
Selecting PSA vs. Membrane Nitrogen Generation Systems

Mike Flowe
Flowe Nitrogen Systems
Keynote Speaker

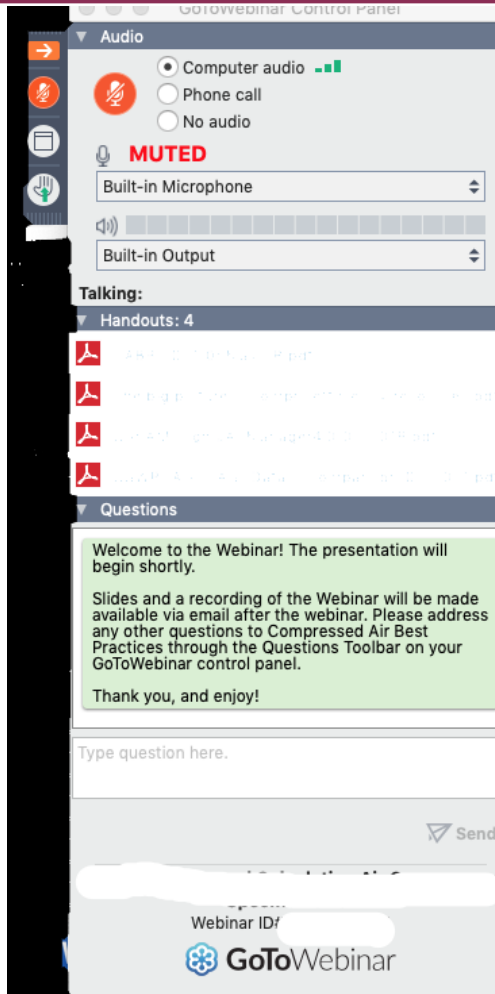
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Q&A Format



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- Please post your questions in the Questions Window in your GoToWebinar interface.
- Direct all questions to Compressed Air Best Practices® Magazine

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Gas Generators

Pneumatech designs and manufactures both standard and engineered on-site gas generator products. Nitrogen and oxygen generators are available with Pressure Swing Adsorption (PSA) technology, resulting in nitrogen purity up to 99.999% and oxygen purity up to 99.9%. Membrane technology is also offered for nitrogen purity levels up to 99.9%.

Pre-defined high-pressure nitrogen acids have been developed as a plug-and-play solution for various applications like laser cutting. Our engineering department hence becomes your best partner for all kinds of special requests.



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Produce your own oxygen or nitrogen in the correct purity for your application. Both gases can be extracted from the ambient air with the help of a compressor and a gas generator, with a quick return on investment.

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14 Klöckner Pentaplast and Energy Management
20 Tröeg's Brewing on Water Conservation
26 Data in Compressed Air Systems
32 Plywood Plant Energy Audit

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Nitrogen Business
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Derrick Taylor
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Sean Dempsey
Southeast Regional
Sales Manager, Sauer
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Bruce McFee
President,
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At the end of the webinar, we are having a fun contest for a chance to win a free full conference pass valued at \$675!

Selecting PSA vs. Membrane Nitrogen Generation Systems

Introduction by
Compressed Air Best Practices® Magazine



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About the Speaker



Mike Flowe
Flowe Nitrogen Systems

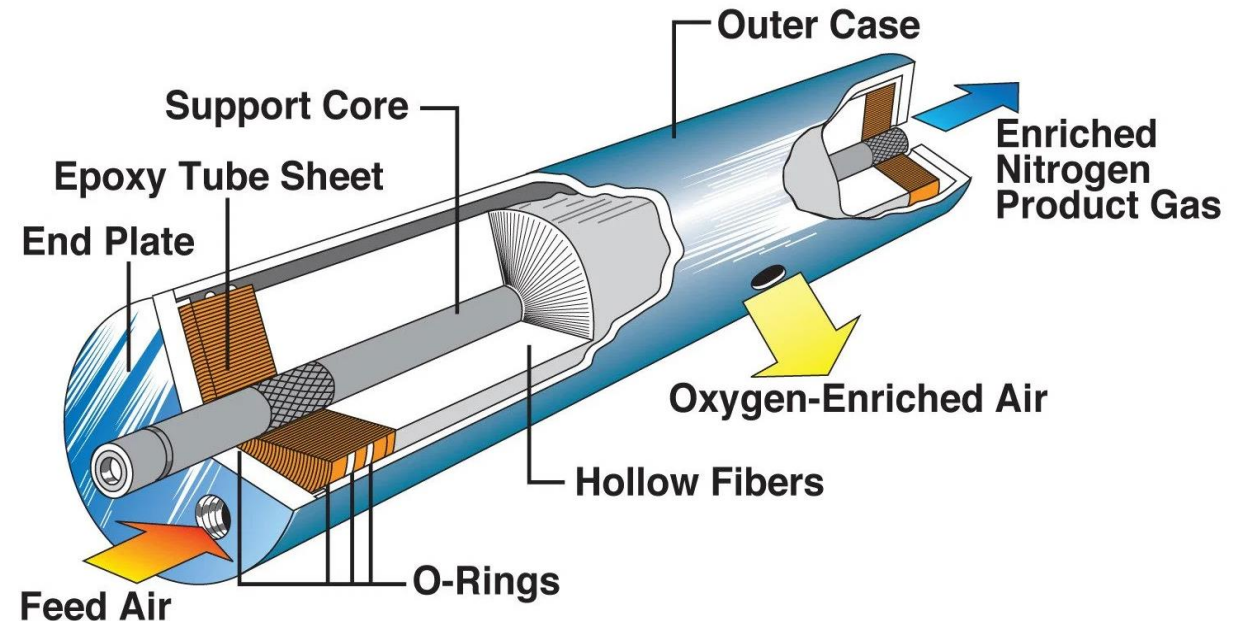
- President, Flowe Nitrogen Systems
- Over 43 years in compressed air and nitrogen generation
- Designed and built N2 generators for the B2 Bomber base in Missouri
- Created prototype systems and standard products for various manufacturers
- Holds a patent for nitrogen system designs

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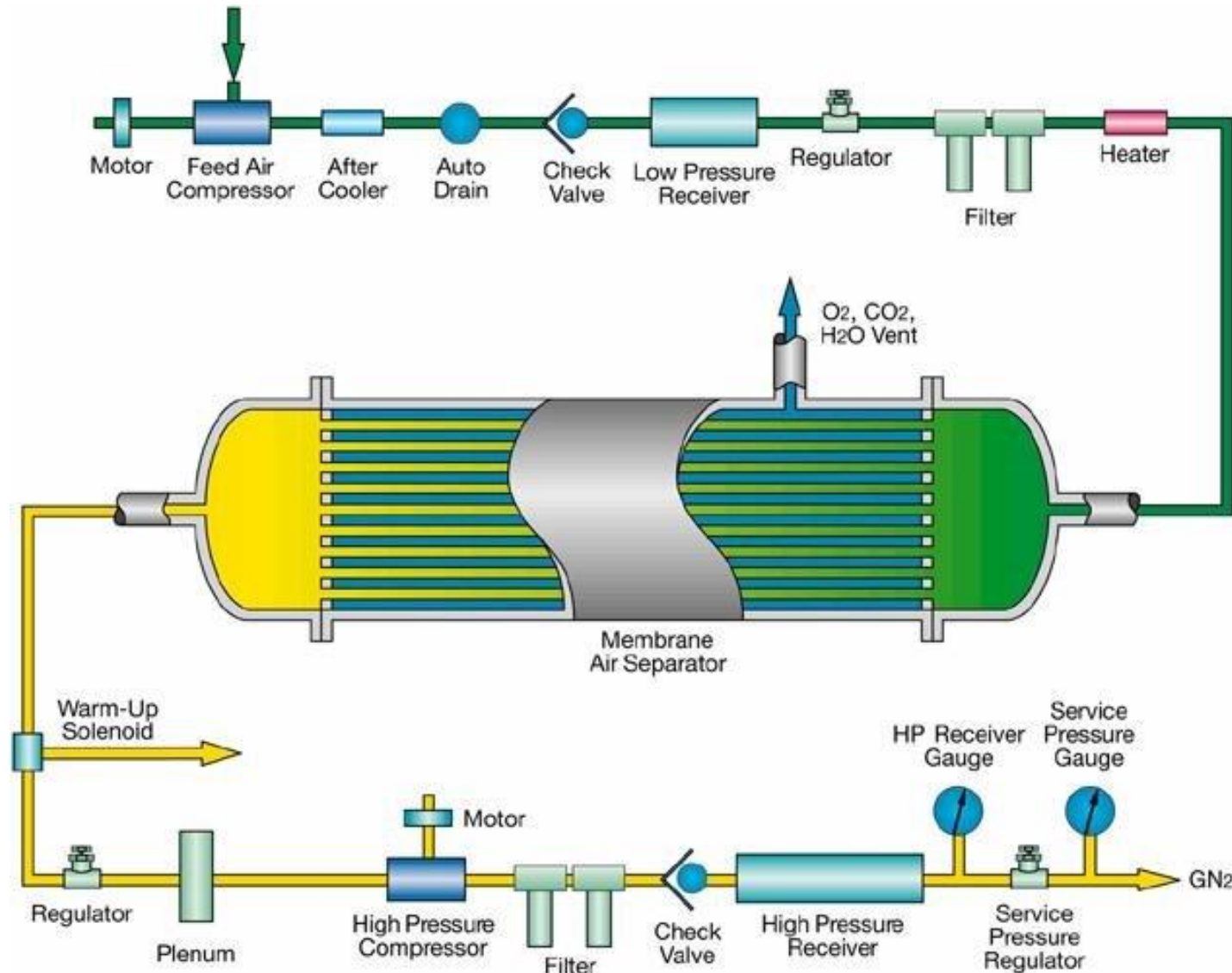


N₂ Membrane Module

- Membrane Module
 - Millions of hollow fibers
 - Selective Permeation
 - Semi-permeable barrier allows certain molecules to pass through while rejecting others
 - Faster gases first
 - Oxygen, Carbon Dioxide, Water Vapor
 - Slower gases pass through fibers
 - Nitrogen, Argon, Methane
- No Moving Parts
- Various module sizes
- Various Capacity – Parallel Flow



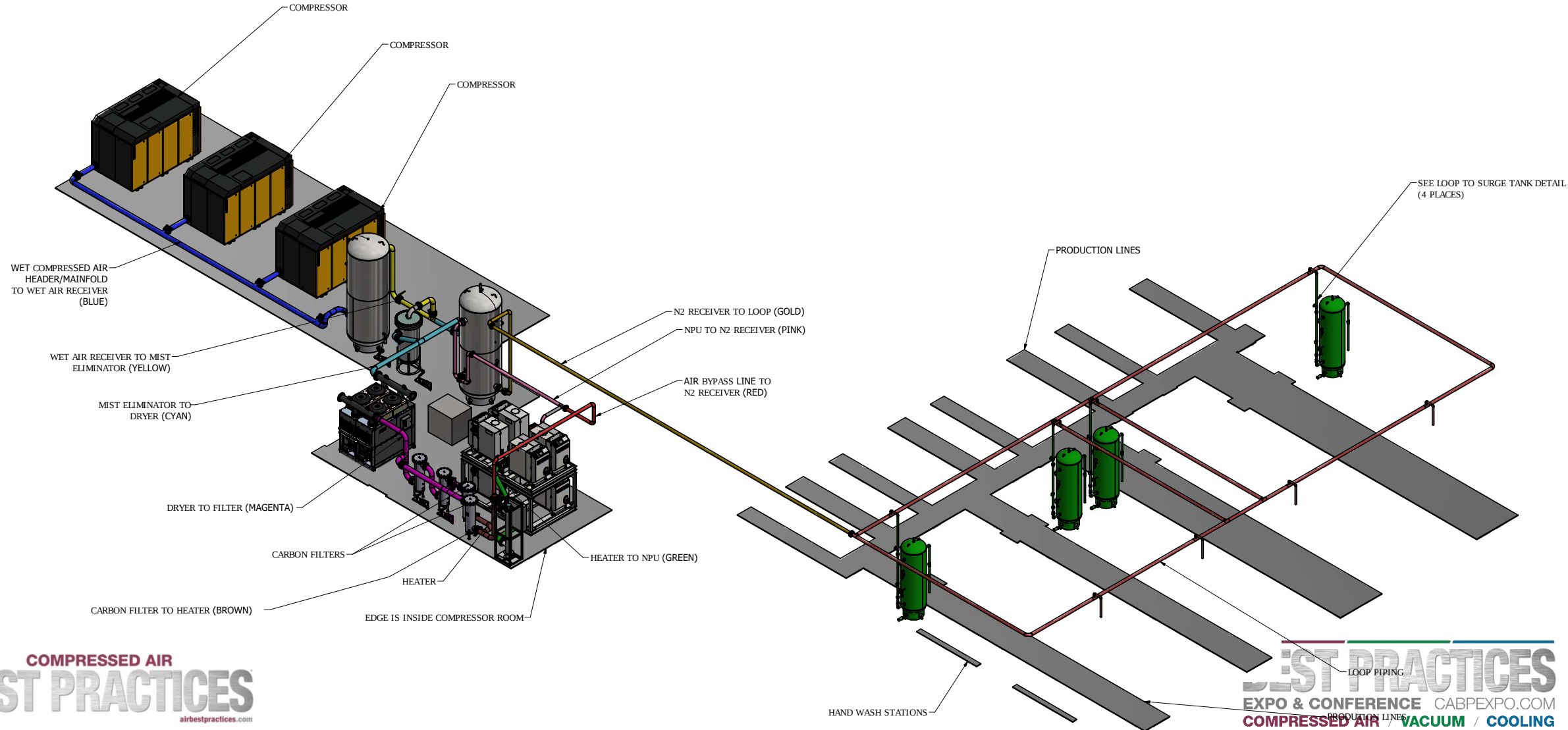
Example: Flow Diagram Membrane Nitrogen Generation System



Example: Small and Large Membrane Nitrogen Generators

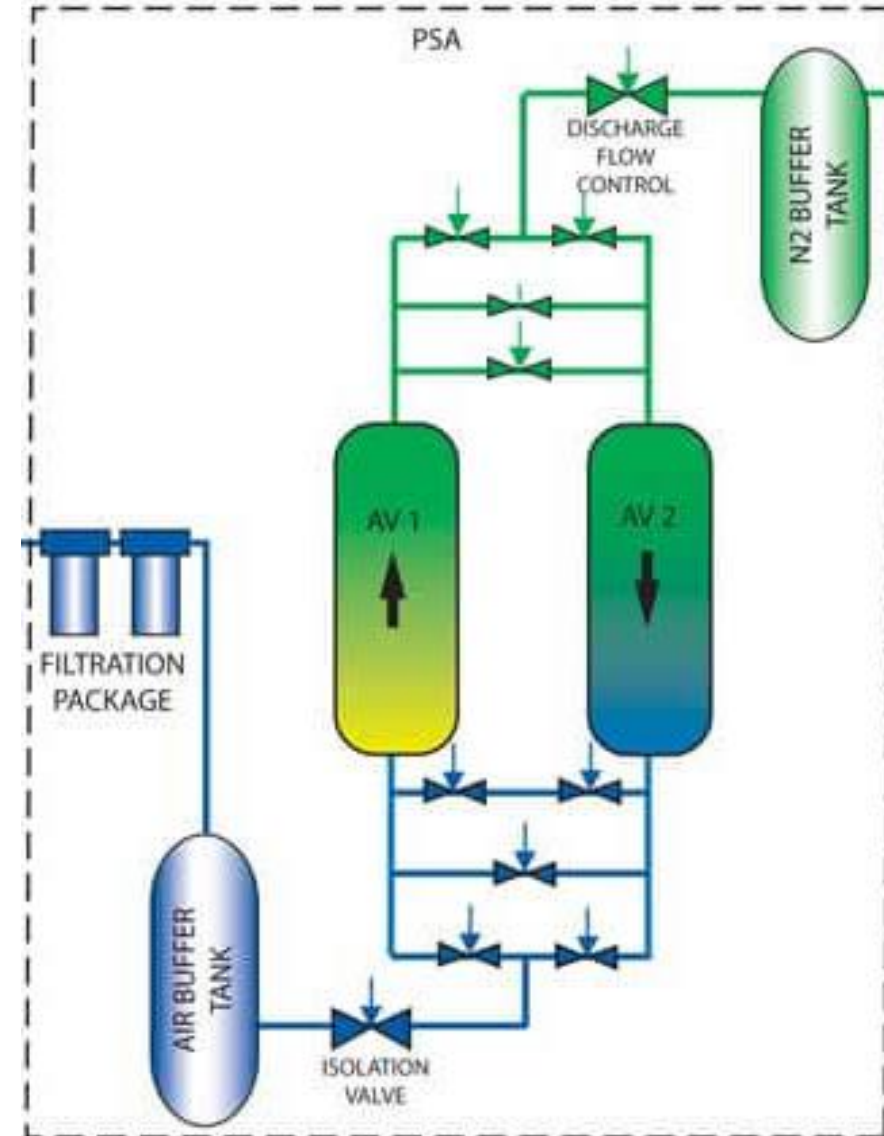


Membrane Nitrogen Generation System Example



N₂ PSA Operating Principle

- Prefiltration (Particulate, Coalescing and Carbon)
- Air Buffer Tank
- Vessels packed with Carbon Molecular Sieve (CMS)
- Vessels 1 & 2 Alternate between Adsorption & Desorption
 - Adsorption Upflow
 - Desorption Down Flow
- Several Steps in the process
 - Equalization
 - Pressurization / Depressurization
 - Adsorption / Purge
 - Then Repeat but switch the towers
- Basic 2 Minute Cycle (1 minute per tower)



Pressure Swing (PSA) N₂ Generator

- Good Example of a PSA showing all the valves clearly
- Left & Right Towers
- Left & Right Inlet Valves
- Left & Right Outlet Valves
- Larger Left & Right Exhaust Valves
- Upper & Lower Equalization Valves
- Purge line for regeneration
- Exhaust Silencer
- Purity/Flow Control Valve
- Control Panel



Large PSA and Membrane Examples



Large N₂ PSA System Example

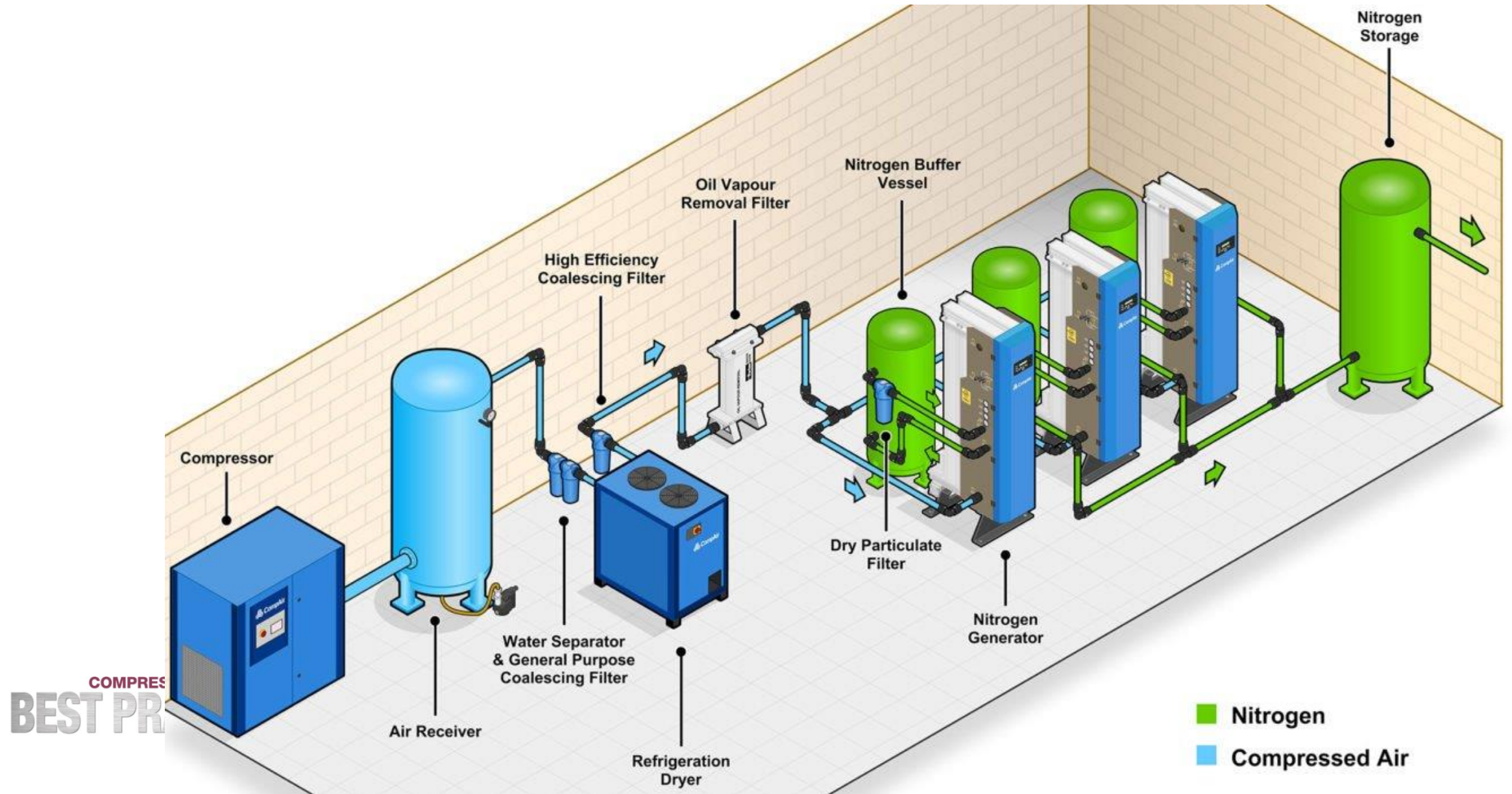


8 Essential Energy-Saving Tips for Nitrogen
Generators

N₂ PSA Example

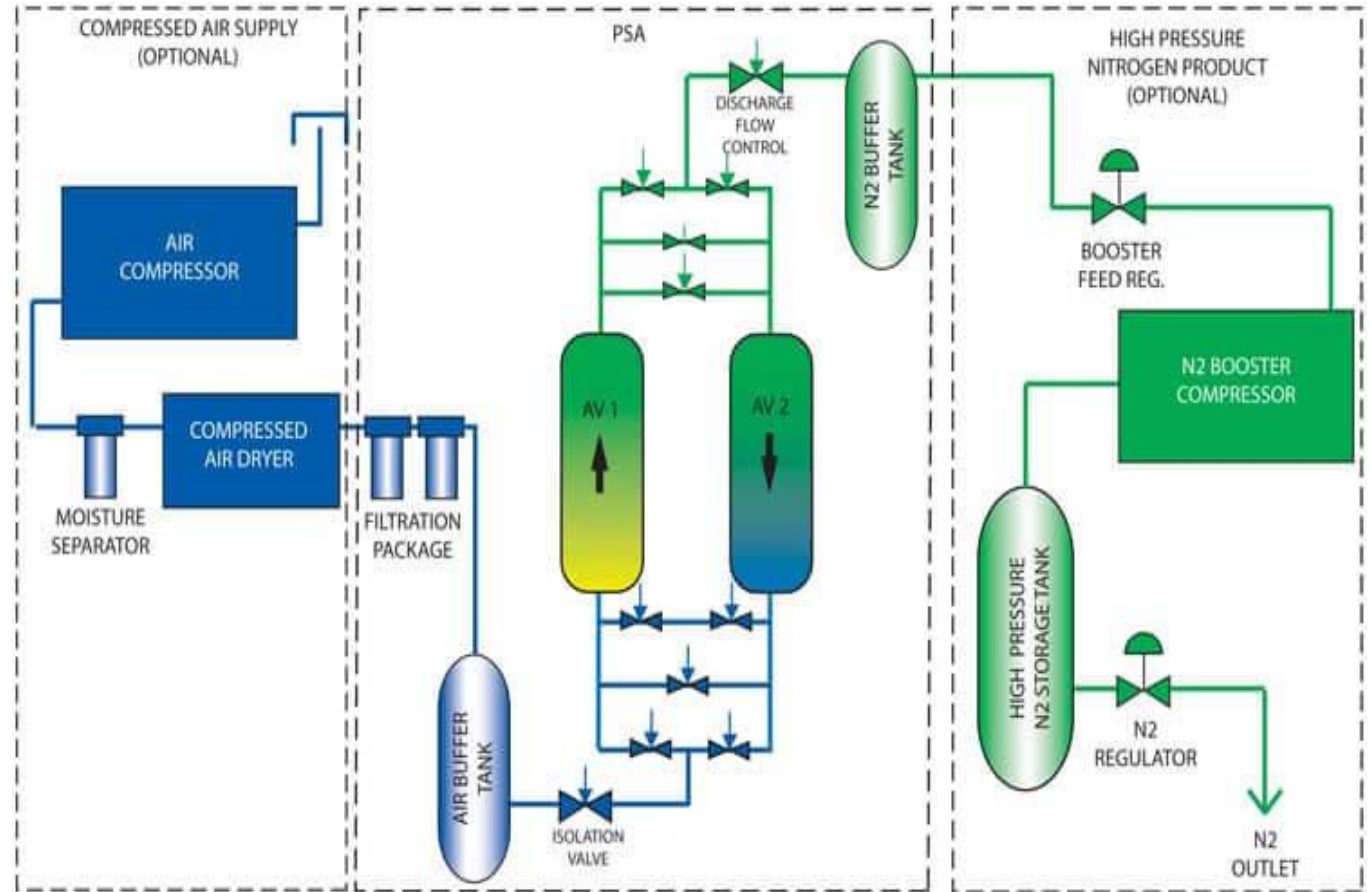


Modular N₂ PSA System Example



PSA N₂ Generating System with Booster

- Compressor & Air Dryer
- Filtration System
- Compressed Air Enters
- Air Buffer
- 2 Vessels with packed CMS
 - #1 Generating Nitrogen Gas
 - #2 Vessel Regenerating
- At end of cycle they switch
- Purity (Flow) Control
- N₂ Buffer / Storage Tank
- Booster System (If high pressure is required)



Pros & Cons Membrane vs PSA

Membrane

- No moving parts in separation process
 - Attractive from a maintenance and simplicity standpoint
- Very Quiet operation
- Smaller Footprint typically
- Easier Installation typical
- Great for lower purity applications (< 95% to 99% purity)
- Good flow capacity – lower purities
- Expansion potential
- Fiber Susceptible to oil, particulate and oil vapor contamination
- Membrane fiber aging – Causes purity decline
- Shorter overall life than PSA - ~10 yrs.

PSA

- Eight Process valves – Every minute
 - Plus a flow/purity control valve all will need repair and maintenance at some point
- Not so Quiet
- Larger Footprint typically
- More Complicated Installation
- Great for higher purity applications (< 95% to 99.999% purity)
- Greater flow capacity at all purity ranges
- Expansion potential – not so much
- CMS Susceptible to oil, particulate and oil vapor contamination
- No Aging on CMS (except for oil contamination)
- Life expectance - ~20 yrs

Reasons & Considerations

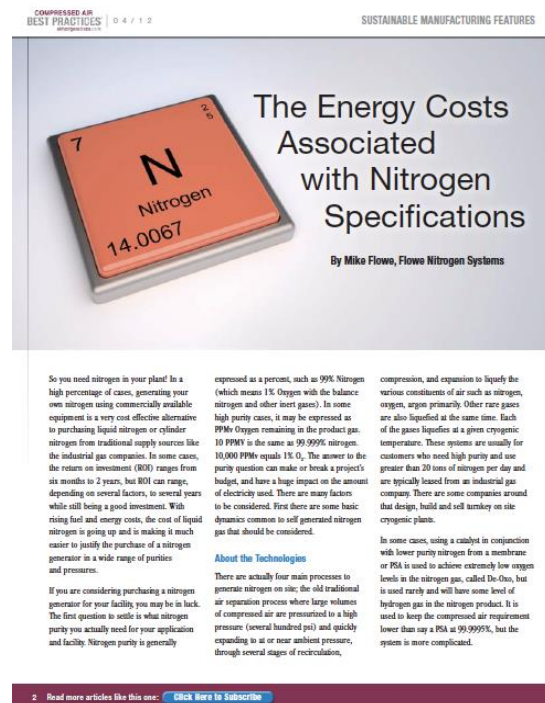
- Oil Free Compressor – Longer Membrane or CMS life
 - Higher purchase cost vs longevity
 - Compressor maintenance cost vs generator maintenance
- Purity – Higher purity consider PSA
 - Purity above 98% - PSA significantly more cost effective
 - Purity below 98% - Membrane is nearly as efficient as PSA
 - Purity above 98% - Membrane efficiency drops off significantly compared to PSA
- Flow Rate – very high flows should consider PSA
- Life Span – Membrane ages and purity declines over time
 - Membrane can perform reasonably well over 10 years with good maintenance.
 - CMS does not lose performance over time so long as contamination is avoided.
 - Can result in over 20 years assuming proper maintenance is adhered to.
- Pressure requirement – high pressures may require a booster
- Temperature – Very important factor in both sizing and operation

Articles By Mike Flowe – Flowe Nitrogen Systems

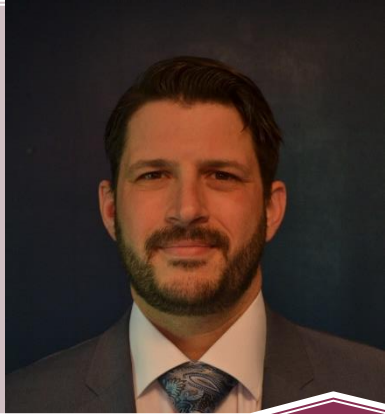
April 4, 2012 Compressed Air Best Practices Magazine

- <https://www.airbestpractices.com/system-assessments/air-treatmentn2/energy-costs-associated-nitrogen-specifications>

A comprehensive study of the energy costs and other considerations of specifying a nitrogen generator system. Covers all factors in the sizing process and comparison of different technologies with respect to purity, temperature, pressure and other factors.



About the Speaker



Ben Smith
Pneumatech

- Industrial Gas Business Line Manager – North America, Pneumatech
- 11+ years of experience in the compressed air industry
- Expert in nitrogen and oxygen systems design, sizing, and integration
- Specialist in nitrogen and oxygen sales training

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Selecting PSA vs. Membrane Systems

Ben Smith
Business Line Manager Industrial
Gas



Product Portfolio



Booster Pumps



ConservAIR



Breathing Air



Adsorption
Dryers



Refrigeration
Dryers



Filtration
Solutions



Gas Generators



Condensate
Management



Purity
Measurement

Product range - Nitrogen



99% 6 scfm
95% 15 scfm



99% 112 scfm
95% 294 scfm



99% 1177 scfm
95% 2354 scfm

Max capacity range scfm
*Multiple units can be used to achieve a higher flow

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Membrane vs PSA how to choose

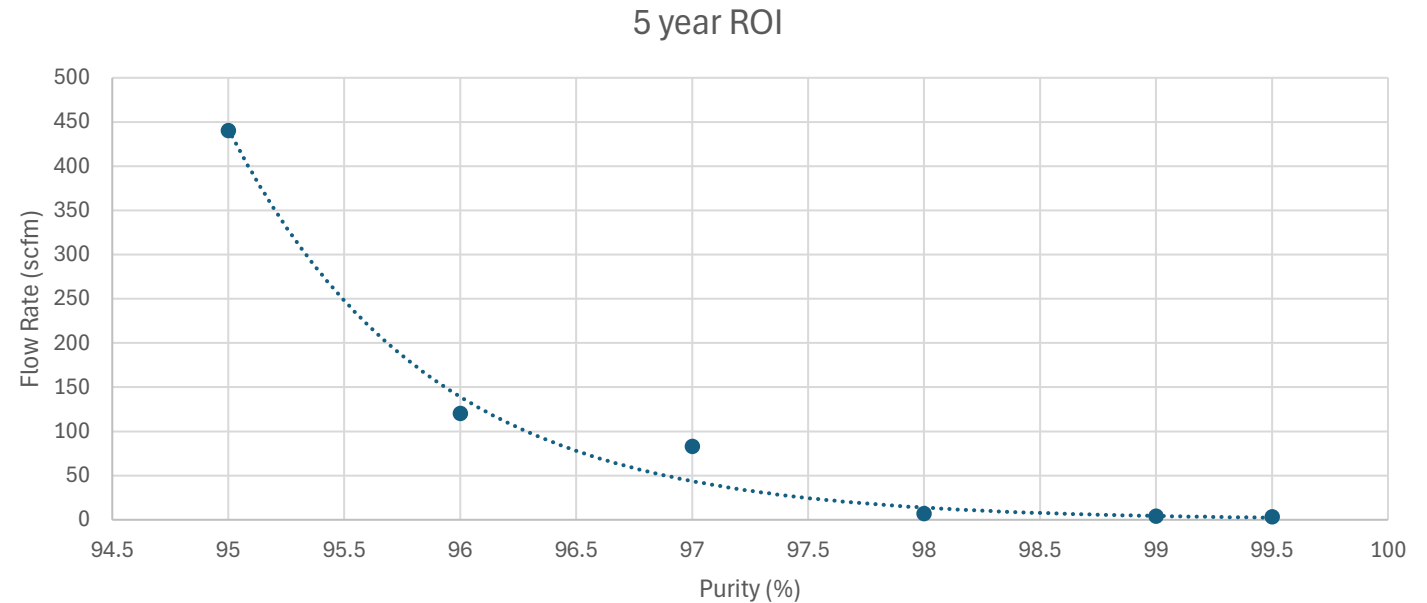
	Membrane benefit	PSA benefit
Max. gas purity >99.5%		✓
Noise level	✓	
Initial start-up	✓	
Footprint	✓	
Simplicity	✓	
Service intensity	✓	
Simplest install	✓	
Very large sizes		✓



Return on Investment Membrane vs PSA

Factors that affect ROI

- Purity
- Flow Rate
- Equipment Costs
- Electricity Cost
- Running Hours Per Year
- Compressor efficiency
- Pressures
- Temperatures



4000 running hours per year, \$0.12/kWh,
21kW/100cfm, 116 psi, 77F inlet, 86F
ambient

Example

■ Customer Requirements

- 99% purity
- 20 scfm
- 100 psi
- 4000 running hours per year
- 86F Ambient
- 77F Inlet
- 20kW/100cfm compressor
- 0.12\$/kWh

• Membrane System

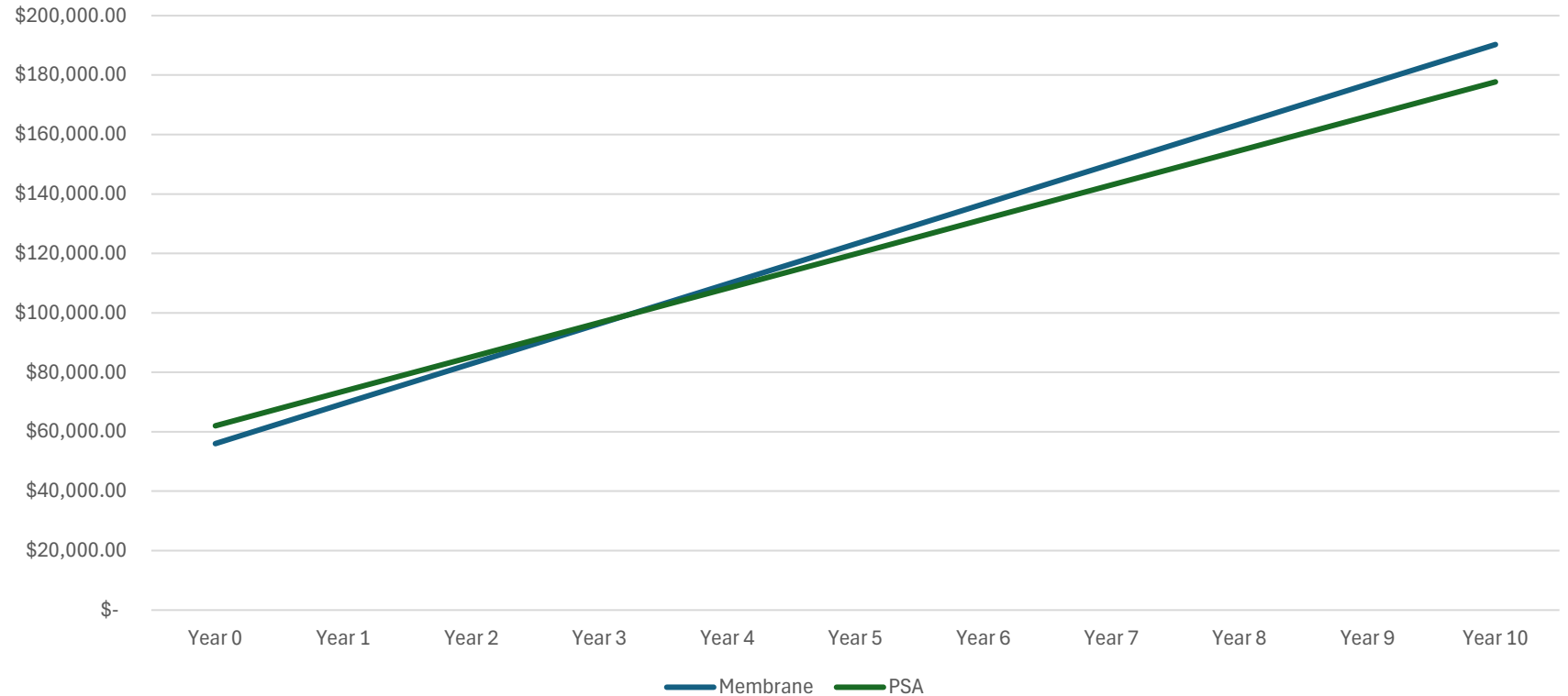
- 100 scfm
compressed air
requirement ~ 25HP
compressor
- Full system cost ~
\$56,000
- Annual service cost
~ \$4500
- Annual energy cost
~ \$8930

• PSA System

- 60 scfm
compressed air
requirement ~ 20HP
compressor
- Full system cost ~
\$62,000
- Annual service cost
~ \$5500
- Annual energy cost
~ \$5970

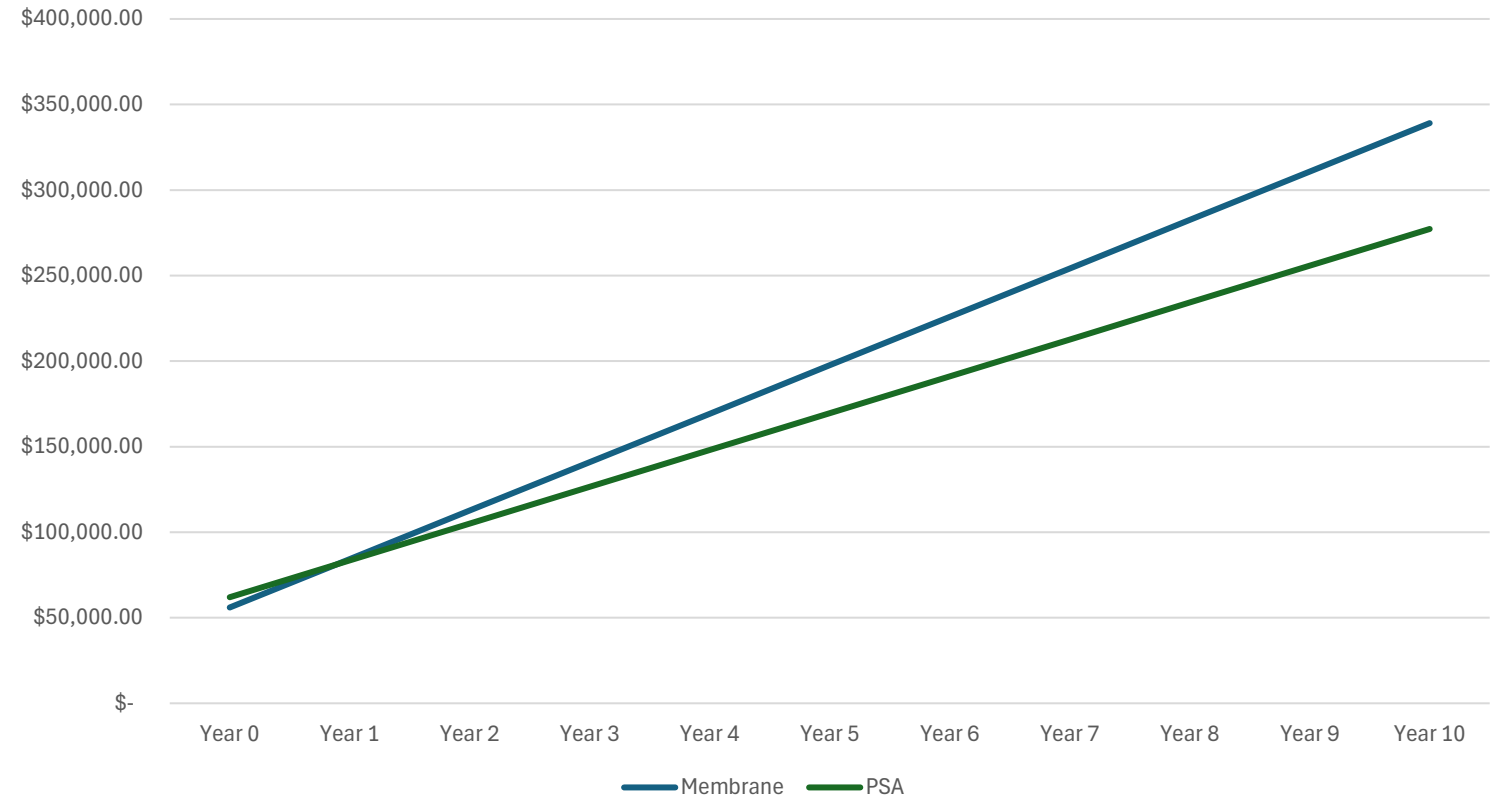
Example

- Results
 - 3-4 year ROI
 - \$12,570 savings over 10 year period



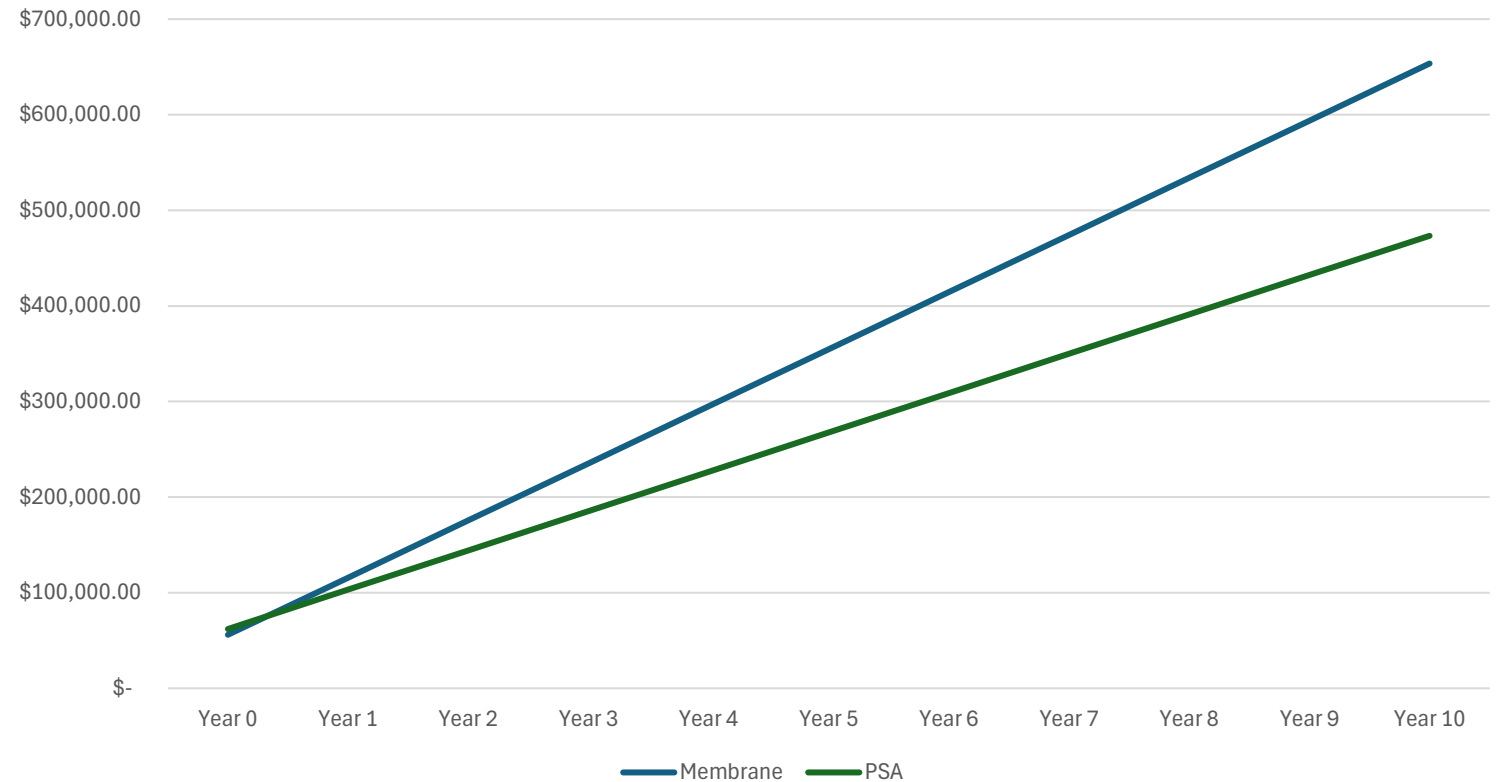
Customer in California - \$0.32/kWh

- Results
 - ~1 year ROI
 - \$61,900 savings over 10 year period



Same Customer - 8000 Running Hours Per Year at 99.5%

- Results
 - <6 month ROI
 - \$180K savings over 10 year period



Conclusion

- Pneumatech offers two calculation tools to help you select the best technology for your application.
 - Quick estimation tool
 - A conservative tool designed for fast estimation of membrane vs. PSA technology.
 - Full estimation tool
 - Designed to take all factors into account to give the most accurate ROI possible.
- Contact Pneumatech to learn more.
 - Benjamin.Smith@Pneumatech.com



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Please submit your answer in the upcoming poll

Which system is typically better for higher purity applications?

A

• Membrane

B

• PSA

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• PSA

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Q&A

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October 2024 Webinar

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Mauricio Uribe
Compressed Air Consultants
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