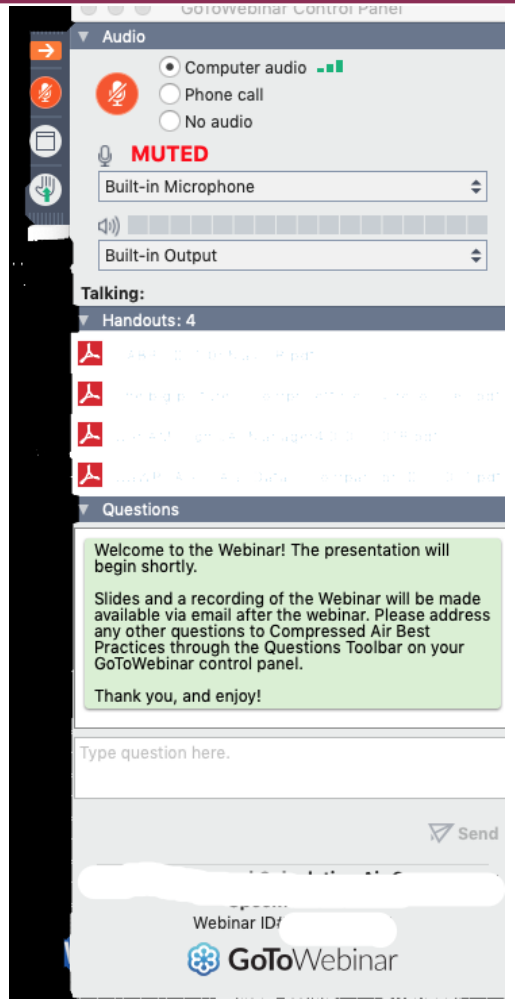
Oil-Free vs. Lubricated Rotary Screw Air Compressors: Pros and Cons

Paul Edwards
Compressed Air Consultants
Keynote Speaker

The recording and slides of this webinar will be made available to attendees via email later today.

PDH Certificates will be e-mailed to attendees within 2 days

Q&A Format



- Panelists will answer your questions during the Q&A session at the end of the Webinar.
- Please post your questions in the Questions Window in your GoToWebinar interface.
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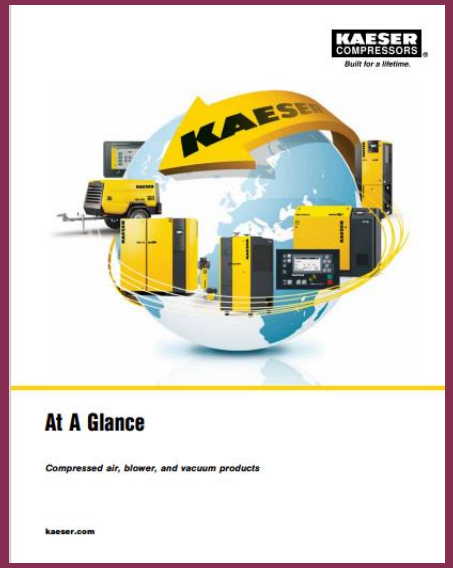
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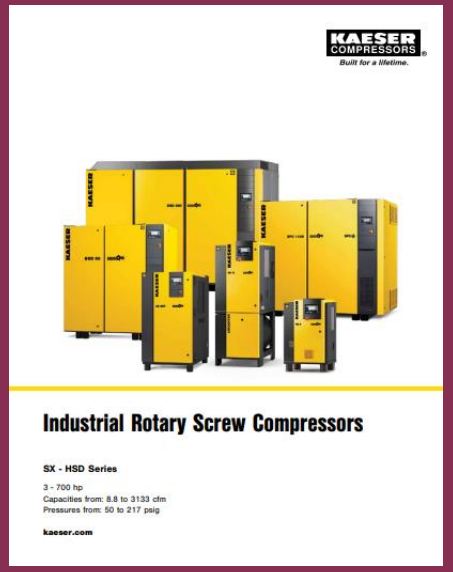
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14 ABC Compressors Supports Logoplaste Sustainable Manufacturing
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30 Central Cooling Systems Part 2 – Tankless Systems

Disclaimer

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

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Oil-Free vs. Lubricated Rotary Screw Air Compressors Pros and Cons

Introduction by

Compressed Air Best Practices® Magazine

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About the Speaker

It's about money, not about air

Paul Edwards
Compressed Air Consultants

- President and Owner, Compressed Air Consultants since 2003
- 39 years of experience in the compressed air industry
- Former Marketing Manager, Product Manager, Ingersoll Rand
- Started up IR's audit business

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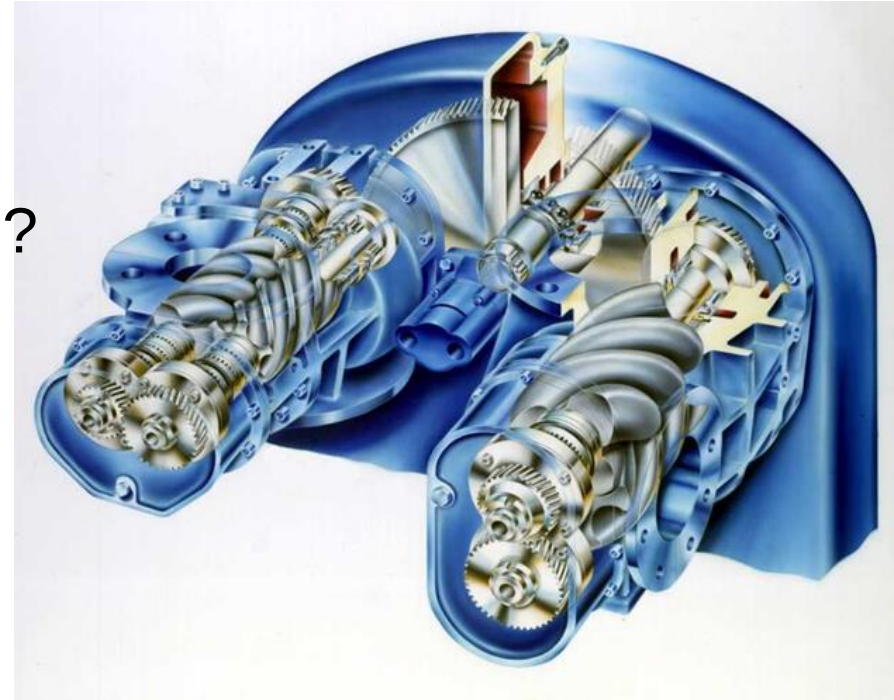
Oil Free vs. Flooded Screw Compressors
Some Practical Considerations

04/13/22

Paul Edwards
Compressed Air Consultants, Inc

Purpose of the Presentation

1. There is no “Best” Choice as there is Variation in every:
   - Process
   - Company including financials
   - Personnel Tolerance for Risk
2. Our job is to collect enough information so that better decisions can be made.
3. Purpose: Are We Asking the Right Questions?
4. What Industries Require Oil Free Air?
5. What Industries Require Oil Free Air Compressors?



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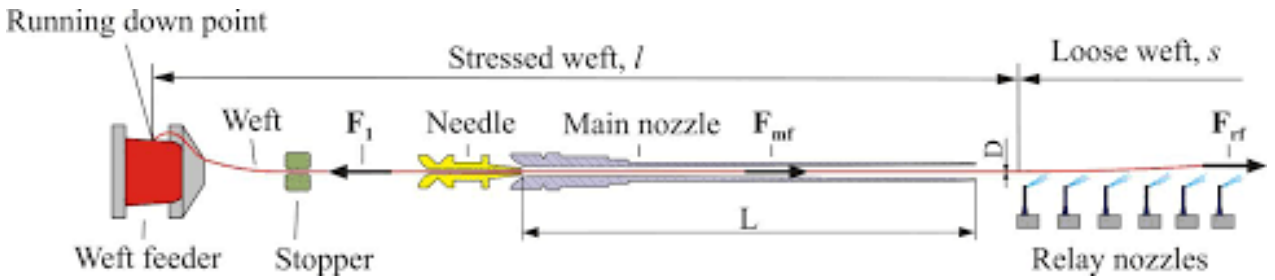
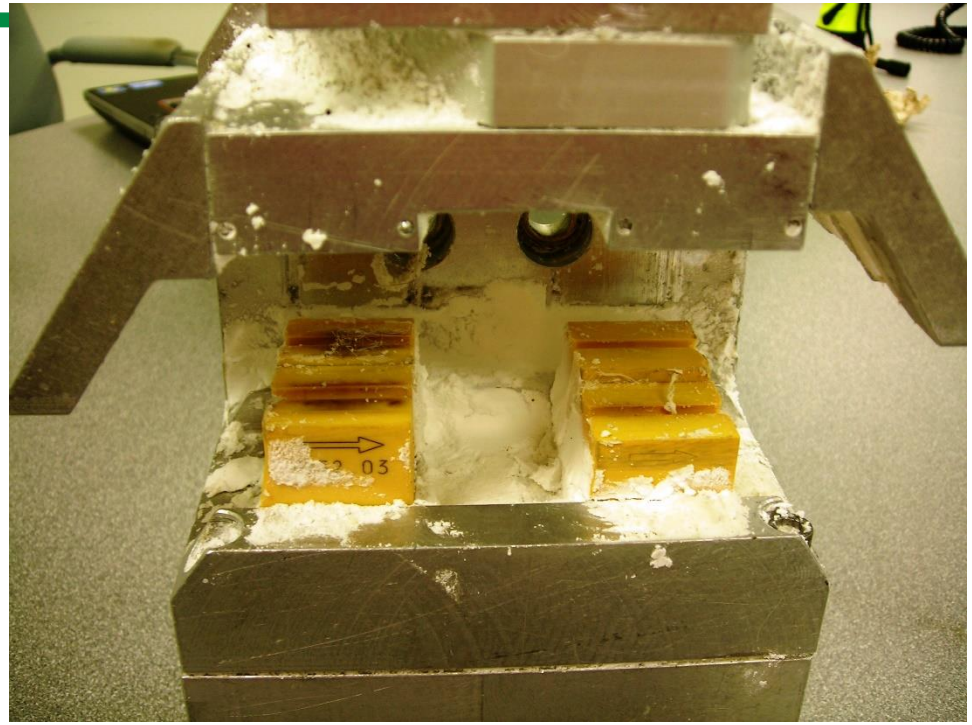
Breaking Paradigms – Textiles Have to Use Oil Free, Right?



ANNALS of Faculty Engineering Hunedoara – International Journal of Engineering



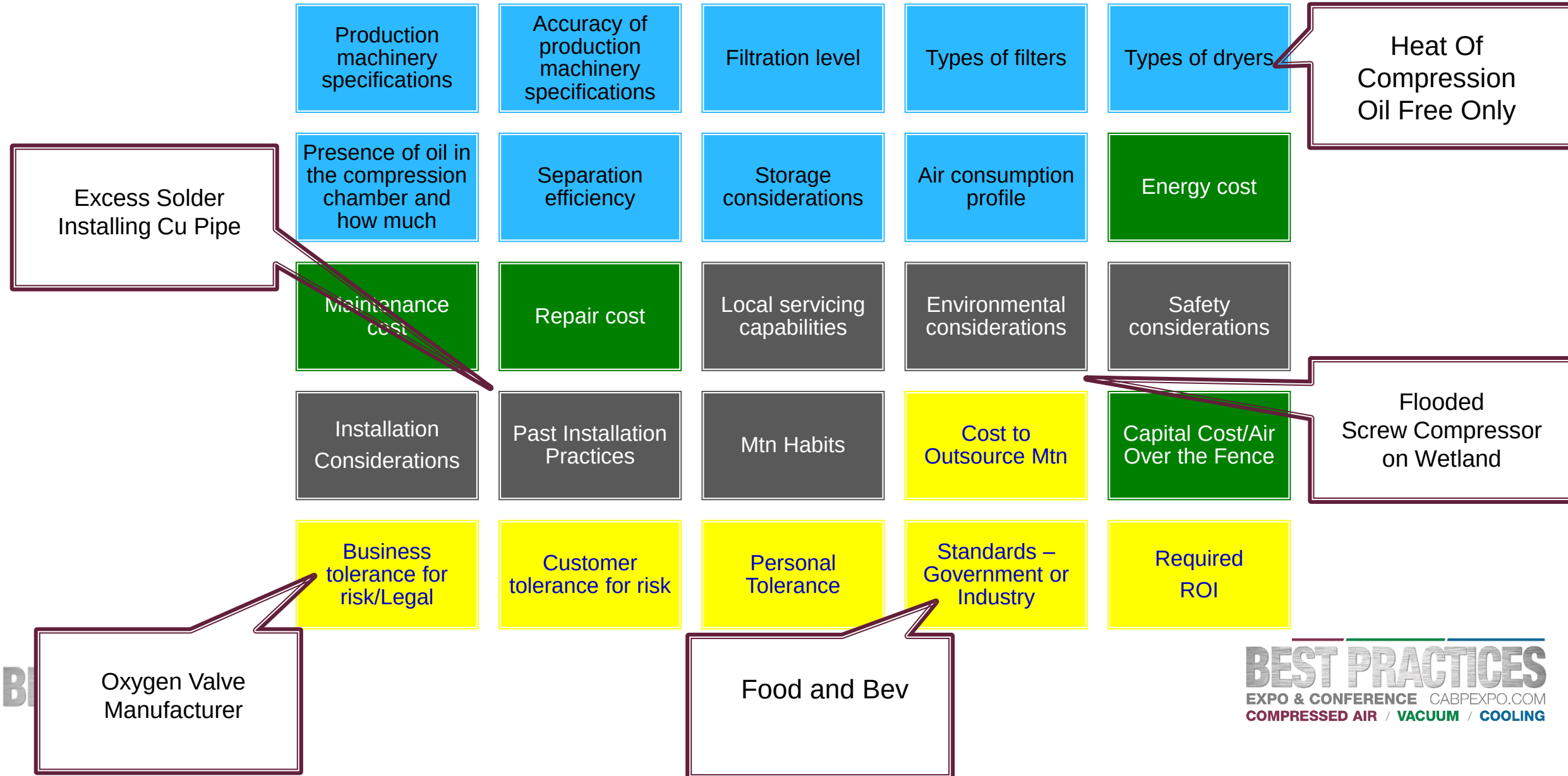
Comp	HP	ICFM	Comp	HP	ICFM	Comp	HP	ICFM
1	1250	5074	21	900	4155	41	900	3760
2	1250	5074	22	1000	5116	42	900	3760
3	700	3000	23	1000	5116	43	700	3000
4	700	3000	24	900	4800	44	700	3000
5	700	3000	25	700	3063	45	600	2504
6	1000	4500	26	1100	6463	46	500	2363
7	1100	4840	27	1250	5800	47	500	2368
8	1000	5000	28	1250	5800	48	500	2368
9	1000	5000	29	1000	4500	49	500	2300
10	1100	5463	30	1000	4500	50	1250	5799
11	1100	5463	31	700	3470	51	1250	5799
12	1100	5463	32	700	3447	52	1000	4462
13	1000	5000	33	1000	4500	53	1000	4462
14	1000	5000	34	1000	4500	54	700	3642
15	1100	5463	35	1000	4899	55	600	2504
16	1100	5463	36	1000	4899	56	450	2104
17	400	1802	37	1000	4899	57	500	2065
18	450	2194	38	1100	4899	58	300	1246
19	500	1890	39	900	3750	**Total**	**50,600**	**235,426**
20	900	4155	40	800	3500			

- Machines 59-62 were flooded screw compressors with Mist Eliminators on both sides of the dryer.
- Other Textile Firms followed the Same Path

Breaking Paradigms – Nitrogen Generation

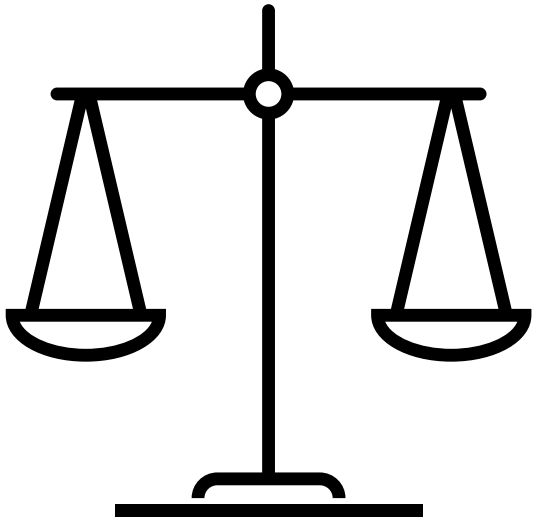
- N2 Generation is Filtering at a Molecular Level
- Industry Standard: Flooded screw compressor

Is it really a simple decision?



Risk/Reward

- The Risk is the Impact of Process Contamination
  - Process Risk
  - Legal/Government Risk
  - Marketing/Perception Risk
- Is there a standard or specification?



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Risk – What are the Standards? – ISO, ISA

ISO 8573-1:2010 Compressed Air Contaminants and Purity Classes						
Class	0	1	2	3	4-9	x
mg/m3	As specified	≤ .01	≤ 0.1	≤1.0	≤ 5.0	>5

Instrument Society of America

Specification ISA-S7.0.0.01 – 1996

This standard establishes four elements for the quality of instrument air for use in pneumatic instruments.

4.1 Dew Point (at line pressure)

4.1.1 Outdoor installations (where any part of the instrument air system is exposed to the outdoor atmosphere). The dew point at line pressure shall be at least 10°C (18°F) below the minimum local recorded ambient temperature at the plant side.

4.1.2 Indoor installations (where the entire instrument air system in installed indoors). The dew point at line pressure shall be at least 10°C (18°F) below the minimum temperature to which any part of the instrument air system is exposed at any season of the year. In no case should the dew point at line pressure exceed 2°C (approximately 35°F).

4.2 Particle size: the maximum particle size in the air stream at the instrument shall be three (3) micrometres.

4.3 Oil content: The maximum total oil or hydrocarbon content, exclusive of noncondensables, shall be as close to zero (0) w/w/ or v/v/ as possible; and under no circumstance shall it exceed one (1) ppm w/w/ or v/v/ under normal operating conditions.

"Class Zero Air"
"As specified by the equipment user or supplier and more stringent than Class 1"

It is whatever the OEM wants to say it is as long as it is better than Class 1

It is important to differentiate between Class 0 as a bona fide technical requirement or as a marketing strategy.

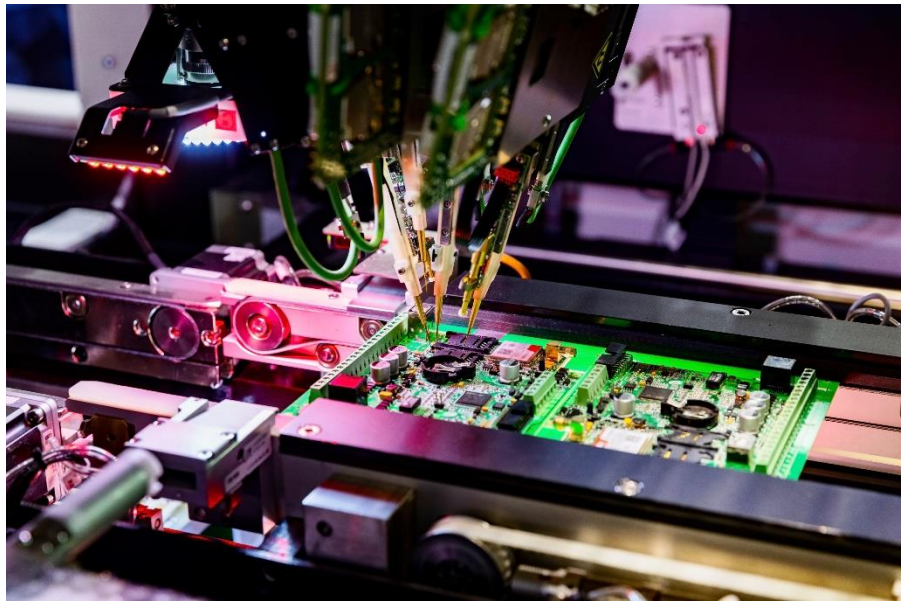
Standards Overview

Industry	Source	Class Recommendation
Electronics	SEMI F47-0706	1
Pharma	ISPE Good Practice Guide: Process Gases	1 or 2
Food and Bev	BCAS	Class 1 (Technically Oil Free)
Instrument Air	ISA (now International Society of Automation)	Between Class 1 and Class 2
Breathing Air	CGA Grade D	1
Chemical	?	
Petrochemical	?	
Textile	?	
Aerospace	?	
Automotive	?	
Paint/Finish	Paint Spraying Equipment OEMs	Class 1 or 2

Ignoring the Risk

- Central American Cookie Manufacturer – Oven Discharge Cooling with Gas and Liquid
  - Engineered Nozzles and Dripping Diester Lubricant
- Frozen Corn Manufacturer – 8500 Cases Recalled due to possible Listeria. Source of Listeria was poor maintenance practices on the compressed air system.

Risk Factors Beyond Compressor Type (Primarily Lubricated Compressor Risk)				
Design – Equipment or Systems	Separator Failure	Human Error	Poor Maintenance Practice	Teflon Wear (Tobacco)



Ignoring the Reward

- Financial Risk Associated with Defaulting to a Specific Approach
- Cement Company Request for Spec Review written by a consulting firm for a new plant in a subtropical climate
  - Oil Free Air
    - Cement Plants Don’t Require Oil Free Air
  - 8.5 bar spec
    - 6 bar highest application pressure
  - -40° C dewpoint
    - Subtropical Climate
- No Process Risk = Cost Benefit Decision

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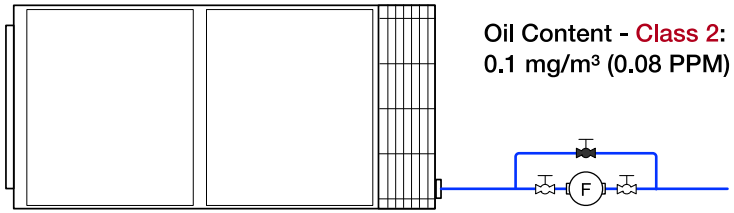
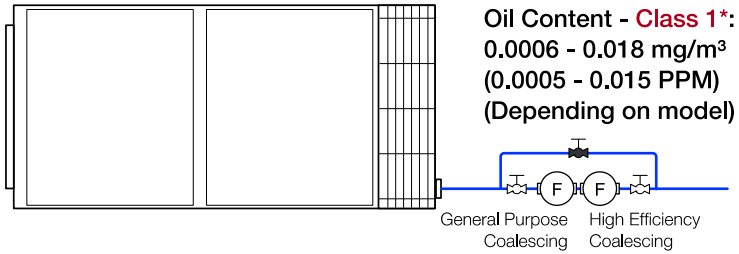
Oil Free vs. Oil Flooded Options

Coalescing Filter



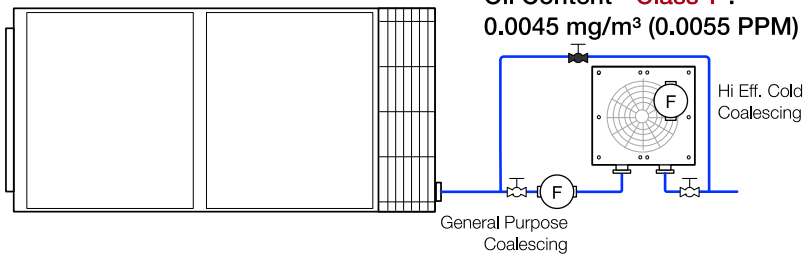
Oil Content - Class 2:
0.1 mg/m³ (0.08 PPM)

Dual Coalescing Filters



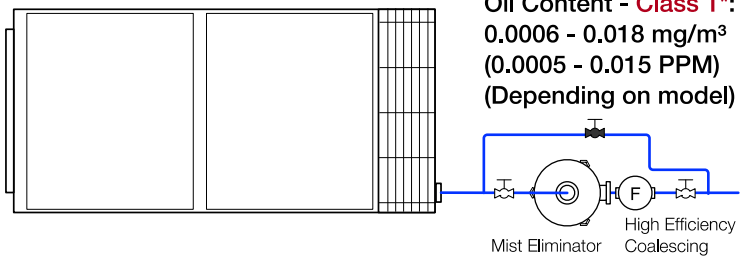
Oil Content - Class 1*:
0.0006 - 0.018 mg/m³
(0.0005 - 0.015 PPM)
(Depending on model)

Cold Coalescer Filter



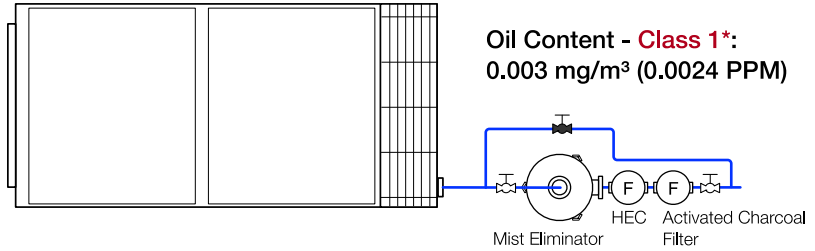
Oil Content - Class 1*:
0.0045 mg/m³ (0.0055 PPM)

Mist Eliminator + Coalescing Filter



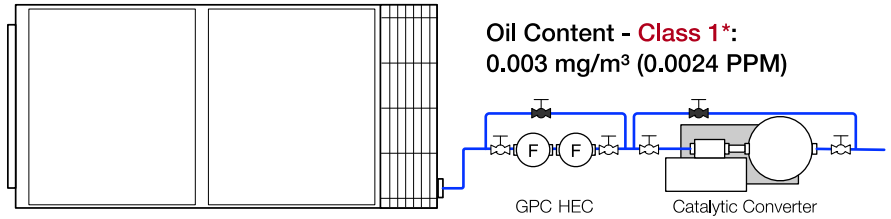
Oil Content - Class 1*:
0.0006 - 0.018 mg/m³
(0.0005 - 0.015 PPM)
(Depending on model)

Mist Eliminator + Coalescing Filter+ Charcoal Filter



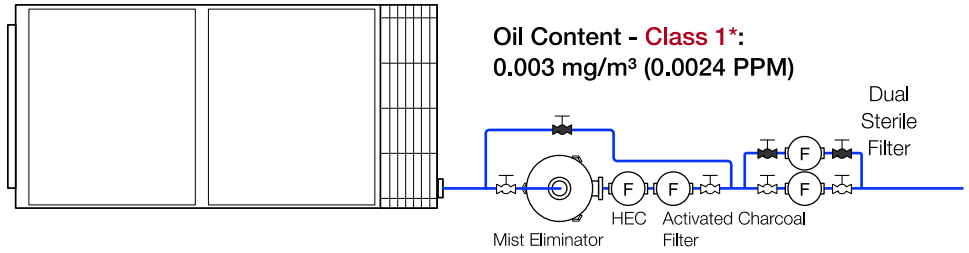
Oil Content - Class 1*:
0.003 mg/m³ (0.0024 PPM)

System with Catalytic Converter



Oil Content - Class 1*:
0.003 mg/m³ (0.0024 PPM)

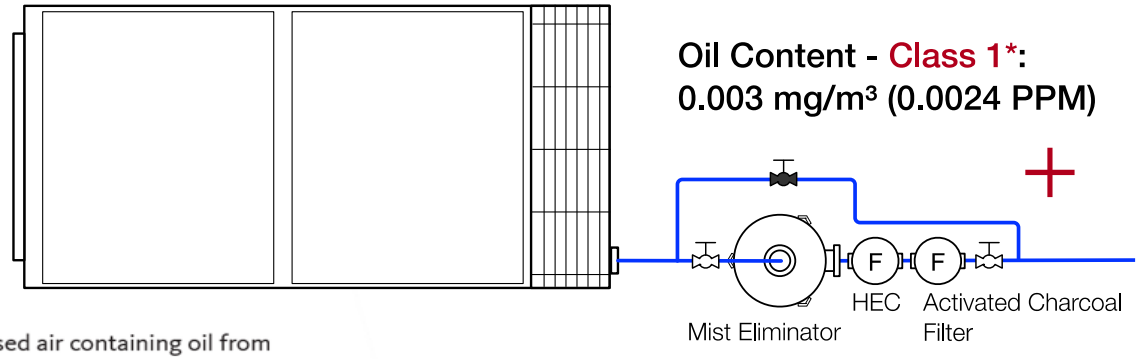
Mist Eliminator + Coalescing Filter+ Charcoal Filter + Sterile Filter



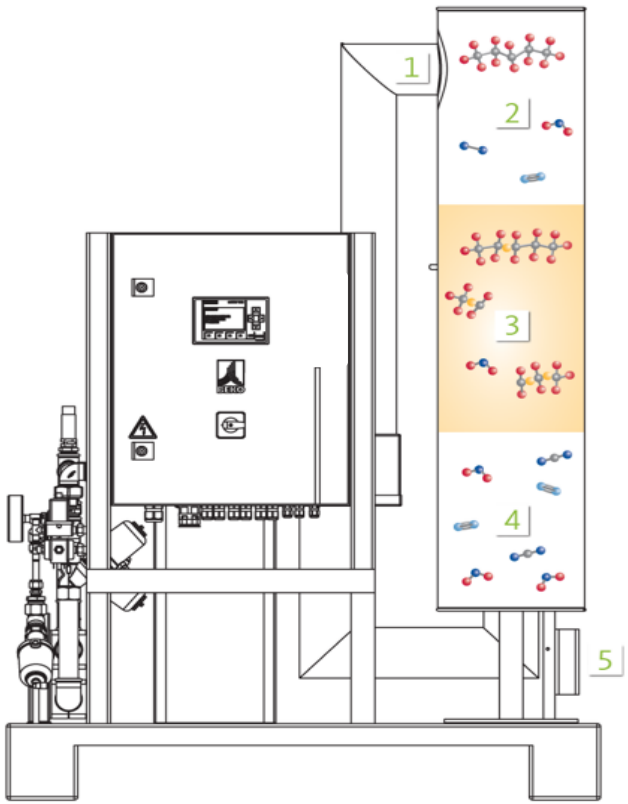
Oil Content - Class 1*:
0.003 mg/m³ (0.0024 PPM)

Belts and Suspenders?

Mist Eliminator + Coalescing Filter+ Charcoal Filter



Oil Content - Class 1*:
0.003 mg/m³ (0.0024 PPM)



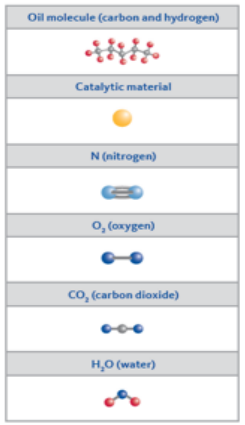
1. Compressed air containing oil from air compression and/or ambient hydrocarbons, bacteria, and viruses

2. Oil molecules will be cracked into smaller molecular chains in the catalytic converter. This process needs only oxygen and heat.

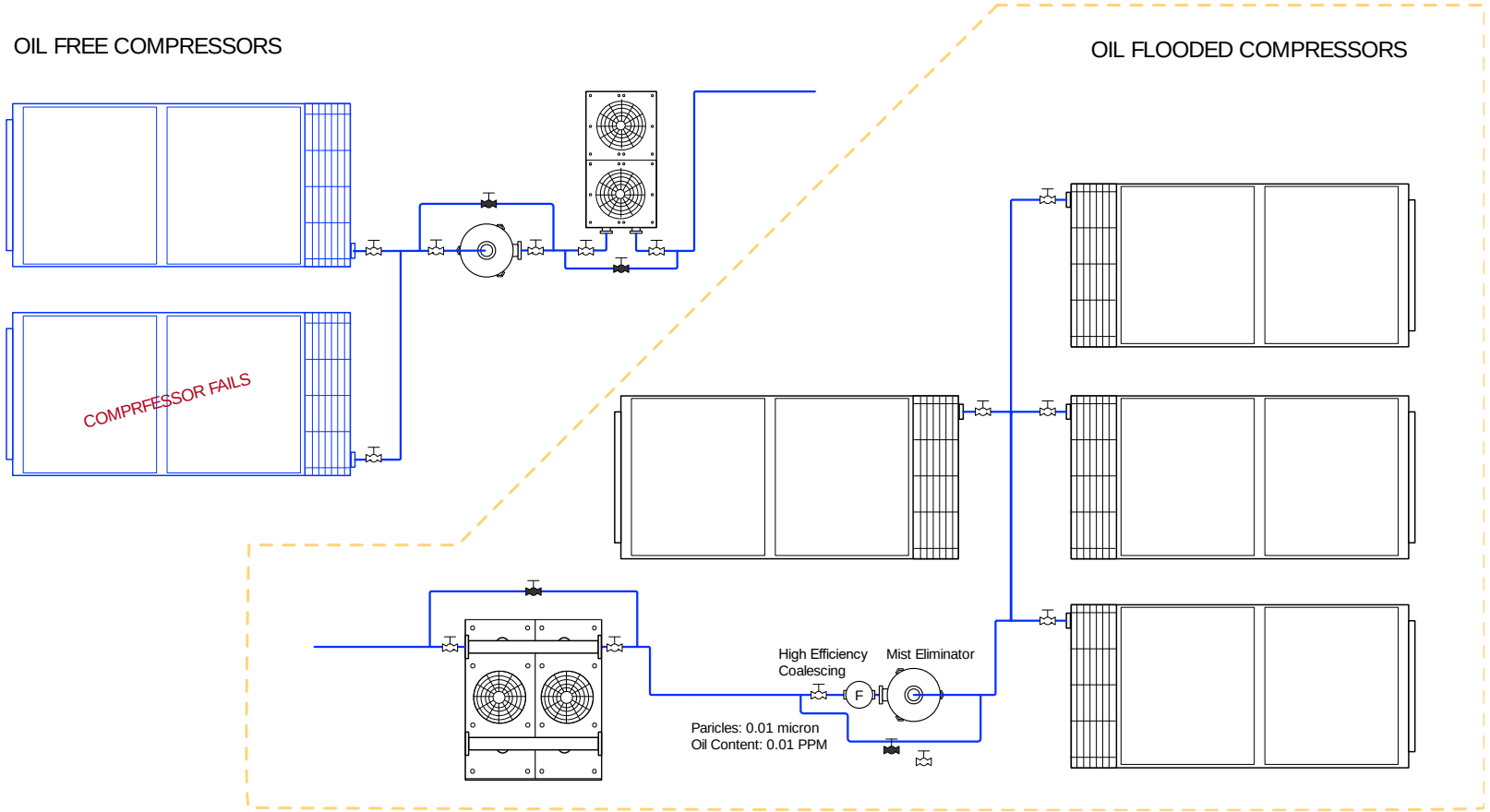
3. Oil molecules will be cracked into smaller and smaller molecular chains as they continue to interact with the catalytic material

4. Hydrocarbon molecules are oxidized into H_2O and CO_2

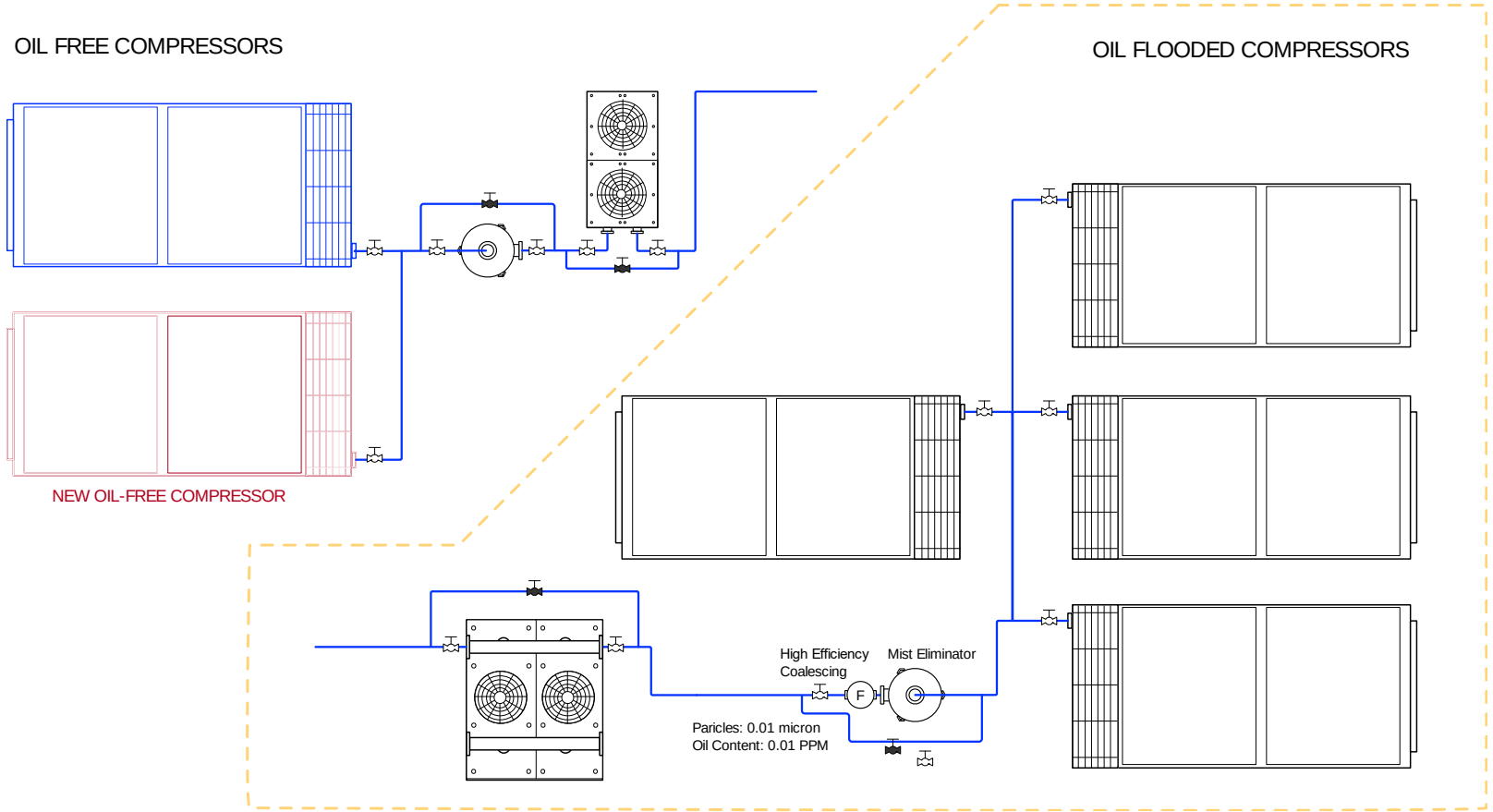
5. Oil and germ-free compressed air in accordance with the ISO 8573 standard



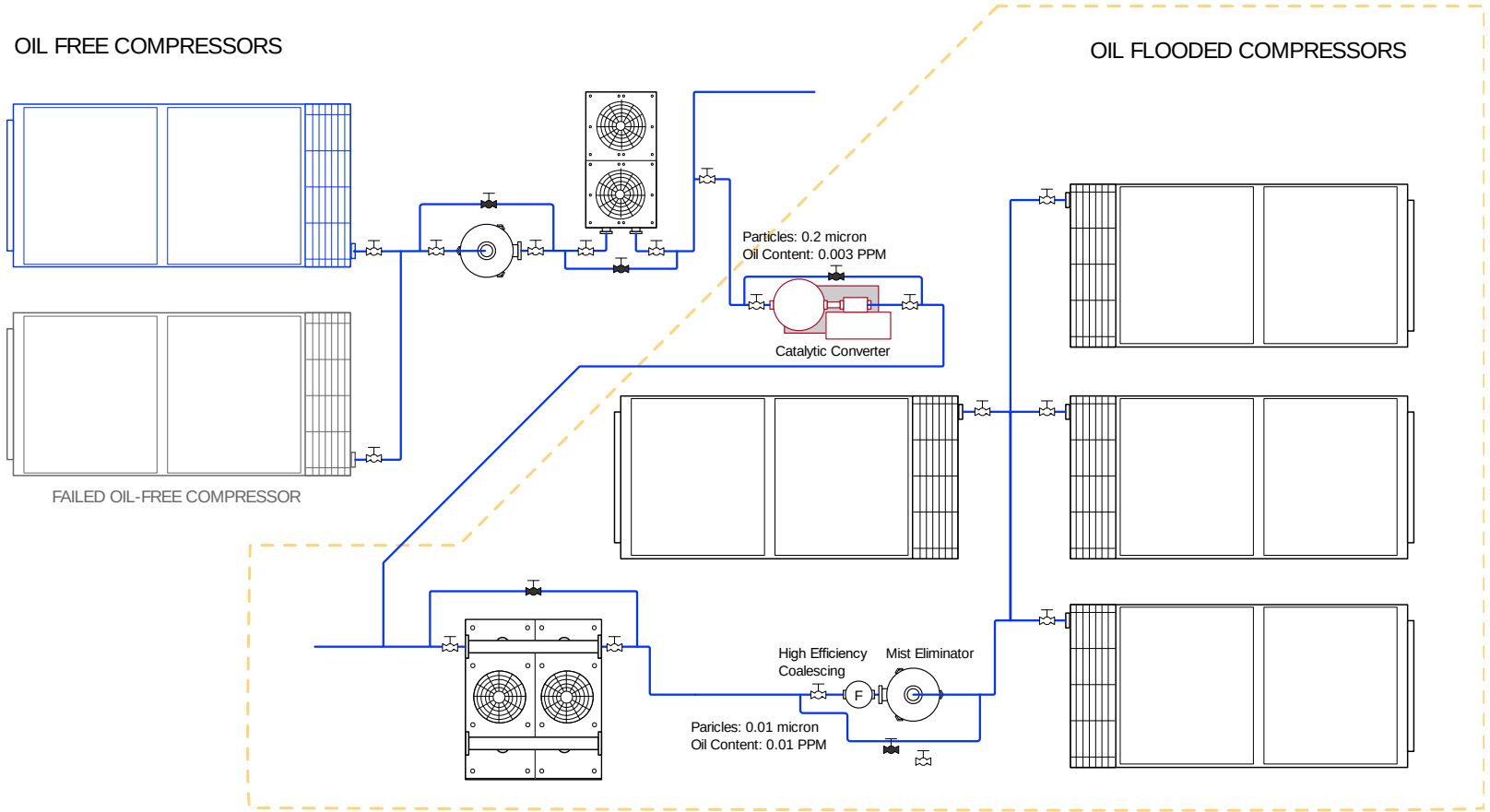
A Practical Application



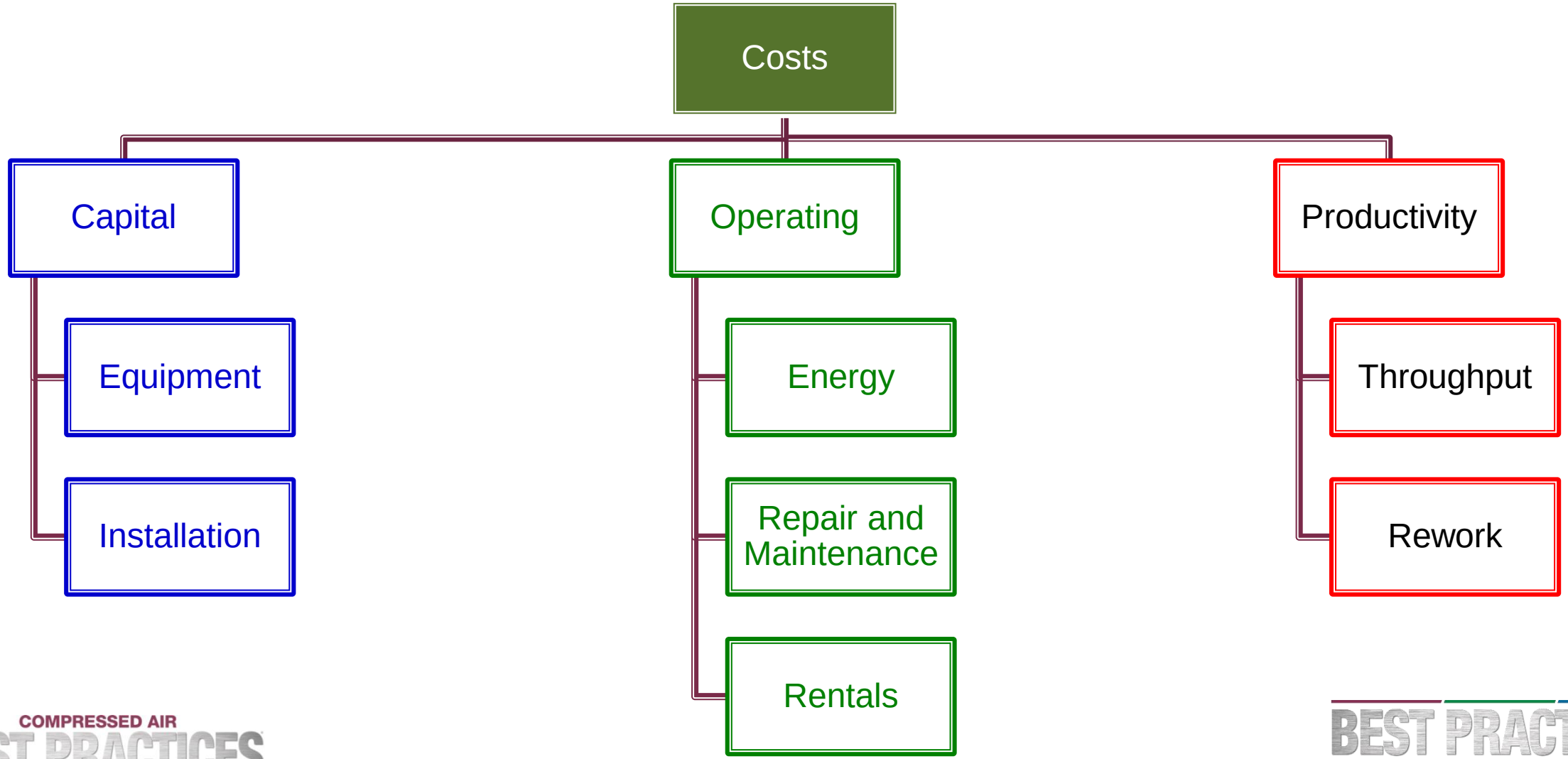
A Practical Application



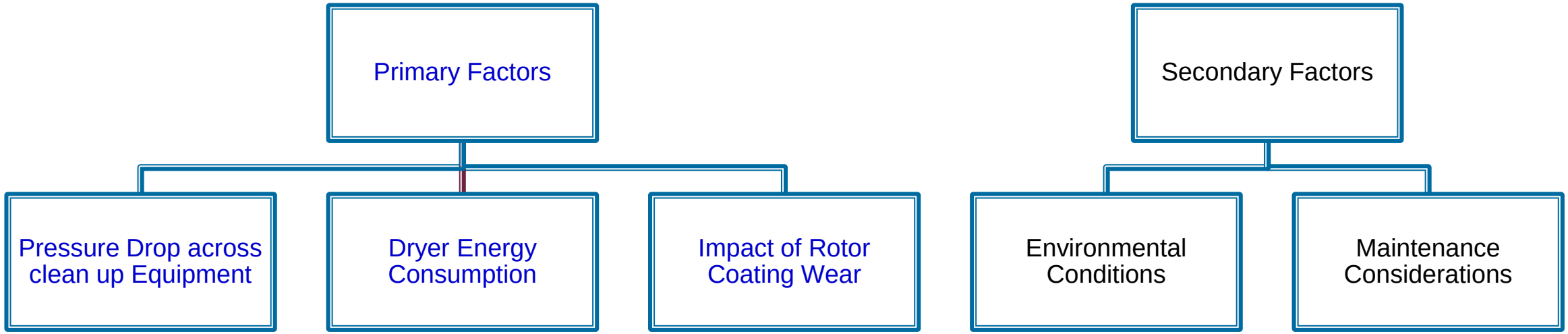
A Practical Application



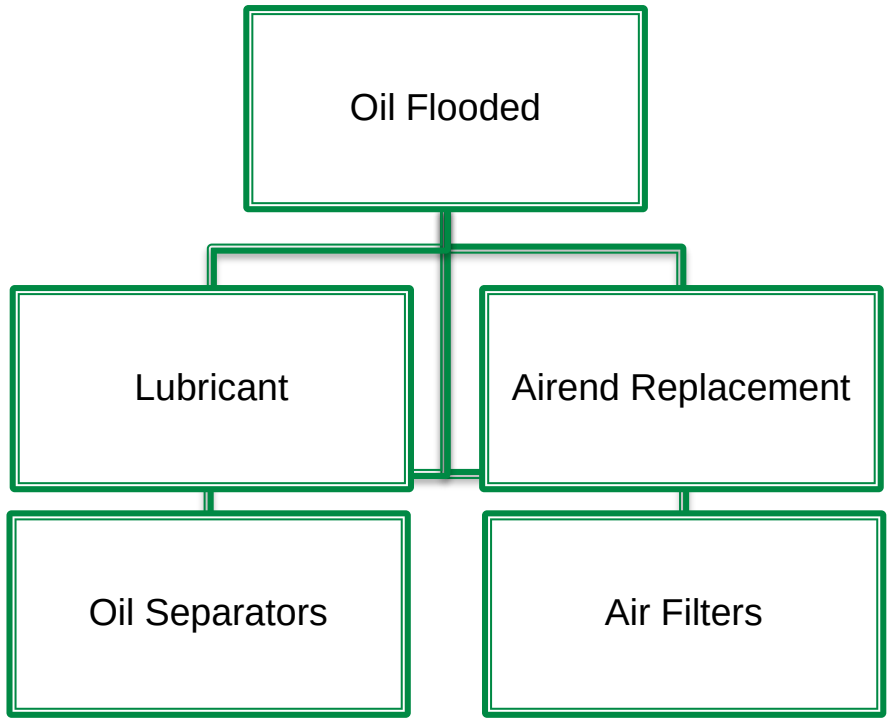
Assume Risk is Acceptable, What about the Reward (Cost)

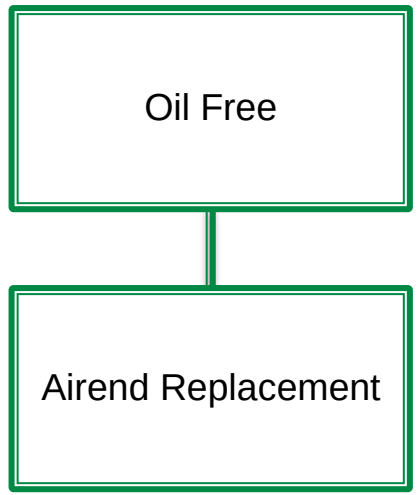


Energy Issues – Account for These



Repair/Maintenance Cost – Account for these





Wild Cards

12-18k Lubes

2 - 4x Lube Purifiers

Extended Warranties

Air Over the Fence

Oil-Free Air by Type of Industry – Screw Only

Strong Risk Factor – Oil Free	Evaluate Risk/Reward	Low Risk – Oil Flooded
Electronics	Aerospace	Paper
Pharma	Chemical/Petrochemical	Metals Mining
Food and Bev	Food and Beverage	Automotive
Breathing Air	Breathing Air	General Manufacturing
	Utilities – Instrument Air	Utilities – Service Air

*Larger Plants will likely go Oil Free due to Capacity Capability of Large Oil Free Screws and Centrifugals

Summary

- There's No One "Best"
- What's Best is Determined by the Customer's Particulars
  - Process
  - Business/Commercial
  - Personnel Risk
- Design the System Around These For Optimization at that Time
- If evaluating oil free vs flooded
  - Evaluate the Risk – Normal and abnormal operating conditions
  - Evaluate the Reward – Account for all Costs especially Energy, Repair and Maintenance Costs

About the Speaker

Steve Arshop
Kaeser Compressors

- Northern California Sales Manager, Kaeser Compressors
- >20 years of experience in compressed air systems
- DOE Certified AirMaster+

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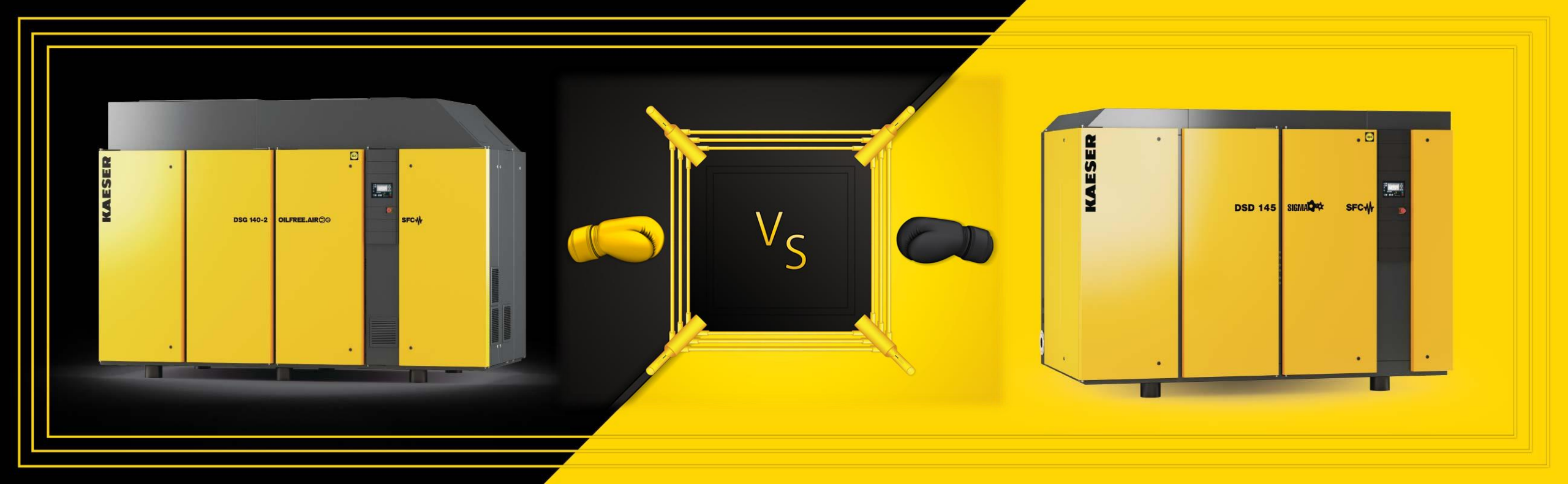

Oil-Free vs Oil-Lubricated Rotary Screw Compressors:

Selecting the right compressor for your facility

Steve Arshop | Sales Manager, Northern California

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OVERVIEW

- Today's compressed air marketplace is dominated by rotary screw compressor technology in sizes from 25 – 500 hp

Other air compressor technologies include:

- Piston (reciprocating)
- Rotary scroll
- Rotary tooth
- Rotary vane
- Axial
- Centrifugal
- Blower (PD and regenerative)

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OVERVIEW

- Oil-free compressors are most commonly used in applications that demand the highest quality air, and/or applications that can't tolerate any risk of gross oil contamination.

  Examples include:

  - Biotech and pharmaceutical
  - Semiconductor and electronics
  - Medical & medical device
  - Food and beverage

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TERMINOLOGY

- There's no universally accepted definition of "oil-free" air or "clean dry" air
- An "oil-free" or "oil-less" rotary screw compressor doesn't add oil into the rotary screw airend or into the compressed air itself, while an "oil-flooded" (aka "oil-lubricated" or "oil-injected") rotary screw compressor does
- Oil-free compressors still have oil inside them!

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OIL-FREE COMPRESSORS

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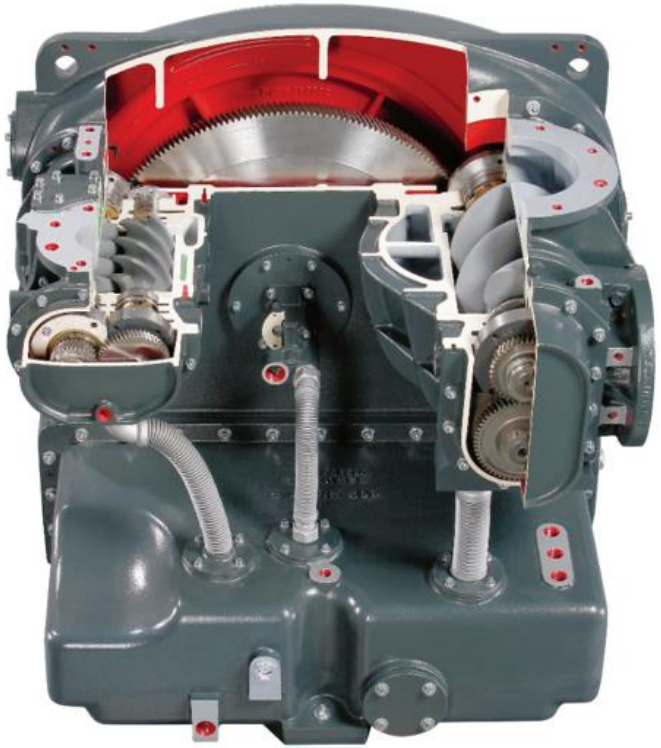
OIL-FREE, AIR-COOLED PROCESS FLOW



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OIL-FREE COMPRESSORS: PROS

- Eliminates risk of catastrophic damage
- Lower routine maintenance costs
- Simplified inline filtration:
  - ➢ Lower investment and maintenance costs
  - ➢ Reduced pressure drop
- Environmental benefits:
  - ➢ Reduced storage, consumption and disposal of oil, oil filters and separator cartridges
  - ➢ Lowered risk of oil spills and leaks
  - ➢ Reduce or eliminate need to treat condensate prior to disposal

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OIL-FREE COMPRESSORS: CONS

- Higher initial purchase price (1.5 – 2.0 X)
- Operating pressures typically limited to ~ 145 psig (10 bar)
- Less efficient = less cfm/hp with efficiency loss over time
- More complex design = more difficult to service, fewer qualified technicians
- Generally expected shorter airend life
- Higher operating temperatures: 350-400°F
- Noisier

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OIL-LUBRICATED COMPRESSORS

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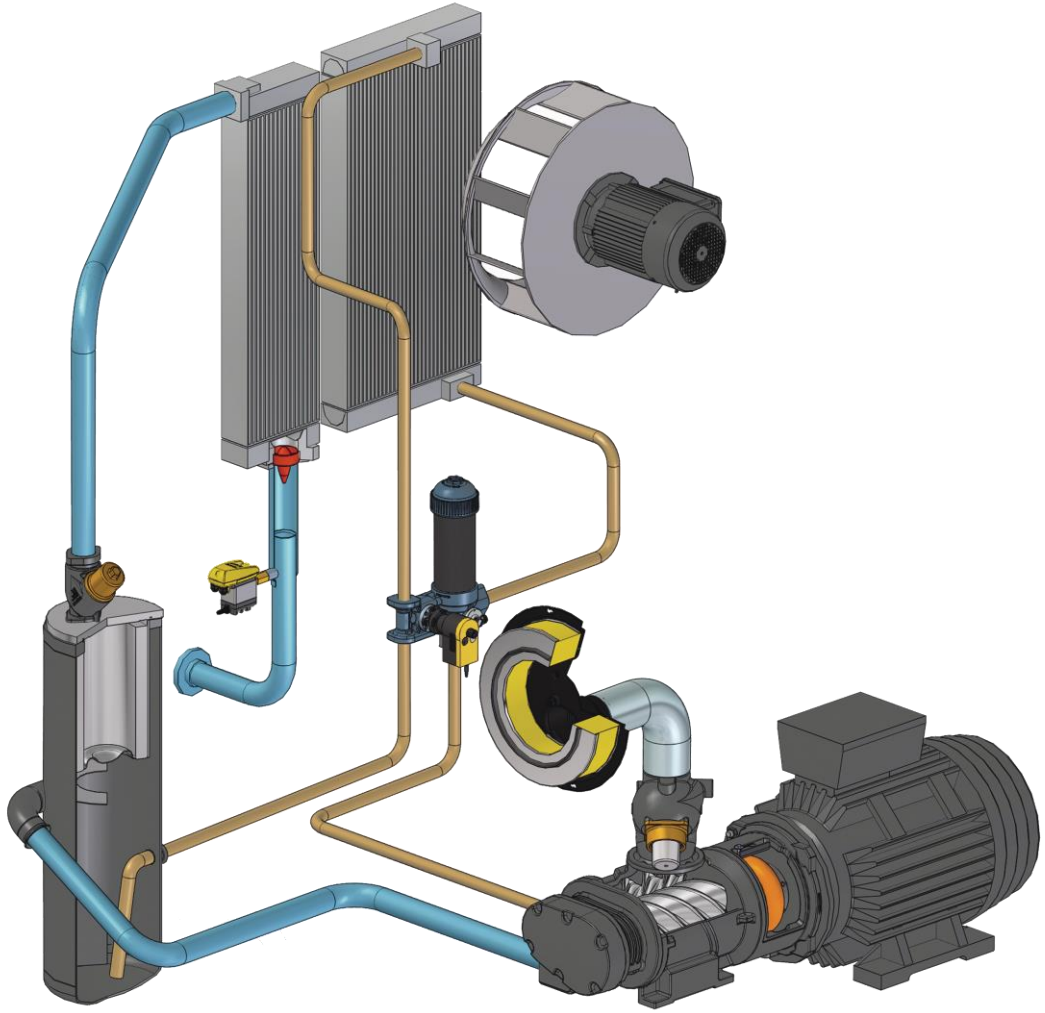
OIL-LUBRICATED, AIR-COOLED PROCESS FLOW



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OIL-LUBRICATED COMPRESSORS: PROS

- Lower initial purchase price
- Operating pressures as high as 200-220 psig
- More efficient = more cfm per hp
- Simpler design = easer to service
- Generally expected longer airend life
- Lower operating temperatures: 150-200°F
- Quieter due to slower rotational speeds

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OIL-LUBRICATED COMPRESSORS: CONS

- "Some" risk of downstream oil contamination, as a result of:
  - Equipment malfunction
  - Improper operation
  - Improper or lack of maintenance
- Higher routine maintenance costs
- Additional inline filtration required to provide comparable air quality
  - Higher investment and maintenance costs
  - Increased pressure drop across more filters
- Environmental issues with storage, use and disposal of oil/filters
- Condensate requires pre-treatment prior to disposal

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COMMON CHARACTERISTICS OF OIL-FREE AND OIL-LUBRICATED COMPRESSORS

- Both ingest the same levels of water vapor and impurities from the atmosphere
- Both require similar clean air treatment to remove moisture and particulates
- Both can be used in breathable air systems, but also require additional downstream treatment and protections to meet OSHA standard 1910.134 for Grade D breathing air

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ISO 8573.1:2010

- Both oil-free and oil-lubricated compressors can be used in systems designed to produce air quality that meets Class 1 for Total Oil concentration
- Because of impurities (e.g. hydrocarbons) in ambient air, both types require some level of filtration downstream

TOTAL OIL Liquid, aerosol, and vapor		
Class	**mg/m³**	**ppm w/w**
0	As specified and more stringent than Class 1	
1	≤ 0.01	≤ 0.008
2	≤ 0.1	≤ 0.08
3	≤ 1.0	≤ 0.8
4	≤ 5.0	≤ 4
5		
6		
7		
8		
9		
X	> 5.0	> 4

** At reference conditions: 68°F (20°C), 14.5 psia (1 bar), 0% relative humidity*

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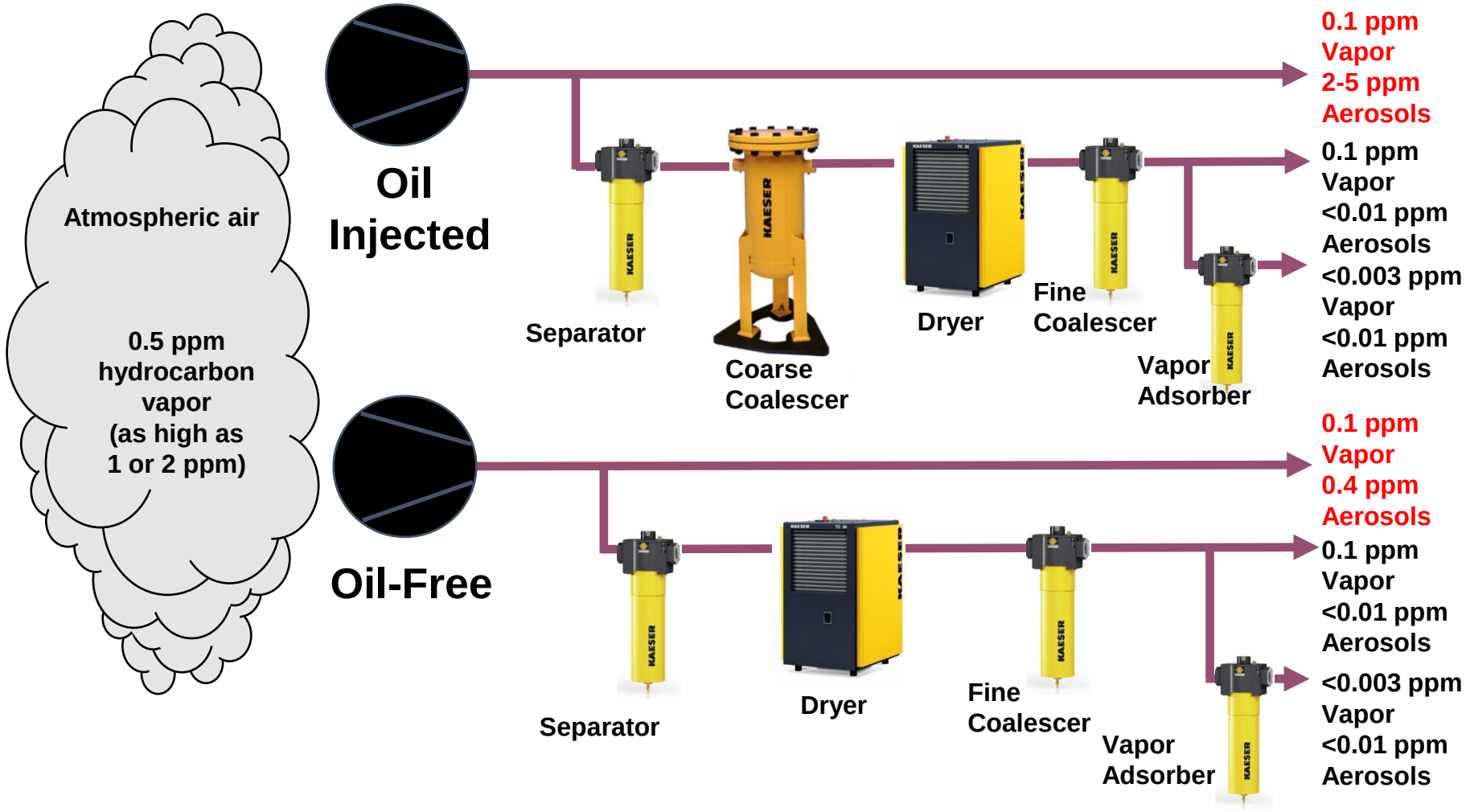
OIL-INJECTED vs OIL-FREE COMPRESSORS



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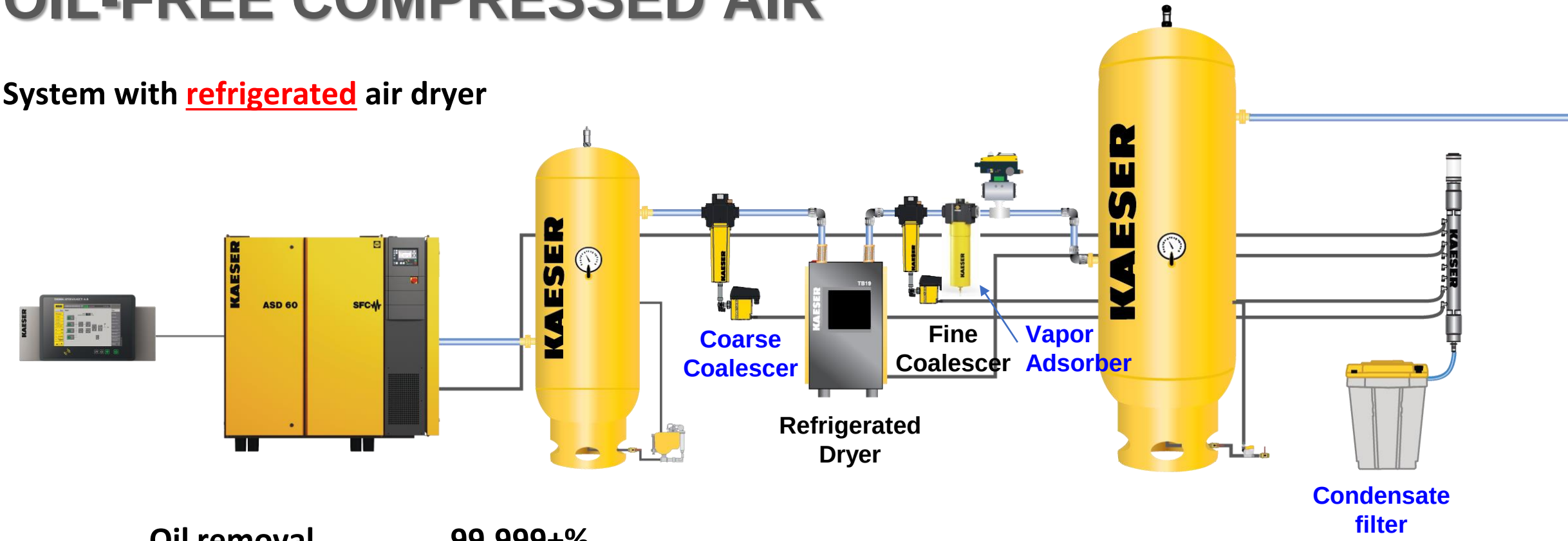
OIL-FREE COMPRESSED AIR

System with refrigerated air dryer



Oil removal	**99.999+%**
Oil carry-over	**0.01 ppm w/w aerosols**
	0.003 ppm w/w vapor
Pressure dew point	**+35 to +50ºF**

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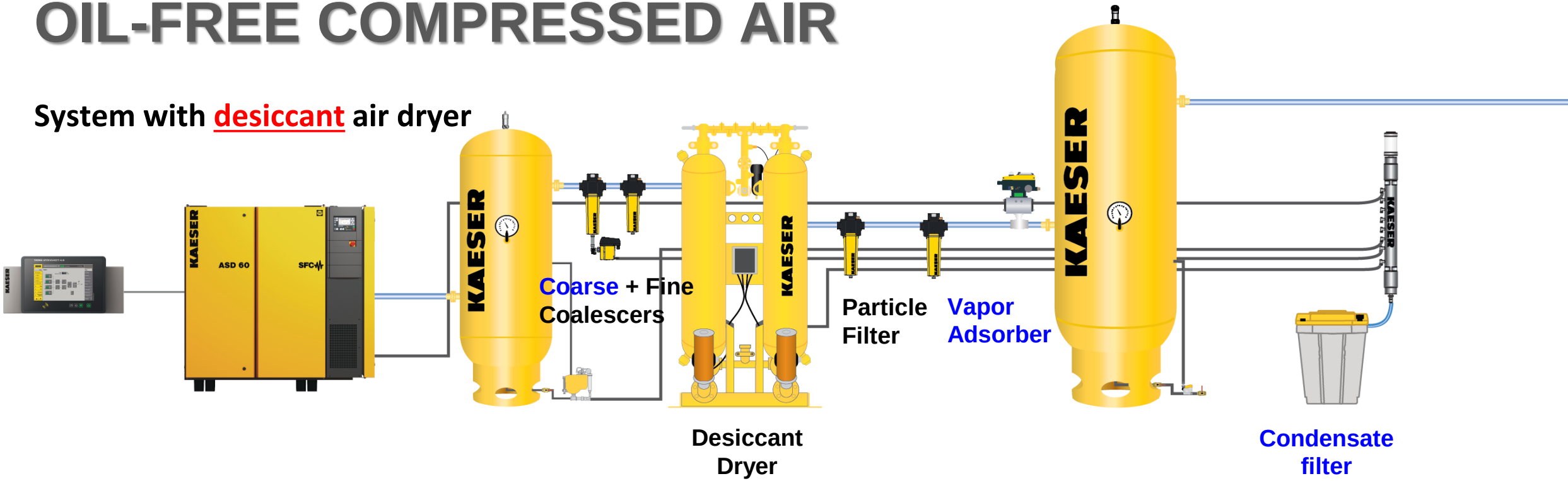
OIL-FREE COMPRESSED AIR

System with desiccant air dryer



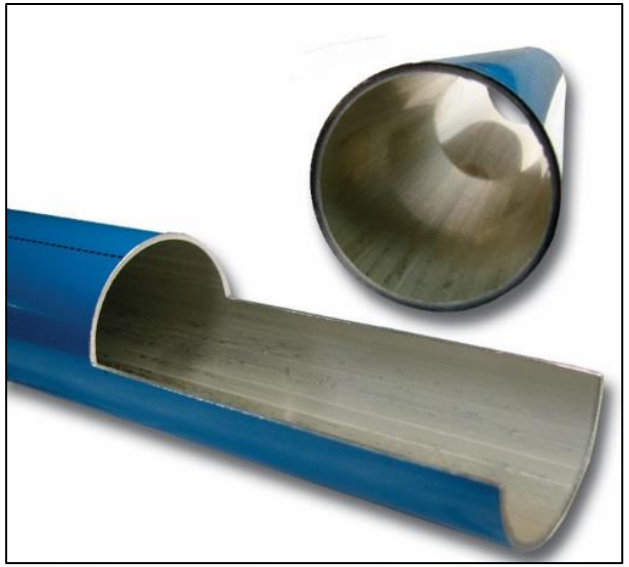
Desiccant Dryer

Condensate filter

Oil removal	**99.999+%**
Oil carry-over	**0.01 ppm w/w aerosols**
	0.003 ppm w/w vapor
Pressure dew point	**-40 to -100ºF**

SYSTEM DESIGN CONSIDERATIONS

- Use of FDA-approved food-grade lubricant
- Receiver tanks – untreated vs. internal treatment
- Process piping – stainless steel, copper & aluminum
- Re-using existing tanks or piping?
- Use of bypass piping?



SYSTEM DESIGN & OPERATIONAL CONSIDERATIONS

- 24/7 operation vs. system shutdowns/start-ups
- Stabilizing system pressure - minimize compressor cycling through storage & controls
- Maintenance procedures & quality PM parts
- Implement routine air quality sampling & testing program

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FINAL THOUGHTS

- Do your processes, applications and finished products truly require an oil-free compressor?
- What are the consequences of downstream oil contamination?
- Does your company mandate which type of compressor to use?
- Do your customers mandate which type of compressor to use?
- Evaluate and weigh the risk/rewards for each compressor type.

Best Practices EXPO Contest

Play for a chance to win a **FREE Full Conference Pass** to the Best Practices 2023 EXPO & Conference!! This is a $675 value! This contest is open to factory personnel, compressed air distributors, utility incentive programs and engineering firms. Exhibiting and sponsor companies are not qualified. Winners will be randomly selected from those who submitted a correct answer and notified tomorrow via email.

Please submit your answer in the upcoming poll

Which of the following industries is most likely to require oil-free compressed air?

A	• Pharmaceuticals
B	• Paper
C	• Metals/Mining

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*By entering you are giving permission to announce your name if you are a winner

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Oil-Free vs. Lubricated Rotary Screw Air Compressors Pros and Cons

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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The recording and slides of this webinar will be made available to attendees via email later today.

PDH Certificates will be e-mailed to Attendees within 2 days.

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Tom Taranto
Data Power Services
Keynote Speaker

Thursday, April 27, 2023 – 2:00 PM EST
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