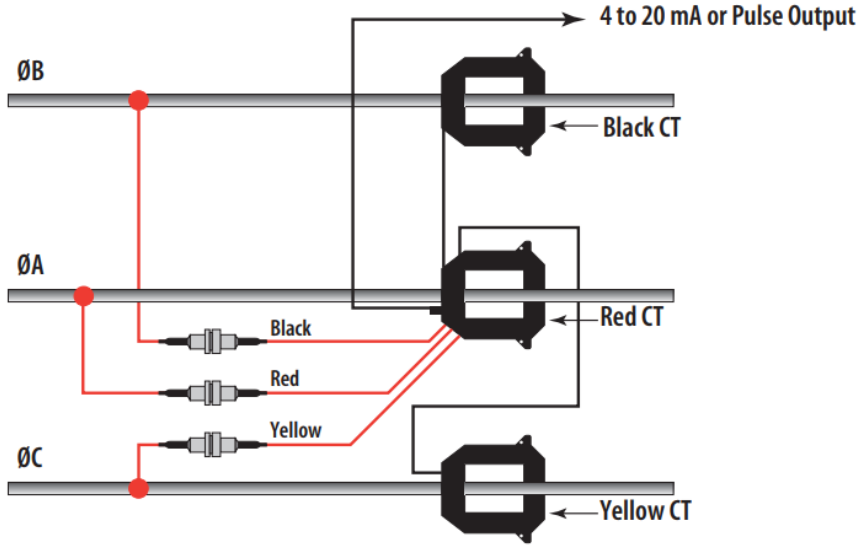
- **Common Issue In All Examples:**
- Don’t Try to Measure Every Load
- Use Subtraction to Determine Flow to an Area

Power Meter Installation Issues

- For Fully-loaded Motors, Current is a Good Proxy for Power.
- For Unloaded Condition, Current is a Poor Proxy for Power. Large Variations in “Power Factor”.
- An Important KPI is Reduction of No-Load Power Waste.
- Power Measurement is More Accurate.

Power Metering Installation Issues

- Minimum Cat III Rated Power Meter
- True RMS Power Meter
- 3-phase Meter -Requires (3) CTs and (3) Voltage Clamps

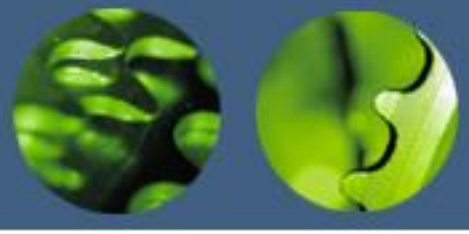


Power Metering Installation Issues

- Don’t Connect Voltage Leads on Live Load
- Have Electrician Install Meter & Require Them to Follow Safe Practices

Tracking Controls w-Performance Curve

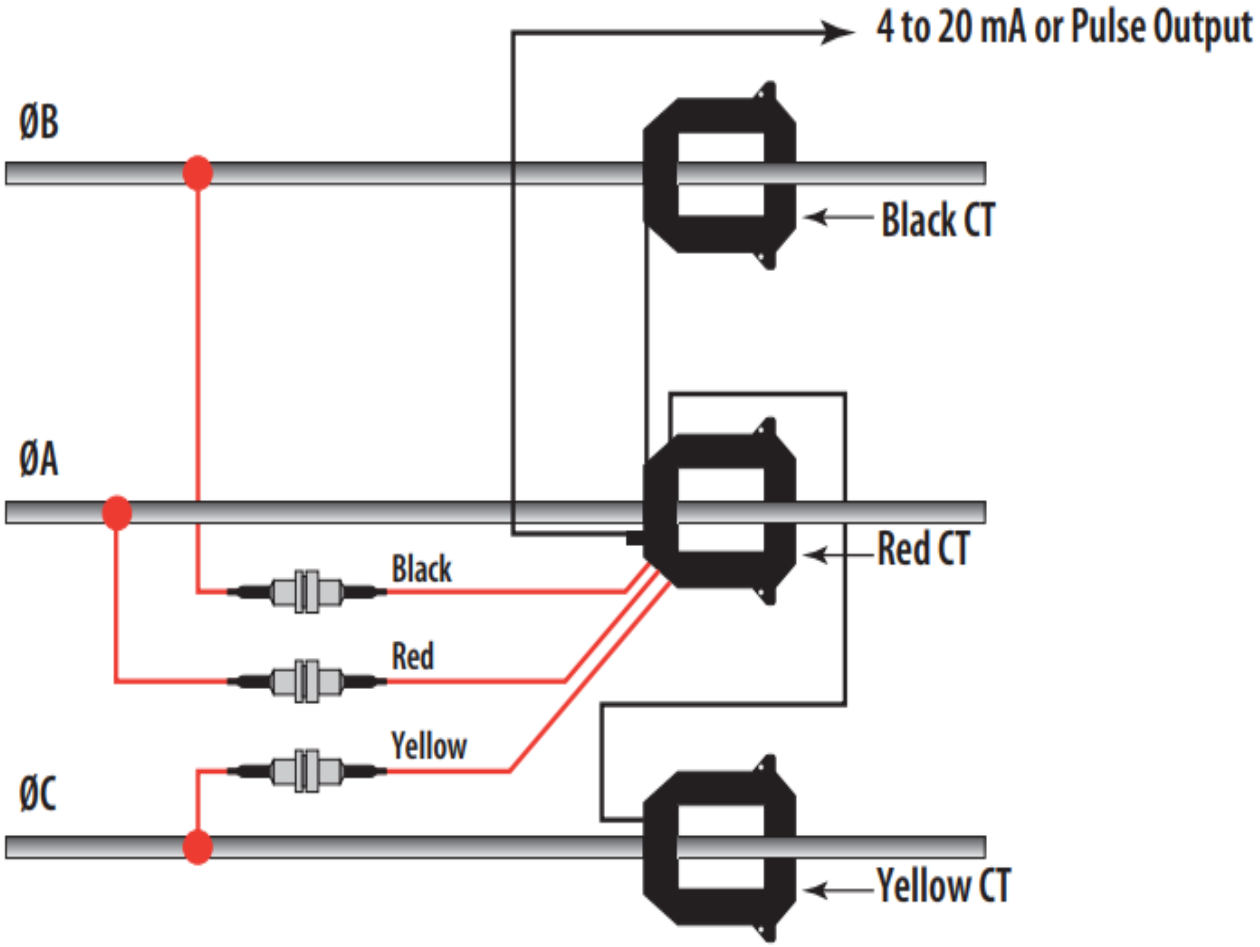
- Measure Total Flow
- Measure Total Power
- Scatter Plot Power vs Flow at Commissioning
- Track Deviation From That Curve
  - VFD Operation – Is it Always “Trim”?
  - Sequencer Operation – Excessive Idling?
  - Control Band – Short-cycling?
  - Controls “Slope” - How Well do Controls “Shave” Power With Reduced Flow?

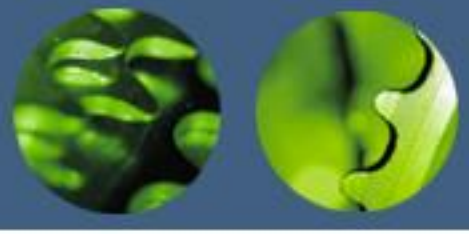


Example System

- (1) 400hp VFD Compressor
- (1) 200hp Fixed Speed Compressor
- Refrigerated Air Dyers
- (1) Regenerative Nitrogen Generator
- N2 Generator Switching Caused Regular “Blips” in Flow Demand, Difficult to Tune Compressor Controls Optimally
- Detailed Audit Showed Problem, After Analysis
- Overall Flow and Power Plot is Better Way

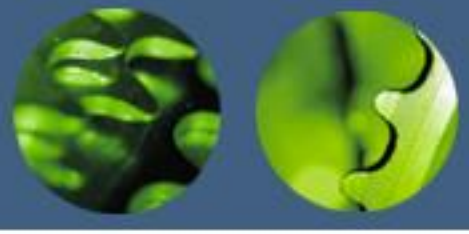
Example Curve





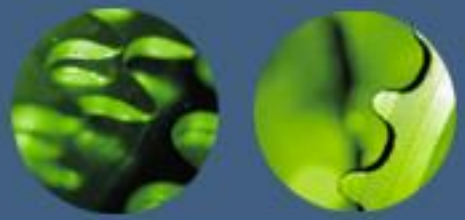
Tracking Usage

- Complex Systems Have Big Supply – Demand Disconnect:
  - Flow Reduction in System Might Not Be Seen at Compressor Room Due to “Noise”
  - Departments Are Segregated – Cost Responsibility for Usage Can be Different than Generation
- Piping Runs Might be Too Short in Compressor Room for Flow Metering
- 100% System Flow Metering is Not Possible
- The Most Important Usage Might be the One You Can’t Meter…



Example System

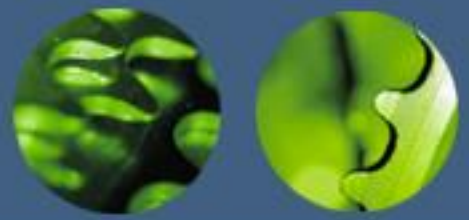
- Area of Concern is Less Than 20% of System Demand – You Think
- Project Reduces Flow 50% in That Area
- 10% Too Small to See and Quantify at Main Compressor Flow / Power Meters
- Use Hot Tap Meter Pre-Post for Area
- Determine Drop in Average Flow
- Assign Savings by the Flow Change and “Slope”:
- Reduced Energy = Reduced Flow / (scfm/kW slope) x hrs/yr



“Gap” Flow

- After Metering “All” Demands, Total Flow is Far Less Than Compressor Room Flow.
- This Has Happened on my Last Two Large Metering Projects.
- Not a Loss. You Don’t Know Where Waste is Until You Start Measuring
- The Difference Between Compressor Room and Total System Flow is a Valuable Metric. SCADA System Can Track it.

Example of Gap Flow



Conclusions

- Measuring BOTH Power and Flow is Needed.
- Installing Flow Meters in the Best Place is Somewhat Trial and Error
- Power Metering is Most Accurate Way to Quantify Losses Due to Controls
- Power Meters Must be Safely Installed
- Two Calculations Are Important:
  - Flow Change
  - Power/Flow Slope

Thank you

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About the Speaker

Pascal van Putten
VPInstruments

- CEO of VPInstruments

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Identify optimization opportunities

Turn measurement data into energy savings

Pascal van Putten, CEO
VPInstruments

Compressed Air Best Practices® Magazine
Webinar Feb 2018

Common challenges

- Which signals to measure
    - Flow, Pressure, Temperature, kW, Dew Point
- Understanding measurement uncertainties and their causes
- Relating measurement results to real issues

Where to install your sensors

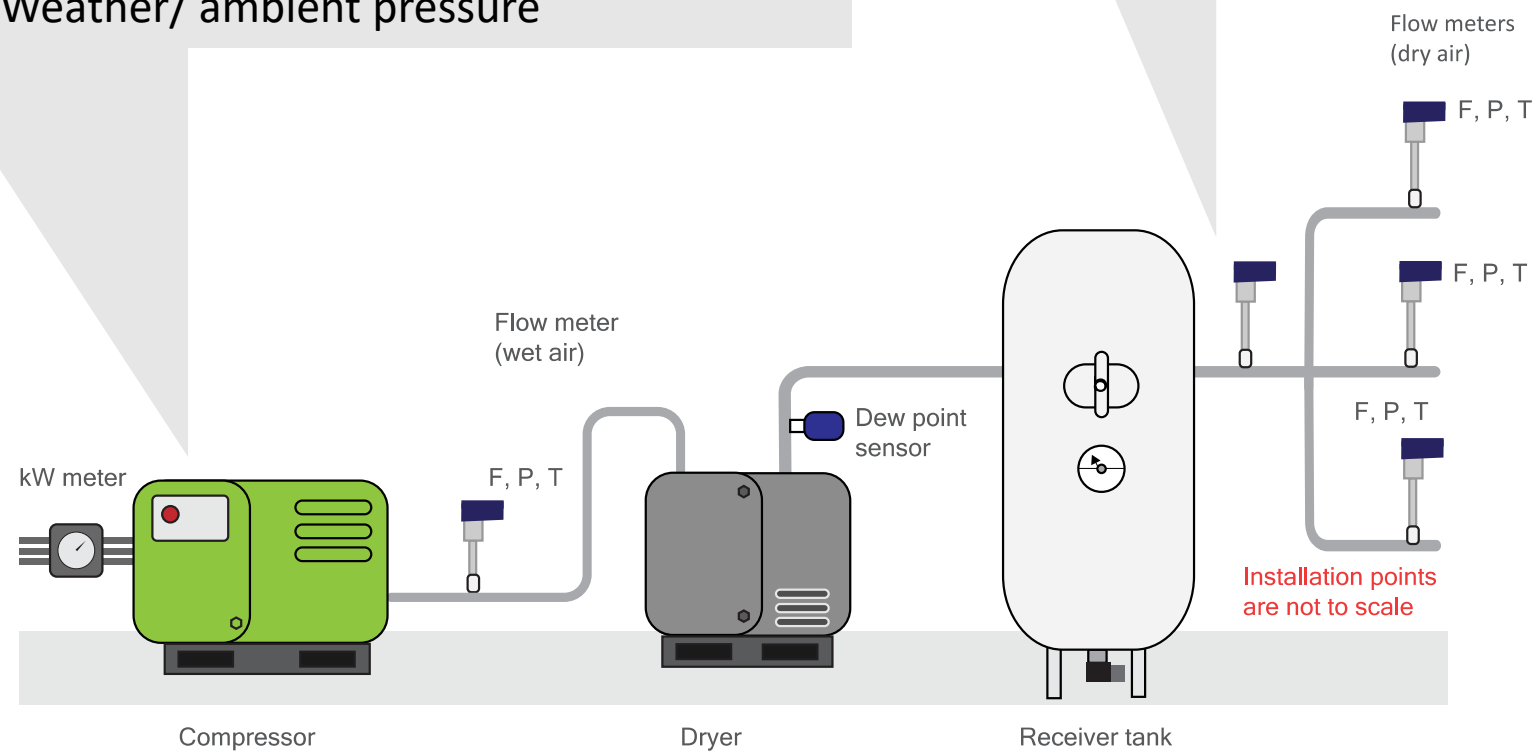
What's your goal?

Compressor performance:

- Amp meter (or kW meter)
- Flow meter
- Pressure sensor
- Temperature sensor
- Weather/ ambient pressure

Demand side:

- Flow
- Pressure / pressure drop
- Temperature
- Dew point



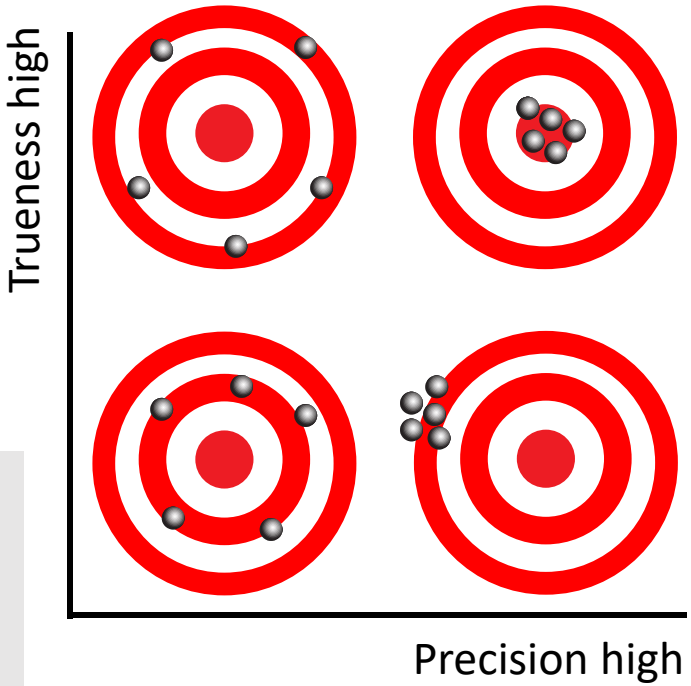
Understanding measurement uncertainties

Key to the right conclusions

Total Measurement Uncertainty (TMU):

- See ISO 17025 and similar directives
- Get familiar with the basics

$U=SQRT(U1^2+U2^2+U3^2..)$



Compressor performance example TMU's:

- Amp meter (or kW meter) : < 1% f.s.
  - -kW from amps vs real kW?
- Flow meter : +/- 5%
  - Inner pipe diameter
  - Flow profile
  - Temperature
- Pressure sensor : +/- 0.5% f.s.
- Temperature sensor : +/- 1 degree
- Weather/ ambient : +/- 20 mbar

Understanding measurement uncertainties

Key to the right conclusions

Some tips

- Know the uncertainty of all equipment involved
- Do not debate anything +/- 1%, first estimate the TMU
- System conditions can change: measure long enough
- Take seasonal/ weather/altitude influences into account

" Your average air consumption is 30.397 SCFM"

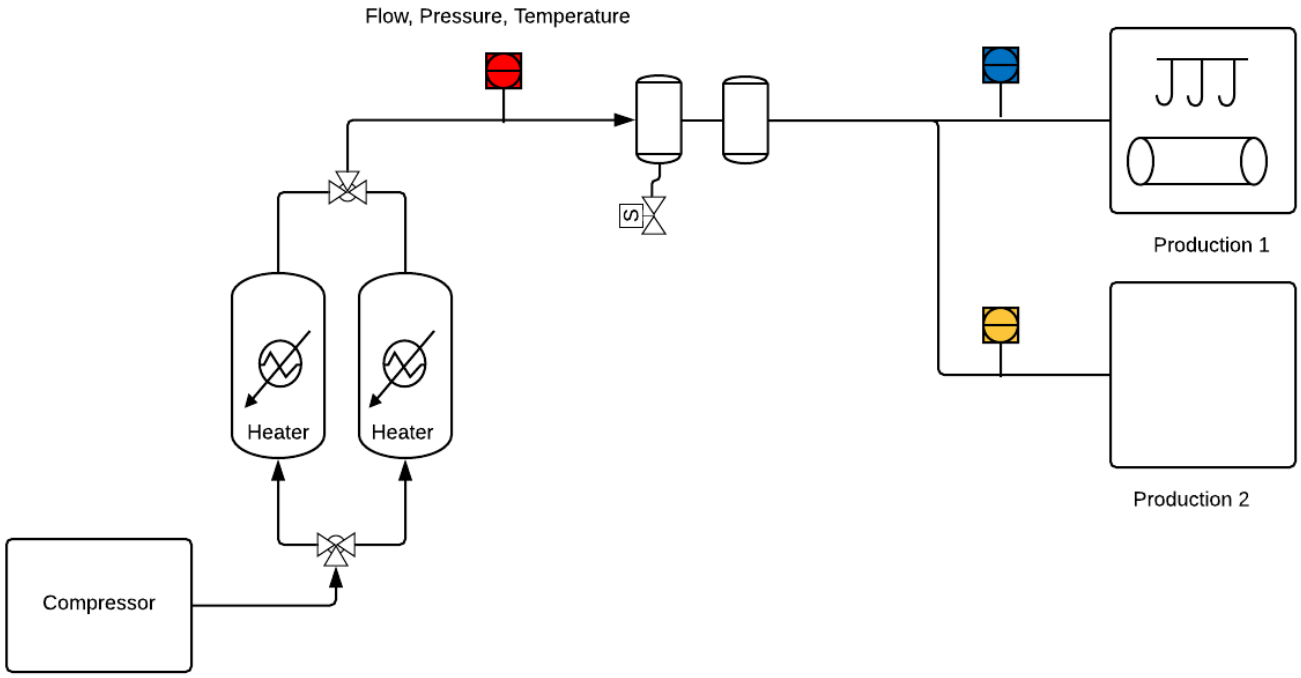
Should be re-phrased properly:
Your air consumption is **30** SCFM* +/- 5%, or:
Your air consumption is between 28.5 and 31.5 SCFM*

*Reference conditions: 68 F, 0% RH, 14.73 Psi(a)

1. Pressure issues

Optimize the control system

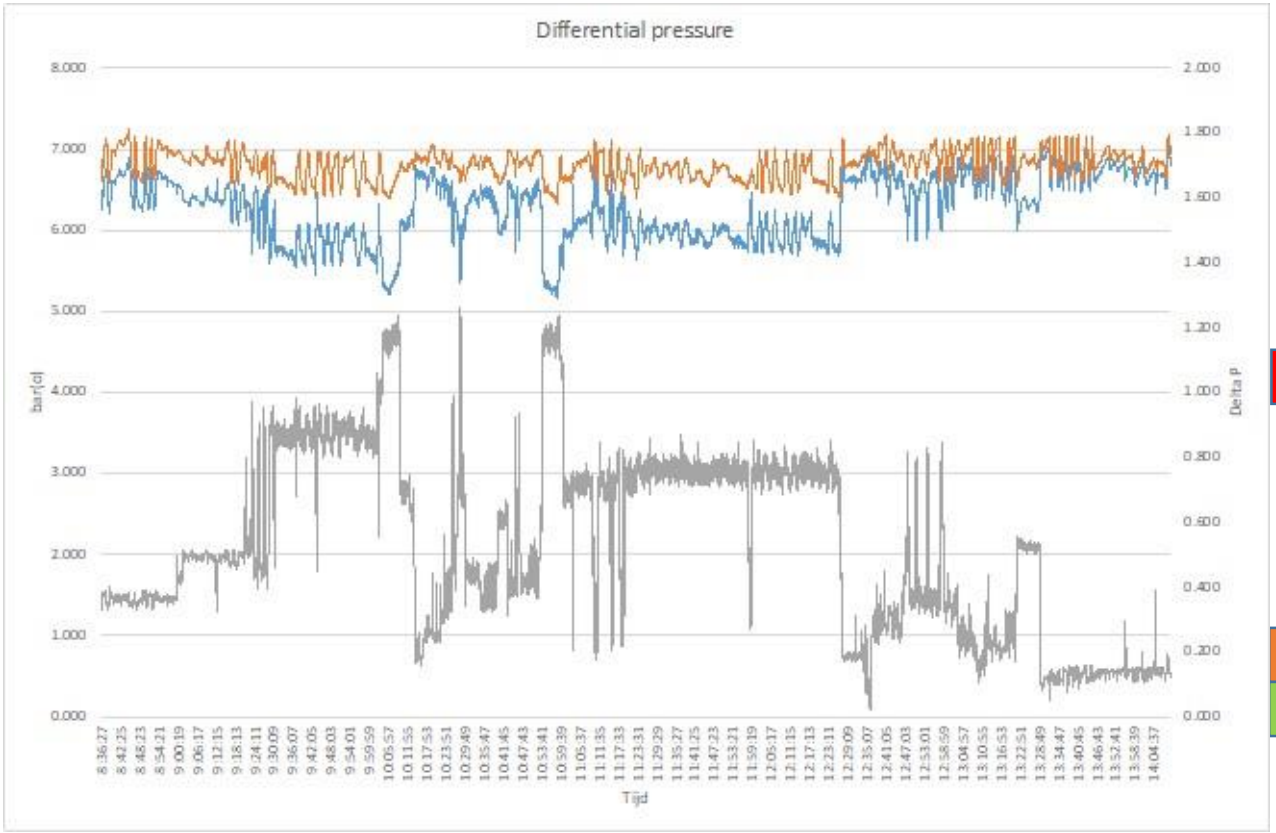
- Typical graph: Pressure drop over equipment
- Reasons: Receiver too small, Filters too small or internally polluted, pipe diameter too small for required demand, Control valve not properly tuned.
- Three in one flow meters can monitor system behavior



1. Pressure issues

Optimize the control system

Typical graph: Pressure varies significantly with flow
Reasons: Receiver too small, Control system not properly tuned, pipe size too small

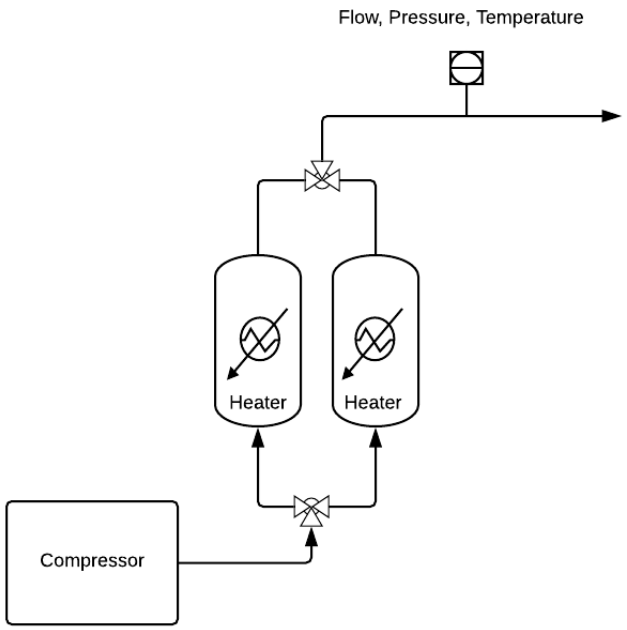


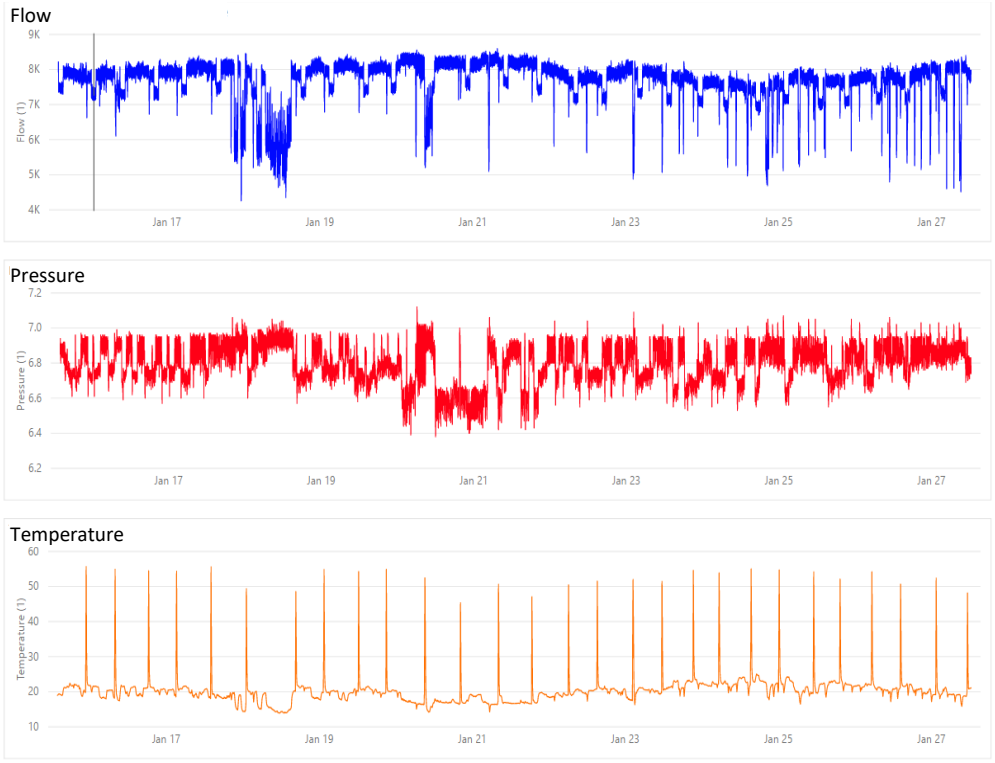
2. Dryers: Temperature

Large temperature swings or peaks

Symptoms:

- Temperature varies with demand or large temperature peaks
- Temperature difference before/ after dryer starts to increase when demand increases
- Reasons: Malfunctioning dryer, dryer too small for demand





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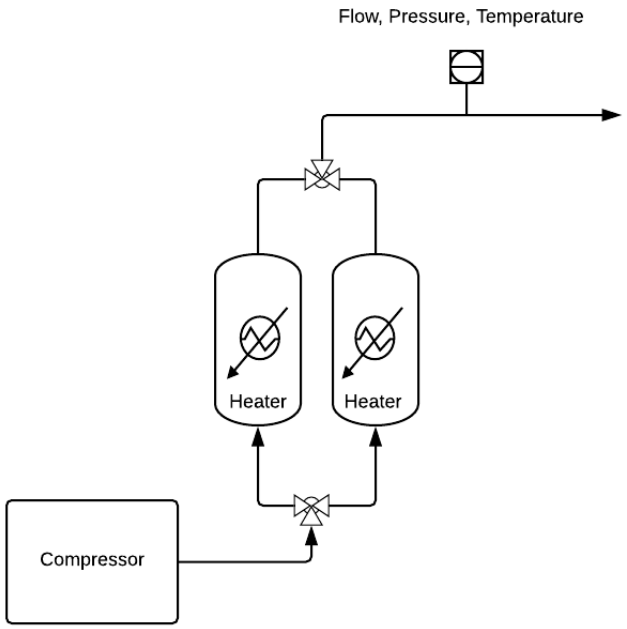
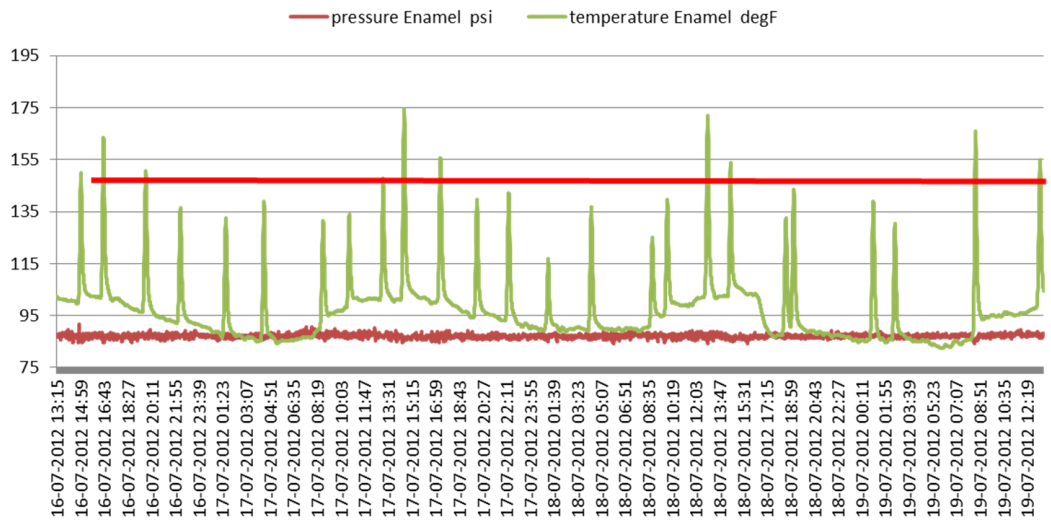




3. Demand side: production equipment

Revealing the savings opportunity with flow measurement

- See the effects of lower pressure on air demand
- See difference between nozzles

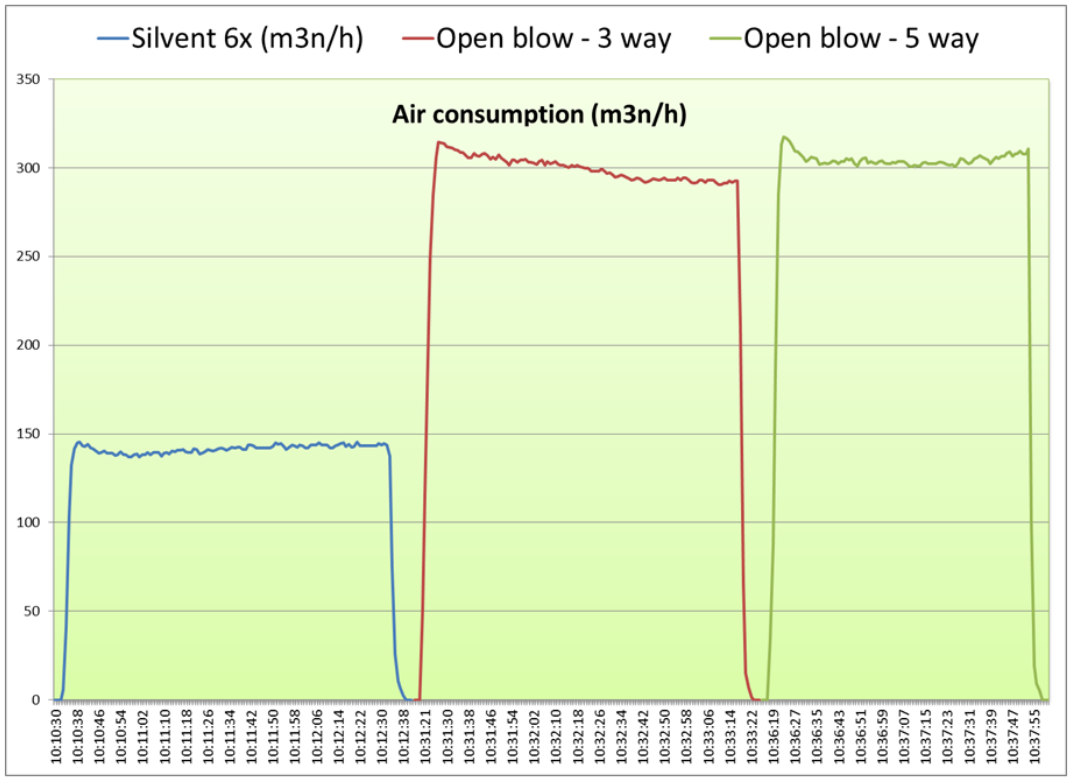
Open blow pipes (two bolts used to shut off)

Engineered nozzle

3. Demand side: production equipment

Revealing the savings opportunity with flow measurement

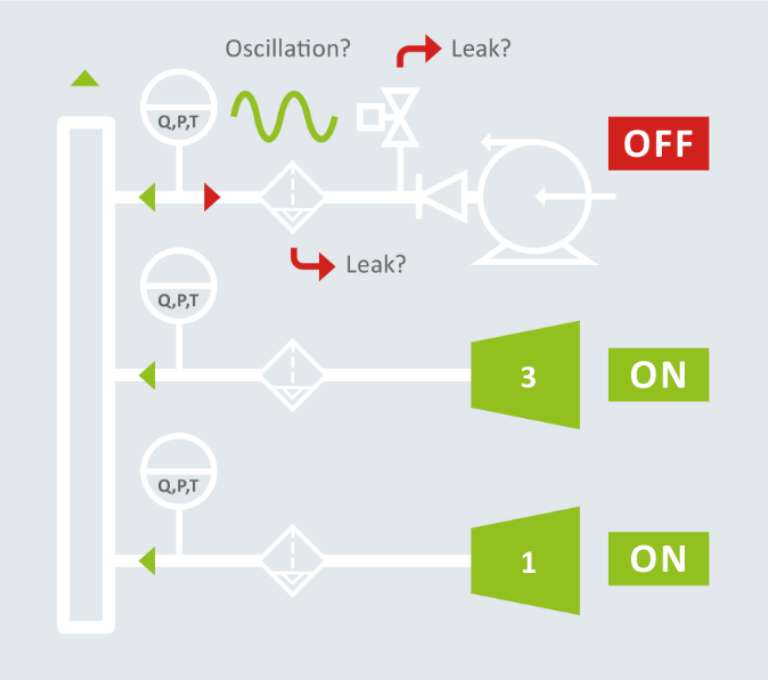
- Savings: 9 K USD per year
- Flow meter with integrated pressure sensor
- Real ROI calculation

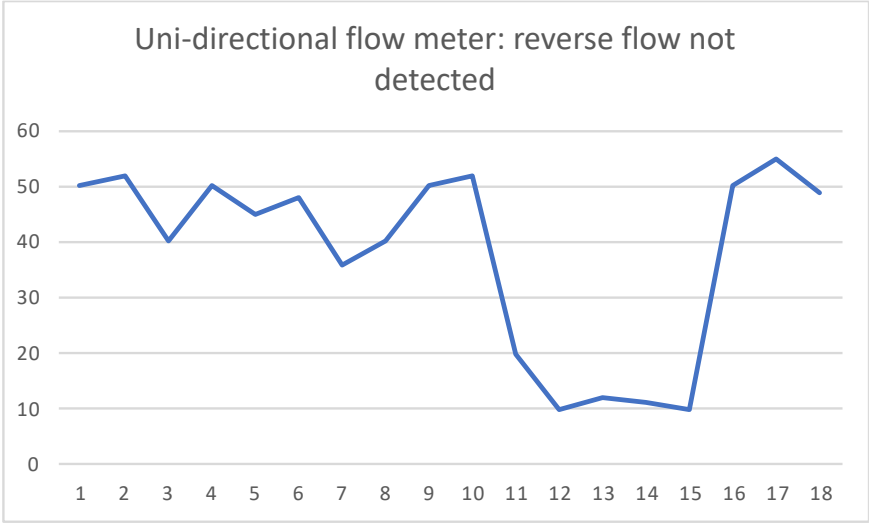


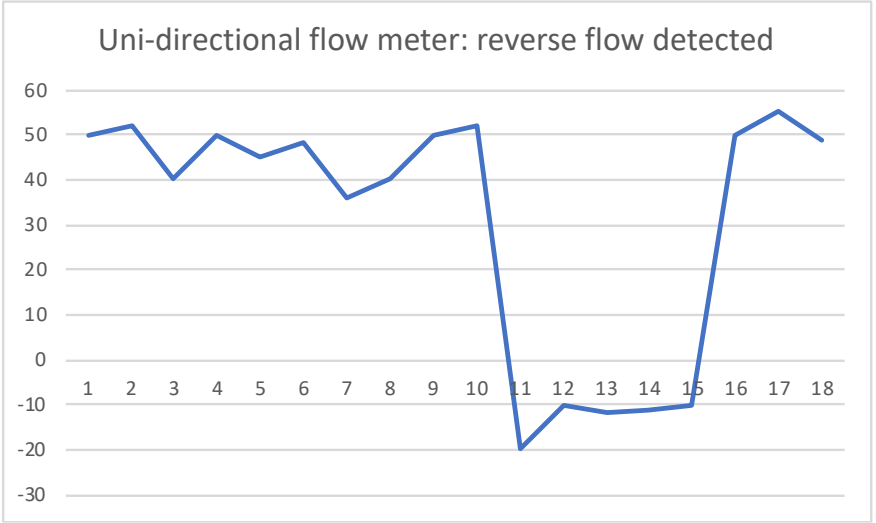
4. Bi directional flow measurement

Directing you towards the right conclusions

- Reverse flow: expensive mistakes
- Non return valves
- Receiving tanks



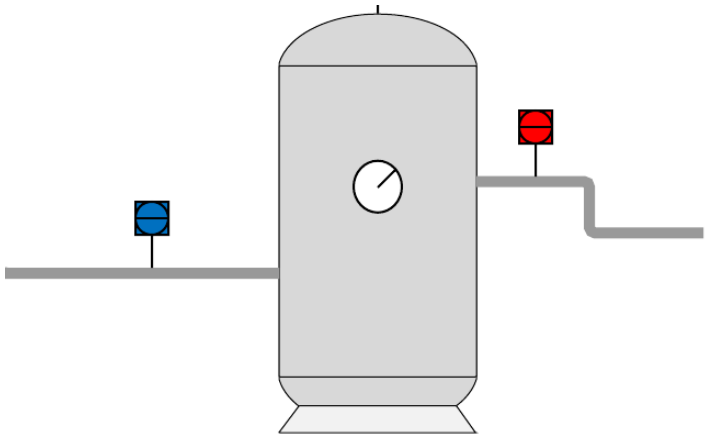


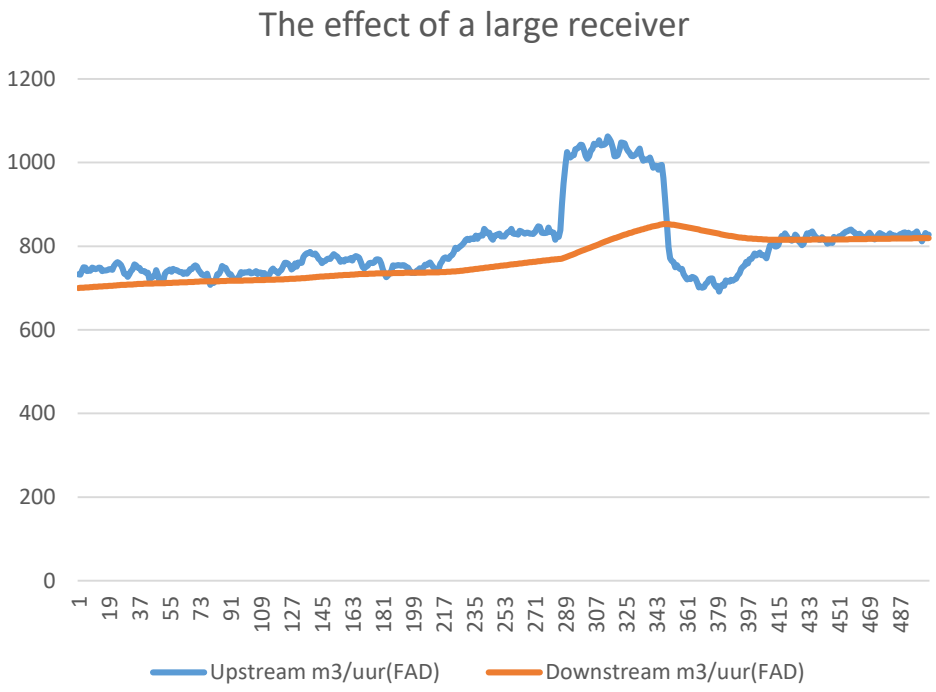


5. Receivers

Receivers are great signal filters

- Receiver tank: input is equal to output….
- Output is filtered
- Large receiver = large signal filter
- Downstream : filtered
- Upstream: unfiltered





Tips & conclusions

- Be alert/ reasonable on measurement uncertainties
- Combining signals reveals more savings
- Knowing the PID = Crucial for analysis
- Hire an expert/ auditor to help

Thank you!

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Keynote Speaker

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