Blowers ■ Compressors ■ Vacuum Pumps

SELECTING THE RIGHT BLOWER TECHNOLOGY

AERZEN®

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Available Blower Technology

- Positive Displacement
  - Two lobe or Three lobe
  - Rotary Lobe Compressor

Rotary Lobe Compressor

Rotary Lobe Blower

Available Blower Technology

- Centrifugal
  - Multi-stage
  - Single stage with gear
  - Single stage high speed turbo
    - Magnetic Bearing
    - Air Foil Bearing

Multi-stage

High Speed Turbo

Integral gear single stage

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Positive Displacement Blowers - Aerzen Generation 5 Packages

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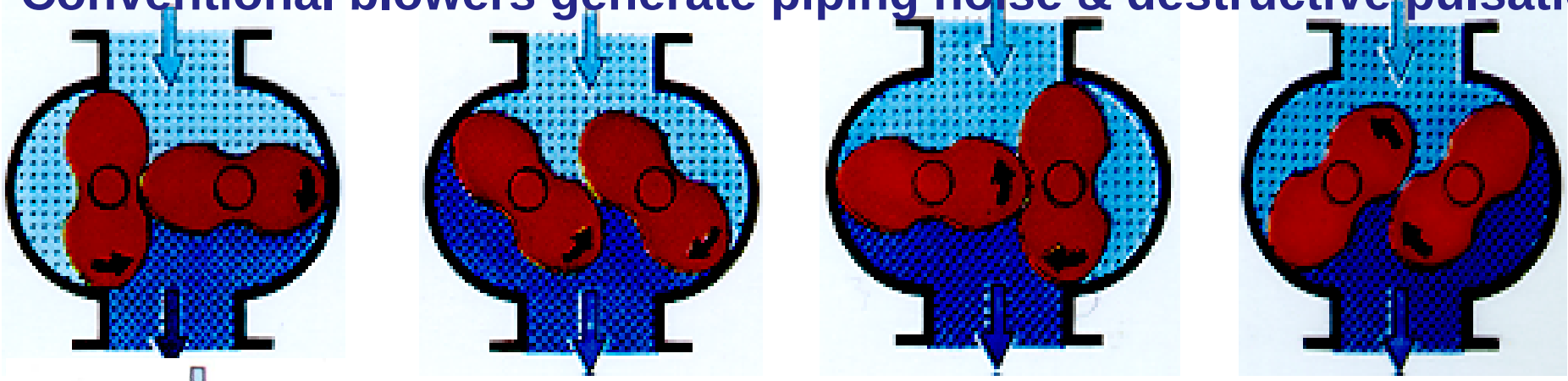
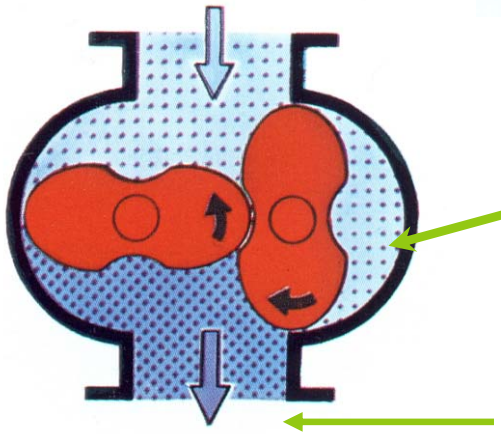
Pulsations and piping noise

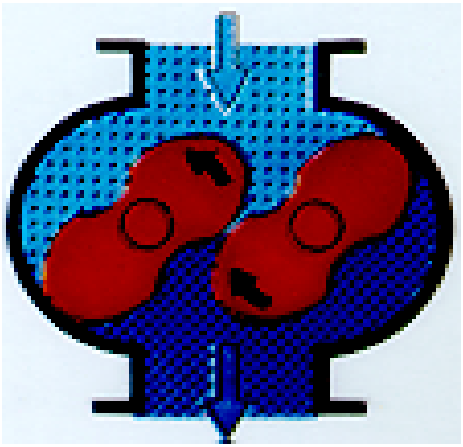
Conventional blowers generate piping noise & destructive pulsations





Atmospheric pressure (light blue)

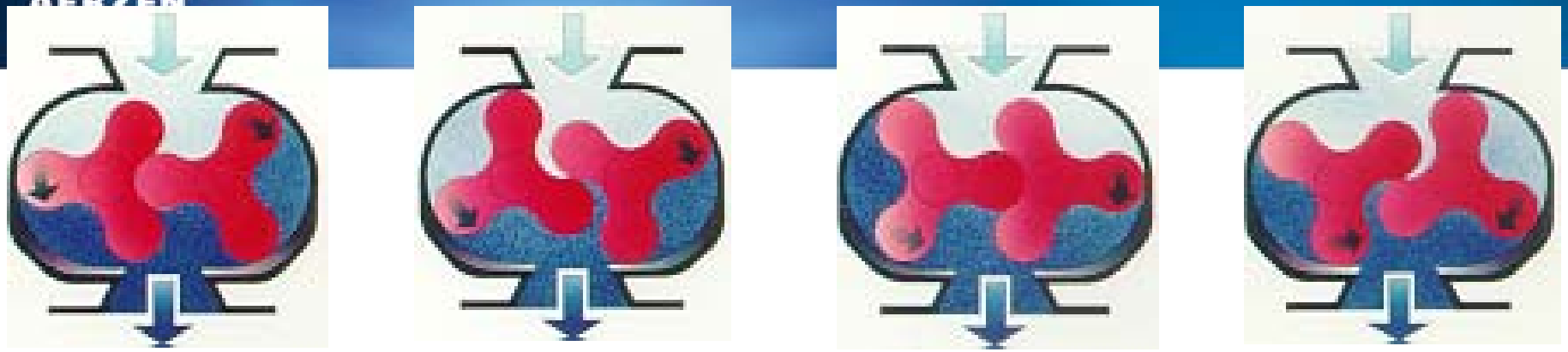
System pressure (dark blue)



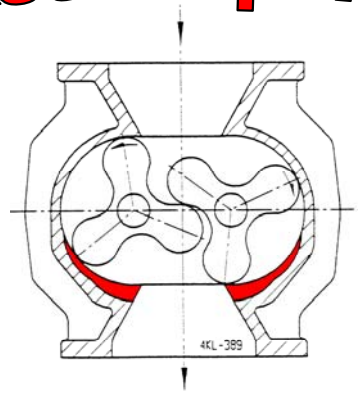
Pressurized air in discharge is about to return into blower housing

Abrupt pressure equilization causes sound wave and shock

Three – Lobe Blower

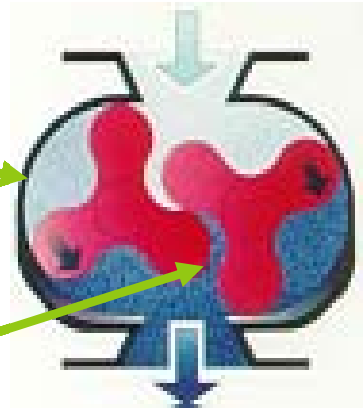


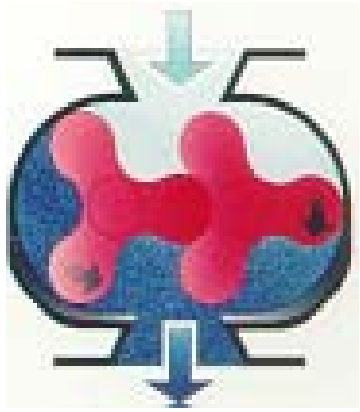
Return ports



Returning air pressurizes this chamber

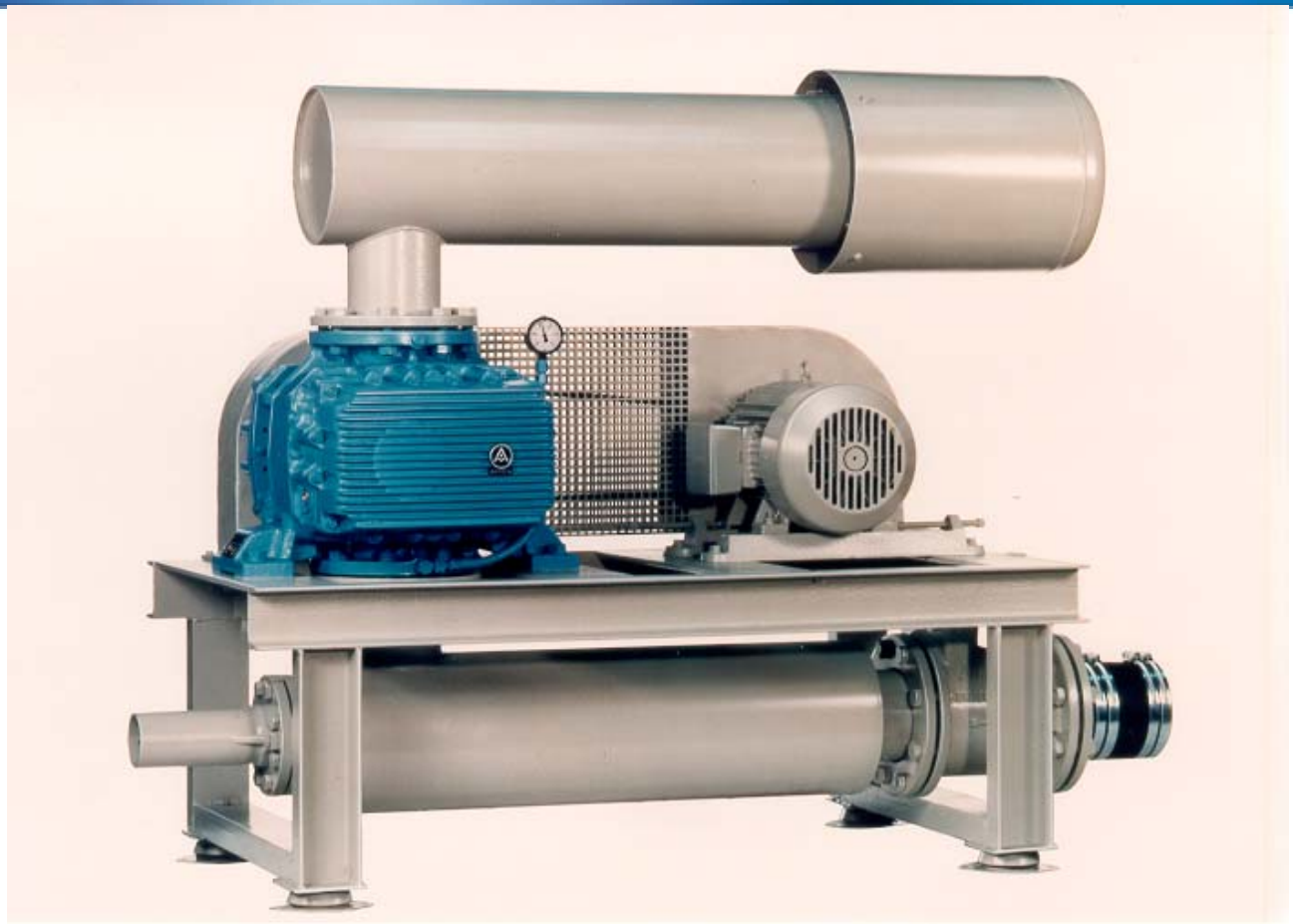
Wave created by squeezed volume meets discharge wave at 180°





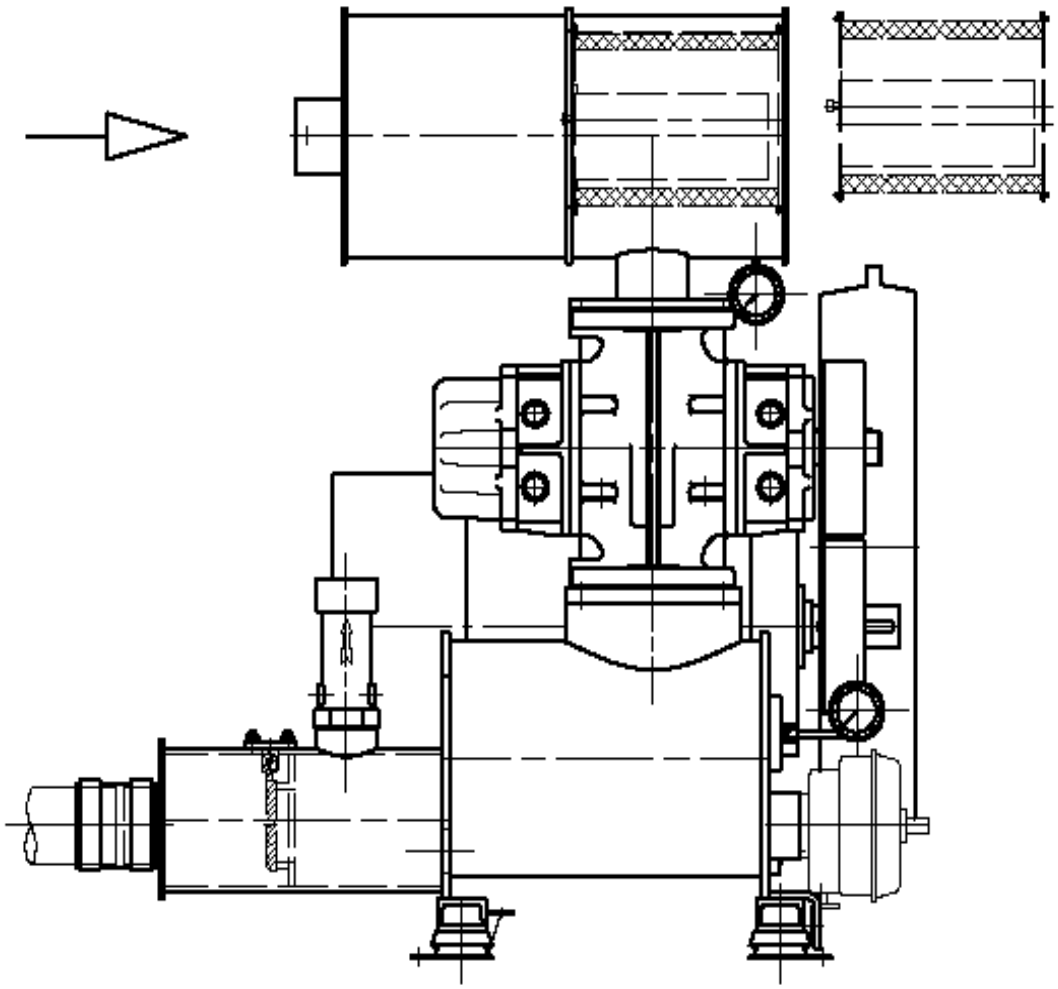
the wave of reduced amplitude is then DEPHASED by the incoming 'squeeze' pulsation. <u>The result is 95% - 97% pulsation cancellation!</u>

Packaging Innovation



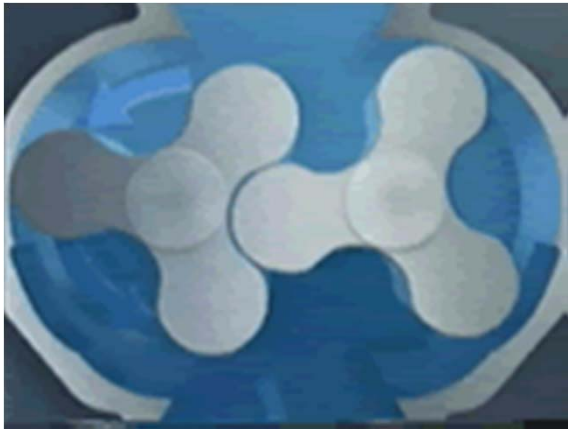
Compact I from 1960's

Packaging Innovation



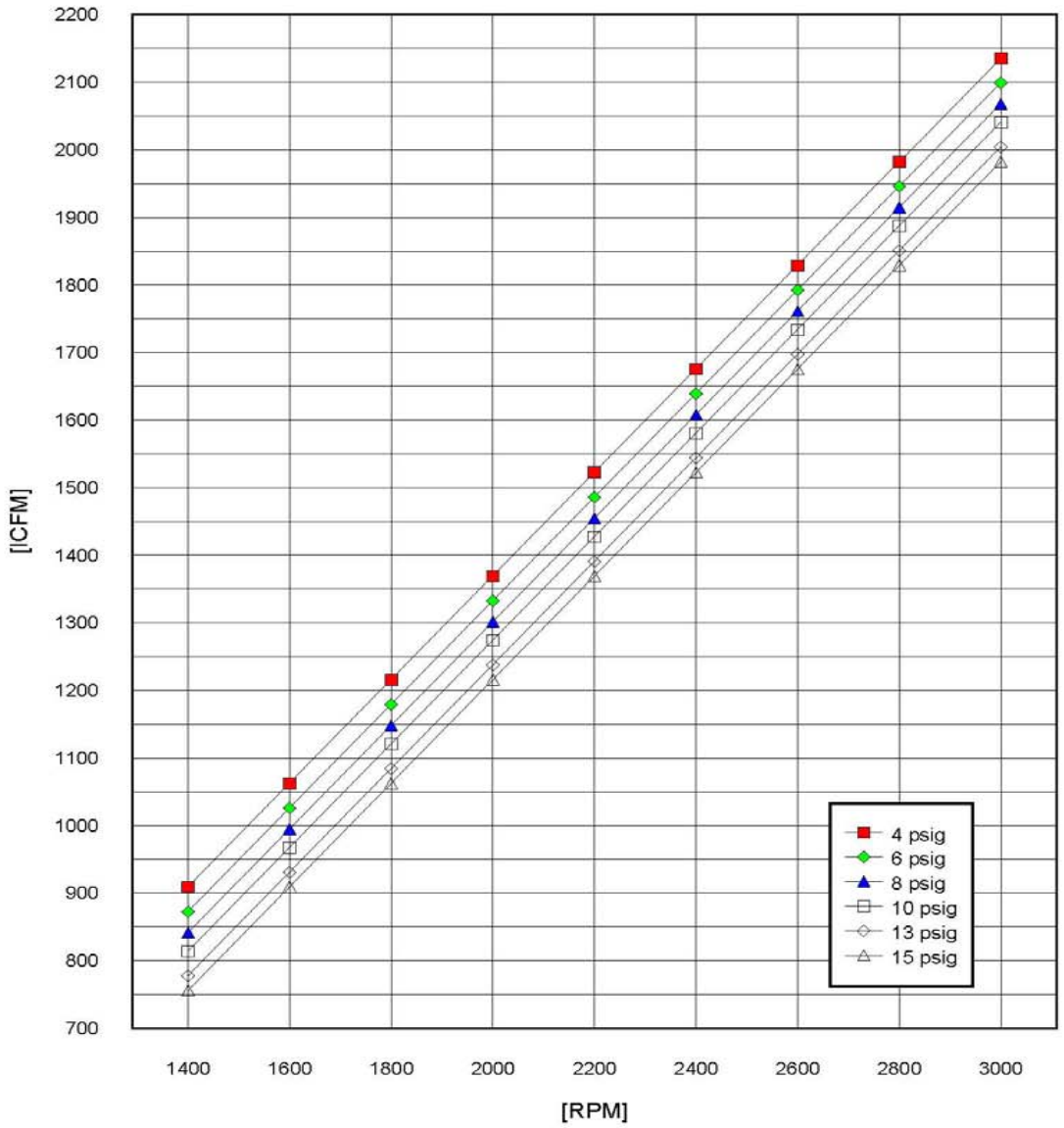
Blower Design Principles

- Positive Displacement Blower
  - Constant volume against varying pressure
  - Flow changes by varying speed with VFD
  - High Turndown (Typically 4:1)
  - Easily adapts to changes in pressure & temperature
  - Lowest initial cost



AERZEN GM 60S DELTA PACKAGE, PRESSURE

INLET FLOW

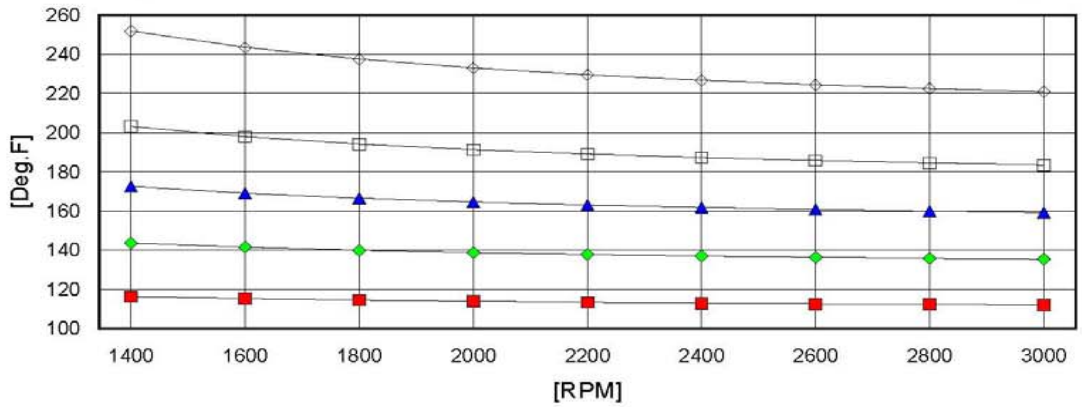


Performance data based on air @ 68 deg.F/ 14.7 psia inlet.

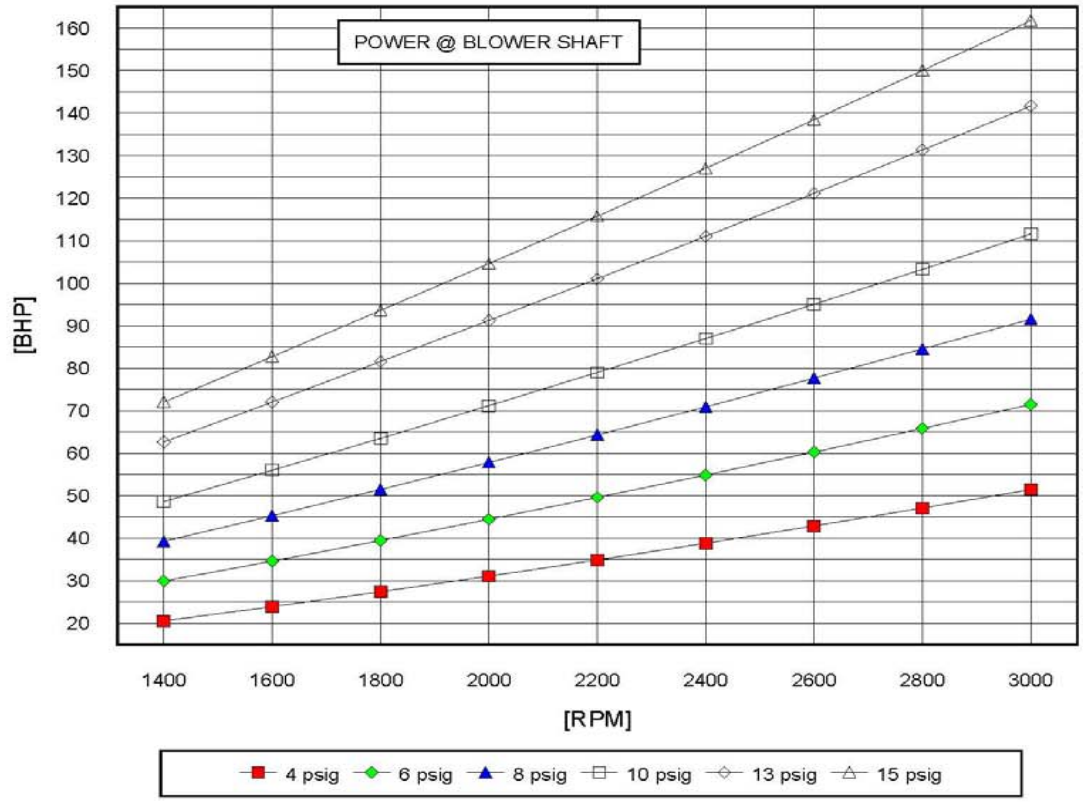
See temperature chart on second sheet for allowable operating range.

AERZEN GM 60S DELTA PACKAGE, PRESSURE

DISCHARGE TEMPERATURE



MAXIMUM ALLOWABLE DISCHARGE TEMPERATURE: 285 deg.F
Performance data based on air @ 68 deg.F/ 14.7 psia inlet.



Blowers ■ Compressors ■ Vacuum Pumps

Delta Hybrid

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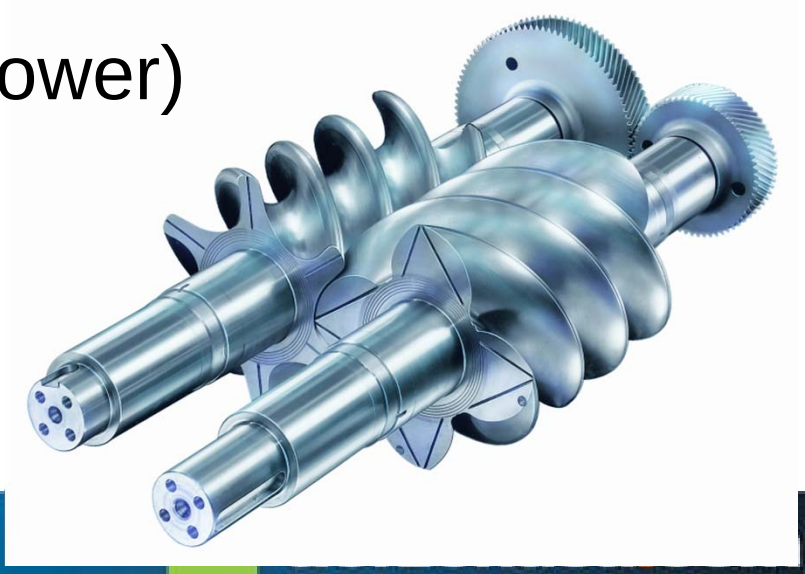
Delta Hybrid Concept

- High Efficiency of a Compressor
  - Comparable Efficiency to Turbo
- Packaging Principles and Economy of Aerzen Generation 5 Blower Package
- High Turndown (4:1)
- Proportional Control (Standard VFD)
- Capital Cost:
  - 10% > PD
  - 20-40% < Turbo

Compressor Design Principles

- Positive Displacement Compressor (VML)
  - Used since the 1940's (Deep Cell Aeration)
  - Rotors mesh, compressing air inside housing
  - Flow changes by varying speed (VFD)
  - Design for up to 50 psig
  - Higher capital cost (2X PD blower)

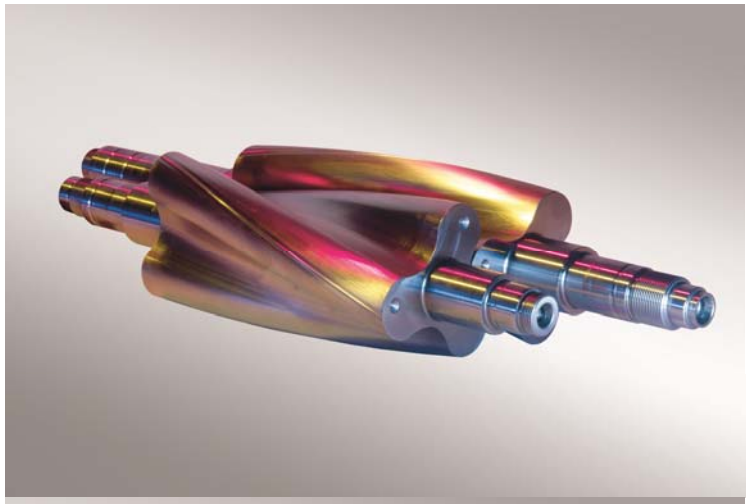


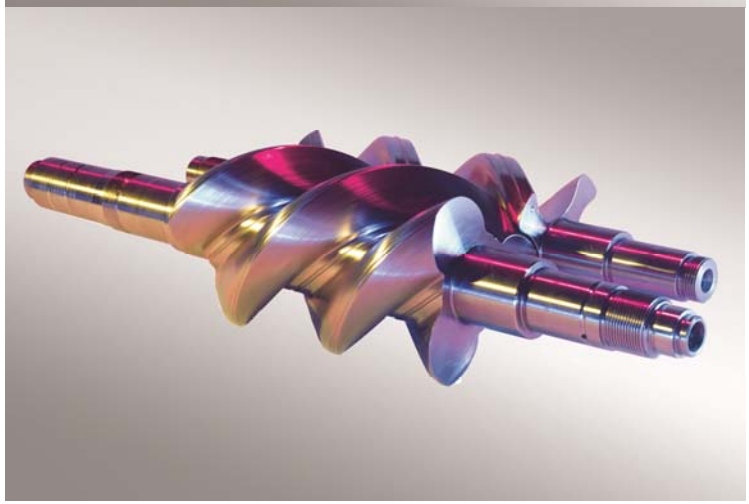
Delta Hybrid Advantages

- More Efficient than Aerzen 3 Lobe Blowers
  - 5% - 25% Energy Reduction

- Two rotor profiles:
  - L: Isochoric compression (supercharger)
  - S: Screw compressor profile (3+4)
  - Why: Proper Profile Required for Optimal Performance

Hybrid Rotor Profiles





- L Series (Patented)
- 3 + 3 Twisted Rotors
- Range: 3-8 PSIG

- S and H Series
- 3 + 4 Screw Rotor
- Pressure Range:
  - S: 7-15 PSIG
  - H: 16-22 PSIG

Hybrid Machine Ranges

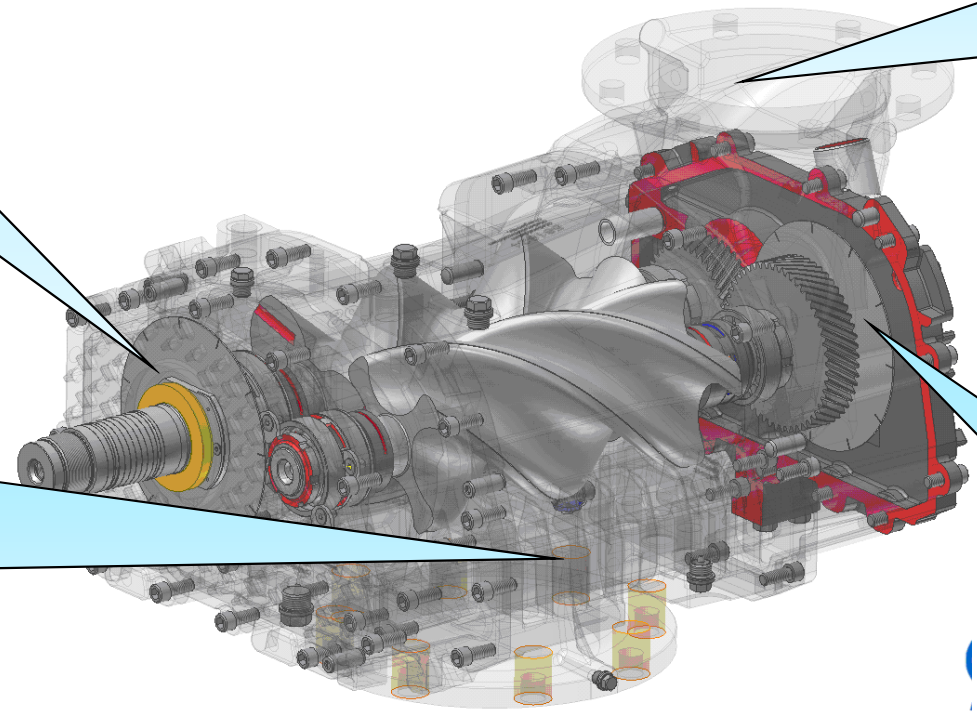
- 250 to 5,000 CFM 25 to 400 HP

Positive pressure							
Size	Differential pressure		Volume flow		Motor power		Noise pressure level *
	max. mbar	max. psi	max. m³/h	max. cfm	max. kW	max. HP	max. dB(A)
D 12 H	1500	22	670	390	37	50	73
D 12 S	1000	15	690	410	30	40	72
D 17 L	800	12	810	480	30	40	66
D 24 H	1500	22	1370	810	75	100	76
D 24 S	1000	15	1390	820	55	75	74
D 28 L	800	12	1340	790	45	60	70
D 36 H	1500	22	2100	1240	110	150	76
D 36 S	1000	15	2150	1270	75	100	76
D 46 L	800	12	2350	1380	75	100	70
D 62 H	1500	22	3400	2000	160	200	81
D 62 S	1000	15	3500	2060	110	150	79
D 75 L	800	12	3870	2280	132	175	77

Delta Hybrid Innovations

Non-Wearing Shaft Seals

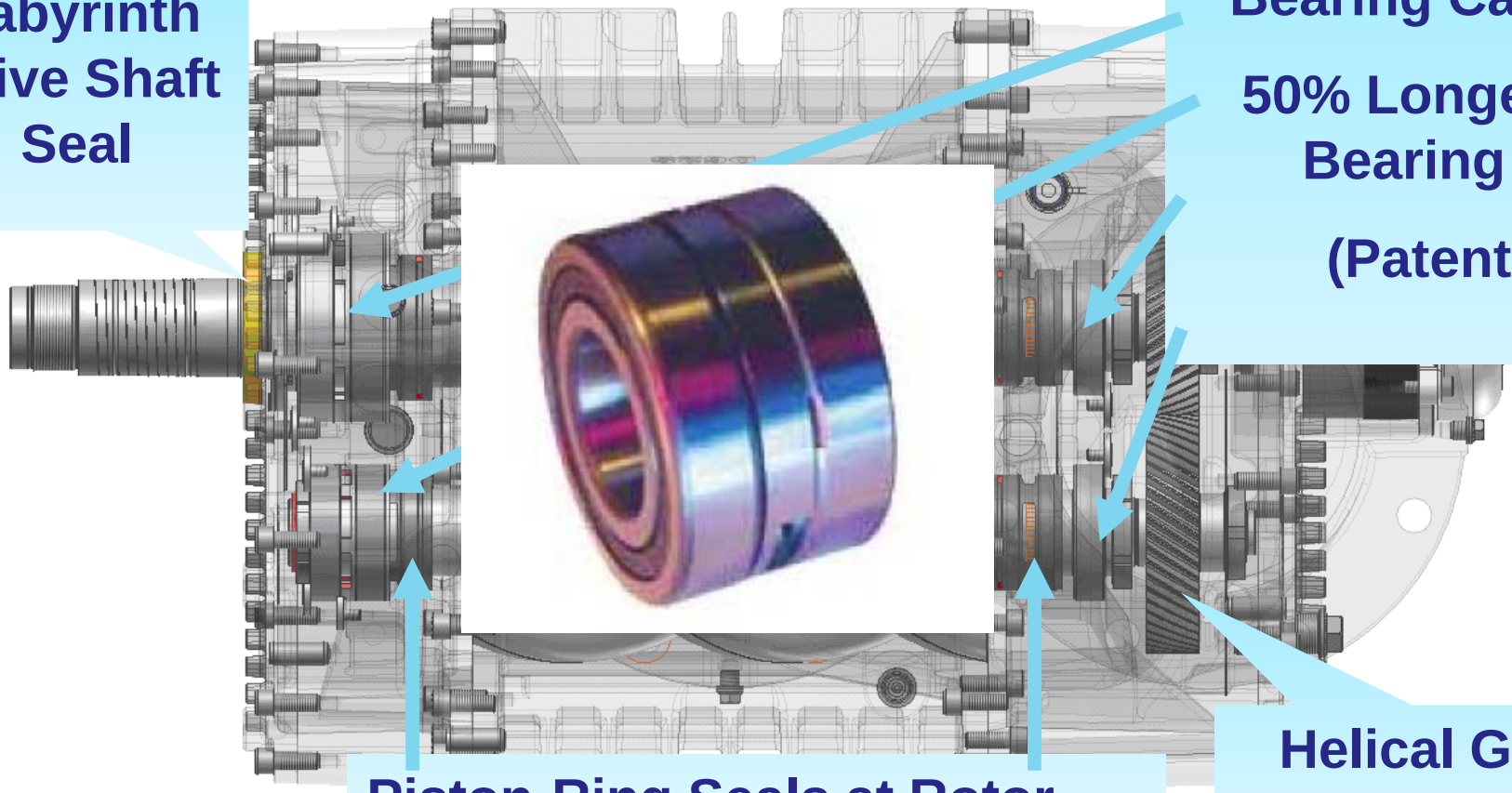
Fluidic Inlet Port



Large Oil Cooling Surfaces (Patent)

Timing Gears on Cool Side

Delta Hybrid Innovations



Labyrinth Drive Shaft Seal

Bearing Cartridge

50% Longer L-10 Bearing Life

(Patented)

Piston-Ring Seals at Rotor

Helical Gears (Hydraulic Fit)

Delta Hybrid Packaging

Spring Loaded PRV

Easy Access to Filter

Quietest Package (76 dBA)

Side by Side Installation

Base with Oil Pan

Non-Absorptive Discharge Silencer

Startup Unloading Valve

Oil Change from Front

Check Oil While Running

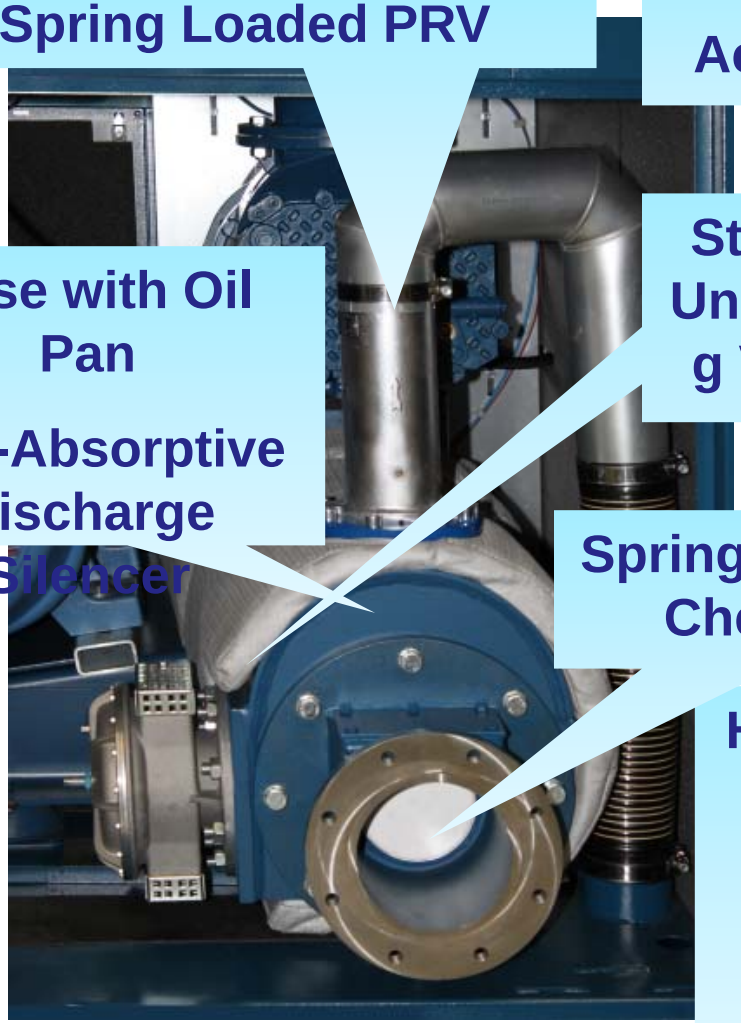
Springless Integral Check Valve

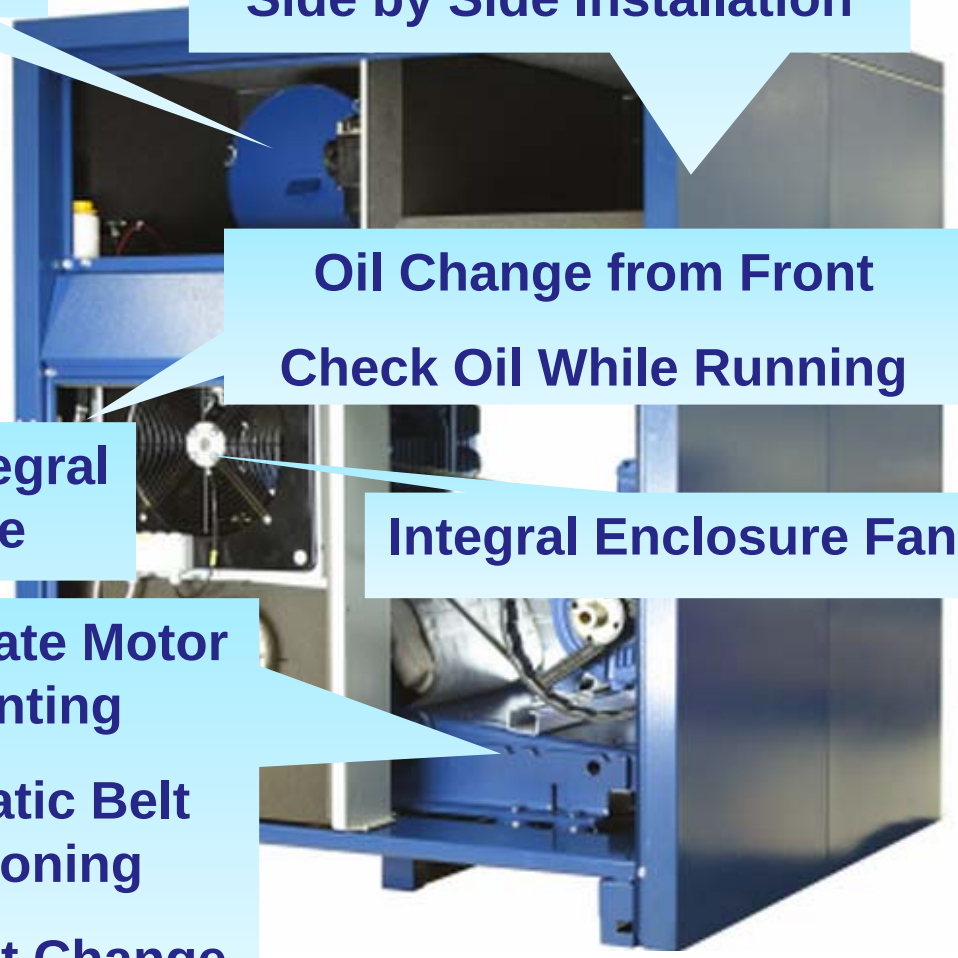
Integral Enclosure Fan

Hinge Plate Motor Mounting

Automatic Belt Tensioning

Easy Belt Change





Blowers ■ Compressors ■ Vacuum Pumps

Single Stage Oil Free High Speed Turbo Blower

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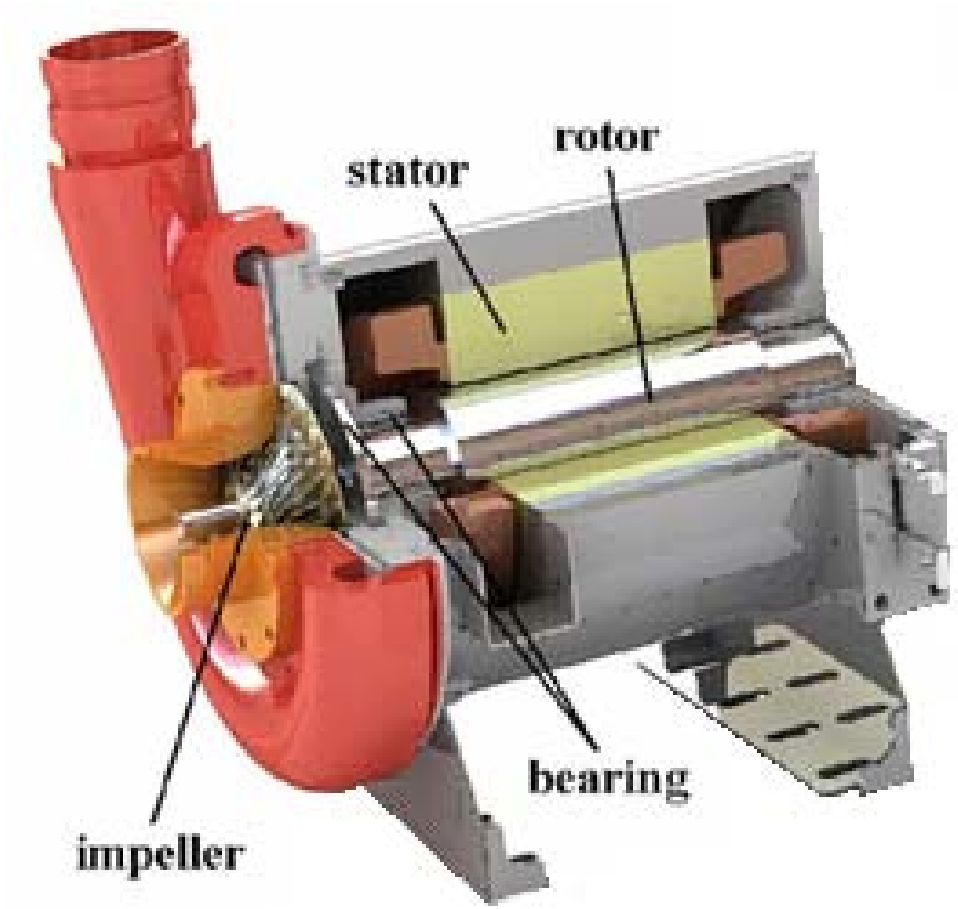
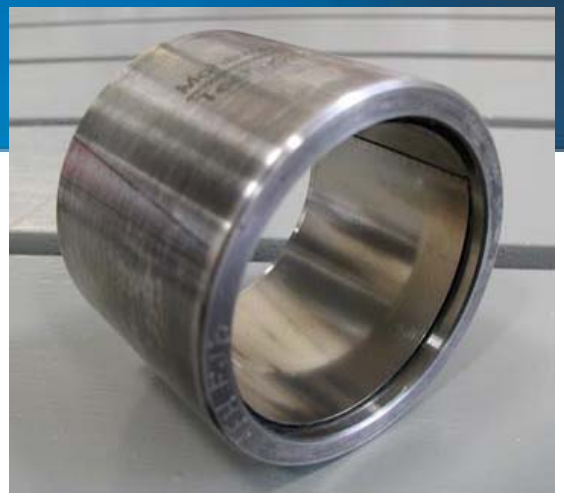
From KTurbo to Aerzen

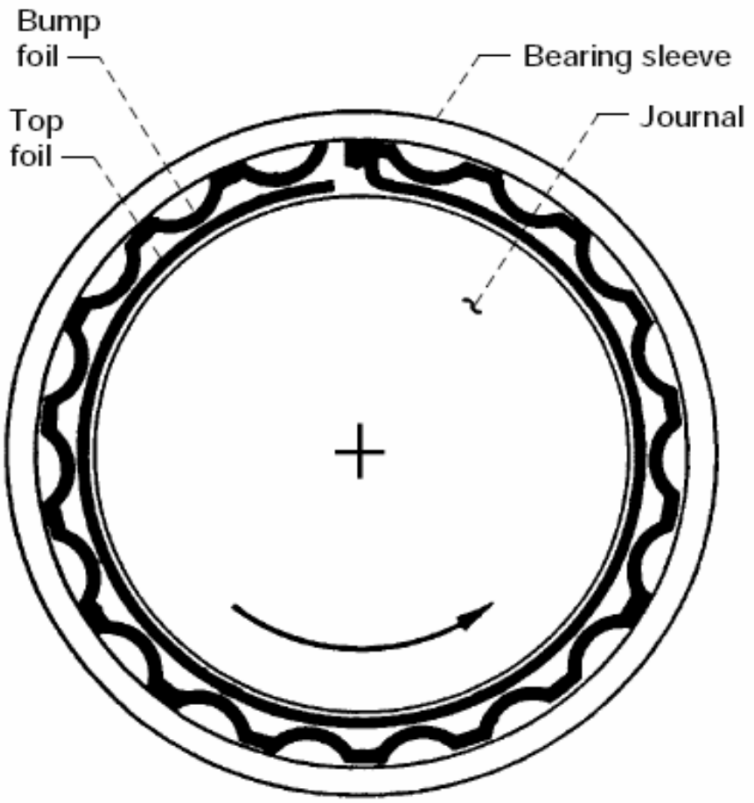
- State of the Art Components
  - Permanent Magnet Motor
  - Air Foil Bearing
  - Stainless Steel Impeller
  - CPU Controlled Inverter
  - Advanced Protection & Control

State of the Art Components



Air Foil Bearing





1. Top Foil

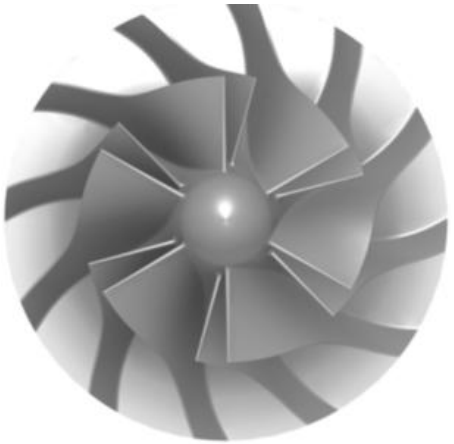
- TEFLON-S
- 20,000 On/Off Cycles

2. Bump Spring

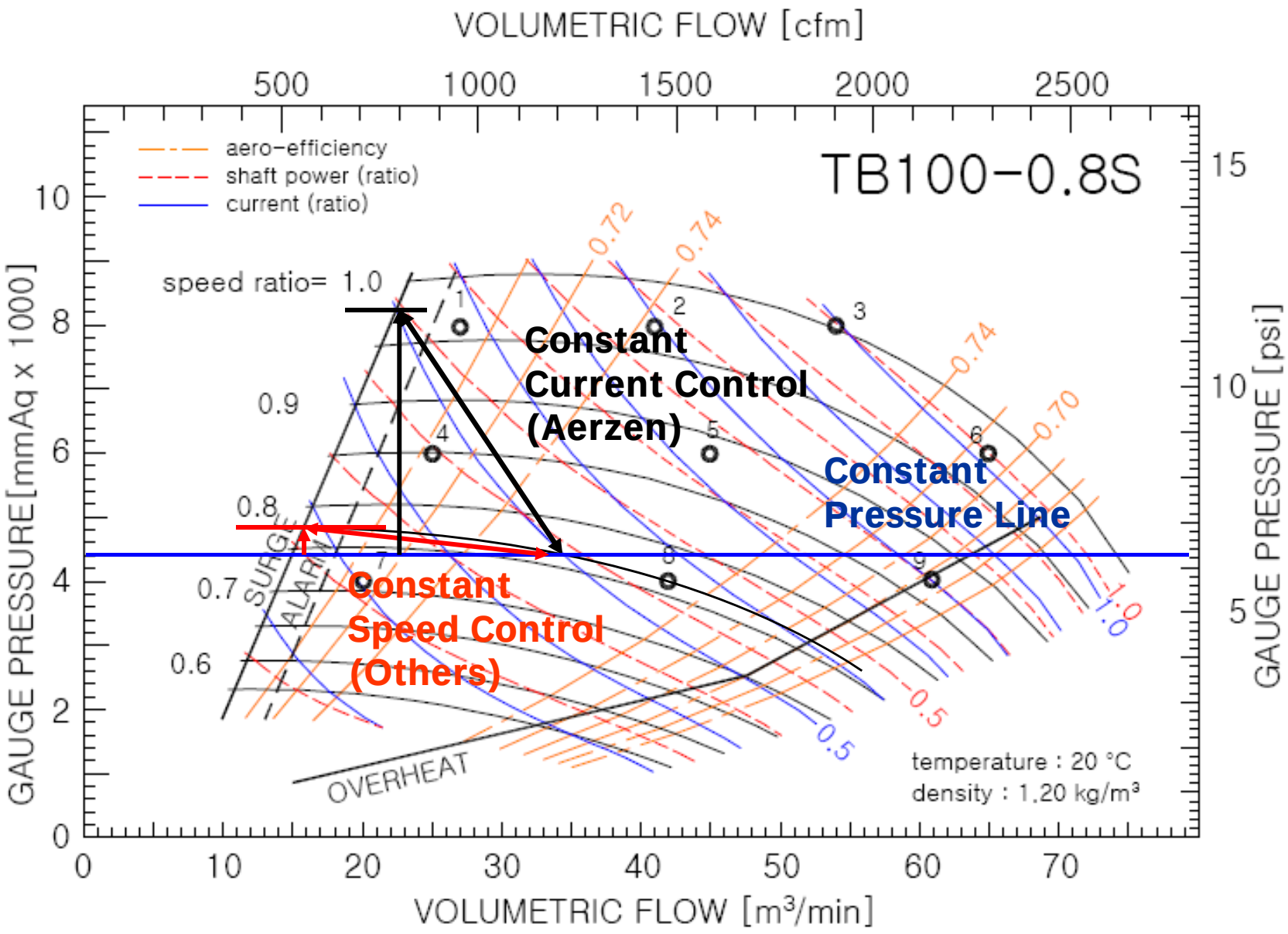
- 10-30 Year Life
- Advanced technology (4th Generation)

Impeller Design

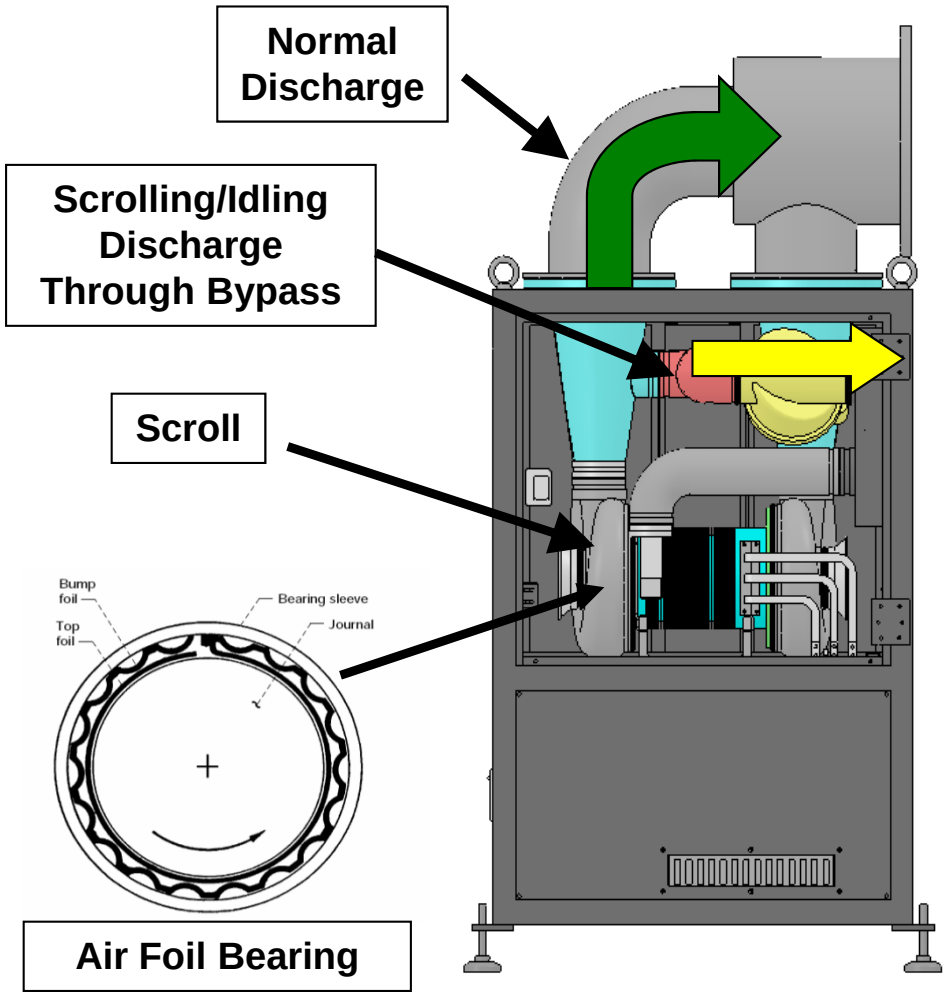
- Jet Engine Technology
- 17-4 PH Stainless
- Strength and Efficiency
- High Rise to Surge



Performance Map



Idling/Scrolling Function



- Bypass Valve Opens
- RPM Drops to ~10,000
  - Sufficient to maintain "loft" on Bearings
  - Minimal Power Draw (Avg 2%: 2 – 5 kW)
- Avoids Bearing Wear
- Avoids Start/Stop Cycles
- Useful in SBR/MBR Systems

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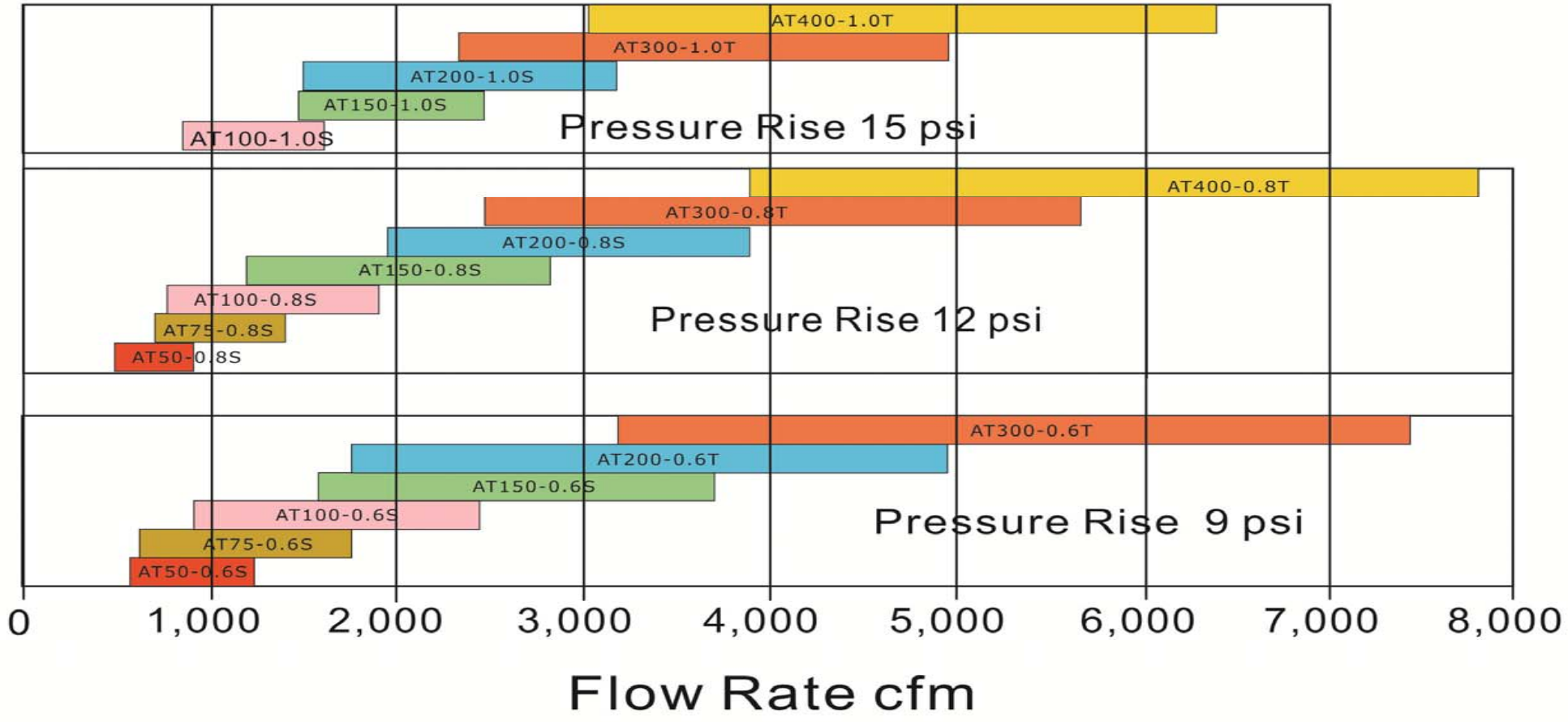
Aerzen Turbo TB/AT Series



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Which Technology to Choose?

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Proper Evaluation

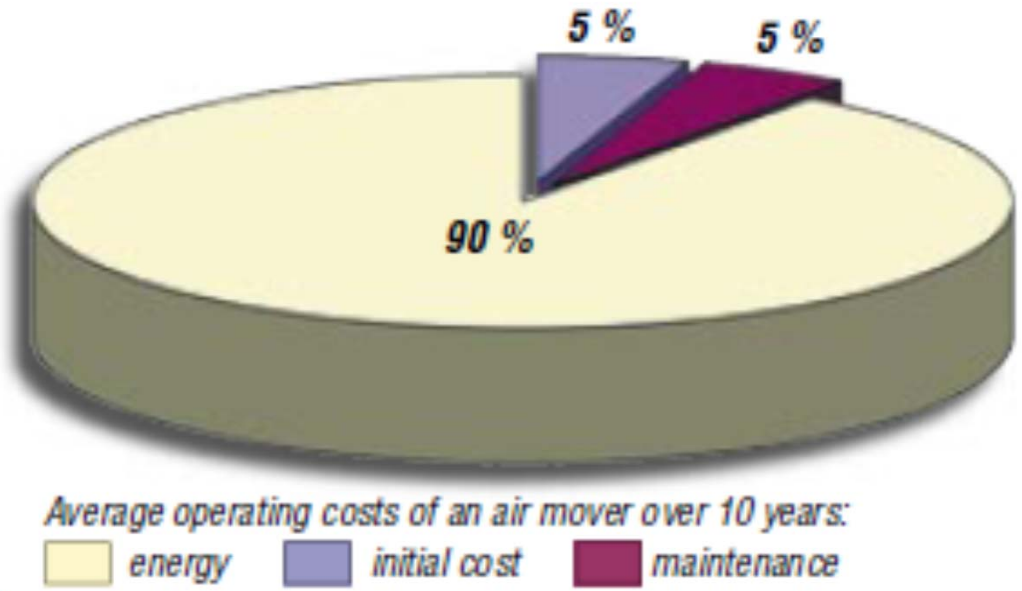
- Will Life Cycle Costs be Evaluated?
  - Not always
    - Filter Air Scour (limited duty)
    - Smaller Sizes (Low HP)
    - Low Electrical Costs
  - Capital Costs may be the deciding factor
    - Standard PD Blowers

Proper Evaluation

- If Life Cycle Costs Will be Evaluated
  - Conduct a Fair, Representative Evaluation (Aerzen Whitepaper)
    - Use Expected Operating Points
    - Not Design Point Only
  - Include ALL Package Losses
  - Compare with PD Blower, Turbo Blowers, Screw Compressors, & Hybrid Rotary Lobe Compressors

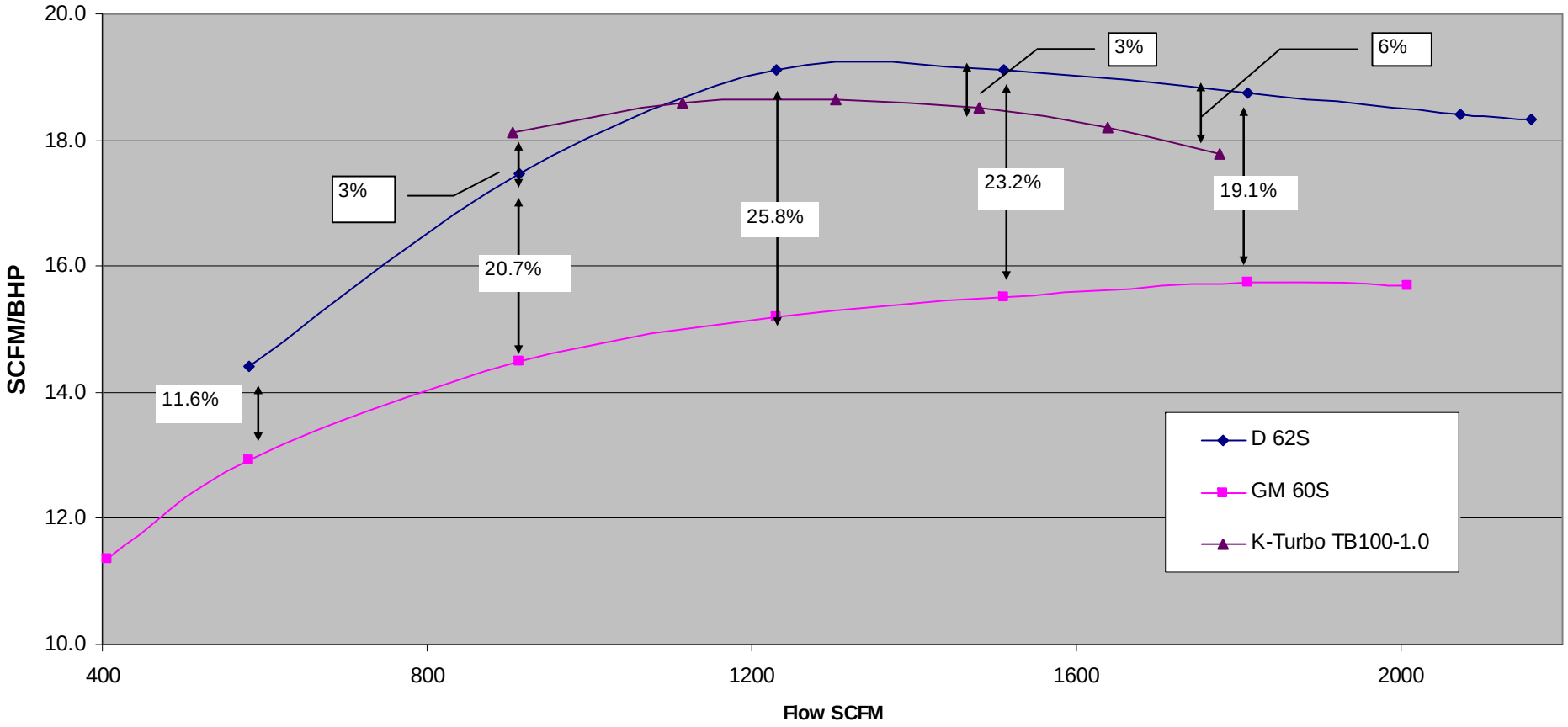
Life Cycle Costs

- Energy Costs are the Most Significant Factor in Aeration Blower Evaluation.
  - 60% of WWTP energy use is for Aeration
  - 80% - 90% of Life Cycle Cost is Energy

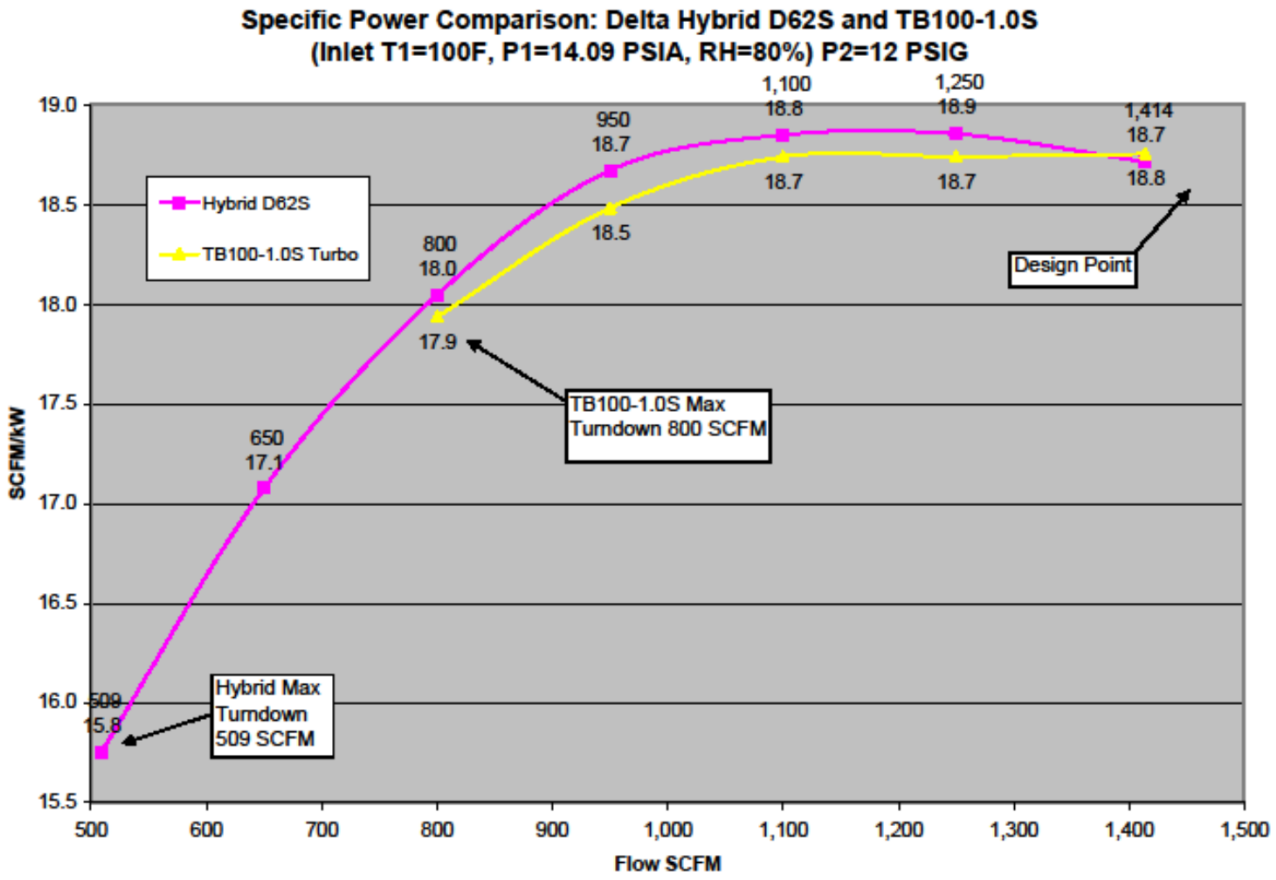


Performance Comparison

Specific Power Comparison Delta Hybrid D62S, GM 60S, and K-Turbo TB100-1.0
(Inlet T1=68F, P1=14.5 PSIA, RH=0%) P2=11.6 PSIG



Performance Comparison



Proper Evaluation

- Aeration System Characteristics
  1. Varying Water Depth (SBR/Digester)
  2. On/Off Cycling
  3. Higher Pressures
  4. Turndown Requirements

Generation 5 Blowers

- Efficient 3 Lobe Blower
- Quiet Package (70-75 dBA)
- Easy Installation & Maintenance
- Side by Side, Indoor Outdoor

Optimal Uses:

- Capital Cost Primary Factor
- Low Electrical Costs
- Intermittent Use
- Large Turndown Requirement

Delta Hybrid

- Same Packaging as Generation 5
- Superior Efficiency to Standard PD
- Similar Efficiency to Turbo
- Excellent Turndown (4:1)

Optimal Uses:

- Life Cycle Cost Primary Factor
- Flows <3,000 SCFM
- Varying Pressures
- Higher Pressures
- Large Turndown Requirement

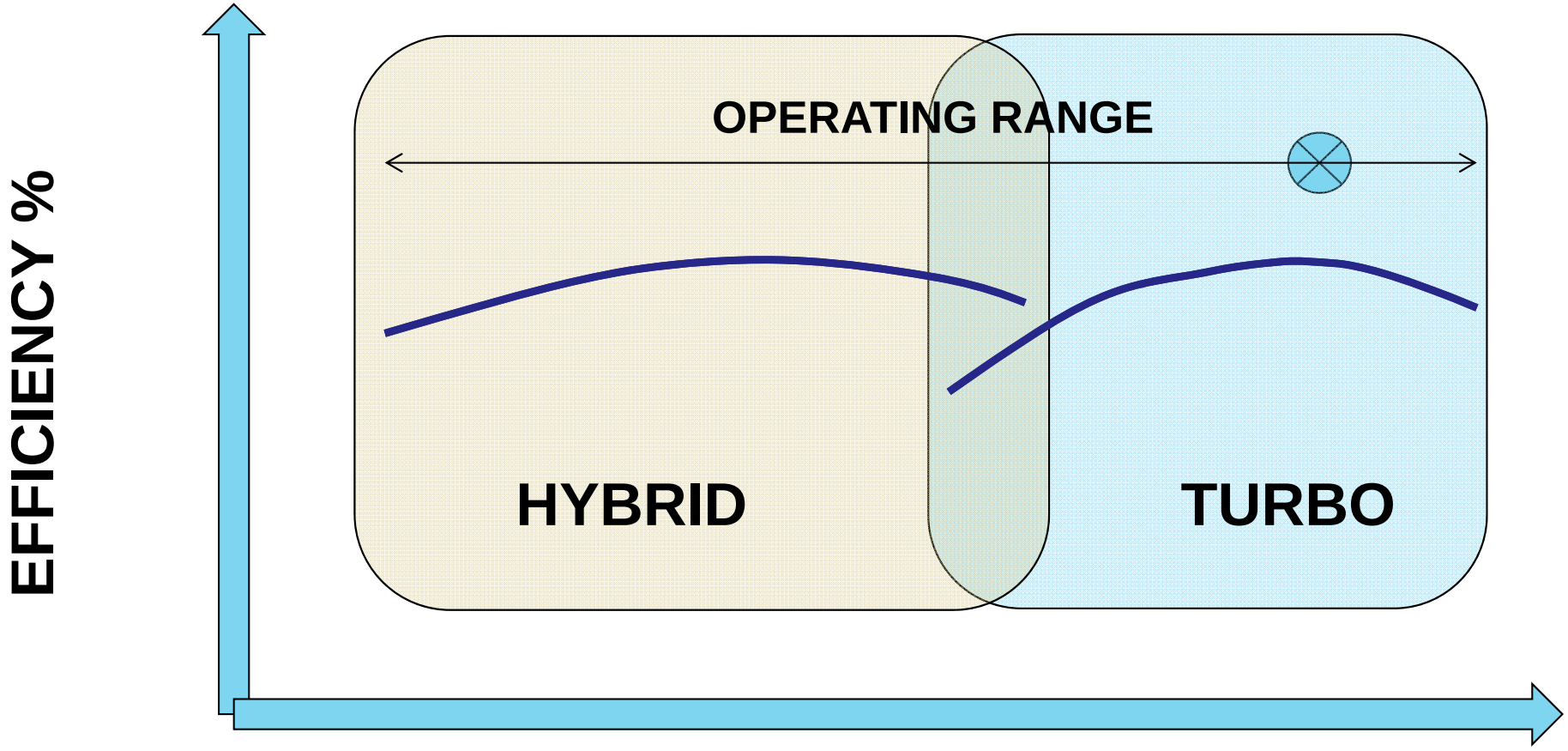
Turbo

- High Volume in a Compact Package
- Quiet Package, Easy Installation
- High Efficiency
- Complete Package (VFD, Control Panel)

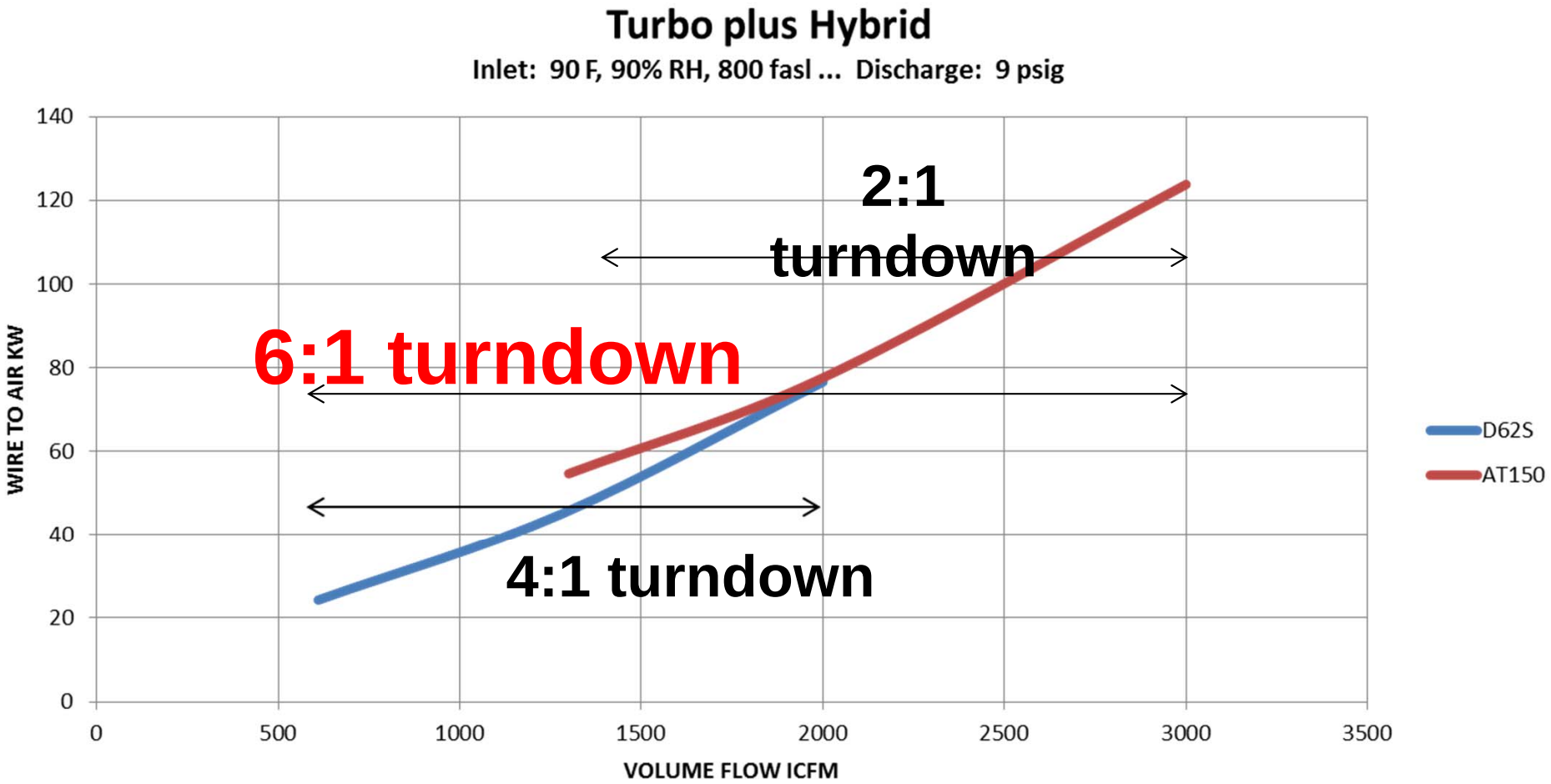
Optimal Uses:

- Life Cycle Cost Primary Factor
- High Volumes at Low Pressure
- Flows >1,000 SCFM
- Limited Turndown Requirement (2:1)
- Relatively Stable Pressures

Multiple Technologies



Multiple Technologies



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Thank You

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