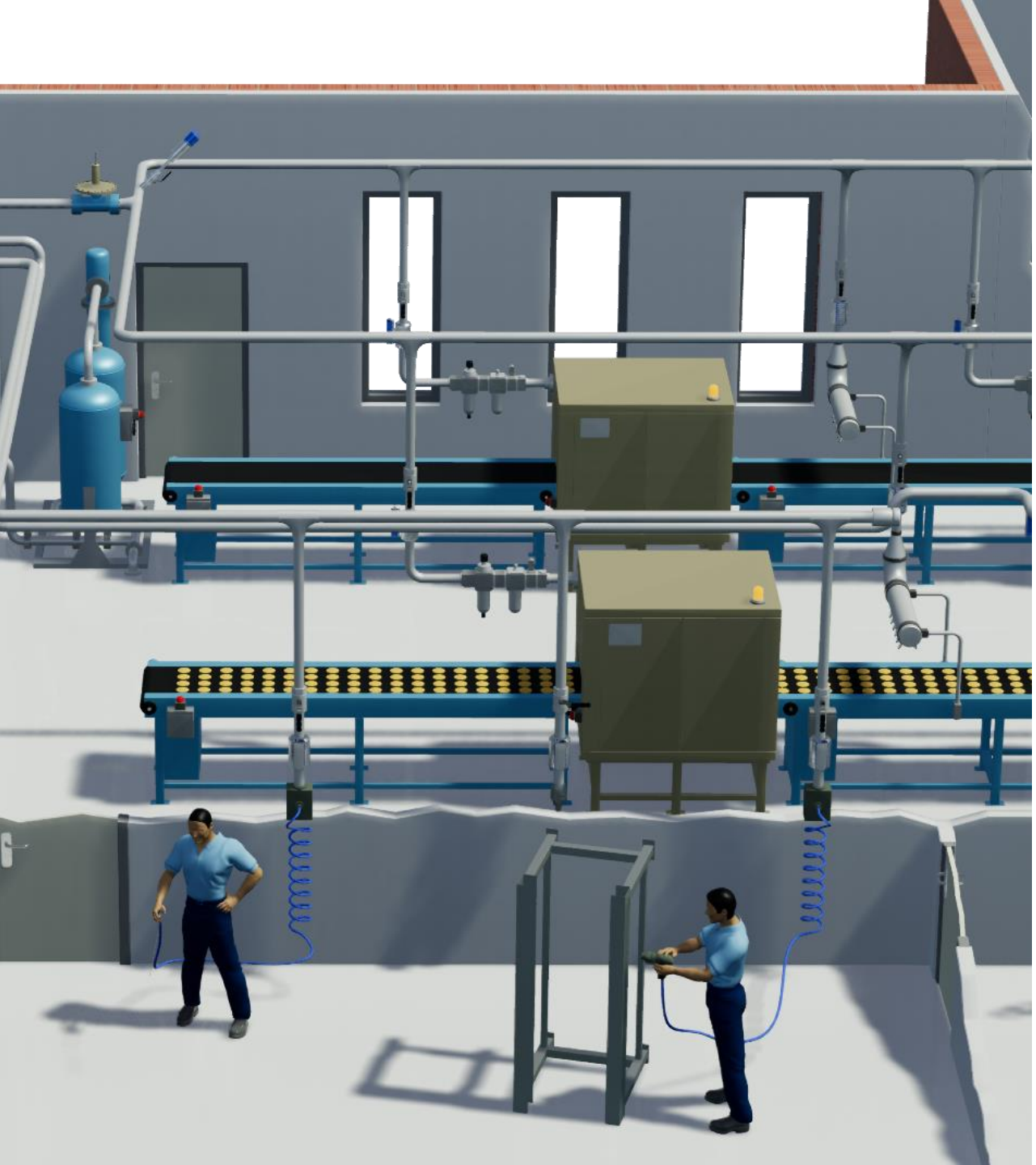


VP INSTRUMENTS

System Measurement: Demand Side

Best Practices

IETC, December 9, 2020

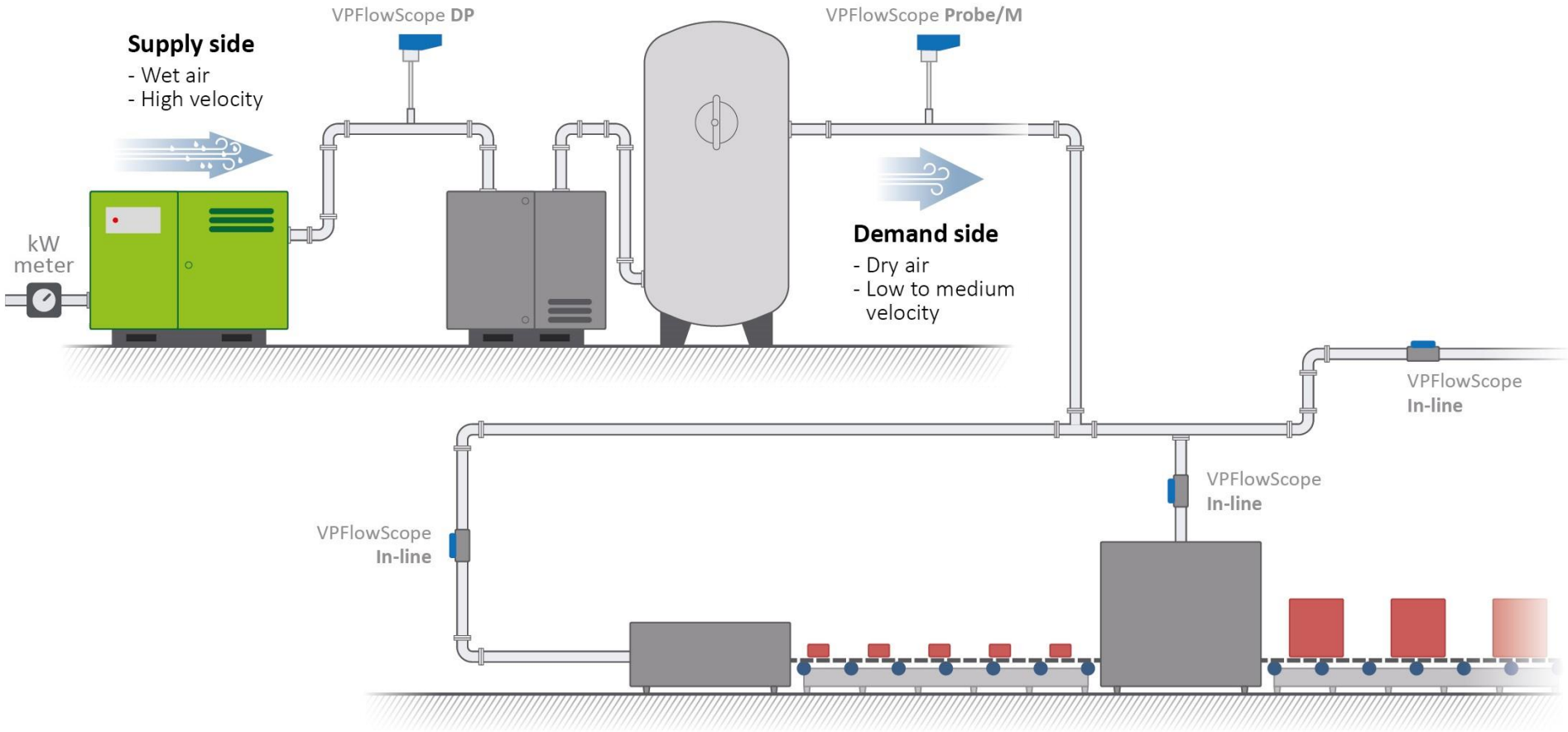
Introduction

Chuck Mays

- Sales Manager VPInstruments North America
- VPInstruments has developed and supplied Energy Management Solutions for compressed air, technical gasses as well as other utilities for more than 20 years

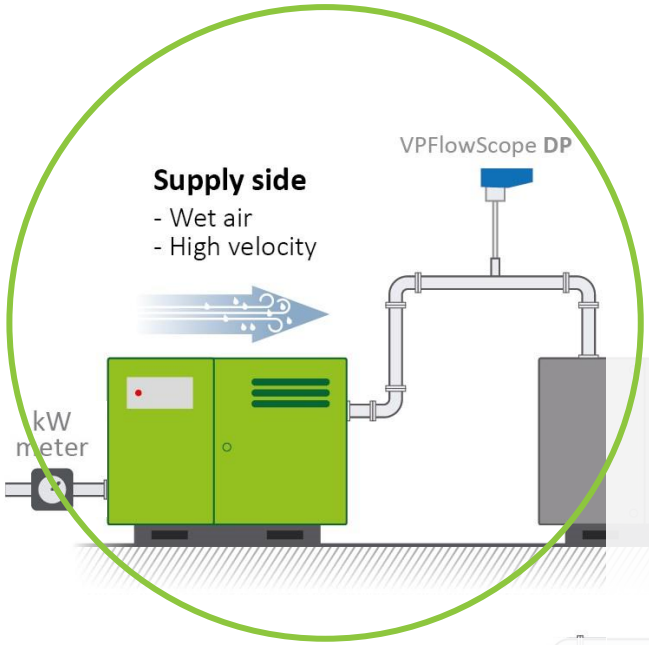
Flow measurement locations

In compressed air systems



Supply side

In compressed air systems



Supply side:

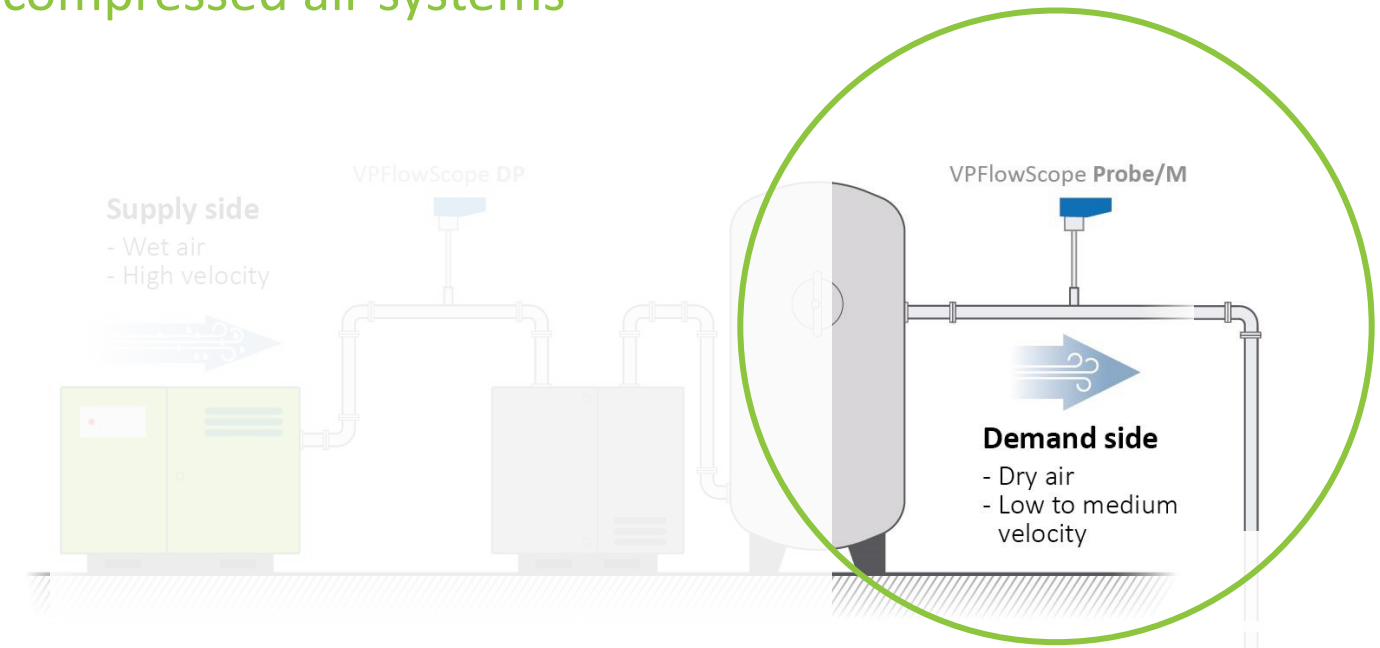
- Compressor performance / contribution to total flow
- Compressor efficiency (combined with power meter)

Conditions:

- Hot, saturated compressed air
- Difficult to find a good metering location

Demand side

In compressed air systems



Demand Side:

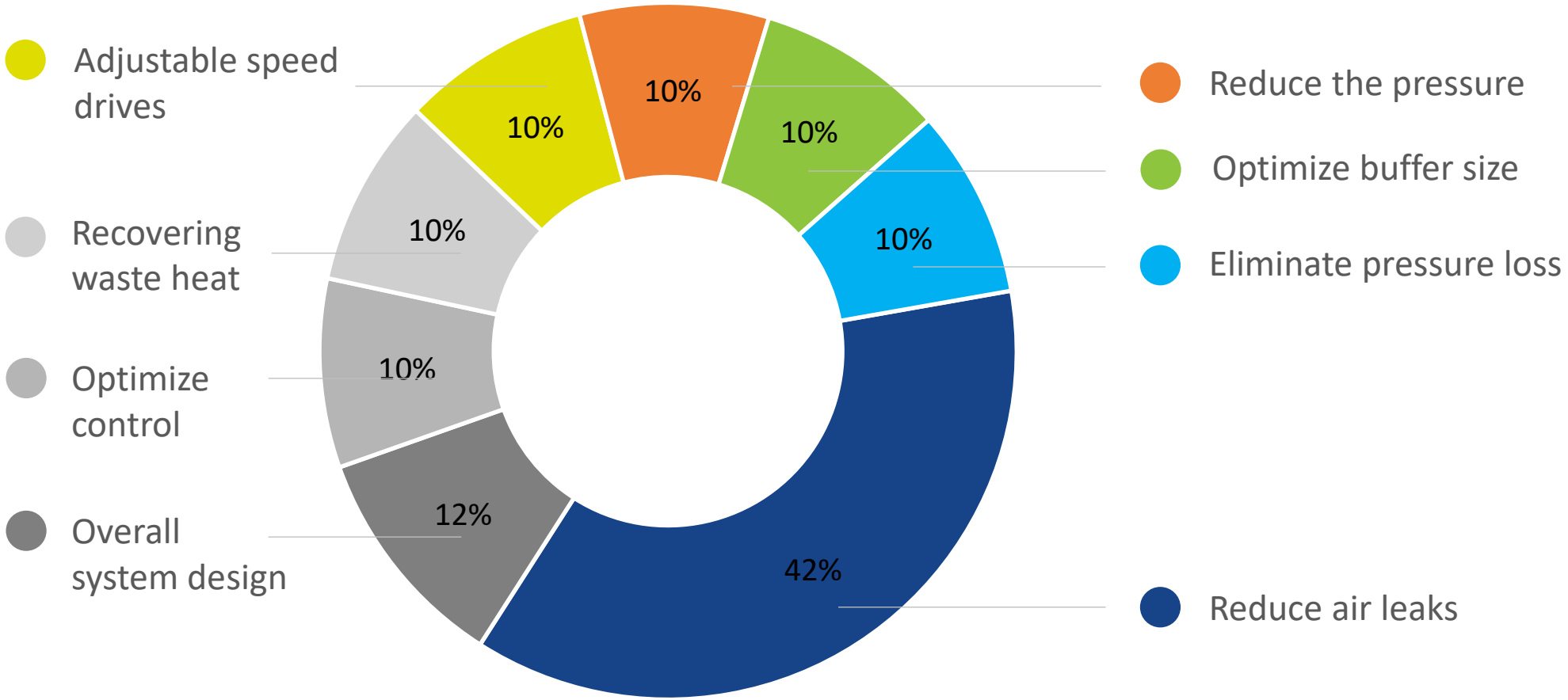
Main header:

- Collect a total demand profile
- Total leakage level during non production hours

Branch lines

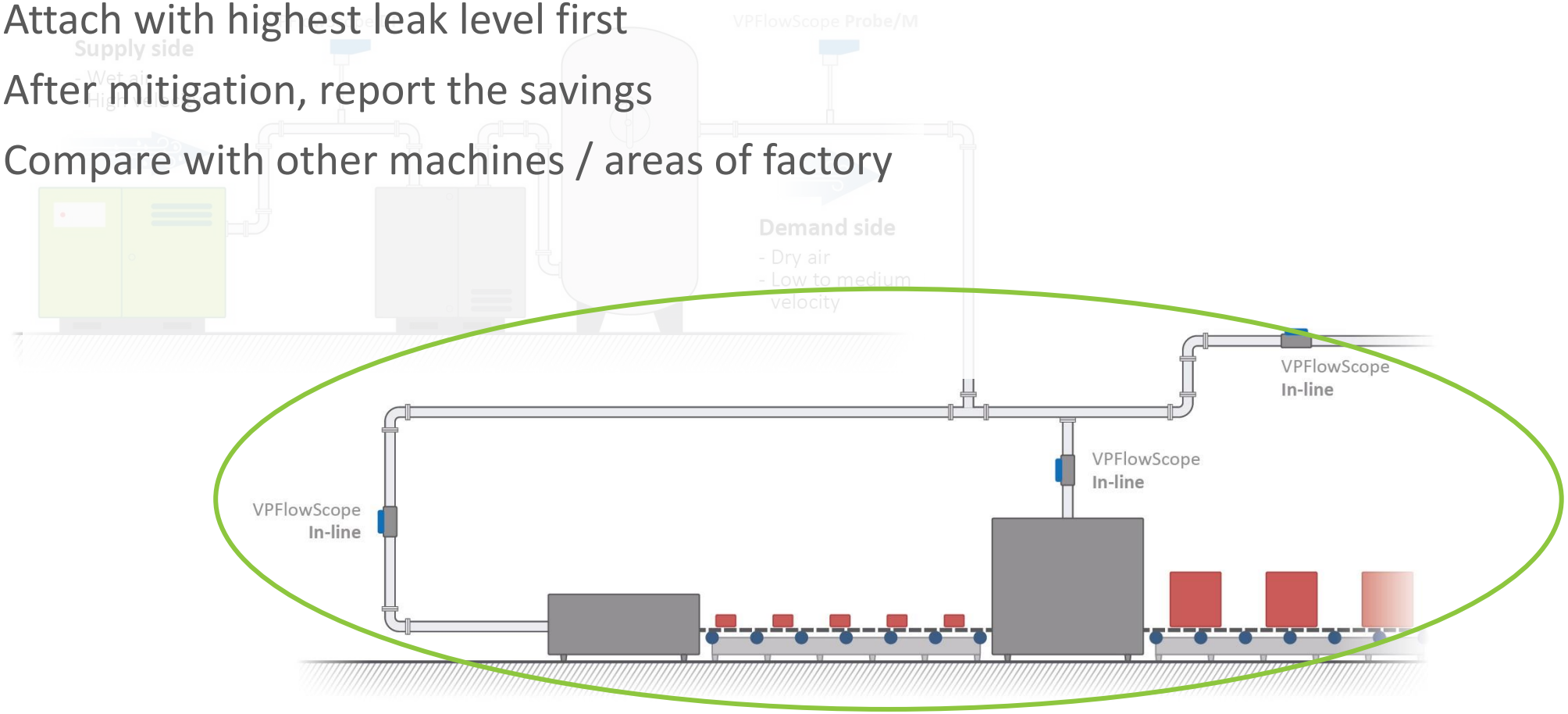
- Consumption per department / machine
- Cost allocation
- Point of use measurement data
- Leak measurement

Where to find savings



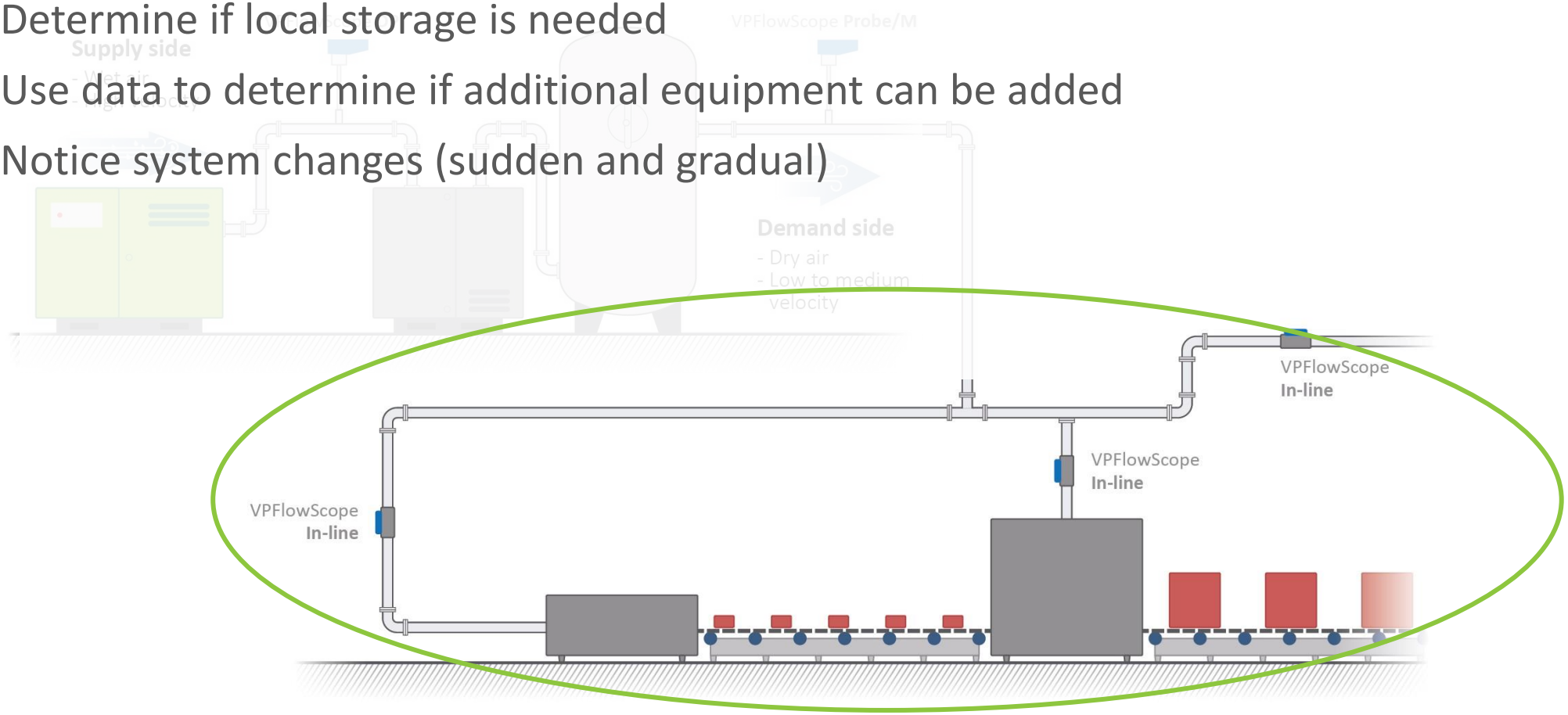
Leaks

- Measure flow with machines off
- Determine the cost for leaks
- Attach with highest leak level first
- After mitigation, report the savings
- Compare with other machines / areas of factory



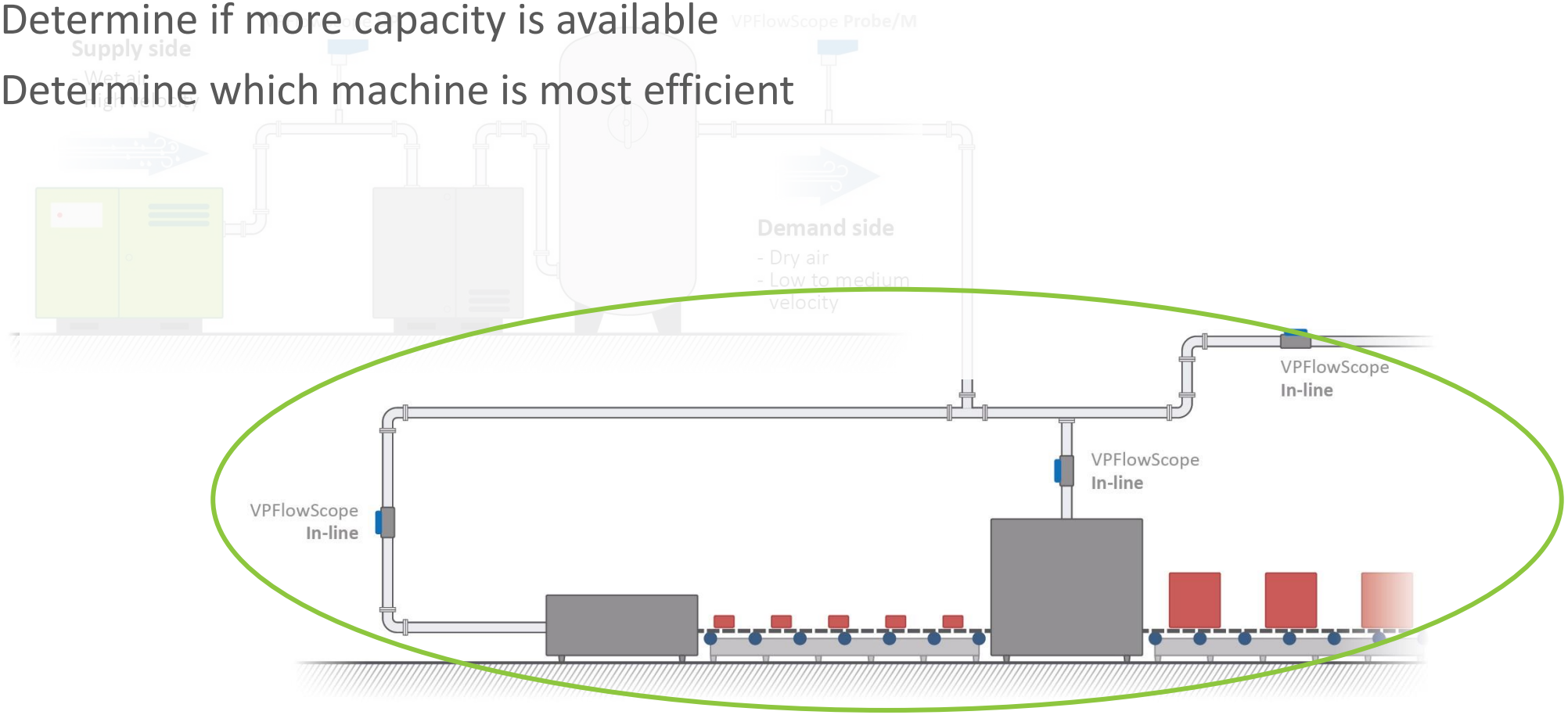
Data for decisions & problem detection

- See what pressure is being used / is available
- Monitor pressure changes due to equipment
- Determine if local storage is needed
- Use data to determine if additional equipment can be added
- Notice system changes (sudden and gradual)



Costs per widget

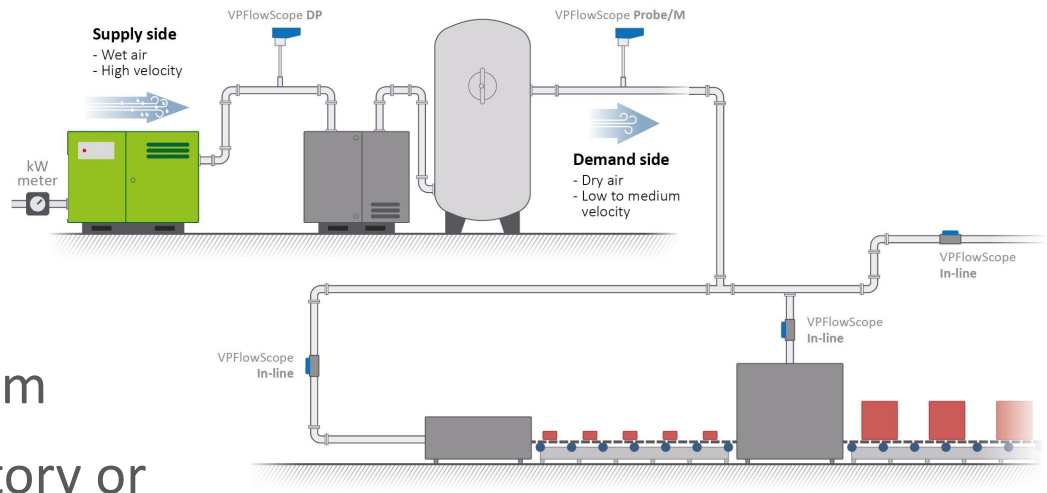
- Determine the air cost for a machine / factory area
- Allocate cost per widget / ton of product
- Determine if more capacity is available
- Determine which machine is most efficient



Example: Cost allocation

In this example:

- Accounting determines that the monthly cost for electricity is $5400
- There are three areas in the factory
- How do you allocate costs?



What you need:

- Energy measurement of the compressed air system
- A measurement of the air to each area of the factory or machine.

Example: Cost allocation

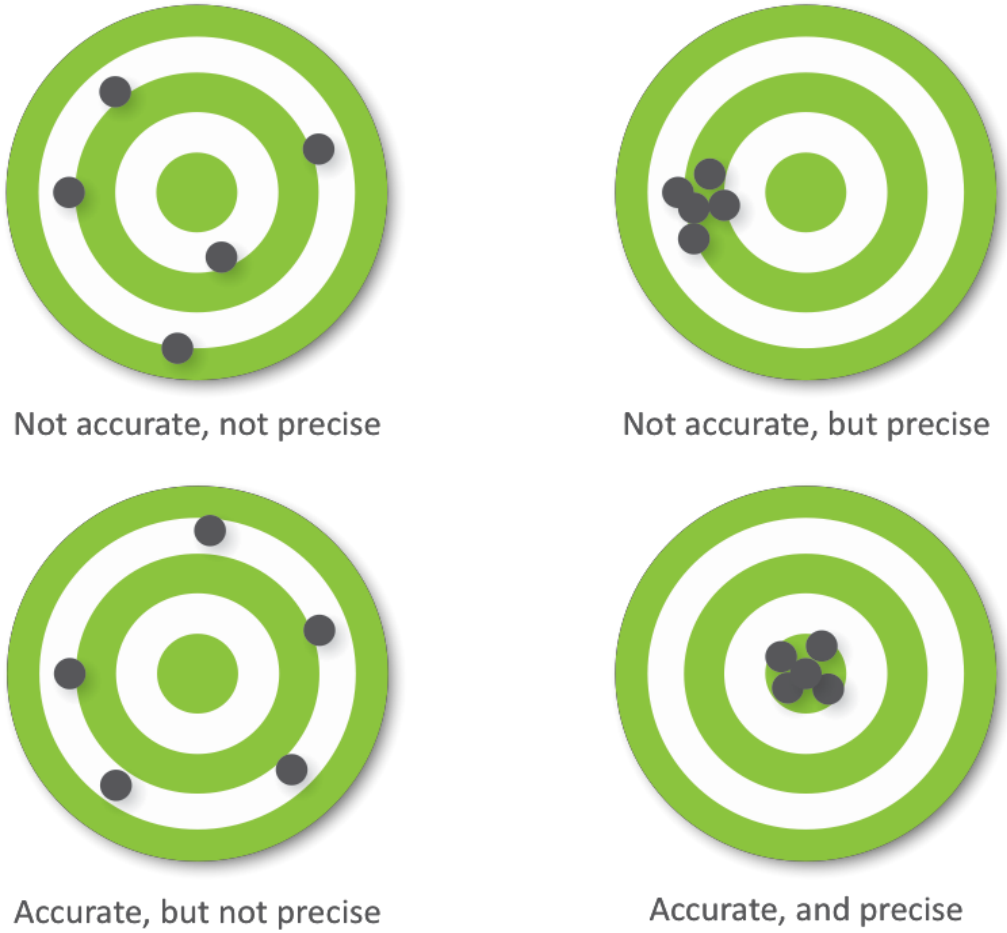
Cost/CFM of Air Used

- Based on an average of 450 CFM and $0.10 per kW-h
- Total Cost for the Month: $5,400
- Cost per 1,000,000 CF: $278

	Factory Area 1	Factory Area 2	Factory Area 3	Total
Cubic Feet (CF)	4 M CF	5M CF	8M CF	17 M CFM
Allocation	$1,112	$1,390	$2,224	$4,726

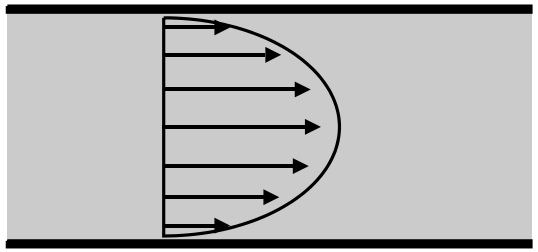
- Hold On! The total cost does not equal $5,400.
- $674 dollars of air was used that is not being metered!

Accuracy and repeatability (precision)

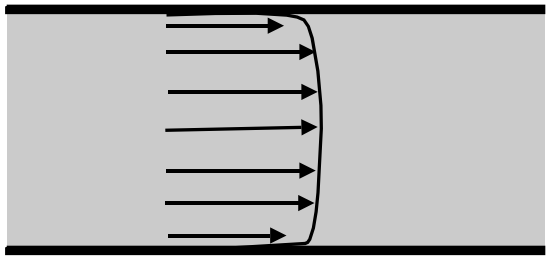


Turbulent flow profile

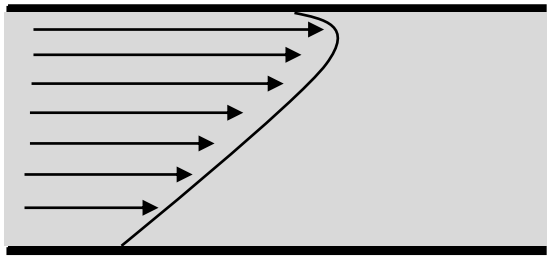
Laminar flow profile

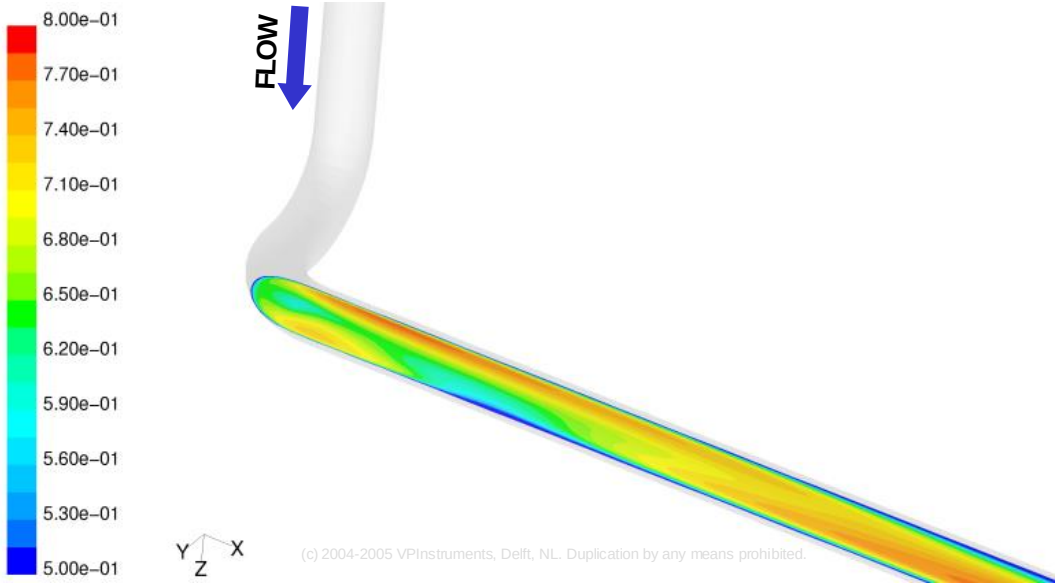


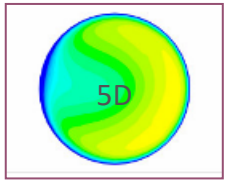
Turbulent flat profile after 20..40 D

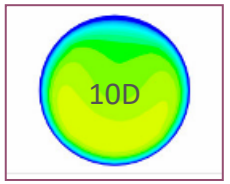


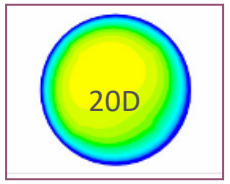
Distorted Turbulent profile 10D and elbow

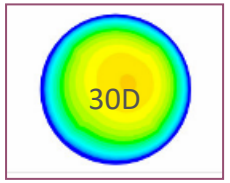










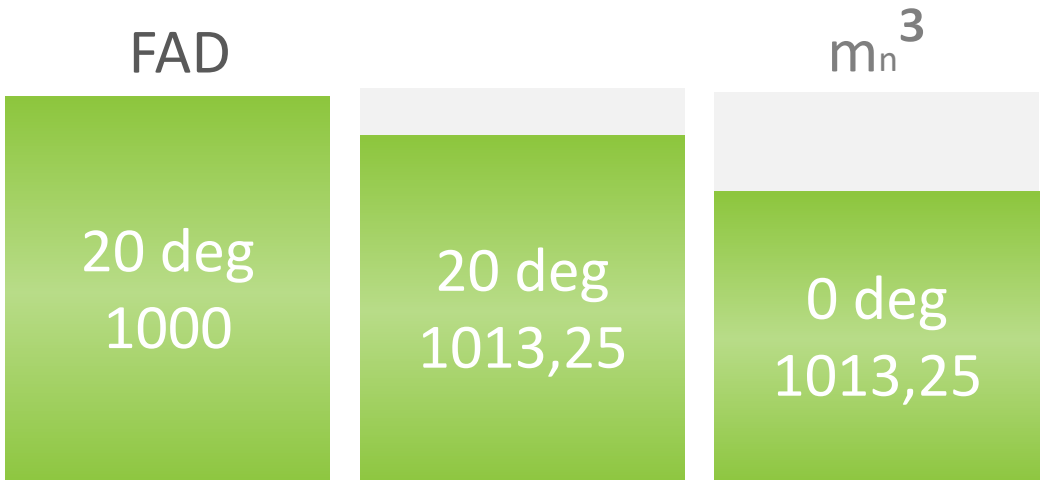


Which Standard? Comparing apples with apples

- Volume flow vs. mass flow. (m3/time vs kg/time)
- Reference conditions:
  - 0˚C reference (Normalized): DIN 1343
  - 20˚C reference (FAD): See ISO 1217
  - 15˚ reference: See DIN 1533 or ISO 2533
  - CAGI: 68 F, 14.5 PSIA, 0% water vapor pressure

- From FAD to normal: 8,7% difference!
  - **100 m^3/hr FAD** ∗ 273,16/(273,16+20)

    ∗ 1000/1013,25 = **91,95 m_n^3/hr** (Normalized)



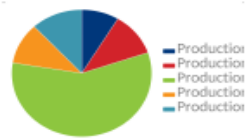
Energy Management Report

OVERVIEW AIR USAGE

PARAMETER	CURRENT PERIOD	LAST PERIOD	DELTA	YTD	
Production 1 [Totalizer]	33737	35786	-2049	15931	m3n
Production 2 [Totalizer]	-183745	616017	-799762	171900	m3n
Production 3 [Totalizer]	481316	471405	+9911	1541188	m3n
Production 4 [Totalizer]	132742	27602	+105140	442695	m3n
Production 5 [Totalizer]	44988	16392	+28596	132997	m3n
Total	509038	1167202	-658164	2304711	m3n

AIR DISTRIBUTION

- Production 1: 31412 m3n
- Production 2: 40292 m3n
- Production 3: 210408 m3n
- Production 4: 38131 m3n
- Production 5: 43126 m3n
- Total: 363371 m3n



ELECTRICITY USAGE

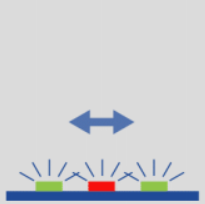
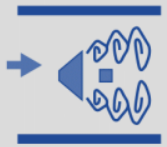
PARAMETER	CURRENT PERIOD	LAST PERIOD	DELTA	YTD	
Compressor 1 [Input 0]	2105	644	+1461	36643	kWh
Compressor 2 [Input 1]	94787	114759	-19972	327341	kWh
Compressor 3 [Input 2]	103669	100176	+3493	318100	kWh
Machine 1 [Input 3]	8148	2202	+5946	18741	kWh
Machine 2 [Input 4]	18265	7050	+11215	36380	kWh
Total	226974	224831	+2143	737205	kWh

KPIS

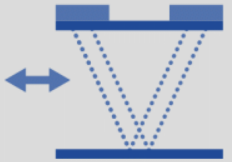
KPI	CURRENT PERIOD	LAST PERIOD	DELTA	UNIT	STATUS
Average usage	97.68	107.81	-10.13	m3n / hour	
kWh today	679586453....	521433752....	+158152700...	kWh	
Efficiency	112213.73	78010.86	+34202.87	kW / m3n / min	
Costs per m3n	37.40	26.00	+11.40	Euro / m3n	
m3n today	363370.75	401047.03	-37676.28	m3n	

Flow meter selection

Principles compared

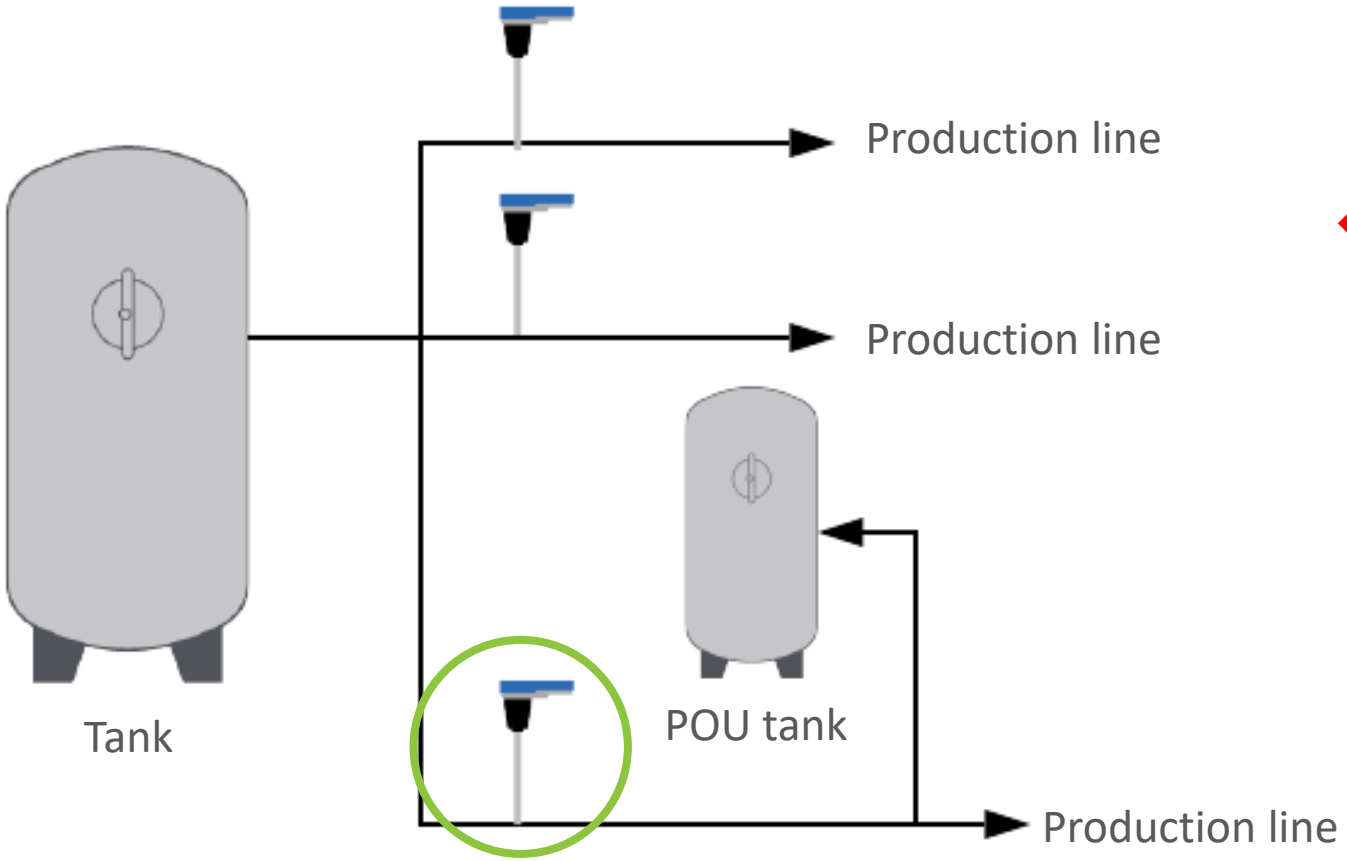


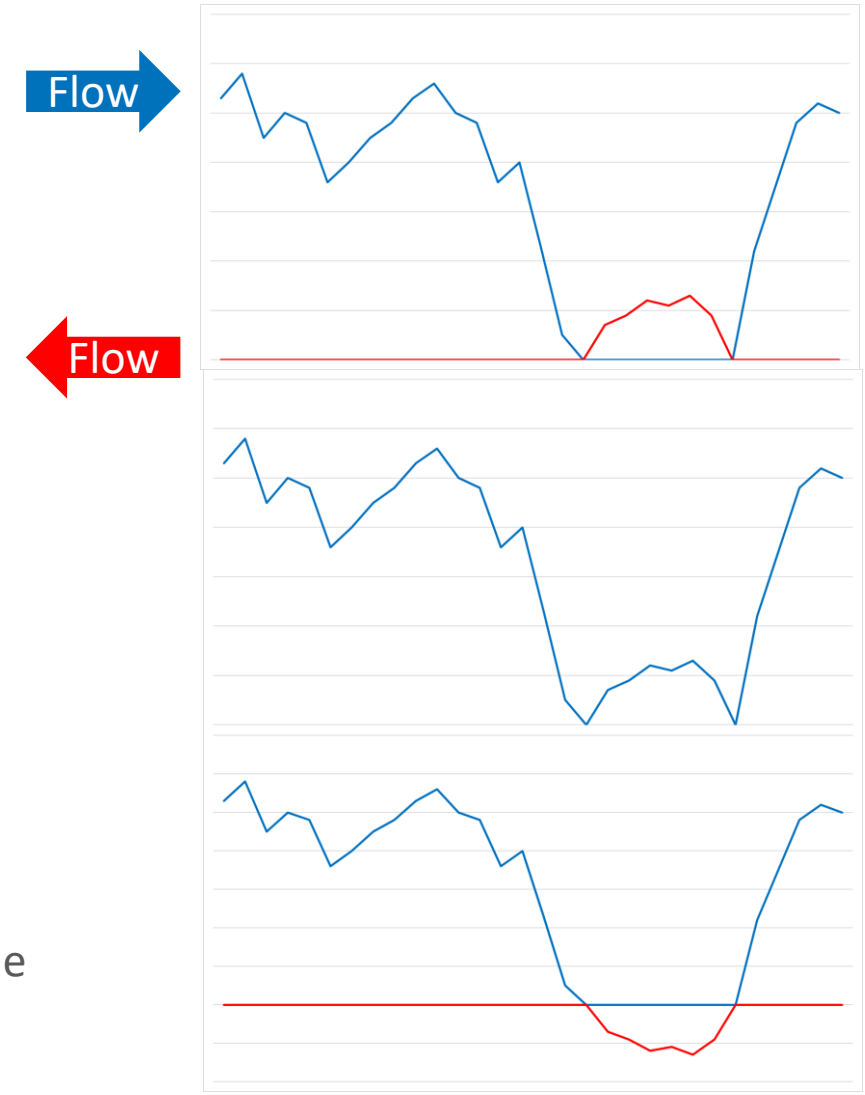



	Thermal	Vortex	DP – Orifice plate	DP – Cone meter	Coriolis	Turbine/ rotary displacement	Clamp on ultrasonic
Mass flow	Yes	Optional	Optional	Optional	Yes	Optional	Optional
Meter run	20D	15D	15D	5D	0D	10D	20D
Pressure loss	Low	Medium/high	high	high	Low	Low	Low
Dirty air	Fouling	OK	Clogging	Clogging	Internal fouling	Faillure	OK
Wet Air	Spikes	OK, spikes	OK	OK, orientation	Yes, but affects reading	Faillure	Spikes
Range	1:250	1:10	1:10	1:10	1:100	1:100	1:100
Accuracy	2%	2%	2%	2%	0.5 .. 1%	0.5…1 %	1%
Purchase price	$	$	$	$	$$$$	$$	$$$
Maintenance	Medium	Low	Medium	Medium	Low	High	Low

Do you need Bi-directional?

Demand side (reverse flow)





+1002 m_n^3

+941 m_n^3

- 61 m_n^3

+880 m_n^3

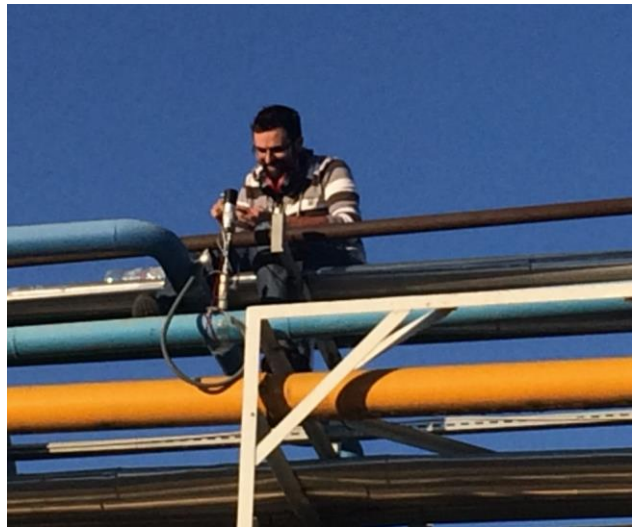
Selecting a flow meter

Some basic considerations

- Type of gas
- Flow range
- Humidity (dry/saturated)
- Diameter
- Pressure
- Temperature range

Consider the external environment

- Accessibility (e.g. for maintenance)
- Excessive heat/radiation
- Water ingress
- Corrosive atmosphere
- High voltage lines
- Vibration
- Traffic
- Outside installation / IP Rating
- Country certification



Other things to consider

Model selection

In-line / flanged / ultrasound meters:

- Differently priced. Expensive for large pipes or chosen measurement technology
- Possible with inlet tubing for right upstream length
- More expensive when by pass is needed
- May require depressurizing the CA system
- Some may require additional pressure and temp sensor for mass flow

Insertion probes (2 inch and up)

- Installation possible in pressurized conditions
- Easy to insert or to take out for service or mobile measurements

Example: Textile factory

Solution

- Central compressed air monitoring system
- 3 x flow meters for dry air measuring flow, pressure, temperature, total flow

Added Value

- Losses are identified immediately
- Leakage management
- Possible pressure reduction 7.25 psi
- Increased production efficiency
- Increase production by adding 4 loom machines

Feroze1888 Mills Limited

"Compressed air management allows us to increase our production!"

Example: Cocoa factory

Results

- Efficiency increase from 7,36 to 5,83 kW/m3
- Leakage volume: 50%.
  Savings potential > $ 100,000 USD
- Increase in production by solving leakages in machines

Conclusions

- Demand side flow measurements provide many possibilities
- Permanent flow measurements provides the right data for proper investment decisions
- Flow measurement leads to energy savings and even to production increase
- Key is to determine first your purpose of the flow measurement
- For proper flow measurement, location and installation are key

THANK YOU!

Chuck Mays

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