ENVIRONMENTAL EFFECTS ON BLOWERS **DESIGN AND INSTALLATION BEST PRACTICES**

Best performance and maintenance
in the wastewater treatment industry

WHITEPAPER

ENERGY **PERFORMANCE**

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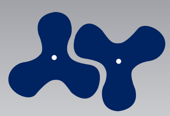
This is an energy-intensive process for the wastewater treatment sector; in fact, the energy used for aeration can, in some instances, be as high as 70 per cent of the site's total energy consumption.

Such a critical process needs to be well designed and installed to ensure maximum performance – helping to protect uptime, avoid efficiency losses and avoid high maintenance costs.

This whitepaper will explore the benefits of correct equipment design and best practices for installation as well as the importance of a thorough maintenance regime, focusing on the following blower types:



Positive displacement rotary lobe blowers

Screw blowers

High-speed turbo blowers, with centrifugal compression

DESIGN **CONSIDERATIONS**
3 STEPS FOR SUCCESS

Step 1. FLOW & **PRESSURE**

The first area to consider when designing and specifying a new blower system is the flow and pressure requirements.

As blowers are designed to run at low pressure, any unplanned increase in pressure can place additional demands on the blower's performance and the associated energy costs.

For example, clogged diffusers are a common cause of pressure increase, potentially raising the pressure demands between 30 to 50 percent.

Many operators may not be aware of this issue, as specification is often based on the theoretic initial pressure that is in the tank, without considering the impact of clogged diffusers.

The actual and potential pressure increases should be an important area to clarify before any investment in replacement blowers or new plant commences.

In our previous whitepaper, which discusses the energy importance of turndown capabilities, we explore the blower's ability to reduce its airflow rate quickly and efficiently to meet the changing air demands of a site.

In essence, the greater the turndown, then the more flexibility a wastewater plant has in handling unexpected demands. It is therefore of prime importance to size the blower correctly to meet the plant demand and specific process requirements, considering:

- Minimum and maximum air pressures
- The compressed airflow (demand) required by the system
- Speed regulation: With process demands for air fluctuating constantly a blower's ability to increase and decrease air flow rates is vital
- Pressure drops: Shortening piping distance, ensuring smooth piping bends and replacing damaged parts can help overcome this issue

THE IMPACT OF THE APPLICATION

There are a wide range of differing applications, which can be affected by the process water level and therefore, will result in pressure variations which need to be accounted for at the design stage.

Blowers have been specified typically based on the dissolved oxygen demand required by the aeration process, as well as factoring in data predictions based on future demand and projected 'worst-case' load scenarios.

A typical sludge aeration process, for example, benefits from a fairly constant water level meaning pressure variations are minimal. This is a very common application for blower technologies, however specifying based on previous experience or typical scenarios alone will not deliver the best results, likely resulting in higher energy consumption as the system overcompensates for pressure drops. In more recent years, ammonia effluent measurement has been favoured as an in-direct means of measuring the oxygen levels and can provide a more precise means of defining the air demand.

THE TOP THREE CONSIDERATIONS

Analyse if you are sizing the blower equipment based on oxygen content or ammonia levels. The plant may have altered its processes over time, meaning previous or historic blower sizing parameters will now have changed.

Check if your data is factoring in any oversizing. A typical plant will account for an additional 50 percent capacity and it is important that this information is relayed to your blower equipment partner. Without this data, they may undersize the blower installation based on the specific plant only.

For sequencing applications, ensure you provide both pressure points, both maximum and minimum, to ensure the blower is sized accordingly.

PROCESS APPLICATIONS AND THE IMPACT ON **FLOW AND PRESSURE**

Application	Purpose	Pressure considerations
Equalisation basins / flow equalisation	Helps avoid shocks or sudden influx of effluent in storm conditions – and prevents the plant from discharging.	The stop/start nature of the process, as opposed to a continuous flow process, means the blowers and vacuum equipment must be designed to meet variations in pressure.
Sequencing batch reactor	This system comprises a single tank in which a modified activated sludge process takes place, using a cycle of feed, settle, react and decant.	The reactor volume process is higher than for continuous flow processes. Aeration is also stopped for settling and decant periods, presenting challenges for the flow level.[2]
Aerobic digestion to reduce sludge volume	Reducing and stabilising sludge volume can enable greater efficiencies further along the treatment process.	During this process the digester volume changes, which can affect the required volume flow rate from the blower.

AT A GLANCE – DETERMINING THE CORRECT FLOW AND PRESSURE

1. The required flow is determined by the amount of oxygen (the 'biological oxygen demand') required in the treatment system
2. A standard cubic meter per hour (m^3/h) requirement for the system can then be determined, which will help dictate the blower sizing
3. Next, is to define the anticipated pressure of the system. The psi rating effectively measures the amount of system backpressure the blower can handle, with a more powerful motor equating to more pressure in the system

[1] https://www.sciencedirect.com/topics/earth-and-planetary-sciences/sequencing-batch-reactor
[2] https://www.blowervacuumbestpractices.com/industries/wastewater/proper-blower-system-design-variable-wastewater-depth-processes

Step 2. SITE CONDITIONS

Ambient temperature, the site altitude and humidity will all impact on the design of the correct blower system – and no one installation will be exposed to the same conditions as another. Operators need to provide precise data that ensures the resulting blower design can meet the rigours of the plant environment.

TEMPERATURE AND ALTITUDE

The standard cubic meter per hour (m^3/h) required can vary under different temperature conditions. For example, hot air contains less oxygen than colder air per cubic metre, directly influencing the required minimum and maximum flow that the blower must be able to generate.

Atmospheric pressure decreases as altitude increases, so it is equally important to consider the extra differential pressure created as this can have a major impact on correct blower selection and design.

The sizing of the cooling fan, used where blowers are installed in an enclosure, is another important factor.

The air mass can alter significantly based on altitude and temperature; for example, a site operating at 0 metres above sea level at 20°C will have very different demands to a site at 1000 metres altitude at 35°C.

This is where the selection of the correct compression technology can pay dividends. Lobe and screw blowers use volumetric compression and de-air using volume reduction, meaning varying temperature conditions have less of an impact.

In contrast, high-speed turbo blowers operate on the principle of dynamic compression. They use the air mass to compress, which can be affected significantly by variations in temperature.

H2S ISSUES

Hydrogen Sulphate (H2S) is a by-product found in the wastewater treatment process and is the result of the organic breakdown of waste material with a low oxygen content. H2S is highly corrosive and can affect the inner workings of the machine, such as the motors and bearings. During running hours, the impact is mitigated somewhat by the heat generated by the blower, but when the machine is idle, it can then struggle to restart.

Oil lubricated machines fare slightly better, but on oil-free designs, where there is metal-to-metal contact it can present a serious long-term issue for equipment longevity and reliability. To overcome this issue, manufacturers can provide solutions with PTFE coatings on the rotors or stainless-steel components on high-speed turbo blowers.

Step 3. DERATING

Most motors are limited to 1000 metres altitude, with for example, a rated power of 30 kW.

In simple terms this means that the blower will operate at a lower power (for example, 25 kW instead of 30 KW) above this altitude.

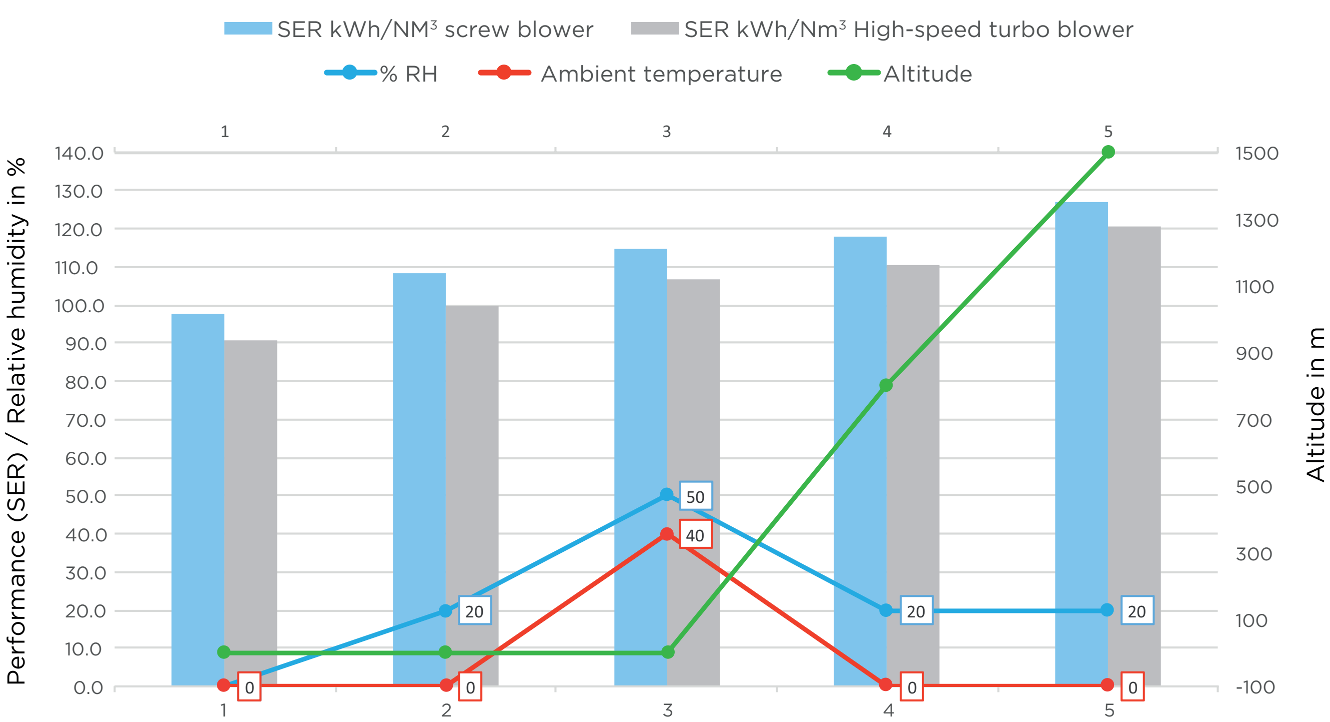
It is of prime importance that the manufacturer is informed of the specific altitude versus rated power requirements, enabling the motor to be overrated if necessary to avoid any dip in performance.

TECHNOLOGY **COMPARISON**

Technology	Design	Flow considerations	Pressure considerations	Site condition considerations (temperature / altitude / humidity)
Lobe	• Positive displacement • 3 lobes • Main motor coupled with V-belt and pulley transmission • Oil-free	The flow output of a positive displacement compressor is always constant	•Limited to 1 barg •Worst efficiency at maximum pressure 1 bar •Lower efficiency than screw machine at pressure higher than 0,45 barg •Relatively constant flow rate against variable output pressure	Altitude impacts on the compression ratio. For altitudes above 1,000m and temperatures higher than 40°C, a derating factor on the motor should be considered
Screw	• 3x5 or 4x6 profile rotors • Main motor coupled with belt and pulley transmission • Oil-free	The flow output of a positive displacement compressor is always constant	• Pressure range from 0,4 to 2,5 barg • Three outlet ports to maximise the efficiency in three ranges • Better efficiency than lobe technology for pressures higher than 0,45 barg • Polytropic compression • Relatively constant flow rate against variable output pressure	Altitude impacts on the compression ratio For altitudes above 1,000 m and temperatures higher than 40°C, a derating factor on the motor should be considered
Turbo	• Centrifugal blower • Low pulsation • High-speed motor and direct drive • Contactless transmission • Air foil or magnetic bearings • Oil-less	Dynamic blowers operate at both variable pressure and flow	• Available in 0.6, 0.8, 1.0 & 1.2 versions • High efficiency compared to traditional technology • Compression is external to the blower and overcomes system back-pressure • Performance can be affected more by local/operating conditions than traditional technologies such as lobe & screw	• Altitude impacts on pressure ratio • Temperature and humidity affects power consumption and efficiency • Operating range is limited to from -10°C to 40°C • For constant high temperature operation, the machine must be derated or operated at restricted speeds. Maximum operating temperature is 150°C

EFFECT ON BLOWER DESIGN - **A PRACTICAL EXAMPLE**

Performance of screw and high-speed turbo blowers at different inlet conditions
For delta pressure: 700mbars - Flow: 1350Nm³/h



BEST PRACTICE FOR **BLOWER INSTALLATION**

The correct design of the blower technology is only one part of the equation. Operators should also work with their supplier to ensure all factors related to the installation of the system have been considered.

And, once installed, staff should be encouraged to consult the operating manual regularly, to ensure best practice is maintained. Some of the questions operators should be asking their supplier are:

Question	Areas to consider	Impact on performance
Is there sufficient space to install the blower technology?	The footprint can vary depending on the technology chosen. Operators should ensure that they assess the available space, especially in replacement or retrofit scenarios.	A poorly installed blower, with insufficient space may result in increased pressures or overheating.
What areas should be considered around ventilation?	Blowers emit a lot of heat, which can be increased further in high ambient temperatures. This heat derives from both the compression process and from the motors.	It takes more energy to compress warm air. This can cause more frequent breakdowns as well as wasting energy. Operators should look to remove as much of the heat from the operation, and the environment, as possible.
What about heat rejection from any equipment installed indoors?	Heat recovery can be a good option, especially with larger blowers in the 200-520 kW range.	Heat recovery can save a significant amount of otherwise wasted energy.
What should be considered around air flow?	Air flows in a circular motion and it is important to reduce any turbulence to enable the smoothest flow in the aeration tanks.	A well-designed and maintained pipe network can help avoid pressure losses and result in better energy performance.

BLOWER CONTROL

Sophisticated controls installed in the plant will be measuring every parameter – including flow, pressure and oxygen. This means that the blower technology installed also needs to be controlled precisely, helping to match pressure and flow to plant demand.

Blower technologies are available with a range of control options, ranging from proprietary micro-controller to PLC-based controls.
Most plants will have a master control system to maintain airflow or meet dissolved oxygen demand and it is important that operators understand and follow the controls' function for panel operation.

VARIABLE-FREQUENCY DRIVES

Variable-speed blower technology is proven to help lower energy consumption when specified correctly for the application. However, an important area, which is often overlooked, is the potential for electrical interference with other sensitive equipment in the plant.

Operators should mandate the use of shielded cable and additional filtration to help avoid any issues. In addition, the ease of electrical installation is another consideration. Selecting high-speed turbo technologies, with their plug and play functionality, can help speed up installation times as there is only one wire to connect.

BEST PRACTICE IN ACTION

Robuschi has worked with EPS, a wet infrastructure specialist which designs, builds and, in some cases, operates water and wastewater treatment plant, on upgrading the wastewater treatment systems of Dairygold, a major dairy processor in Ireland.

The requirement was for a high-speed blower solution that would help with the aeration of the effluent coming from the dairy factory. Additional requirements included low noise emissions as the blowers were to be installed outdoors. Five Robox Turbo blower units configured in parallel were supplied to the end user to provide aeration for the Mallow site's two settlements tanks and ensure standard standby capability.

Robox Turbo blowers were chosen over conventional rotary lobe blowers due to their outstanding energy efficiency, compact design, quiet operation and suitability for outdoor installations.

These oil-free blowers are easy to maintain as they are direct driven and do not require any pulleys or belts. Their installation is simple and inexpensive, with the integrated VSD (Variable Speed Drive) and PLC (Programmable Logic Controller) systems allowing for plug and play operation.

40% smaller footprint

20% lower noise levels

25% lower energy consumption, resulting in savings of circa £30k per annum

MAINTENANCE

LIFETIME SYSTEM PERFORMANCE

If all site conditions are not considered fully, maintenance costs can increase considerably. Poor performance can lead to additional repair costs and more frequent replacement of key components.

Regular servicing and professional maintenance strategies can help to extend a system's lifecycle and reduce unexpected downtime.

This is especially the case when planning for overhauls, where plants are running near capacity and there is limited equipment redundancy.

This topic will be explored in greater detail in our next whitepaper, where we consider some of the key factors for improved system maintenance.

THE **ROBOX RANGE**

TOTAL BLOWER CAPACITY

Robuschi's new **Total Blower Capability** concept is a comprehensive package of cutting-edge blower solutions that includes rotary lobe and screw technologies, efficient high-speed turbo, and multistage centrifugal blowers, including side channel blowers.

Range up to 2,500 mbar(g) and Flow up to 70,000 m³/h

ABOUT **ROBUSCHI**

Robuschi has been a leading partner for the wastewater industry for many decades. Its wide product portfolio, such as blowers and pumps, offers energy efficient and sustainable solutions for a variety of applications in this field.

Ecological sustainability is part of the Robuschi strategy, focusing on promoting environmentally friendly solutions, enhancing energy saving and protecting natural resources. We lead the market in developing innovative technologies that support our customers:

- Top energy efficiency
- Low lifecycle costs
- Low noise
- Water 4.0
- Ease of maintenance
- Compact
- Tailor-made offers

Ingersoll Rand water and wastewater treatment solutions offers a broad range of services to help lower cost of ownership and improve blower performance. We work with operators to increase output, improve sustainability and environmental performance and cut costs, backed by our professional service and support.

If you have found this guide useful, then why not take a look at our previous whitepapers?

The next in our series of whitepapers will explore the importance of correct blower maintenance in reducing energy consumption and total cost of ownership.

Keep in touch with us for more information.

Previous Whitepapers

Contact us

www.robuschi.com