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Price versus TCO?

A long-term cost analysis model for the wastewater treatment industry

Consider the **complete** lifecycle

Total cost of ownership (TCO) or purchase price? Experts agree that a detailed evaluation of expenses related to owning and operating any new equipment purchase should be front of mind - before agreeing to a sale.

Yet, for many, the choice between TCO or the initial purchase price is not a key consideration. All too often, the selection process focuses on the initial price tag, with less importance placed on the ongoing operating and maintenance costs.

Indeed, where budgets are tight, it can be tempting to opt for a good deal; a discounted price that, while it may improve short-term profitability, can have a detrimental effect on long-term ownership costs.

Some studies suggest that the initial price can represent less that 10 per cent of the total lifetime costs for industrial equipment, with energy costs and maintenance representing at least **five times** more than the upfront costs. When considering new capital investment, it is important to be able to compare and evaluate all facets of the equipment or system proposed against any other solutions being considered to reach a true conclusion on overall ownership costs.

Below is a useful at-a-glance introduction to some of the key areas to consider:

Purchase cost – The initial cost

Operating costs – The cost of installation and commissioning and the energy required to power the equipment

Maintenance and service – The cost of routine preventative or predictive maintenance, alongside reactive emergency repairs, and the cost of genuine spare parts. Some customers may also wish to evaluate the cost of downtime within this metric; analysing the reliability of the different equipment technologies being considered

Equipment longevity – An important component in TCO that is often overlooked. What is the expected lifetime of the equipment, how does that compare to other solutions on the market and how soon will it need replacing?

In this whitepaper, we explore some of the considerations around TCO for the wastewater treatment industry. In this energy-intensive sector, there is a high demand for process air technologies, ranging from pumps and low-pressure compressors to positive displacement rotary lobe, screw and turbo blowers. With the average lifecycle of a treatment plant counted in decades, we detail some of the considerations when selecting blower equipment to perform cost-efficiently throughout its service life.

The factors that contribute to **best-in-class** TCO

Total cost of ownership – at a glance

The aim of TCO is to place a single value on the complete lifecycle of a capital purchase. In the wastewater industry, this must take into account every phase of ownership, from the initial purchase tag, to the on-going energy costs, maintenance, repair and servicing costs.

Blowers are a key piece of equipment for aeration in the wastewater industry, which is a critical and energy-intensive process for this sector. Low-pressure blowers supply process air to aeration tanks, which are activated by the oxygen delivered as part of process air. Mixing the sludge with oxygen increases its gas yield and reduces its retention time in the tank. If a site's blowers cannot deliver the required air to the aeration tank, then the treatment process will fail.

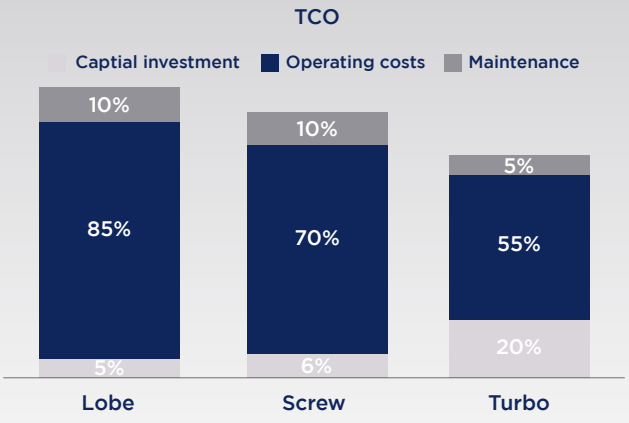
Aeration and energy consumption

The energy used for aeration in a wastewater treatment plant typically accounts for between 50-60 per cent of the site's total energy consumption and in some instances, can be as high as 70 per cent.

Blower efficiency is therefore a key priority but analysing rated energy efficiency alone is not the best measure of the long-term operating costs. The blower with the highest-rated efficiency will not automatically provide the lowest overall energy consumption. There are many other variables and operating conditions to consider in order to select the most suitable aeration blower, which this whitepaper will go on to examine.

There is a wide choice of blower technologies on the market, but for the purposes of this whitepaper, we will concentrate on the following, key types:

- Positive displacement rotary lobe blowers
- Screw blowers
- Turbo blowers, with centrifugal compression



Let's now take a look at the three key factors to take into account before embarking on a blower equipment investment programme and an overview of the key technologies available.

Step 1. Capital investment **costs**

Specifying for success

When purchasing a new blower, the technology chosen must be based on the precise application demands and operating parameters. With numerous types of blower technology available, this needs careful consideration.

Before focusing on the technology, the following areas should be considered as part of the specification process, to ensure the type of blower has been sized correctly to suit the plant and its varying conditions:

- Minimum and maximum air pressures
- The compressed air flow required by the system
- The blower's overall energy consumption

Capital investment should also take into account any costs for designing, installing and commissioning the system, including any electrical or mechanical infrastructure set up requirements.

The technology comparison – price

- Rotary lobe blowers operate on the principle of isochoric compression, whereby air is delivered without having been compressed inside the blower block. The volume of air inside the block remains constant and, for that reason, this technology can be less efficient that a screw or turbo blower.

  Rotary lobe blowers also cost less than both screw and turbo blowers, but tend to consume more energy.

- Screw blowers use internal compression to reduce the volume of air while inside the blower's airend, offering good efficiency. With a mid-range price, screw blowers do need to be sized correctly, but offer reliable-turndown facilities.

- The latest, dynamic high-speed turbo blowers with centrifugal compression are typically the most expensive blower option, but with this bigger price tag comes higher levels of efficiency. A pressure rise is achieved by adding kinetic energy to a continuous flow of air through the rotor or impeller, for superior energy performance. A high-speed motor coupled directly to the impeller means that there is also no gearbox and therefore no mechanical friction losses for improved efficiency.

Step 2. Operating **costs**

The energy equation

Operators will want to ensure that their blower package has been optimised to minimise energy consumption as much as possible.

The following examples should be considered as best practice when specifying an energy-efficient solution.

- Regulate speed, with the use of variable speed drives and invertors, as well as sophisticated control systems, to match air flow to plant demand. With process demands for air fluctuating constantly in aeration application a blower's ability to increase and decrease air flow rates is vital
- Minimise pressure drops, as this can affect operating pressure. Shortening piping distance, ensuring smooth piping bends and replacing damaged parts can help overcome this issue

The technology comparison – energy

- Rotary lobe blowers can lose efficiency due to increased pressure and rely on external compression, which can be less efficient than internal compression. As constant volume machines, they deliver a fixed discharge against the system back pressure. This means that it is important to have adequate size piping and large radius bends to maintain high working efficiency and low power consumption. Rotary lobe blowers also cost less than both screw and turbo blowers, but tend to consume more energy.

- Screw blowers use internal compression, which is proven to reduce energy costs, especially when using an integrated frequency convertor to vary the speed of the drive motor to adapt to changes in air demand.

- Turbo blowers feature a high-speed motor and drive to reach high rotational speeds, with the advantage of a variable frequency drive to adjust speed easily. The impeller uses air foil bearings, which generate a completely contactless transmission when the turbo blower is running. This eliminates any mechanical efficiency losses, as well as ensuring no oil is needed in the system's air end, all contributing to high energy and environmental performance.

Step 3. Maintenance **costs**

Lifetime system performance

The final piece of the TCO equation is the cost of servicing and maintaining the installation. Some key considerations to help minimise these costs are:

- Invest in machinery that is, by its design low maintenance or can be serviced easily
- Always choose genuine spare parts and lubricants. These are manufactured to meet the same standard as the equipment they are intended for and will ensure that performance is not compromised
- Consider oil-free options. No oil in the machine means there is no oil to purchase, maintain or dispose of
- Manage pipework leaks, which can contribute to as much as 20 to 30 per cent in wasted energy
- Follow the manufacturer's required maintenance schedule

The technology comparison – maintenance

- Maintenance requirements for screw and rotary lobe blowers tend to be similar. They are easy to maintain with a simple design that has relatively low service demands.

- Turbo centrifugal blowers are well suited to medium or large air flows at a wastewater treatment part. With no oil and the contactless transmission, maintenance demands are reduced significantly – also contributing to excellent longevity.

Technology **comparison**

Technology	Design	Purchase price considerations	Operating and energy costs	Maintenance
 Lobe	• 2 or 3 lobes • Main motor coupled with belt and pulley transmission • Oil-free	• Lower capital cost • Frequency converter compatibility • Controller option • Robustness to harsh conditions	• Limited efficiency due to external compression • Improved efficiency with frequency converter • Additional efficiency losses to consider (transmission, gears, motor) • Wide turndown range for any application	• Robust and easy to maintain
 Screw	• 3x5 or 4x6 profile rotors • Main motor coupled with belt and pulley transmission • Oil-free	• Medium capital cost • Frequency converter compatibility • Controller option	• Increased efficiency due to internal compression • Improved efficiency with frequency converter • Additional efficiency losses to consider (transmission, gears, motor) • Wide turndown range for any application	• Robust and easy to maintain
 Turbo	• High-speed motor and drive • Contactless transmission • Air foil or magnetic bearings • Oil-less	• Higher capital cost and high longevity • Plug & play solution with frequency converter and controller	• Energy savings of up to an additional 40% • No mechanical efficiency losses • Easy-to-use control system • Very efficient at the duty point	• Oil-less • Limited maintenance operations

Planning for tomorrow

Implementing a long-term strategy for both the selection, purchase and ongoing operation of a blower or compressed air system will pay dividends. Not only will this approach ensure that customers specify best-in-class performance equipment to begin with, but also have a robust approach to the ongoing reduction of both operating and maintenance costs.

There are also additional parameters which will impact on total cost of ownership; the plant's design and demand for air. These consider such areas as the 'worst-case' load scenario for the treatment plant over a 20-year forecast and by how much to over-size the blower technologies from the outset to account for increased demand.

This important area will be examined in our next whitepaper, as we look at the benefits of greater turndown as part of the overall air demand.

If you have found this guide useful, then why not take a look at the next in our series, which explores the benefits of turndown in the aeration process; a technique which can have a beneficial impact on total cost of ownership?

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Robuschi is a leading supplier of rotary lobe, turbo and screw blowers, low-pressure screw compressors, liquid ring and centrifugal pumps, and other customised solutions for an extensive range of industries. This includes the wastewater treatment, aquaculture, manufacturing, medical, plastics, chemical and pharmaceutical, pulp and paper, and environmental sectors. Founded in 1941, Robuschi became part of Gardner Denver in 2011. Now part of Ingersoll Rand, Robuschi believes in innovation and investing in modern machining systems and state-of-the art production processes.

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