Math and Maintenance for Pumps and Blowers

Overview of Blower Technologies and Comparison of High-Speed Turbo Blowers

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Today’s Buzzword in Wastewater Treatment

- High Speed Turbo Blowers
  - Changed the industry
  - Significant area of innovation in blower design
Agenda

- Role of blowers in wastewater treatment facilities
- Review of Different Blower Technologies
  - Positive displacement
  - Multi-stage
  - Single-stage centrifugal
  - High-speed turbo blowers
- Compare various high-speed turbo blowers
- Things to consider on your next project
- Questions and Comments
Role of Aeration Blowers in Wastewater Treatment Facilities
Process Air Production Represents Over one Half of Total Energy Used at a Typical WWTP

Energy usage at a typical WWTP

- Process Air: 55%
- Pumps: 20%
- Lighting: 8%
- Clarifier: 5%
- Other: 12%
Benefits of High Efficiency Blowers

Energy consumption commonly accounts for 75 percent of the total life-cycle cost of a blower.

Optimized blower and process air controls will also help reduce blower operating costs.
Review of Different Blower Technologies
Different Blower Technologies

- Multi-Stage Centrifugal
- High-Speed Centrifugal
- Single-Stage
- Positive Displacement
The Right Blower?

- One type fits all is not the right answer!
- Need to find the right fit for each project
  - Blower that provides the most efficient system
  - Best value to Owner
## Typical Blower Efficiencies

<table>
<thead>
<tr>
<th>Blower Type</th>
<th>Nominal Blower Efficiency (percent)</th>
<th>Nominal Turndown (percent of rated flow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Displacement</td>
<td>45-65</td>
<td>50</td>
</tr>
<tr>
<td>Multi-Stage Centrifugal (inlet throttled)</td>
<td>50-70</td>
<td>60</td>
</tr>
<tr>
<td>Multi-Stage Centrifugal (variable speed)</td>
<td>60-70</td>
<td>50</td>
</tr>
<tr>
<td>Single-Stage Centrifugal, Integrally Geared (with inlet guide vanes and variable diffuser vanes)</td>
<td>70-80</td>
<td>45</td>
</tr>
<tr>
<td>Single-Stage High Speed Turbo **</td>
<td>70-82</td>
<td>50</td>
</tr>
</tbody>
</table>

**Testing methods are not consistent among different manufacturers**
**Blower Curves Comparison**

- **Positive Displacement**
- **Single-Stage Centrifugal**
- **High-Speed Turbo**
- **Multi-Stage Centrifugal**

System Curve

* Single-stage centrifugal blower with dual-point control

** High-speed turbo blower with speed control only
Centrifugal Blower Operating Range

- Surge Line
- Blower at various capacities
- Operational Range
- Choke Point

Flow Rate

Resource Ratio
Positive Displacement Blowers

- Impeller: Two or three lobes
- Controls
  - Constant or variable speed (typically belt-driven)
- Simple instrumentation
- Requires large silencers (intake and discharge)
- Lowest capital cost
- Smaller installations
Multi-Stage Centrifugal

- **Impeller**
  - Series of enclosed impellers
    - Cast or fabricated
    - Various steel alloys

- **Controls**
  - Inlet throttling
  - Discharge throttling (less efficient)
  - Speed control with VFD

- **Bearings**
  - Anti-friction roller type
  - Grease or oil lubrication

- **Instrumentation**
  - Simple
  - Monitor bearing temperature and vibration

- **Electric motor (2-pole most often)**
  - IC engines (not often)
Single-Stage Centrifugal

- Single impeller
  - Open face (most common)
  - Enclosed (Roots)
  - Milled or investment casting
  - Aluminum and SST most common

- Controls
  - Constant speed
  - Inlet guide vanes
  - Discharge variable diffuser vanes
  - Turndown to ~ 45%

- Bearings
  - Journal type bearings
  - Anti-friction roller-type on smaller units

- Instrumentation
  - Complex
  - Vibration, temperature, pressure, power

- Electric motor (2-pole or 4-pole)
  - IC engines
High-Speed Turbo Blowers

- Significant area of innovation in blower design
- Introduced to North American market around 2007
- Industry “game changer”
- Offers energy savings with lower maintenance costs
High-Speed Turbo Blowers

- Single impeller (dual impeller by some manufacturers)
  - Open-face impeller
  - Three-dimensional milling or cast
  - Various material choices (aluminum alloys, stainless steel, etc.)

- Controls
  - Variable speed (single-point control)
  - Discharge variable diffuser vanes (Turblex dual-point control)
  - Turndown to ~ 50%

- Advance bearing design
  - Allow for higher speeds
  - Two configurations
    - Air bearing (most common)
    - Magnetic bearing
  - Bearings require no lubrication system
High-Speed Turbo Blowers

- Instrumentation and electrical components
  - New to municipal wastewater market
  - High speed VFD (may require harmonic filters)
  - High-speed permanent magnet motor
- Blower enclosure
  - Single-source responsibility by blower manufacturer for all components
  - Easy installation
  - Cooling requirements vary by manufacturer
  - Provides sound attenuation
# High-Speed Turbo Blowers

## Turbo Blower Technology – at a Glance

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
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<tbody>
<tr>
<td>High efficiency over wide range of flows</td>
<td>Relatively new technology in North America</td>
</tr>
<tr>
<td>Packaged unit provides small footprint</td>
<td>Limited sizing options</td>
</tr>
<tr>
<td>Good turndown capacity</td>
<td>Multiple units needed for large installations</td>
</tr>
<tr>
<td>Quiet operation</td>
<td>Unknown long-term reliability</td>
</tr>
<tr>
<td>Few moving parts, low maintenance requirements</td>
<td>Periodic replacements of special electrical components</td>
</tr>
<tr>
<td>No complex oil cooling system required</td>
<td>VFD requires special filters to eliminate disturbances to plant’s power system</td>
</tr>
</tbody>
</table>
Comparison of Various High-Speed Turbo Blowers
High-Speed Turbo Blowers

- Many manufacturers entering US wastewater market

Neuros
Siemens (Turblex)
Aerzen (K-Turbo)

Hoffman
HSI
ABS (HST)
Atlas Copco
Two Types of Installations

Inlet air from blower room

Piped/ducted inlet air
Differences Among the Various High-Speed Turbo Blowers

- Bearing Configuration
- Impeller Fabrication and Materials
- Cooling System
- Blower Controls
# Two Bearing Configurations

<table>
<thead>
<tr>
<th>Blower Manufacturer</th>
<th>Air Bearing</th>
<th>Magnetic Bearing</th>
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<tbody>
<tr>
<td>Neuros</td>
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<tr>
<td>Turblex</td>
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<tr>
<td>Aerzen</td>
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<tr>
<td>Dresser Roots</td>
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# Impeller Design

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<tr>
<th>Blower Manufacturer</th>
<th>Milled Impeller</th>
<th>Cast Impeller</th>
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# Cooling System

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<tr>
<th>Blower Manufacturer</th>
<th>Use Process Air (Self-Contained within Enclosure)</th>
<th>Separate Cooling System (External Heat Rejection)</th>
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<tr>
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# Blower Controls

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<th>Dual-Point Control (Variable Speed + Other)</th>
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Things to Consider on Your Next Project
Clealry Define Efficiency

A determination of wire-to-air efficiency takes into consideration all blower energy losses affecting the Owner’s “bottom line.”

* Testing methods are not consistent among different manufacturers
Specify a Pressure Rise to Surge Point

- Pressure Rise To Surge
- Surge Line
- Speed Lines
- Specified Design Point
- Operational Range

Graph:
- Flow Rate vs. Resource Ratio
- System Curve
- Surge Line
Specify Site Specific Operating Conditions

- **Temperature**
  - High Temp used to size blower (volute/impeller)
- **Site atmospheric pressure**
- **Guaranteed power consumption at actual operating conditions**
  - Base specified points on estimated operating time under those conditions
Questions & Comments

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