The Role of Sensors and Instrumentation in Enhancing Air Compressor Performance

Ron Marshall
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Keynote Speaker

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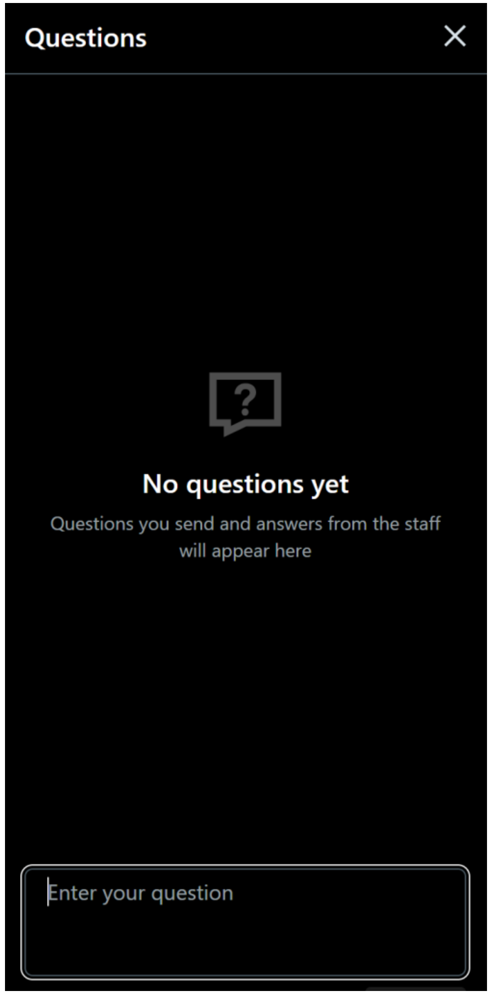

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BETTER AIR QUALITY
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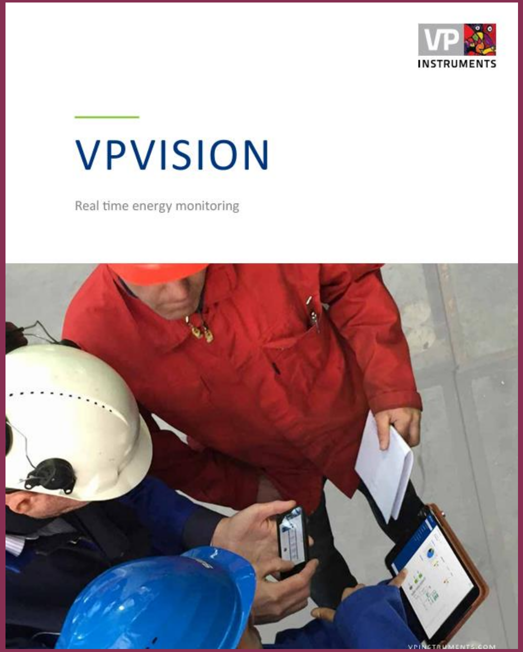
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Disclaimer

All materials presented are educational. Each system is unique and must be evaluated on its own merits.

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The Role of Sensors and Instrumentation in Enhancing Air Compressor Performance

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About the Speaker

Ron Marshall
Marshall Compressed Air Consulting

- Consultant MCAC
- 38 years with Power Utility
- 27 years Technical CA Support
- CAC Level 2 Instructor
- International Trainer UNIDO
- 900+ projects completed

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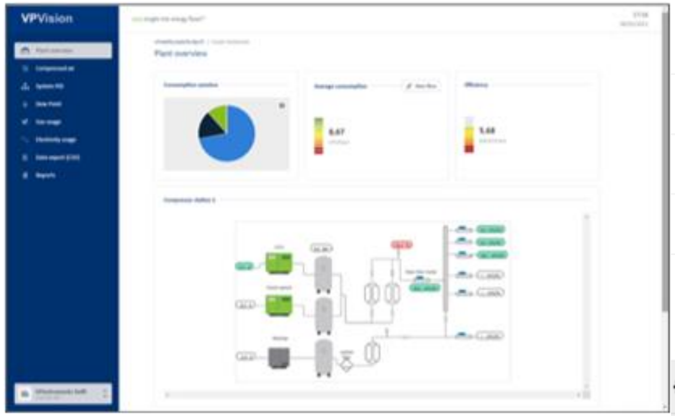
The Air Guy

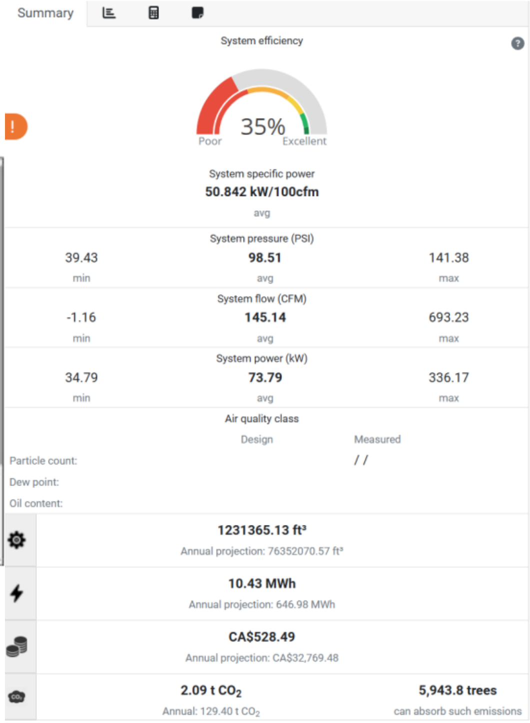
Coming Up – Temporary Data Logging

- Why measure?
- What do we measure?
- What can measurements tell us?
- Tools - data loggers and instruments
- Capture baselines and calculate KPIs
- Advanced data analysis
- Real life examples
  - Tractor Plant
  - Bus Manufacturer
  - Farm Implement
- Summary

Why measure – what's the benefit?

- Even the most basic automobile has instrumentation to help you operate.
- Yet, compressed air systems are often lacking even the most basic measurement instruments
- Without measurement it is very difficult to properly manage a compressed air system
- Management means:
  - Verifying proper operation
  - Controlling costs
  - Ensuring air quality
  - Detect impending problems
  - Managing system capacity
  - Troubleshooting problems



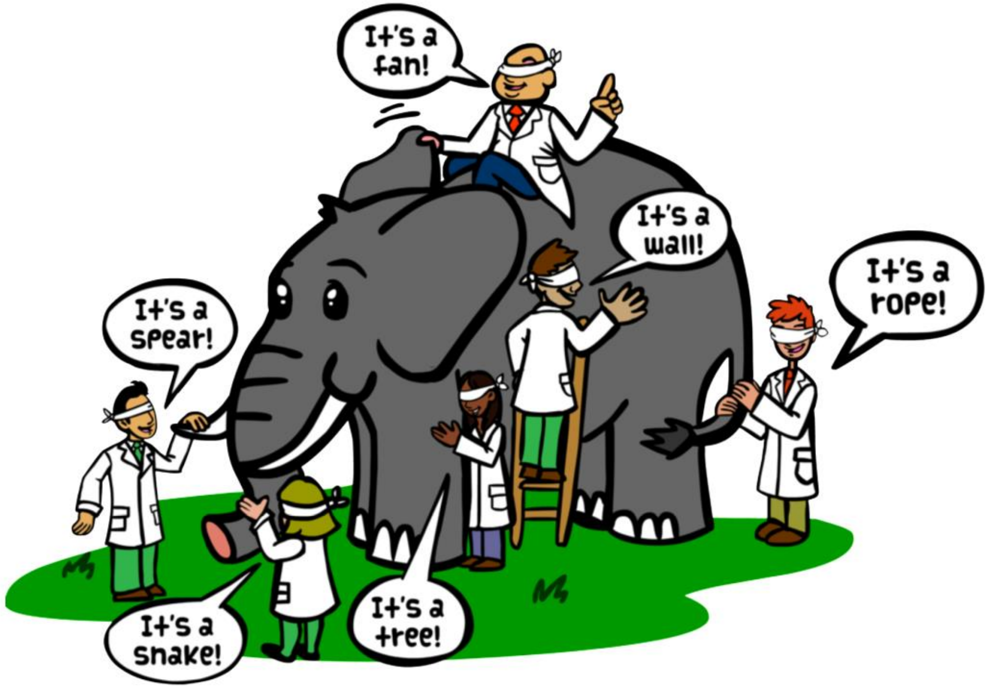


What do we measure?

Inadequate measurement can lead to incorrect interpretation of the data

Some common measurements:

- Pressure
- Amps / Power
- Flow
- Temperature
- Dewpoint
- Air quality

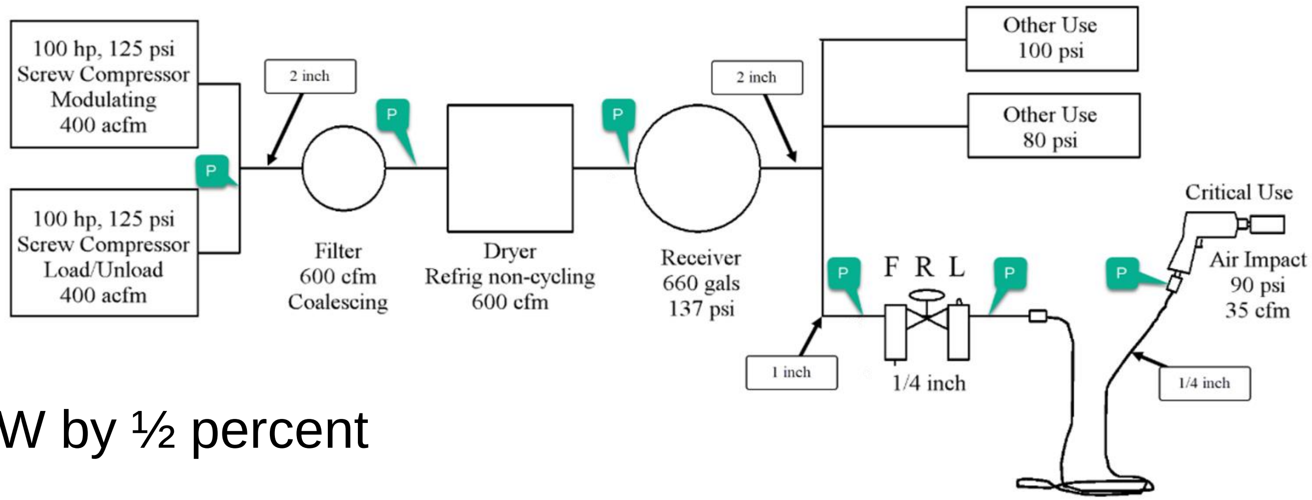


What do we measure - Pressure

Pressure Profile:

The pressure profile is the most important, some pressure points need to be defined:

- Compressor discharge
- Filter discharge
- Dryer discharge
- FRL inlet
- FRL outlet
- At tool (spot check)
- Note every extra psi increases kW by ½ percent

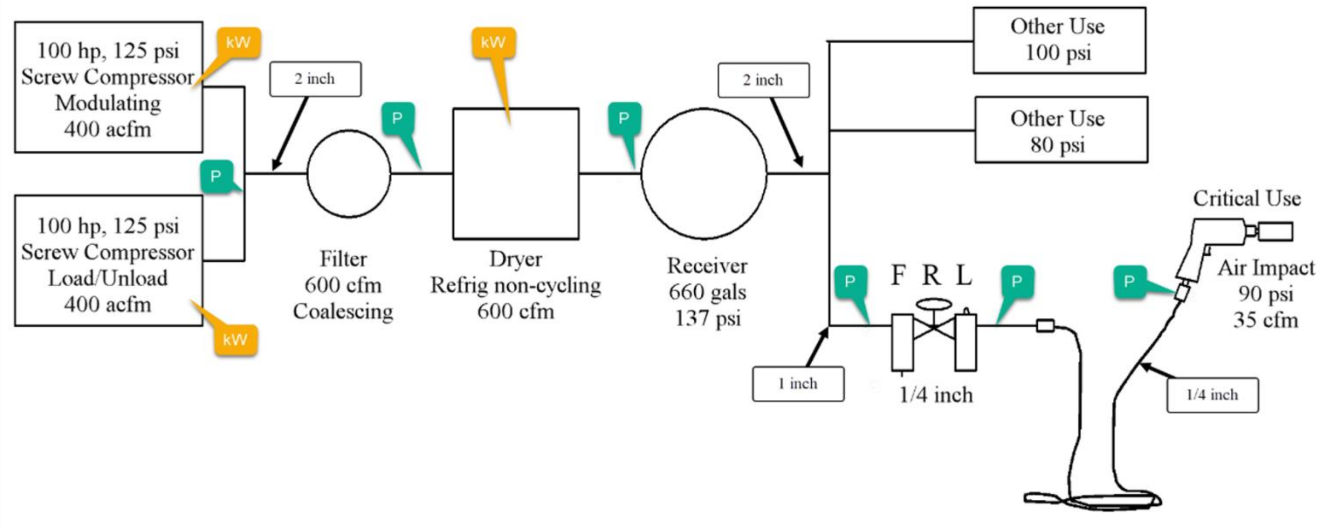


What do we measure - Power

Power/Energy Profile:

A power/energy profile will be required if annual costs are to be calculated:

- Compressor amps/volts/kW
- Dryer kW (optional)
- kW (fans or pumps optional)
- Cooling/Heating system

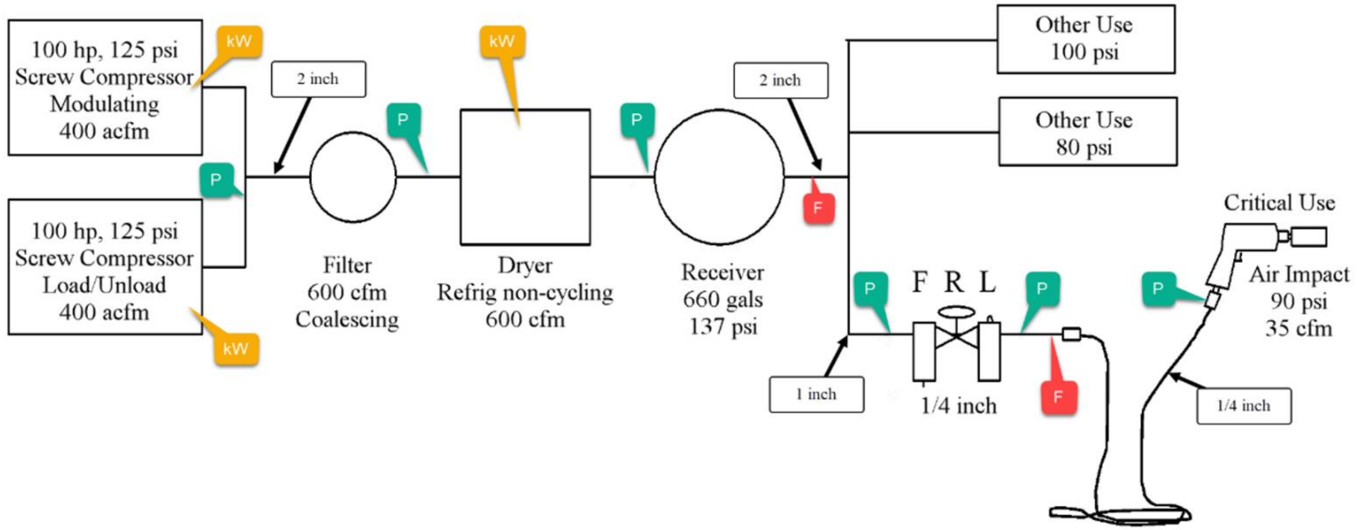


What do we measure - Flow

Flow Profile:

A flow profile will be important to assess kW per unit output:

- Compressor room discharge
- Flow to the critical user
- If flow meters not available for the compressors use calculated flow
- Leak load can be measured with this instrumentation or calculation method
- Location of flow meter can be important, flow characteristics differ

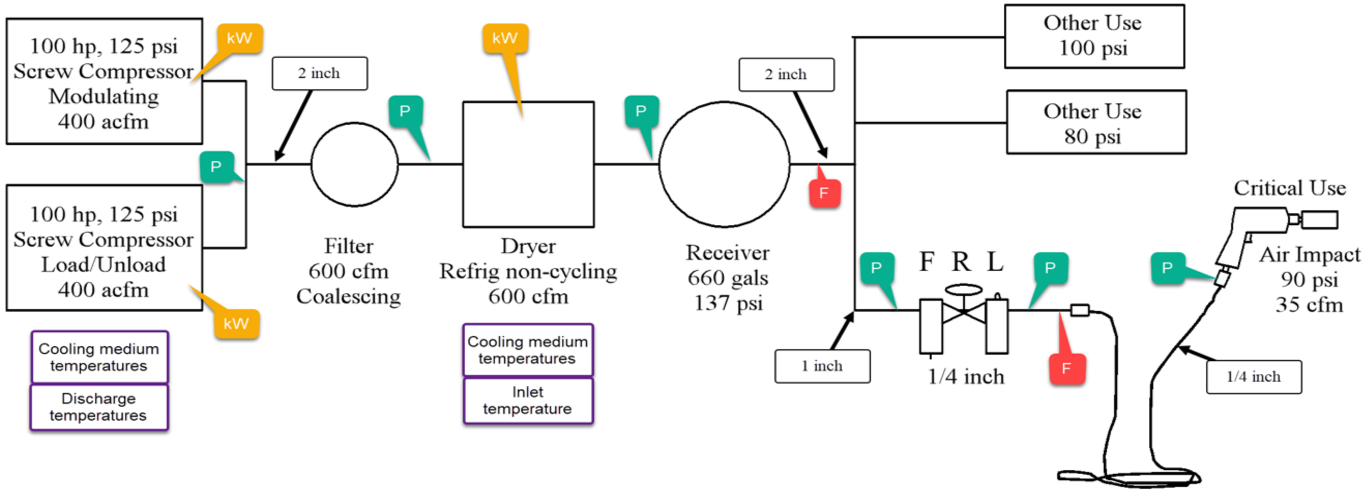


What do we measure – Temperature / Dewpoint

Temperature/Dewpoint Profile:

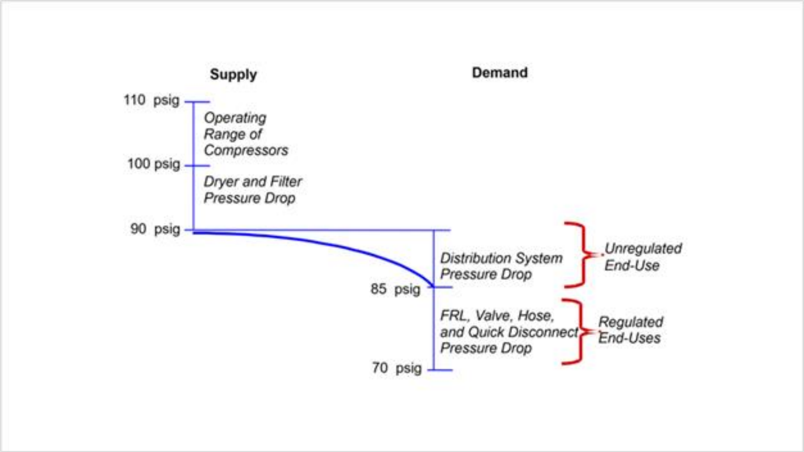
Temperature readings may be important in diagnosing problems. These could be spot check measurements or data logged over time:

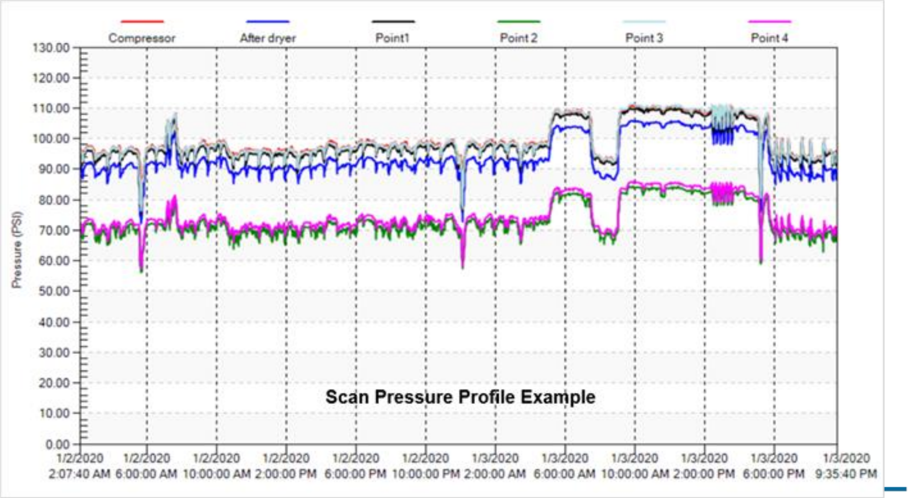
- Compressor ambient conditions and cooling medium
- Compressor internals (coolers)
- Compressor discharge temperatures
- Dryer inlet temperatures
- Dryer cooling medium temperatures
- Dewpoint measurements



What can measurements tell us?

- Goal for any compressed air system is to provide a clean, dry, stable supply of compressed air at the appropriate pressure in a dependable, cost-effective manner
- Measurements can tell us if we are meeting this goal and lead us to understand what can be done to improve the situation





Tools - Data loggers and Instruments

- System characteristics can be measured using accurate measurement instruments
- Time based data loggers are typically used to do temporary system audits
  - Independent data loggers
  - Base station loggers
  - Cloud based loggers
  - Some instruments can log data
- By far the easiest way to have a compressed air system measured is by bringing in a competent service company that already has a good set of measuring devices

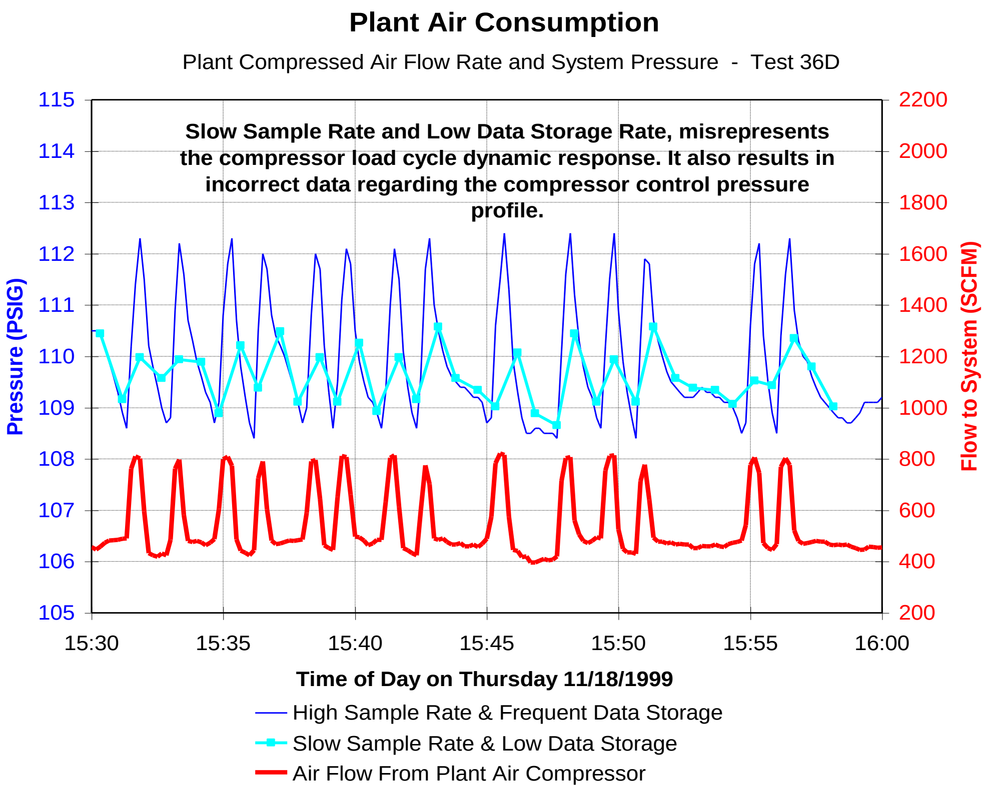






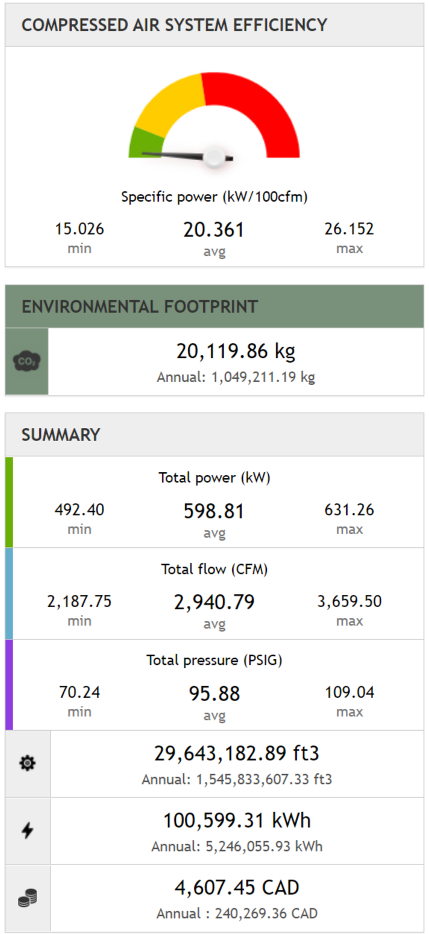

Tools - Data loggers and Instruments - Limitations

- Often a trade-off on sampling frequency due to memory limits – aliasing problems
- Inadequate sampling leads to interpretation errors
- Some loggers and instruments need external power – fail if accidently unplugged
- Flow meters installed incorrectly or getting wet cause errors, reverse flow cause incorrect assumptions
- Unmeasured parasitic flow
- Lack of easy to access measurement points
- Instruments out of calibration



Capturing Baselines and Calculating KPIs

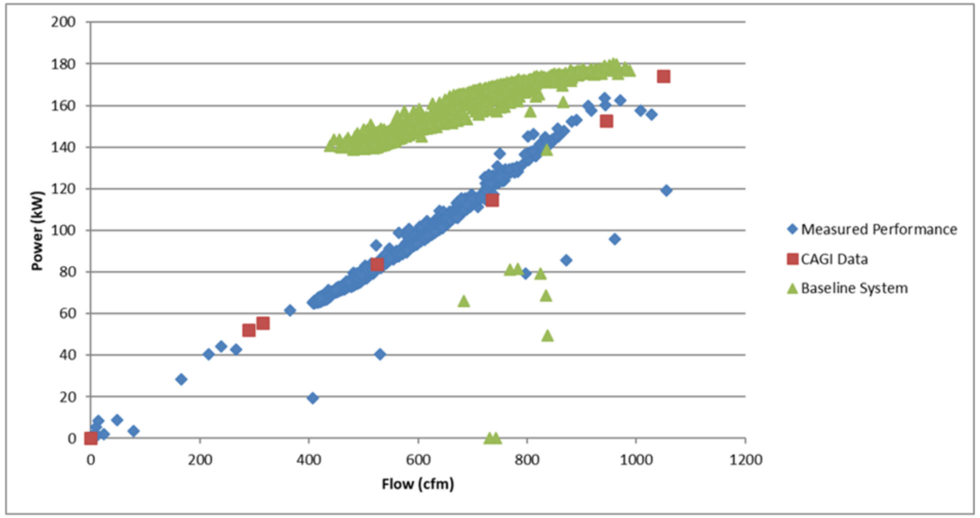
- Data logging allows us to capture baselines with which we can compare future or past operation
- Key performance indicators can be calculated from the data to show how well the system is operating
- Common KPI's
  - Specific Power
  - kWh
  - Annual cost
  - Leak Level %
  - Pressure in band %
  - kW per production unit output

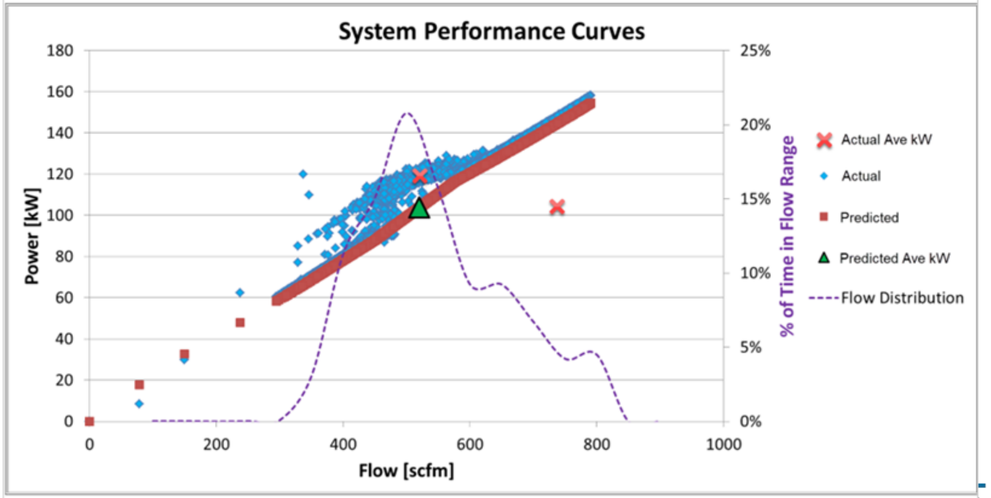


Advanced Data Analysis Using Captured Data

Data logging can be used to assess system power turn down with flow reduction:

- Data is smoothed and plotted on X:Y chart
- Current turn down can be plotted
- Predictions can be added to estimate potential savings by applying efficiency measures
- Anomalies can be discovered by analysis

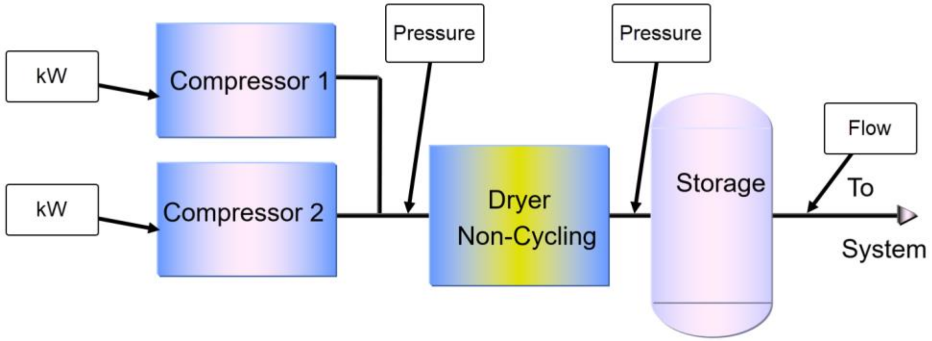




Real life examples – Tractor Plant

Tractor Plant:

- 2 x 200 hp compressors, 100 psi
- Load/unload control
- Two 2,000 cfm WC non-cycling dryers



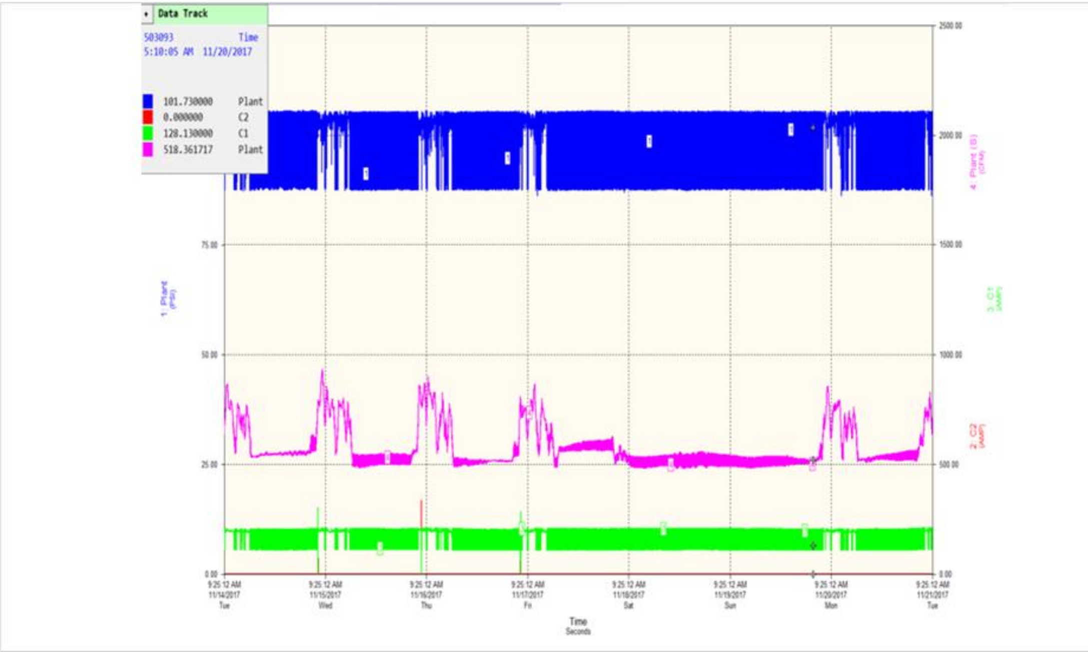
Problems experienced:

- Air system ran 24 hours a day, seven days a week but production shift was only 8 hours x 5 days per week
- Unknown compressed air energy costs and flows

Real life examples – Tractor Plant

Data analysis showed the following:

- Plant pressurized 24 hours x 7 week
- Production 10 hours, 5 days per week
- Average pressure 98 psi
- Average flow 540 cfm
- Non-production flow 510 cfm
- Compressor average power 148 kW
- Dryer average power 14 kW
- Compressor SP 27 kW/100 cfm
- Including dryer SP 30 kW/100 cfm



	Hours	kW	kWh	$ Cost
Compressor	8760	148	1,296,480	$ 31,974
Dryer	8760	14	122,640	$ 2,190
Total	8760	162	1,419120	$ 141,912

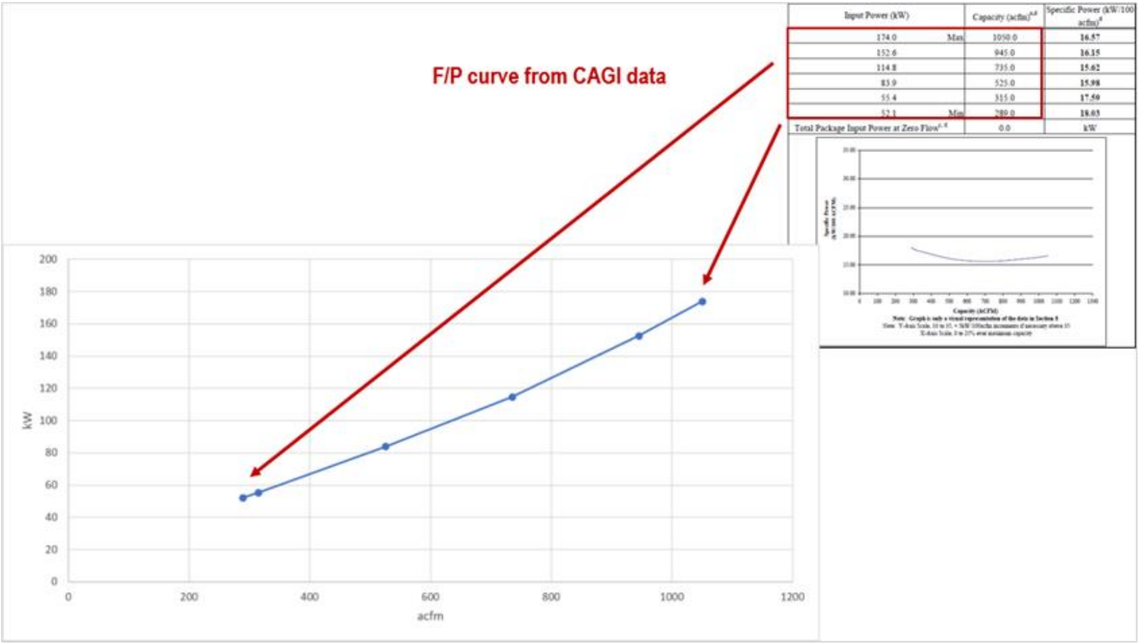
Real life examples – Tractor Plant

New Equipment:

- New two stage VSD compressor
- Cycling dryer

Additional measures:

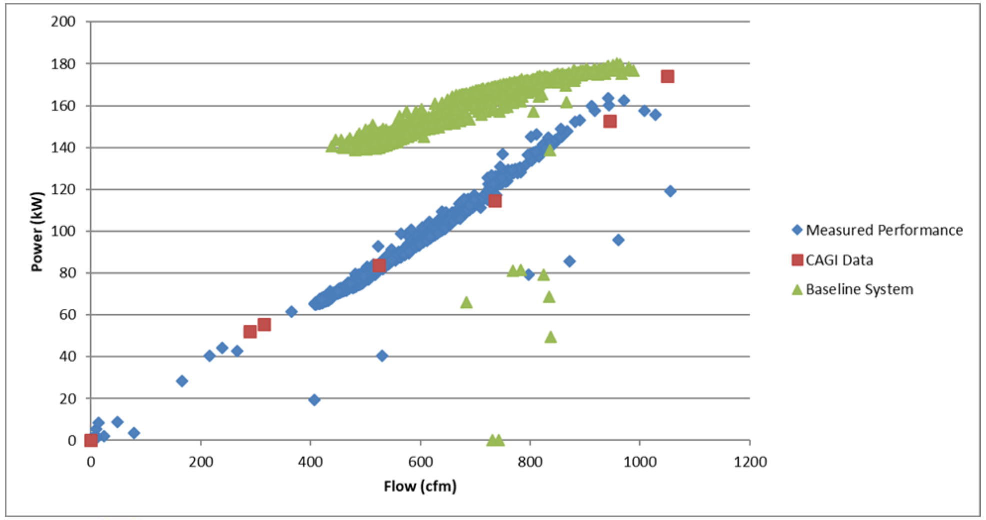
- Reduce Leaks
- Eliminate off hours end uses
  - Air motors to mix paint, found to be not needed
  - Office HVAC system pneumatics 2 cfm
- Turn off compressed air system 70 hours per week
- Right size the dryers



Real life examples – Tractor Plant

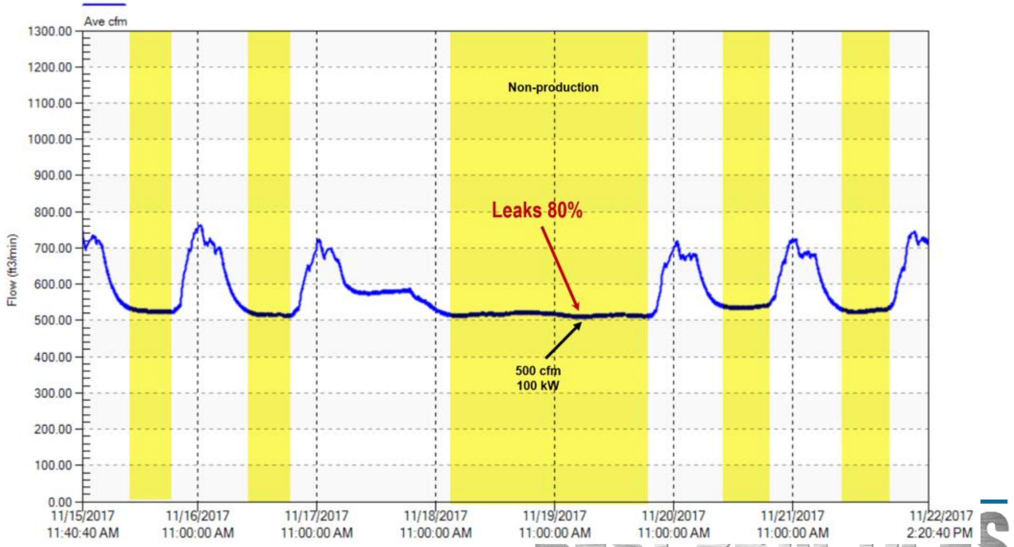
Leakage repair:

- Using 16 kW/100 cfm 100 cfm reduction = 16 kW
- About 140,000 kWh annual reduction expected
- $14,000 in reduced cost



Reducing run time:

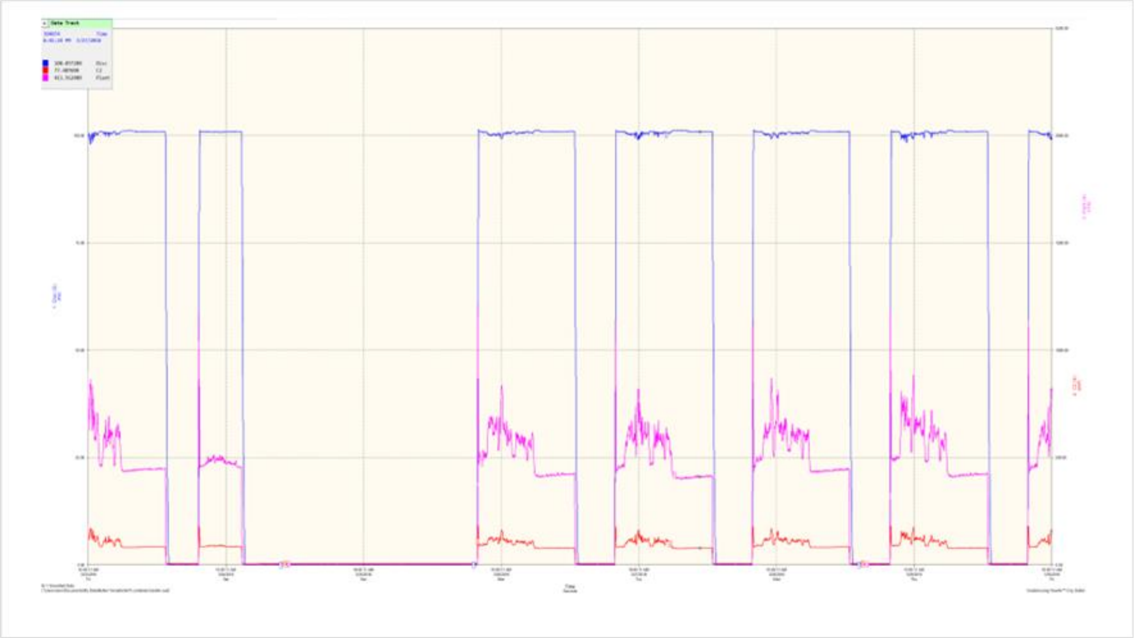
- 52 kW at 510 cfm
- Estimated 70 hours per week
- 3,650 less hours operating
- 309,000 kWh for $30,900 saving
- Small HVAC compressor added $440 per year



Real life examples – Tractor Plant

Verification logging:

- Showed savings slightly less than expected
- Investigation showed less leaks repaired than expected
- Leak repair still ongoing
- Turning off the system during off hours indirectly reduced leakage load by 40%



	Savings Annual	Install Cost
Electrical Savings	$ 90,280	$ 84,500
Heat Recovery	$ 3,500	$ -
Reduced Maintenance	$ 2,500	$ -
Total	$ 96,280	$ 84,500
Simple Payback	10.5	months

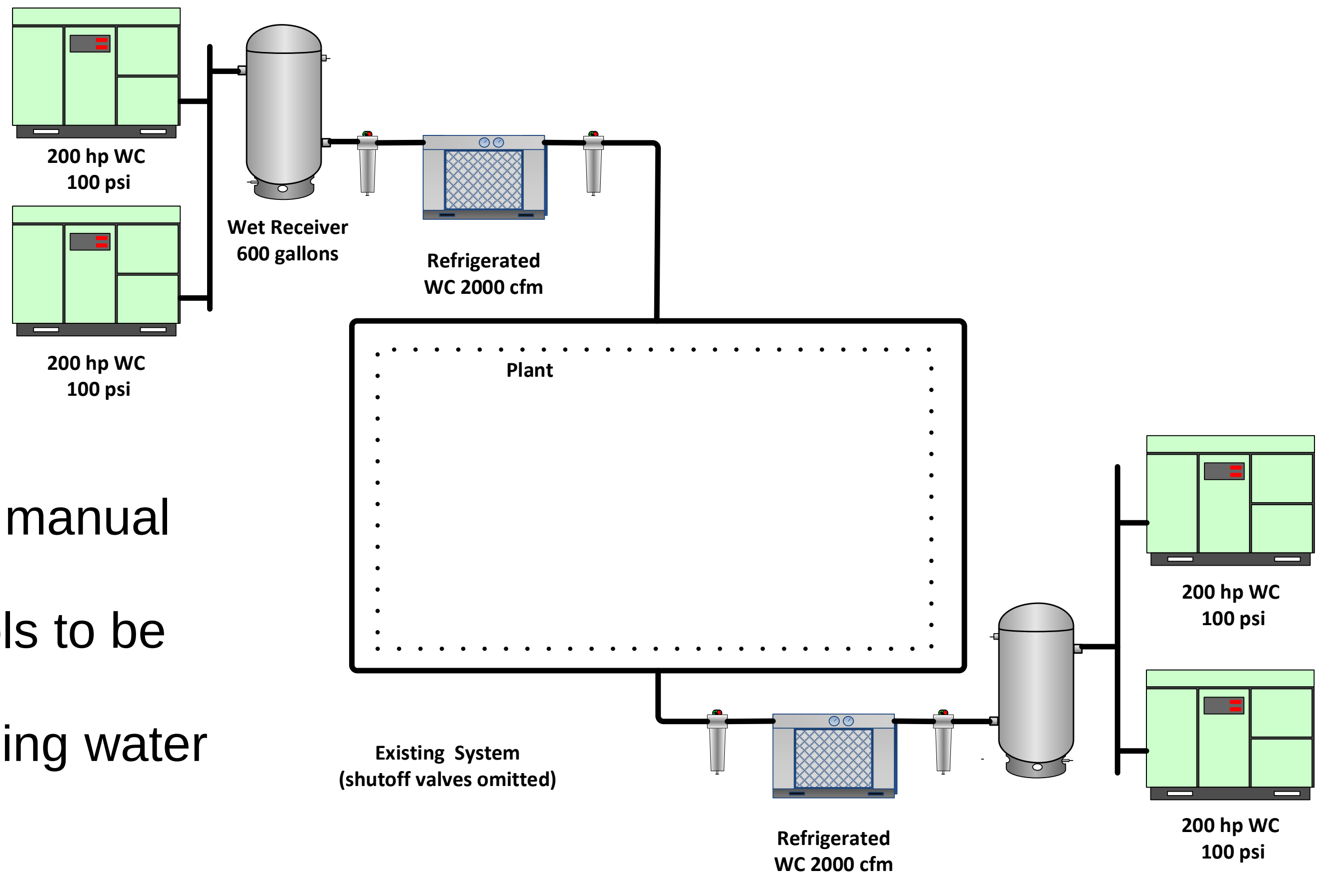
Real life examples – Foundry

Foundry:

- 4 x 200 hp compressors, 100 psi, WC
- Modulation control
- Two 2,000 cfm WC non-cycling dryers

Problems experienced:

- Poor pressure control
- Compressors ran during non-production time, manual intervention was required
- Compressors overheating requiring the controls to be set up to share the load
- Dew point problems due to dryer failures, cooling water was of low quality causing the dryers to trip
- High maintenance costs
- Unknown compressed air energy costs and flows



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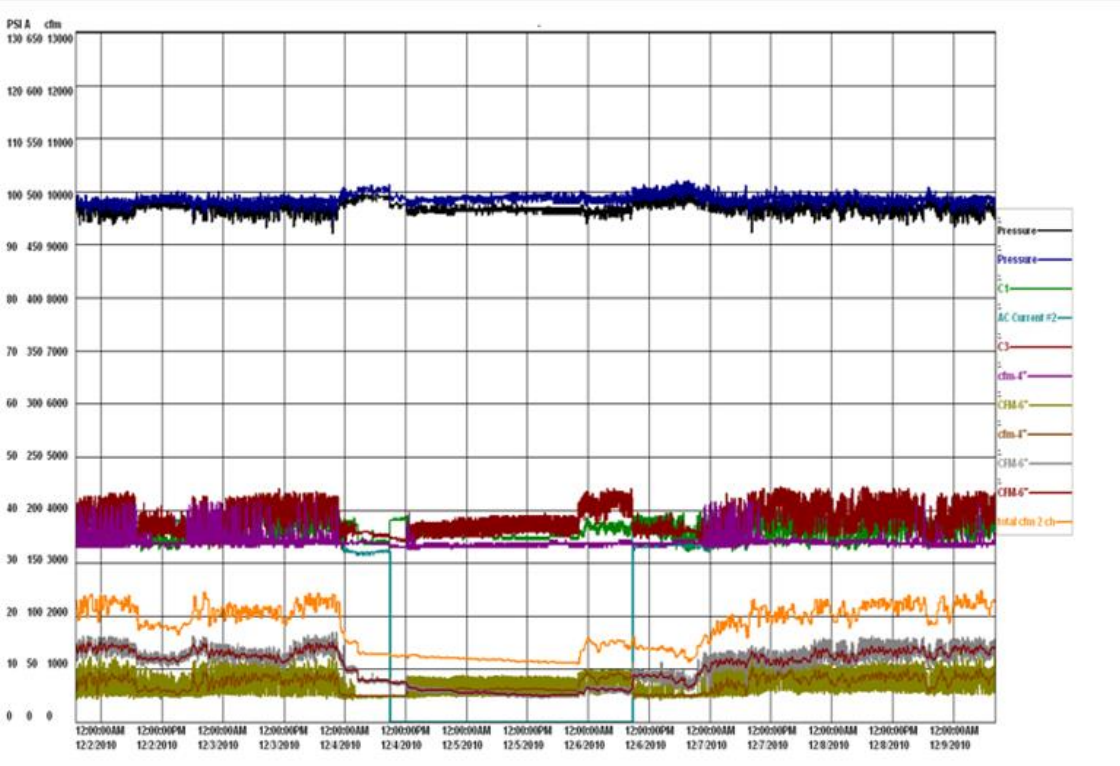
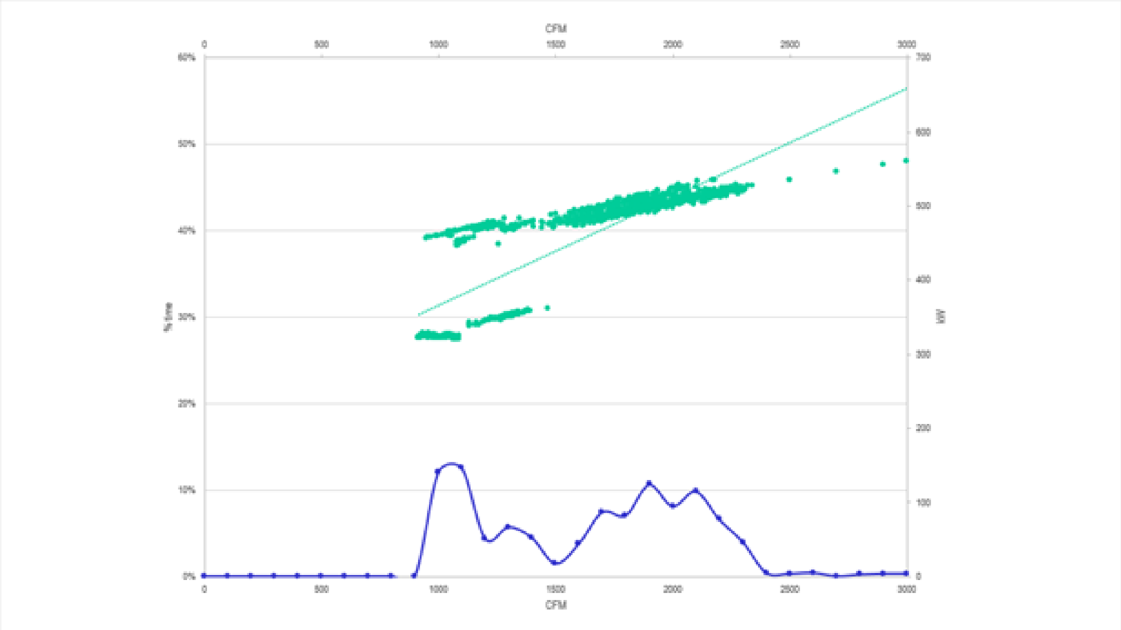


Real life examples – Foundry

Data analysis showed the following:

- Operates 24 hours x 7 days, at an average of 99 psi, production 5 days per week for 6,000 hours
- Four compressors were often running during non-production
- Average flow 1,730 cfm
- Non-production flow 900 cfm indicating high leakage
- Compressor average power 450 kW
- Dryer average power 28 kW
- Compressor SP 26 kW/100 cfm
- With dryers the SP was 28 kW/100 cfm



	Hours	kW	kWh	$ Cost
Compressors	8,760	450	3,942,000	$ 394,200
Dryers	8,760	28	245,280	$ 24,528
Total	8,760	478	4,187,280	$ 418,728

Real life examples – Foundry

Efficiency Measures:

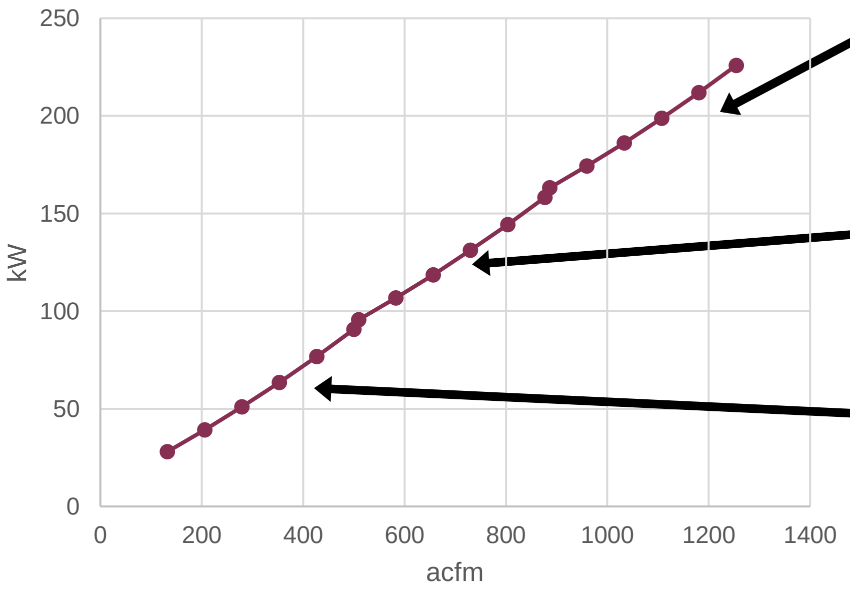
- Add 4 – 200 hp two-stage compressors, one with VSD
- Replace the non-cycling dryers with cycling air cooled
- Better controlling the compressors by adding sequencing control
- Increase storage capacity to aid compressor control
- Reduce leaks and inappropriate uses

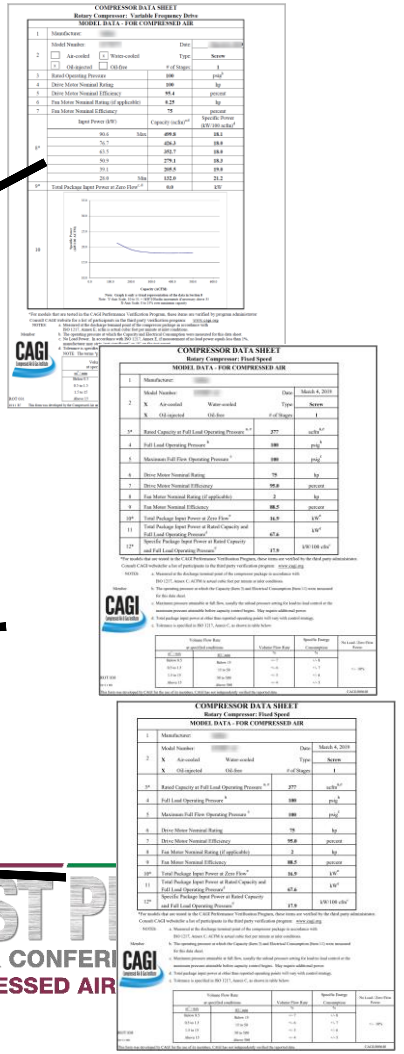
MODEL DATA - FOR COMPRESSED AIR			
1	Manufacturer:		
2	Model Number:	Date:	February 7, 2012
	Air-cooled X Water-cooled	Type:	Screw
	X Oil-injected Oil-free	# of Stages:	2
3*	Rated Capacity at Full Load Operating Pressure [a, e]	1051	acfm [a,e]
4	Full Load Operating Pressure [b]	100	psig [b]
5	Maximum Full Flow Operating Pressure [c]	100	psig [c]
6	Drive MotorNominal Rating	200	hp
7	Drive Motor Nominal Efficiency	95.8	percent
8	Fan Motor Nominal Rating (if applicable)	-	hp
9	Fan Motor Nominal Efficiency	-	percent
10*	Total Package Input Power at Zero Flow [e]	44.6	kW [e]
11	Total Package Input Power at Rated Capacity and Full Load Operating Pressure [d]	178.3	kW [d]
12*	Specific Package Input Power at Rated Capacity and Full Load Operating Pressure [e]	17.0	kW/100 cfm [e]

Real life examples – Foundry

Predicting a system curve

- Multiple CAGI data sheets can be combined for a complete curve (compound line)
- Using captured flow data the savings can be predicted
- Optimized curve approximates a straight line





Real life examples – Foundry

Verification logging results:

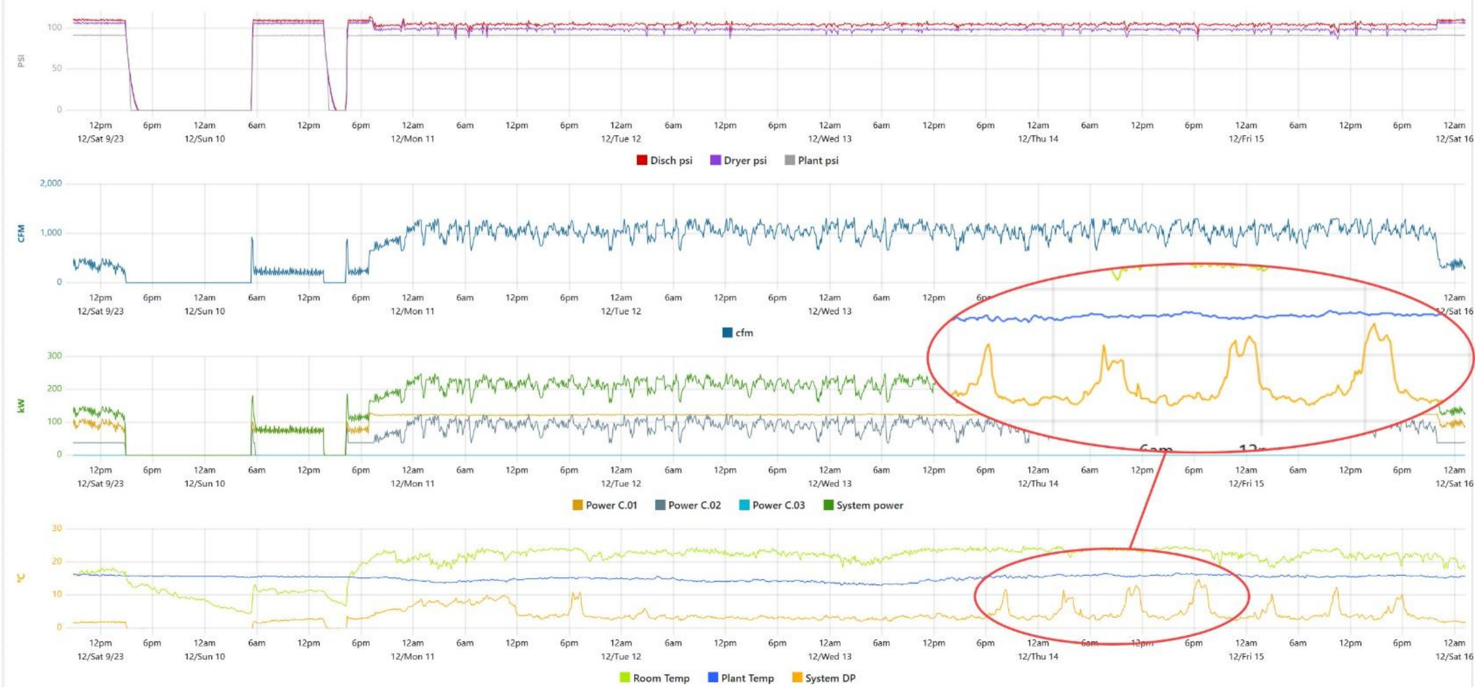
- Savings slightly less than expected
- Investigation showed compressor SP higher than expected but within CAGI tolerances
- Due to sizing there was some control gap issues, VSD should have been larger than base units
- Project payback including additional benefits 1.8 years

	Hours	kW	kWh	$ Cost
Compressors	8760	256	2,242,560	$ 48,618
Dryer	8760	18	157,690	$ 3,066
Total	8760	274	2,400,240	$ 51,684
Saved	8760	204	1,787,000	$ 178,700

	Savings Annual	Install Cost
Electrical Savings	$ 178,700	$ 340,710
Reduced Maintenance	$ 12,000	$ -
Total	$ 190,700	$ 340,710
Simple Payback	1.8	years

Real life examples – Farm Implement - Troubleshooting

- Poor dewpoint experienced in Paint Shop
- Dryer display showed good reading
- Did not show as flow related
- Inlet temperature good
- Room temperature OK
- External probe showed regular spikes



Real life examples – Farm Implement - Troubleshooting

Cause:

- Failed dryer drain
- Internal separator filled up then released all the water (and oil) into the system
- Service company did not believe the suspected cause until showed the data
- Drain replaced and system went to normal

Summary

- Stop operating blind – measure your system
- Measurement is essential for proper management
- A variety of instruments are available
- Measure pressure, power, flow, dewpoint with time-based data loggers, realize limitations
- Assess and analyze data for problems
- Calculate KPIs to assess system efficiency and hidden problems
- Use the captured data to predict savings
- Verify any projects to prove the savings by measuring again
- Use data loggers for troubleshooting – best scenario leave the loggers on permanently to ensure sustainable energy savings

About the Speaker

Pascal van Putten
VPInstruments

- CEO, VPInstruments
- > 20 years experience
- VPInstruments offers industrial clients Energy Management Solutions for compressed air, technical gases as well as other utilities

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Revitalizing Efficiency: Permanent Monitoring

Key to maximum energy savings

Why permanent monitoring?

Because you want to:

- Maintain your savings
- Optimize maintenance intervals
- Benchmark your system
- Compliance (EED, Energy Rebate)
- Peace of mind

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Example project: Furniture

Measurement with 4-in-1 flow meters:

- Compressor room efficiency
- Dew point
- Leaks at dust collectors → broken valves

Results

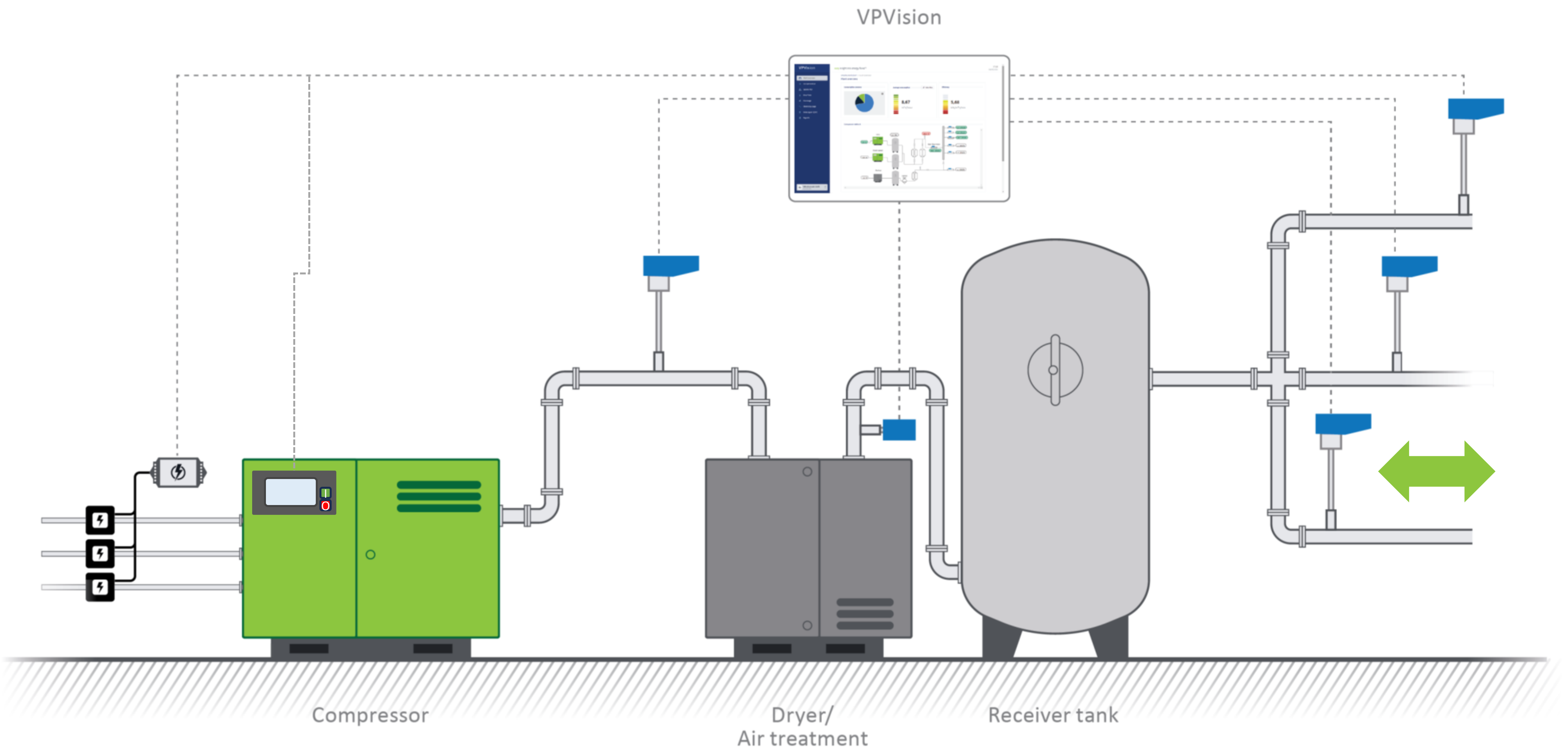
- Higher efficiency thanks to more efficient compressors with master controller
- 1 compressor turned off thanks to lower air consumption
- Peace of mind, thanks to early alerts

ROI

- 2 years

“It gives you a good sleep at night”

How to monitor a compressed air system



Tips for selecting the right system

- ✓ Customizable dashboards to monitor your important KPI’s
- ✓ Including Alarm module for immediate action
- ✓ Report module to your email box
- ✓ Easy expandable: future proof
- ✓ Sensors at the right locations, matching requirements
- ✓ Open data (API) to communicate with other systems (ERP, MRP, CRM)
- ✓ Supplier with proper know-how and support
- ✓ Cyber security: Data ownership/ cloud or on-premise/ redundancy

How to start: Decide on main KPI's

INSTRUMENTS

1. Define your goals and KPI's

Efficiency	Leakage rate	Cost per X
Dew point	Pressure loss	#Shutdowns/ product scrap
Total power consumption	Total air consumption	#Pressure events

How to start: Decide on main KPI's

1. Define your goals and KPI's

Efficiency	Leakage rate	Cost per X
Dew point	Pressure loss	#Shutdowns/ product scrap
Total power consumption	Total air consumption	#Pressure events

How to start?

2. Perform an initial audit

Identify current state

- Compressors' kW
- Compressed air consumption (bi-directional), pressure and temperature (dry side, main header)
- Pressure downstream
- Suspicious areas / consumers
- Leave the audit equipment in place!

How to start?

3. Analyze audit results

How much can you save:

- What are the top 3 issues?
- What is the savings potential?
- What will be the ROI?
- How to maintain savings?

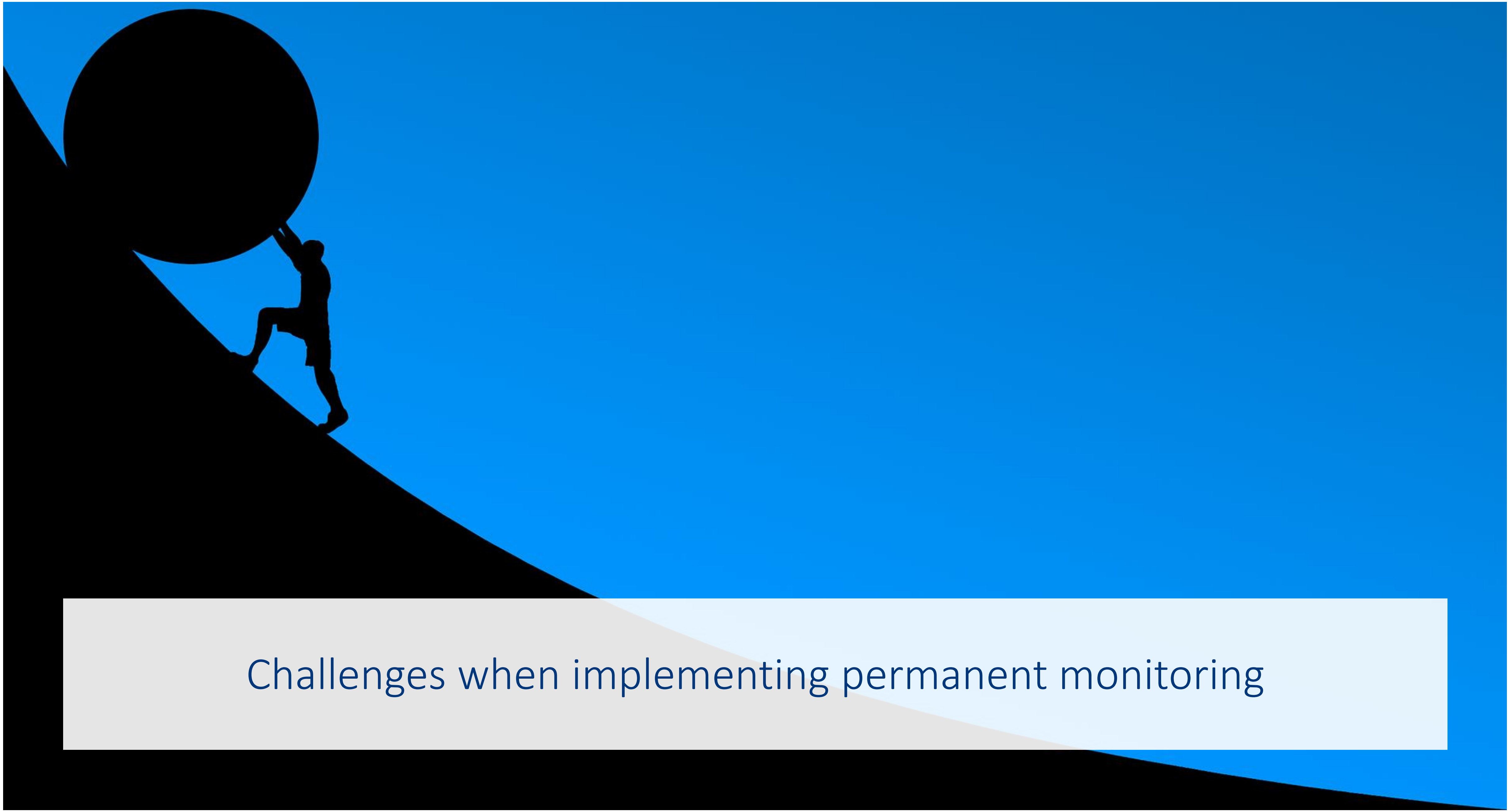
How to start?

4. Install permanent monitoring system

Maximize and maintain your energy savings

- Leave audit equipment (sensors) in place
- Configure alarms, KPI’s and make them available
- Energy savings create funding budget: Expand to other areas

Efficiency	Leakage rate
Dew point	Total air consumption



Challenges when implementing permanent monitoring

Challenges

People:

It’s all about habits and behavioral change

- Lack of interest
- Lack of engagement
- Other priorities
- Lack of experience

Example project: Steel plant

Bag filter houses

- 1000 filter bags: 1 pulse per minute to clean filters
- Specs: ~450 SCFM consumption

Findings

- ~ 750 SCFM actual consumption
- Filters clogged completely
- Root cause: Broken membrane valves

Savings

- 25 K USD savings per year:
- Savings pays monitoring and spare part budget
- Less time wasted on maintenance

Conclusions

Why permanent monitoring will revitalize the efficiency of your plant:

- Proactive approach
- Data-driven investment strategies
- Structured maintenance policies
- Maximized ROI through savings

Challenges:

- Selecting and installing of the right equipment
- People/ behavioral change
- Stakeholders and conflicting interests

Ready for action?

Book a FREE consultation session!

Or leave your questions here:

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The Role of Sensors and Instrumentation in Enhancing Air Compressor Performance

Q&A

Please submit any questions through the Question Window on your GoToWebinar interface, directing them to Compressed Air Best Practices Magazine. Our panelists will do their best to address your questions and will follow up with you on anything that goes unanswered during this session.

Thank you for attending!

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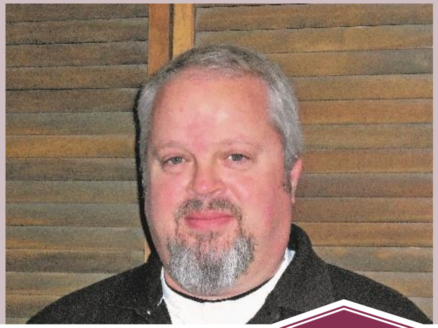
January 2025 Webinar

Designing Low Pressure-Drop Piping Systems for Optimal Compressed Air Flow



Don Van Ormer
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