

History And Overview Of Direct Drive Turbo Compressors

By: Dave Parsons Product Manager High Speed Turbocompressors



Aeration Blowers

- Aeration consumes 40-70% of energy used in activated sludge plants (WEF MOP OM-9)
- For supplying diffused aeration grids, 2 types:
 - Positive Displacement (1854)
 - Approx. 60% efficient
 - Typically smaller (<100 hp)
 - Output varies with speed, not pressure
 - Factory or OEM packages available
 - Widely applied, low capital costs



Aeration Blowers

- **Multistage Centrifugal(1945):**
 - Approx. 65-75% efficient
 - Wide range of sizes, typ. >50 hp
 - Output varies with pressure
 - Widely applied for over 100 yrs.
 - Can be more expensive initially than positive displacement
- PD and Multistage blowers are the workhorses of the industry but the need to reduce energy costs demanded new technology .



Times Have Changed, New Technology Arrived

- With renewed emphasis on energy efficiency, new styles of blowers have now become the leaders.
- High speed turbocompressors offer several potential advantages over traditional blowers:
 - Higher efficiencies
 - Lower maintenance costs
 - Variable output
 - Quiet operation

Centrifugal blower 1st Turbo Compressor

SULZER

Sulzer Pumps

HV Turbo First High Speed Turbo in Europe(1985?) and in US TURBLEX (Now Siemens Turbo Machinery)

Standard Motor

High efficiency, even at turndown

Speed Increasing gear box with journal bearings raises Impeller Speed (Single Stage)

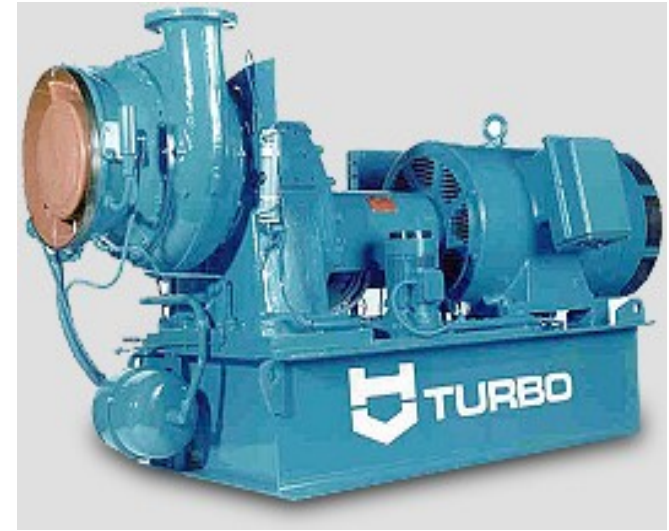
Inlet guide vanes and discharge diffuser vanes

Complex control system

Forced Oil Cooling System

High capital cost

Maintenance at Medium level: Air filters, oil exchange, cleaning of the guide vanes (IGV, ODV), slide bearings life is approximately 8 - 12 years, ball bearing 3-5 years



History Of Direct Drive Turbo Compressors

- Development project of 100 kW power plant with 30 kW turbogenerator at Lappeenranta University of Technology 1981 - > 1985
- ORC (Organic Rankine Cycle) power plant for a saw mill 1987 -> 1989
- High Speed Tech Oy established by professors involved 1988 (non-operating company)
- Rauma Repola made power plant to MIR submarine for deep sea conditions (20 000 feet) 1989-1992
- Submarine used later in Titanic movie to film real Titanic in the bottom of the Atlantic ocean



Heading to first installations

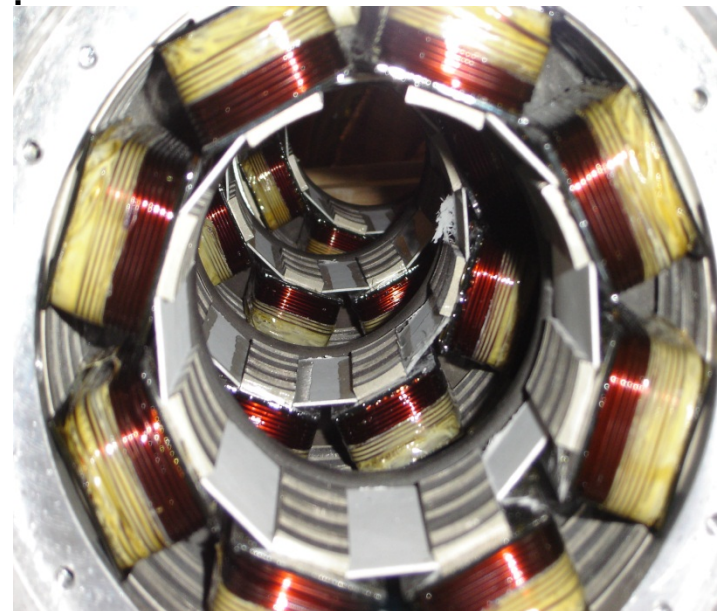
- Rauma-Repola acquisition 1992 -> High Speed Tech Oy Ltd activated
- Technology development and prototypes for microturbine, microgenerator, high pressure pump, compressor, vacuum pump
- Target was set to aeration compressor and vacuum pump 1994
- Basic product development until 1996
- First delivery to Botnia Pulp mill in Joutseno, Finland in 1996
 - 9 pieces 6000-2-H compressor started in **October 1996**
 - Later 1996-1997 two compressors more
 - Installation still in use
 - 9...10 compressors running all the time
 - Introduced to US market at **Chicago WEFTEC 2002**
 - First US installation of 6 units at DePere WI (now New Water formerly Green Bay Metro) **October 2004 Start UP**

Magnetic Bearing

- Includes 5-axis vibration monitoring
- Includes proven complete diagnostics tools & remote monitoring
- Shaft unbalance possible without metal to metal contact:
 - No vibration transmitted to the motor stator
 - Automatic unbalance compensation
- 100% non-contact (even at start-up and shut-down)
- Proven bearing technology with HST:
 - 1996 – 1999: analogue MBC
 - 2000 – 2004: digital MBC11
 - 2005 – present: digital MBC12

■ Maintenance

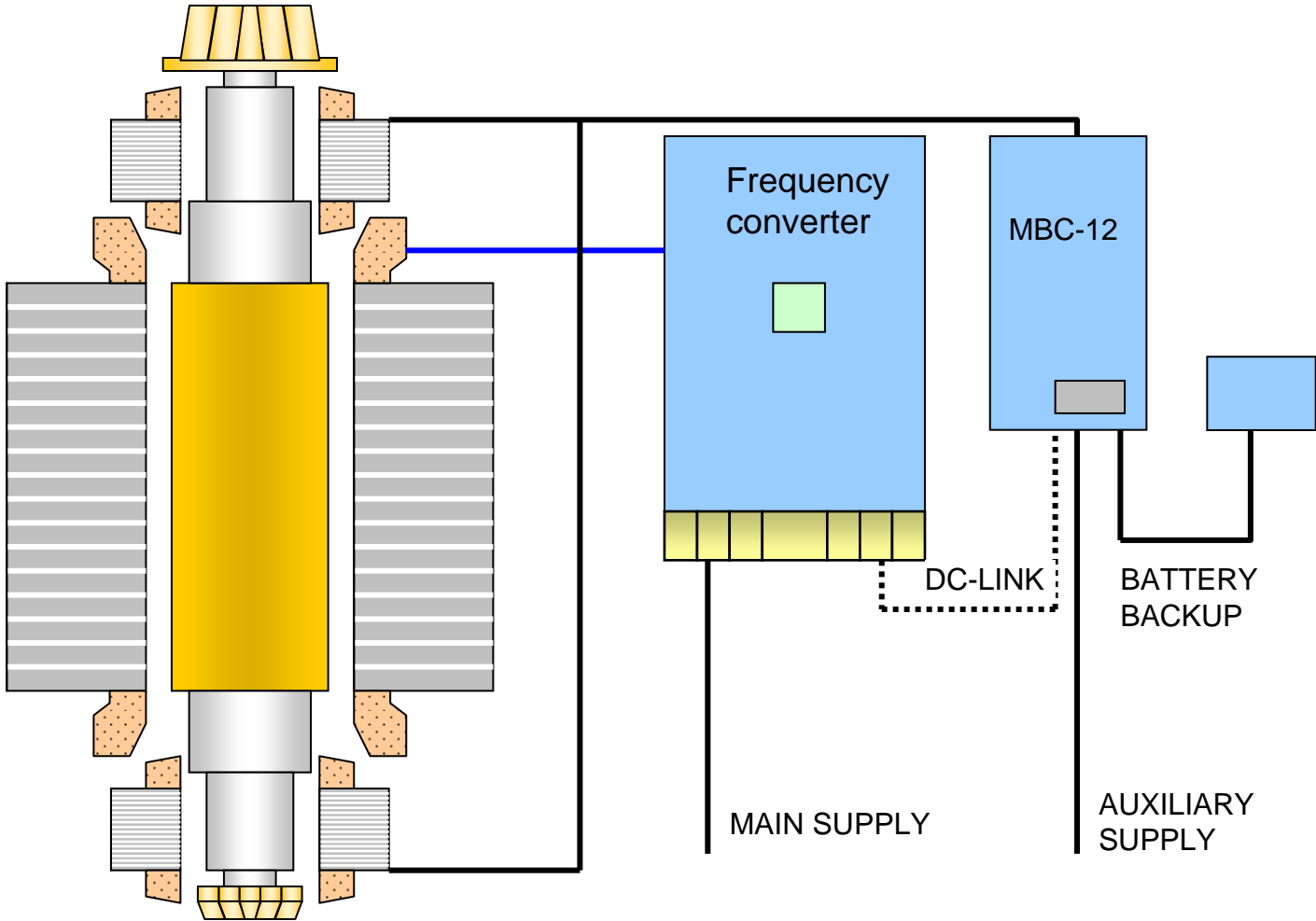
- 25 years or longer before bearing maintenance is needed



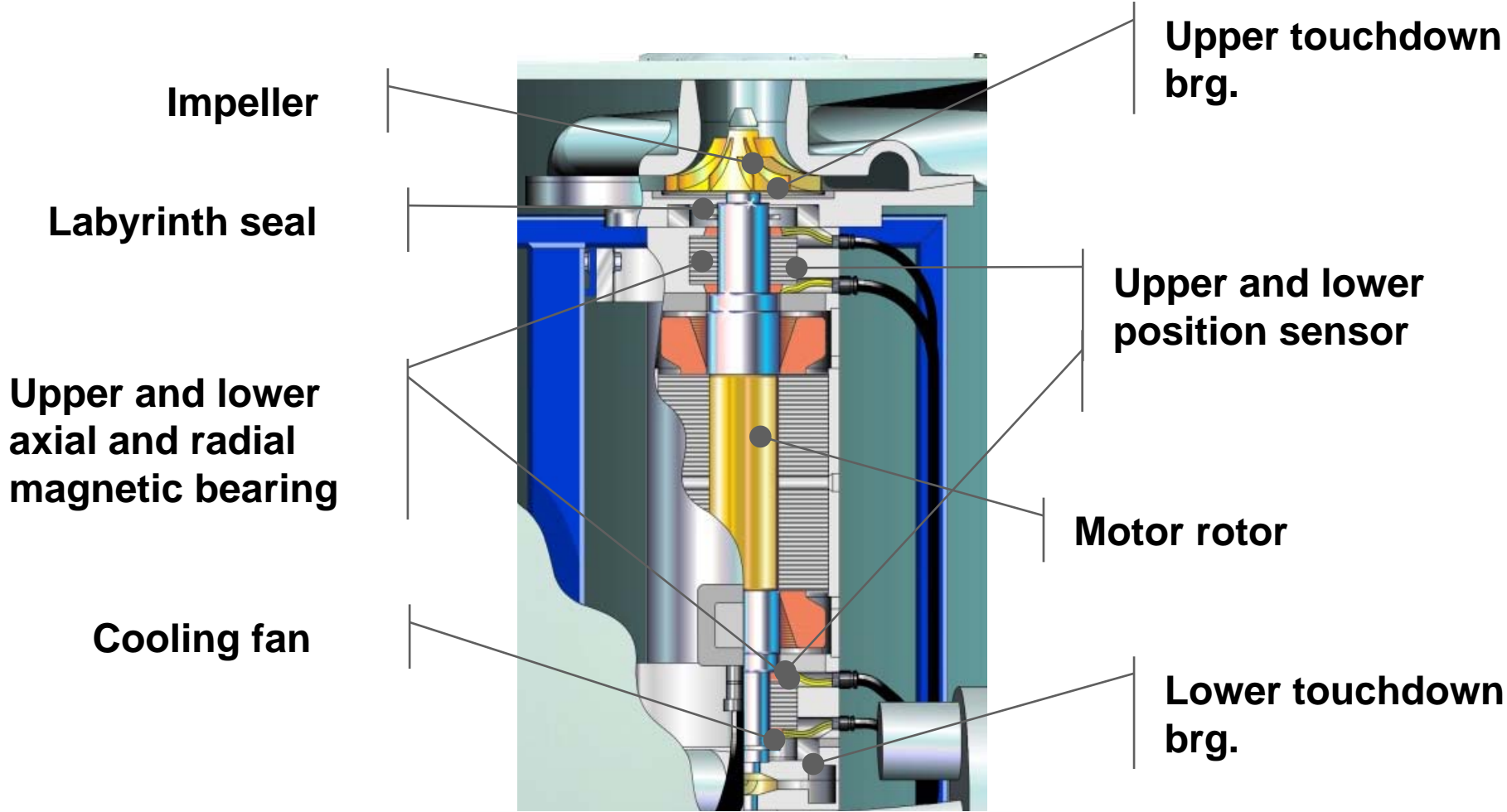
High speed technology:

- ✓ **Single stage radial turbocompressor**
- ✓ **Manufactured using standard components**
- ✓ **Integrated frequency converter with control software**
- ✓ **Variable speed control to match process demand**
- ✓ **Induction motor specifically designed for HST**
- ✓ **Real time monitoring and fault detection**
- ✓ **Magnetic bearings with shaft position control**
 - ✓ **Non contacting**
 - ✓ **No friction losses**
 - ✓ **No wearing parts**
 - ✓ **Oil free air delivered**

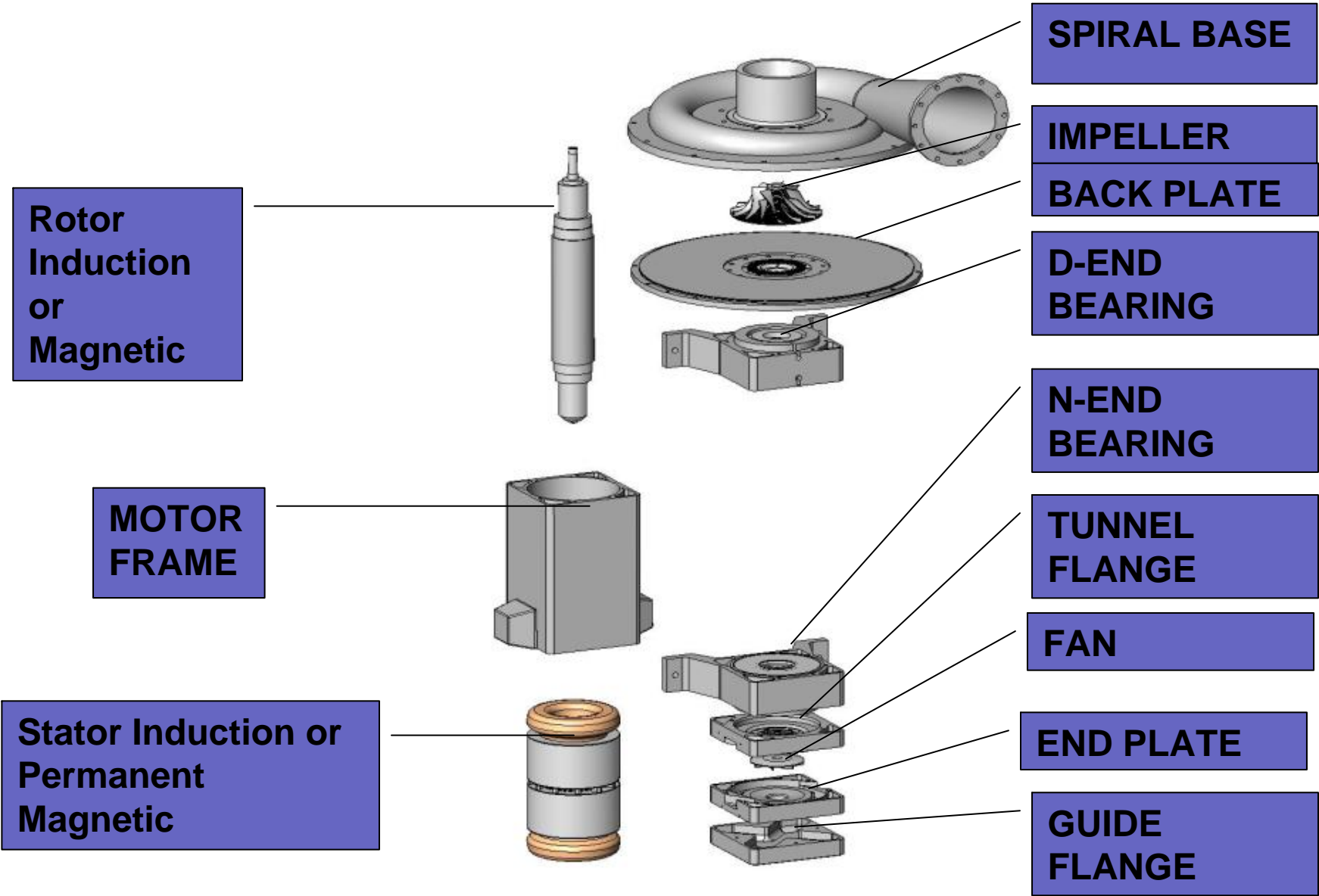
Magnetic Bearing High Speed Technology



High Speed Unit Details:



ASSEMBLY OF THE HIGH SPEED UNIT



Impeller, Safety bearings and Cooling Fan

SULZER

Sulzer Pumps



ABS Turbocompressor family

- High speed turbocompressors with active magnetic bearings
- Oil free air to aeration process with high efficiency
- Compressors with induction motor (flow range 450-6400 SDFM)
 - HST 2500 (92-134 input hp)
 - HST 6000(201-322 input hp)
 - HST 9000(255-322 input hp)
- Compressors with permanent magnet motor (flow range 1300-10,400 SCFM)
 - HST 9500(268-375 input hp)
 - HST 40 (402-536 input hp)
 - HST 20 (150-250 input hpP)



Direct Drive High Speed Turbocompressors

- Different styles from different manufacturers
- Magnetic Bearings – Sulzer/ABS HST, Hoffman Revolution, Atlas Copco ZB-VSD; Spencer AyrJet, Kawasaki, Verdicorp
- Air Foil Bearings – HSI HT(now Atlas Copco); Aerzen (Old K-Turbo); APG-Neuros; Turblex/Siemens (no longer on market?), TurboMax, Roots (GE Energy)
- There may be others that I have not mentioned

Other Magnetic Bearing Unit

- Atlas Copco ZB Units Input kW range of 100kW to 160kW (maybe more offerings) and air flow ranges from 590 CFM to 3500 CFM.
- Piller's Pillerator Input kW range of 150kW to 300kW and air flow range 500CFM to 8,200CFM



Other Magnetic Bearing Unit

- Spencer Ayrjet flow range to 8200 ICFM and horsepower range to 400HP



High speed, high efficiency turbo blower provides energy efficient air delivery

Made in the USA by The Spencer Turbine Company, the AyrJet™ Series 400 is a high speed, high efficiency single-stage turbo blower, driven by a direct drive oil-free permanent magnet motor. It has an integrated variable frequency drive (VFD) with PLC controls.

The product expands Spencer's product offerings for the water and wastewater treatment industries. With flows to 8200 CFM and pressures to 10 PSIG, it handles applications ranging from 0.01 to 400 USGPM. It provides built-in vibration and temperature sensors best-in-industry wire to air efficiencies.

It is standard, and externally mounted inlet is engineered, proven technology magnetic and manage shaft position for proactive catastrophic failure.

To meet continuous-duty aeration requirements, the AyrJet™ Series 400 is designed for applications in municipal wastewater

Materials of Construction
Aluminum 356-T6
Steel: Carbon steel
Paint: Epoxy

Product Features

Technical Data	
Number of stages:	1
Operating speed:	Up to 20,000 RPM
Casing design pressure:	50 PSIG
Inlet connection:	Integrated filter (standard); pipe flange (optional)
Outlet connection:	14" flange
Seals:	Teflon labyrinth impeller seal
Bearings:	
•	Magnetic
•	Self-monitoring
•	Non-contact
•	Built-in power failure back-up protection (UPS system)
•	2 modes of fail safe (back-up roller bearing and auto shutdown on fault)
Lubrication: None	
Impeller:	Machined high strength forged aluminum – 7075-T6 alloy
Dual cooling system:	
•	Integrated air cooling
•	Integrated closed loop 50/50 water-glycol cooling
Filters: Nominal retention 98% @ 15 microns	
First critical speed:	20% over maximum operating
Vibration:	0.5 mils
Control System – UL Listed	
PLC based with touch-screen and interface to the plant SCADA system	
•	Blower system start/stop selection and status indicator
•	Blower control selection: Local or remote
•	Blower set-point entry (RPM or SCFM)
•	Remote signal set point for speed (RPM) and flow (SCFM)
•	Display status for:
•	Actual blower speed (RPM) and set point
•	Actual blower flow (SCFM) and set point
•	Blow-off valve
•	Blower discharge pressure
•	Magnetic bearing
•	Shaft position
•	Motor winding temperature indicator
•	VFD and alarm indicator
•	System vibration alarm indicator

- Hoffman Revolution flow range from 500 SCFM to 9700 CFM and HP range ?

Revolution at Work

On the job, nothing compares to the efficiency and power of the Revolution. It's ideally suited for a range of applications in the oil and gas, air separation, renewable energy, and wastewater treatment markets. The small footprint and reduced installation costs enables the Revolution to function in places traditional blowers cannot. It is the quietest high-speed blower in its class with a one meter certified sound rating at below 80 dba.

Durable, reliable, and efficient, the Revolution offers unprecedented ease of maintenance. We've leveraged decades of Hoffman blower experience and ingenuity to develop a customer solution that sets new standards in efficiency, reliability, and savings.

Package Includes

- A single enclosure housing
- High speed blower/motor unit
- Direct-driven, high-speed motor
- Self-contained cooling system
- Air filtration elements
- High efficiency impeller
- Magnetic smart bearings
- VFD, PLC, HMI (SCADA ready)
- Blow-off valve assembly
- Start-up training
- CSA, UL, and CE quality certified



The quietest blower in its class

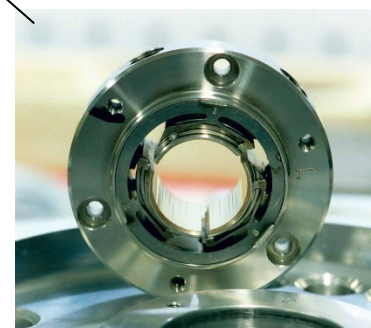
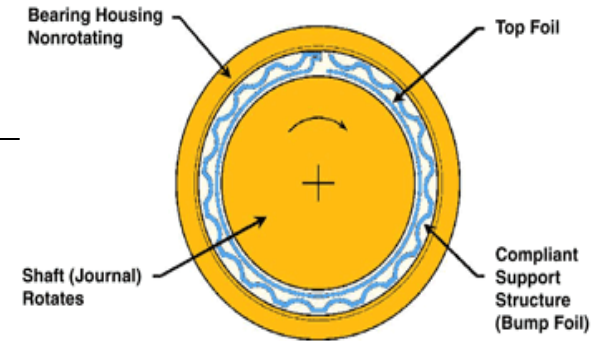


AyrJet by Spencer – The New American Way

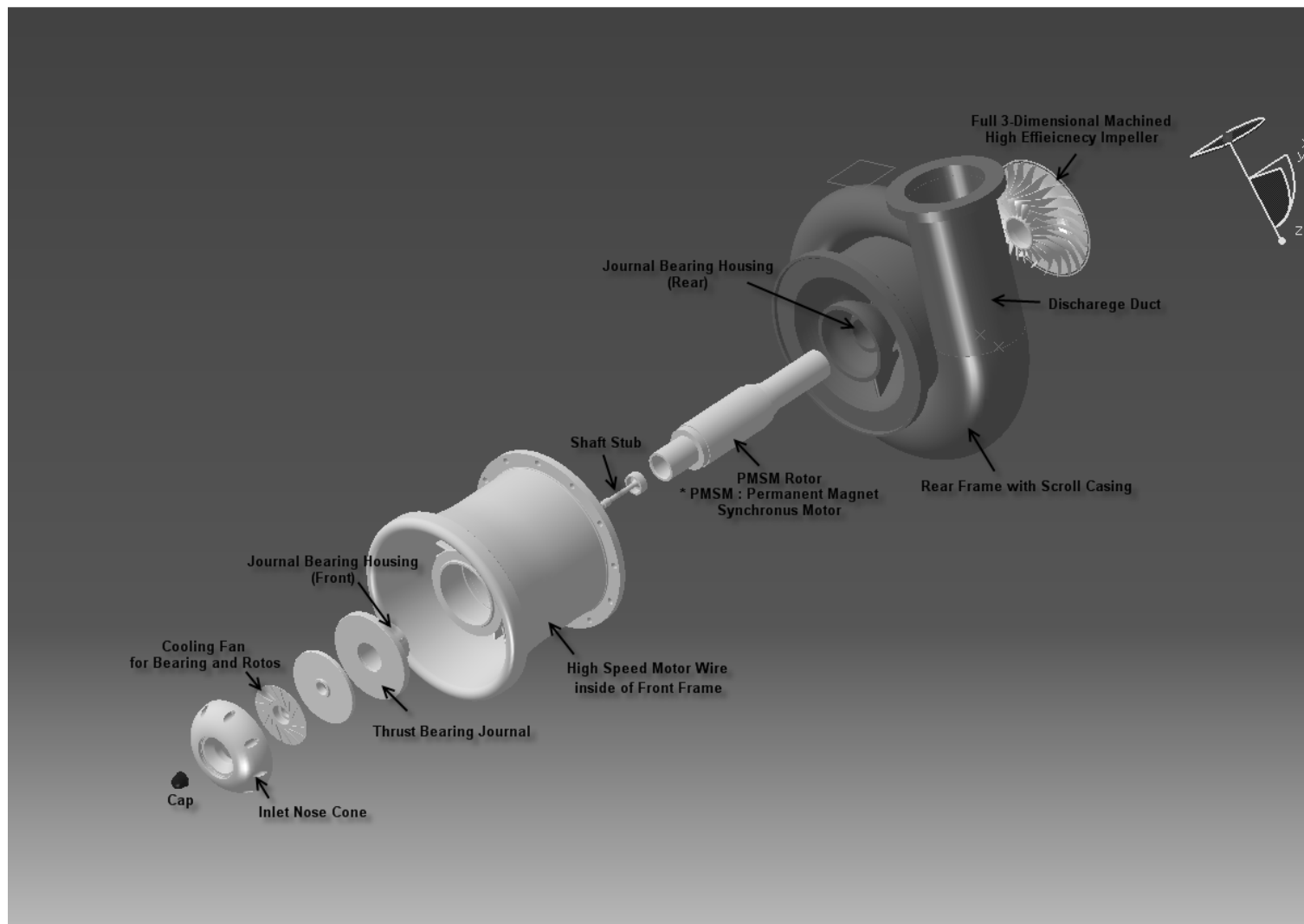
Company • 600 Day Hill Road, Windsor, CT USA 06096 • TEL 800-232-4321 • 860-688-8361 • www.spencerturbine.com

Gas Bearing

- Three basic types:
 - Bump foil (Neuros, Aerzen)
 - Leaf foil (HSI)
 - Tilting pad (history)
- Requires:
 - Good balancing
 - Accurate bearing manufacture
 - Accurate coating manufacture
- No automatic monitoring
 - Vibration measurements
 - Log files, remote monitoring etc
- Maintenance
 - Requires repair of bearing and bearing surfaces every 6-8 years

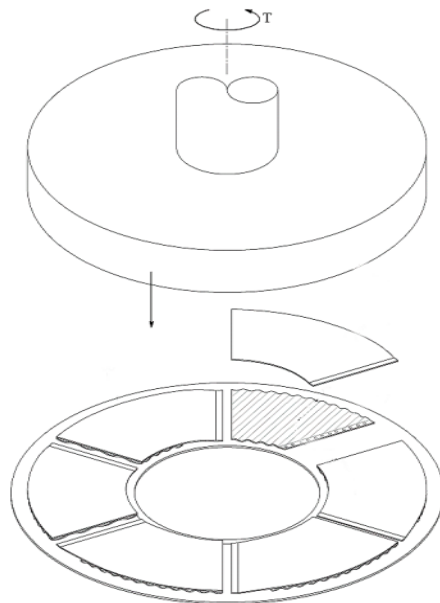
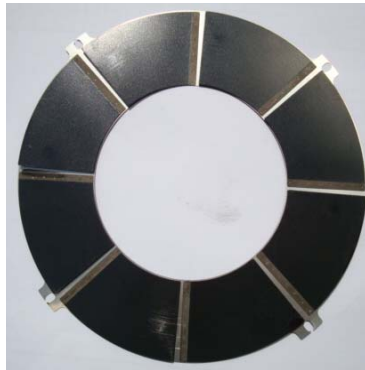


Turbo Blower Core Non-contact, Single Motor, Rotor, Impeller

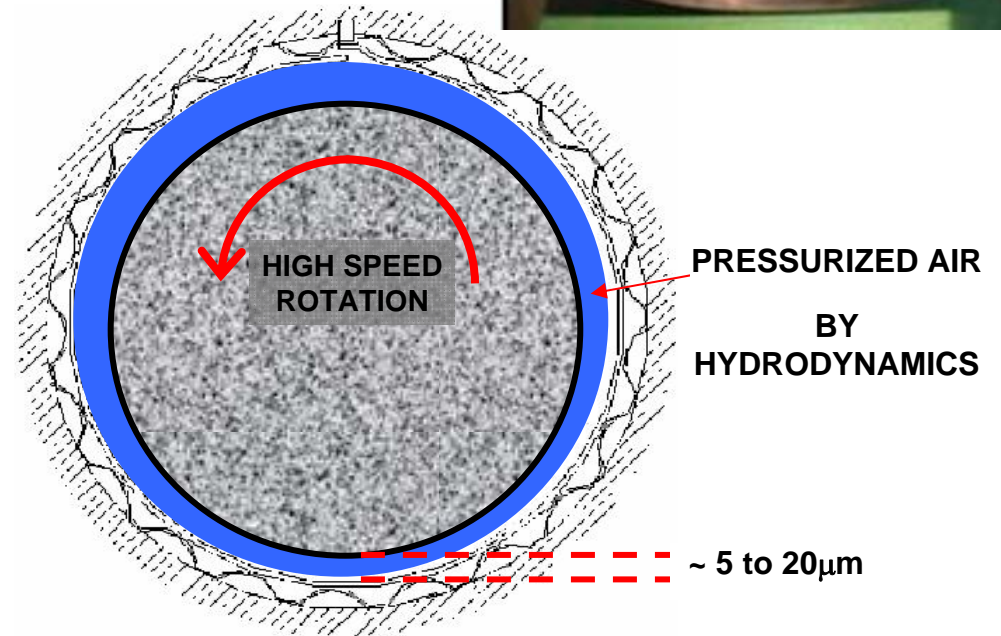
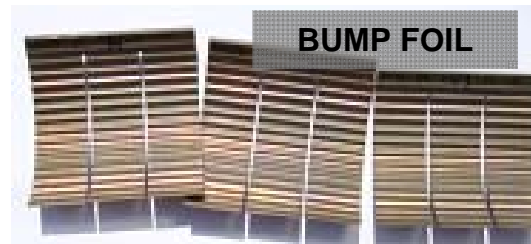


3rd Generation Bump Foil Air Bearing

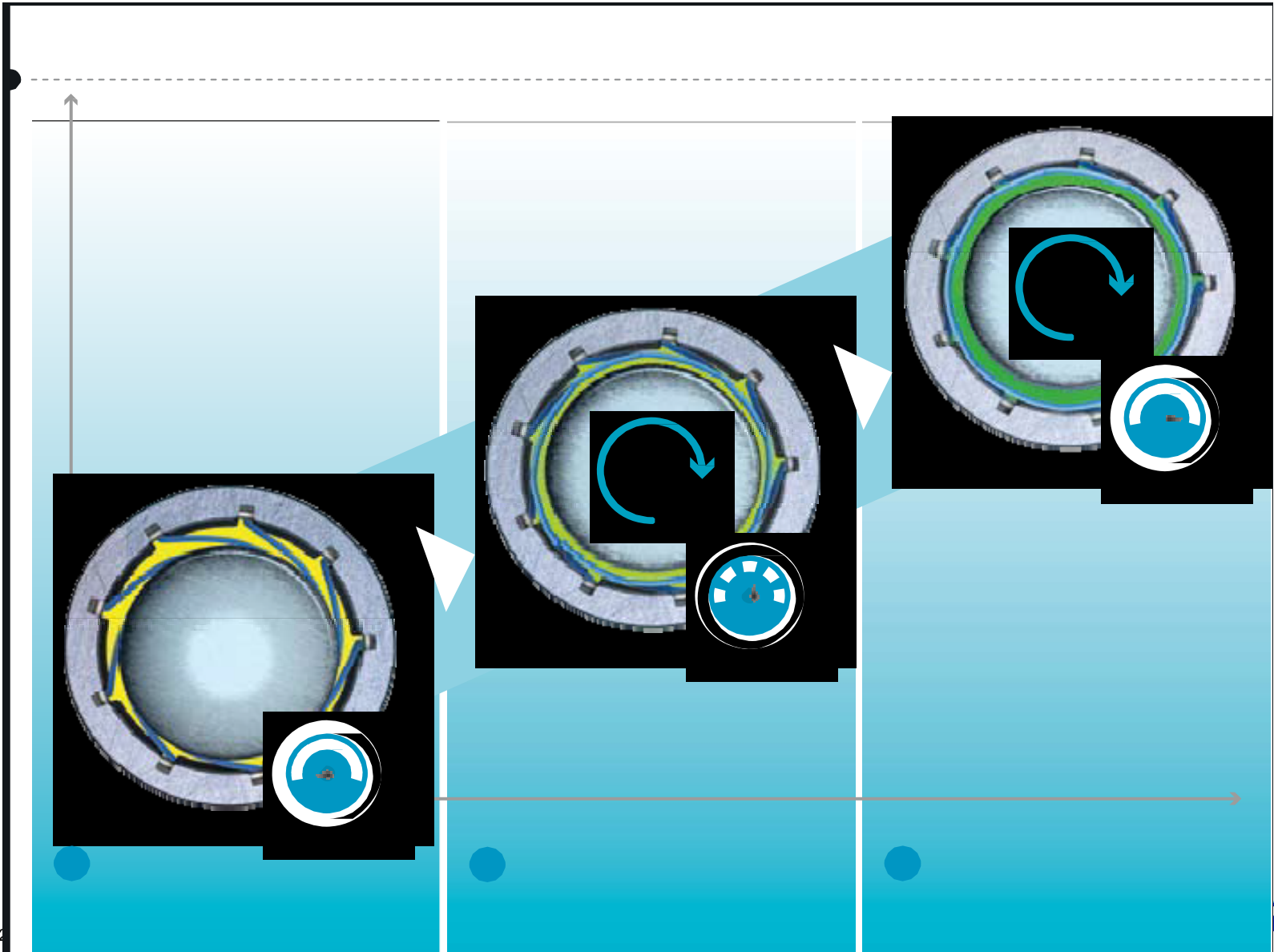
Thrust Bearing



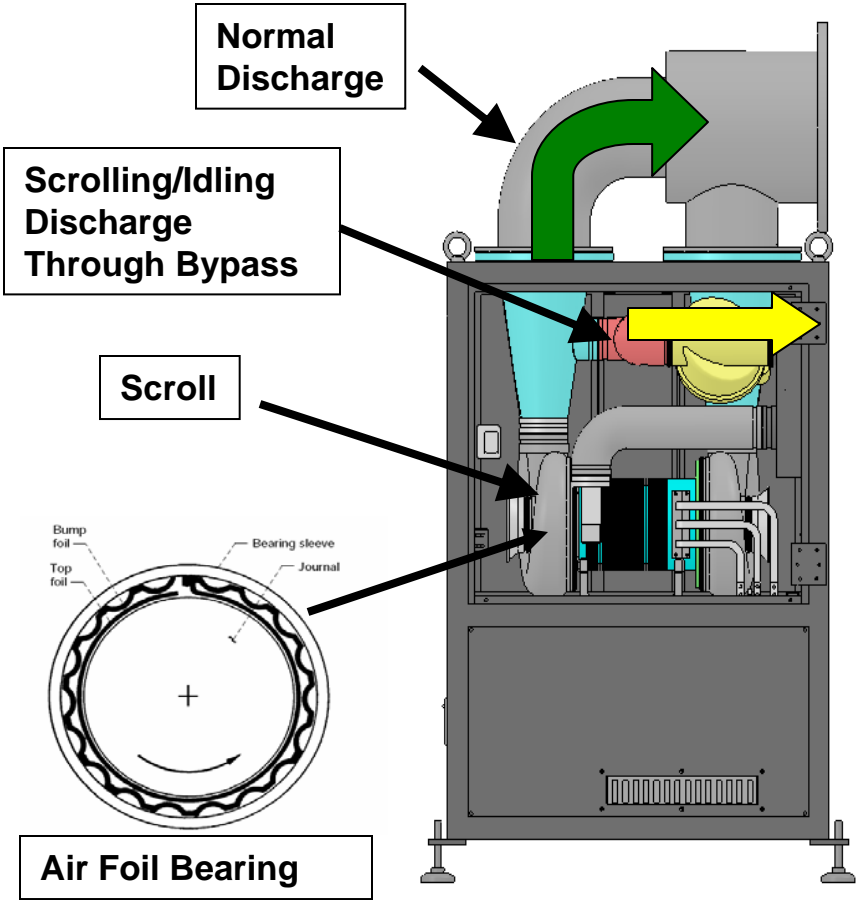
Journal Air Bearing



Leaf Type (Air Foil) Bearing



Idling/Scrolling Function



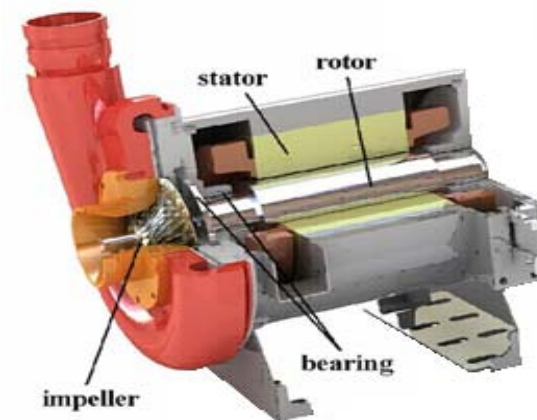
- Bypass Valve Opens
- RPM Drops to ~10,000
- Sufficient to maintain “loft” on Bearings
- Minimal Power Draw (Avg 2%: 2 – 5 kW)
- Avoids Bearing Wear
- Avoids Start/Stop Cycles
- Useful in SBR/MBR Systems

Air Bearing Units

- Neuros NX Series flow rates from 400 - 21,000 cfm and Single core for 50 – 350hp units dual core for 400 – 700hp



- Aerzen TB Series flow rates from 500-9500 CFM and from 50-400 HP



Installation – Lingen, Germany:



☞ Installation:

- ☞ WWTP, municipal
- ☞ 2 x S2500-1-H-4
- ☞ 2 x S6000-1-H-4

☞ Total flow:

- ☞ 10,590 scfm

☞ Flow / unit:

- ☞ 735-1765 scfm (S2500)
- ☞ 1765-3530 scfm (S6000)

☞ Pressure:

- ☞ 12.2 psi

Design & Installation Flexibility Louvered or Flanged Inlet



NX200 - Single Core



NX500 - Dual Core

Design and Installation Flexibility Multiple Units



NX100 & NX150 - Single Core

Geneva, AL USA

- HST 2500-1-L-5
- Start Up November 2009
- In a 25 day billing cycle, the City's electric bill was reduced by \$2600.00. No additional work was done except replacing existing multi stage blowers with ABS HST blowers.

References:

James Dixon – City of Geneva
(334-684-9554)



DePere WWTP, Wisconsin:



- ☞ Installation:
 - ☞ WWTP, municipal
 - ☞ 14.5 MGD
 - ☞ Start Up 2004
 - ☞ 6 x S9000-1-H-5

- ☞ Total flow:
 - ☞ 25,000 scfm

- ☞ Flow / unit:
 - ☞ 1950-5000 scfm

- ☞ Pressure:
 - ☞ 9.9 psi

Downers Grove, Illinois/USA

- Replacing existing blowers
- One HST 9000-1-H-5
- Water height 20 feet
- Remote control with I/O
- Start Up May 2008

References:

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Engineer: Baxter & Woodman
Paval Hajada, PHD P.E.
phajda@baxterwoodman.com
815-459-7860



Naperville, IL USA

- (6) HST 9000-1-L-5
- Start Up October 2009

Contacts:

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Thank you for your attention!

Questions?



**EFFICIENCY HAS A NEW FACE.
ABS TURBOCOMPRESSOR HST 40.**