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Is It Hot Air or the Next Breakthrough? Evaluation of High Speed Direct Drive Blowers

Tony Farina, P.E.

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Overview

- Intro / Background
- Types of Blowers Evaluated
  - Single Stage Centrifugal
  - High Speed Direct Drive
- New Blower Evaluation

Aeration at WWTPs

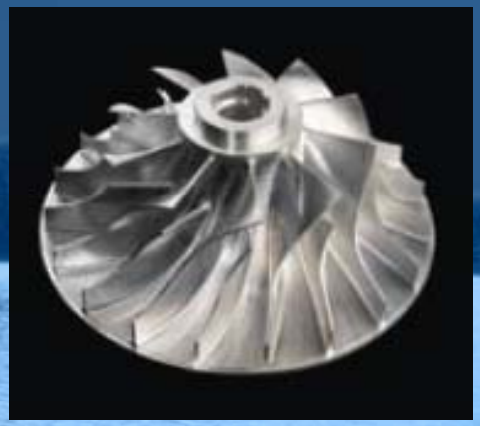
- Biological Treatment
  - Typically the highest power requirement
  - Focus of this presentation
- Aerobic Digestion
- Effluent / Post Aeration

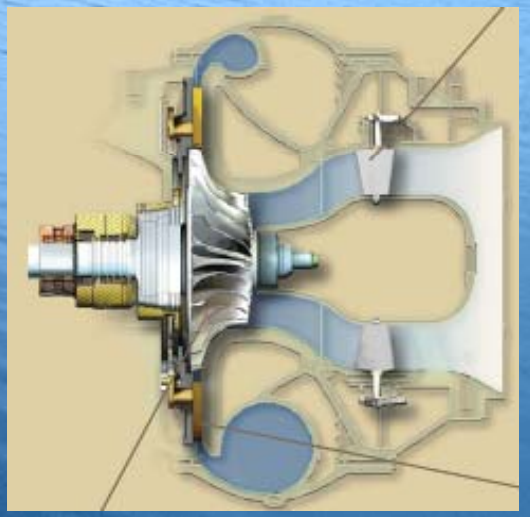
Types of Blowers

- Single Stage Centrifugal (integral gear)
- High Speed Direct Drive (turbo)
- Multistage Centrifugal
- Positive Displacement

Single Stage Centrifugal (IG)

- Single machined impeller
  - Spins at high rpm
- Standard induction motor (constant speed)
- Gearing system increases motor speed to impeller
- Inlet guide vanes and discharge diffuser vanes modulate to vary air flow





Courtesy of Siemens (Turblex)

Single Stage Centrifugal (IG)

Variable Inlet Guide Vanes

Variable Diffusers

Courtesy of Siemens (Turblex)

Single Stage Centrifugal (IG)

- Used at small to large WWTPs
- Bearing lubrication system with air/water cooling
- Efficient over wide range of air flows
- Proven / reliable operation
- Somewhat noisy
- Little vibration

High Speed Direct Drive Blowers

- New to municipal market (1st unit installed in North America in 2004)
- Single machined impeller
  - Spins at high rpm (20,000 – 30,000)
- Typically permanent magnet motor used for higher efficiency at higher speeds
- Blower and motor directly coupled (motor also spins at high speed)
  - Entire unit built by manufacturer (“core”)

High Speed Direct Drive Blowers

Courtesy of ABS

Courtesy of APG-Neuros

Courtesy of HSI

High Speed Direct Drive Blowers

High Speed Direct Drive Blowers

High Speed Direct Drive Blowers

- Manufacturers include:
  - APG-Neuros (most NA installations)
  - ABS
  - HSI
  - K-Turbo
  - Turblex
  - Gardner-Denver

Courtesy of HSI

High Speed Direct Drive Blowers

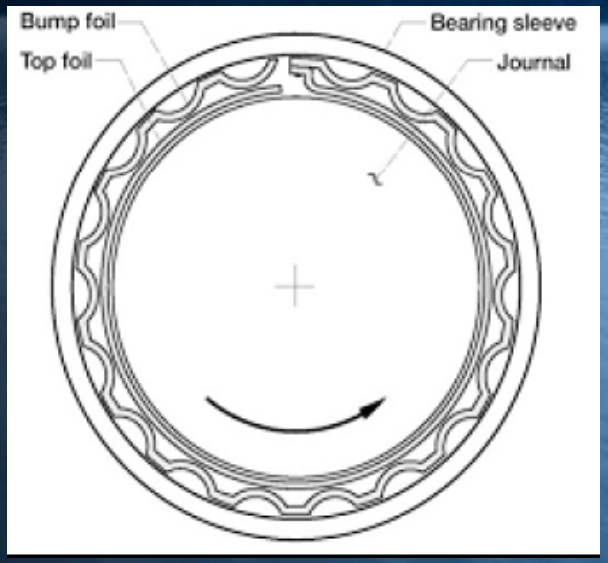
- Motor / blower speed varied with variable frequency drive (VFD)
  - Can turn down to about half design flow without much loss in efficiency
  - VFD and controls provided as part of blower package (inside enclosure or separate)
- Electrical components new to municipal wastewater market
  - High speed VFD (18 pulse) – may require harmonic filters
  - Permanent magnet motor

High Speed Direct Drive Blowers

- Bearings require no lubrication
- Air foil bearing (all manufacturers)
  - Uses blower air to create air foil around shaft
- Magnetic bearing (one manufacturer)
  - Electronic control system continuously monitors and adjusts magnets to position shaft

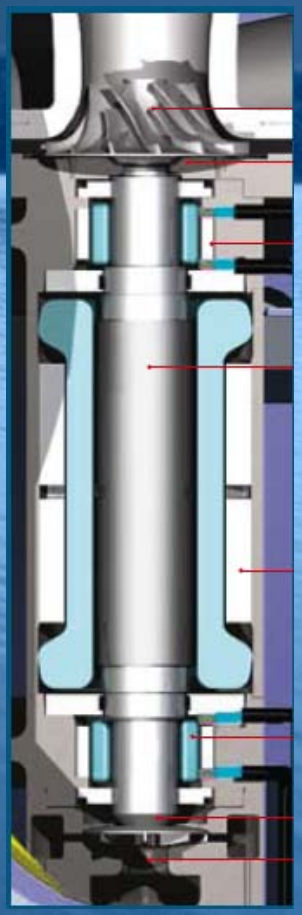
High Speed Direct Drive Blowers

Air Foil Bearing



Courtesy of APG-Neuros

Magnetic Bearing



Courtesy of ABS

High Speed Direct Drive Blowers

- Used at small to medium WWTPs
  - Limited max size (hp/air flow/pressure)
- New – limited operational history
  - Reliable operation so far
- Efficient over wide range of flows
- Replacement of blower, bearing, or motor typically results in replacement of “core”
- Very quiet and very little vibration
- Small footprint

New Blower Evaluation

- High power requirements warrant evaluating different types of blowers for new installations
- Many considerations for evaluation:
  - Monetary
  - Non-monetary
  - Site specific

Blower Evaluation Considerations

- System aeration requirements
  - Peak air flow and pressure
  - Other air flows
- Operating costs
  - Largest cost is typically power
- Maintenance costs
  - Lubrication
  - Air filter replacement
  - Equipment replacement

Blower Evaluation Considerations

- Type of power available and location of supply
- Building footprint and site access
- Operating history / reliability

Example

- Existing WWTP – 4 new aeration basins at 15 MGD annual avg capacity
  - Fine bubble diffusers
  - BOD removal
  - Nitrification
- Basin SWD = 24 ft (limited site area)
- Total air flow required
  - At avg flow = 10,500 scfm
  - At max month flow = 13,500 scfm
  - At peak flow = 22,200 scfm

Evaluation

- Integral gear – Turblex
  - 3 duty + 1 standby
  - 7400 scfm each
- Direct drive – ABS, APG-Neuros, HSI could meet design points
  - 5 duty + 1 standby
  - 4450 scfm each

Capital Cost Comparison

Cost	Integral Gear	Direct Drive (avg)
Blower Equip + Install	$1.5M	$1.6M
Structural / Architectural	$1.0M	$1.0M
Piping / Mechanical	$0.1M	$0.2M
Electrical / I&C	$0.2M	$0.3M
Total	**$2.8M**	**$3.1M**

O&M Cost Comparison

- 20 year period, 5% inflation
- Linear increase in flow
- $0.07 / kW-hr, 6.5% increase annually

	Integral Gear	Direct Drive (avg)
Assumed overall efficiency	77%	74%
Annual maintenance costs	$7500	$2500

Net Present Worth Cost Comparison

Cost	Integral Gear	Direct Drive (avg)
Capital Cost	$2.8M	$3.1M
Power Cost	$3.0M	$3.1M
Maintenance Cost	$0.4M	$0.2M
Total	**$6.2M**	**$6.4M**

Integral Gear vs Direct Drive

Integral Gear	Direct Drive
Proven operational history	Limited operational history
Would require expanding bldg for additional blower in future	Could install additional blower inside current bldg
Complex but reliable lubrication system	No lubrication
Relatively noisy	Quiet
Fewer, larger blowers (3+1)	More, smaller blowers (5+1)
	Smaller equipment footprint, less weight

Questions?

- tfarina@hazenandsawyer.com
- (513) 469-2750