Screw or Rotary Lobe?

Selecting the right blower technology for optimum energy efficiency

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Introduction

Energy is the largest operating cost to a wastewater treatment plant (WWTP) with the energy consumed in running blowers for aeration often cited as the largest of all the energy consumers. With electricity prices continuing to rise, reviewing the energy efficiency of a blower is imperative in selecting the correct blower for any given application - especially when you consider that the energy costs of a blower can account for up to eighty percent of its total lifecycle costs. The type of system and equipment an operator chooses is therefore by no means inconsequential.

Various solutions are available for low pressure systems and the right solution will depend on the specific application. The most common and widely used solutions are rotary blowers and screw blowers - each with their own unique strengths that are ideal under certain conditions.

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Compression methods

Two different compression methods exist in principle:

Isochoric Compression
Isochoric compression refers to the process whereby compressed air is delivered without having been compressed inside the blower block. The volume of air inside the block remains constant. This well-known method is the one used by rotary blowers.

The rotors inside the block have a continuous straight-line profile. Rotary blowers draw a certain volume of air into the working chamber, then rotate further to close this chamber and deliver the unchanged volume of air to the outlet side for discharge. The only reason pressure increases to a maximum of 1000 mbar is because the compressed air flows back.

Rotary blowers can deliver air at up to 1000 mbar gauge pressure and have displacements of between 200 and 9000 m^3/h.

Internal Compression
Screw blowers on the other hand work on the principle of internal compression. Here the volume of air is reduced while it is inside the blower airend.

They have been available for a number of years and it has now become possible to apply the compression technology used for compressors - which normally covers higher pressure - to blowers.

Screw blowers typically deliver pressures of up to 1100 mbar. Because screw blowers normally operate more

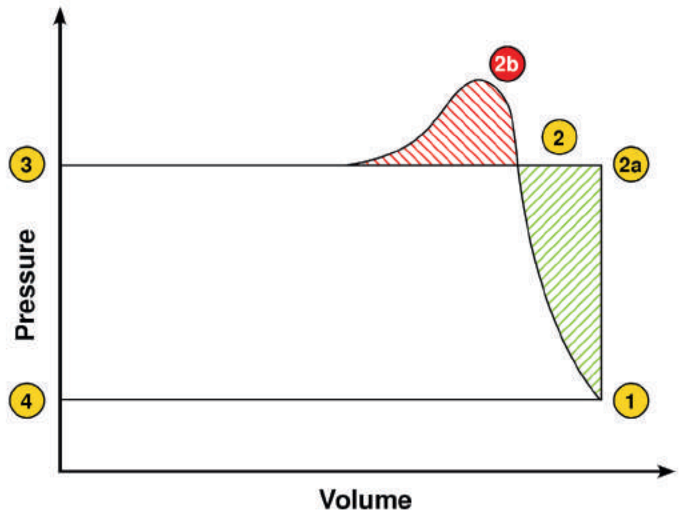
efficiently, their life cycle costs can be up to thirty percent less than rotary blowers since power costs are lower.
What makes this possible is the aforementioned internal compression in the screw airend. Unlike those in rotary blowers, screw blower rotors are twisted and continuously reduce the air volume enclosed in the airend. In addition, screw blower rotors can turn at higher speeds, which improves efficiency.

P/V diagram for displacement compressors

4-1: Intake stage
1-2a: Isochoric compression process - conventional blowers
1-2b: Polytropic compression process - screw blowers
2-3: Discharge against pressure

Lower power consumption with internal compression and no overpressure

Excess consumption during overcompression



**Screw blowers are best suited to applications where pressure demand exceeds a certain level; in such instances they offer significant energy-saving potential (green range).
However, when operating pressure is too low; for example, significantly less than 1000 mbar, the risk of over-compression exists (red range). In such cases, rotary blowers may be the more suitable choice.**

More air and more savings with the latest screw blower technology

The latest screw blower designs recently introduced to the market, feature a number of additional technical innovations that improve their efficiency by almost ten percent in comparison to existing screw blowers. This greater efficiency results from a highly efficient screw profile design - such as KAESER's Sigma Profile where the innovative shape significantly reduces energy consumption.

The latest models also feature additional energy-saving technical innovations.
Earlier generations of these types of compressors usually had a separately driven oil pump with an oil cooler. Their purpose was to keep operating temperature within limits and ensure proper lubrication. However, such components consume power and have wearing parts.
The latest screw blowers feature an internal cooling concept that make oil pumps and oil coolers superfluous. Furthermore, they feature an effective sealing concept that eliminates the need for the vacuum pump previously required to ensure long-term hermeticity. Eliminating such auxiliary devices and circulating oil lubrication also increases the service life of the machines.

A further unique feature of such screw blowers is that they are complete, ready-to-connect packages. This simplifies installation and reduces associated costs.

Selecting the right blower

Screw blowers are by no means always the most suitable choice for a particular application. Whether it is best to use a screw or rotary blower depends on various factors, all of which must be examined for each particular case.

Both volumetric flow rate and pressure have an impact on the design rating and therefore also power consumption. For example, if the required pressure can be reduced by only 100 mbar, power consumption is significantly reduced as a result. If, in addition, volumetric flow rate fluctuates with demand, a combined solution may be the most suitable alternative.

Other criteria may also be relevant, depending on the application. The air injection depth and service life of the blower are also important. For an air injection in depth of up to five metres, rotary blowers are often more suitable; above that, screw systems make more sense.

If the blower application calls for continuous duty - which is often the case for wastewater treatment plants - the amortisation period on the more expensive screw blowers is very short. Although the initial investment is greater because the technology is more sophisticated, lower energy costs quickly offset the higher up-front investment costs when the machines operate continuously.

Depending on the application and how long the compressors are actually operating, it may make sense to select a screw and rotary blower combination.

If several blowers are required for an air centre, the best solution may be to use screw blowers for continuous duty and rotary blowers to cover peak loads.

“The life cycle costs of a screw blower can be up to thirty percent less than rotary blowers”

The importance of planning

It is not only important to consider the individual blowers themselves, but also to consider the entire system as a whole. As proven many times over, the combination of careful equipment selection and optimised interplay between all components within a system ensures best results every time. A single, high-efficiency blower cannot be effective if it is installed incorrectly. In fact, it is not enough to simply install the machines: it is also important to know how to control them and when to turn them on and off, enabling them to perform as effectively and efficiently as possible. Of course this requires meticulous planning prior to installation.

The best way to accomplish this is with an air demand profile that identifies the exact compressed air consumption over the course of a year to establish the blower station’s optimum operating point in regards to energy consumption. Of course the blowers need to be able to deliver the maximum volume of air required, but the system as a whole should provide best possible efficiency at the most common real-world operating point. The best solution can be determined using computer software that compares the efficiency of various blower combinations and the costs associated with maintaining them.

Blower block, power transmission, drive, auxiliary equipment, power electronics, controls. All of these components combine to deliver a complete, ready-to-run rotary blower, screw blower, turbo blower, or whatever equipment is being used to deliver air. It's no easy task to pick the most efficient and robust solution from this variety of available options. It may therefore help to consult standards such as ISO 1217-C in order to avoid being misled by the so-called "coupling power" which is often stated. After all, what truly counts is not the power consumed by the individual blower block or airend, but that used by the entire system.

"Before deciding on a system, it is important to precisely analyse the compressed air demand"

Conclusion

Before deciding on a system, it is important to precisely analyse the compressed air demand for the specific application in question. Once this has been done, the most efficient and cost-effective long term solution can be identified.

It may well be that the system with the higher up-front cost is actually the most cost-effective over the long term when energy costs are taken into consideration. Any initial premium is generally paid back within one or two years. After that, operators save money year after year.

There is no doubt that both rotary blowers and screw blowers are both efficient solutions that each possess a number of advantages. However, which technology will be most suitable and efficient for any given application can only really be determined after conducting a precise demand analysis.

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