How to purchase new compressed air equipment

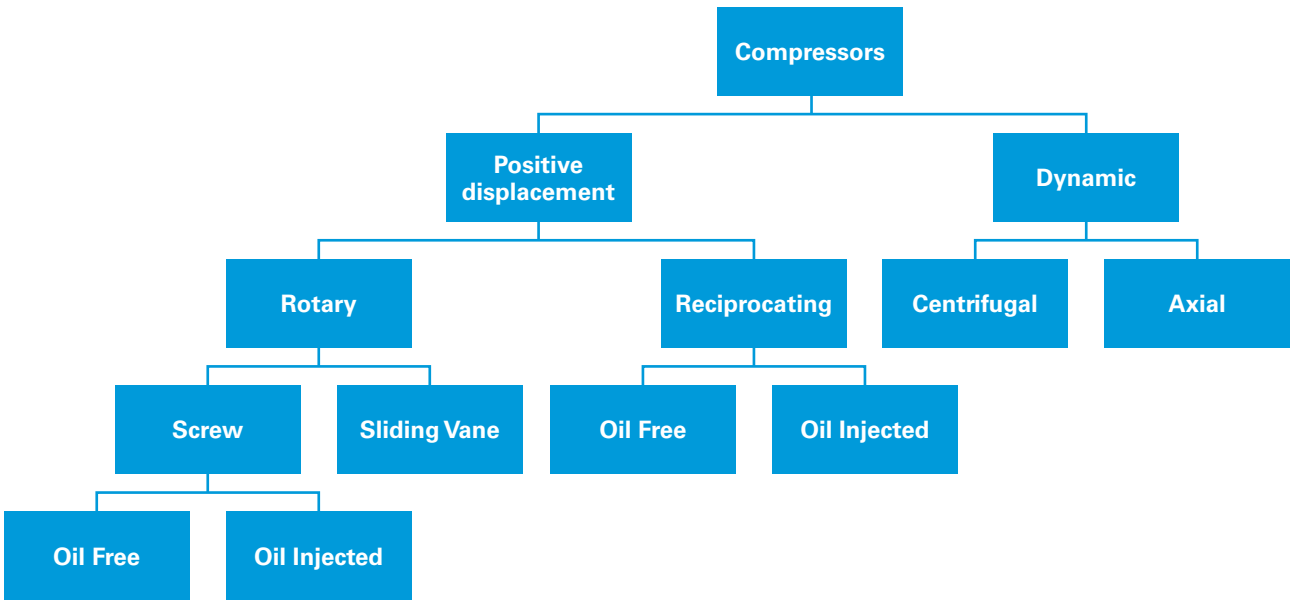
There are many ways to make existing compressed air systems more efficient. But at some point you'll want to invest in new compressors. By choosing the right compressor you can achieve major savings, paying back your investment within a short time.

Every installation is unique, so there is no definitive new compressor solution. Nor is there a simple answer as to when a new compressor will give economical energy savings. However, the points to consider in deciding whether you need new compressor capacity are usually the same, regardless of size.

Compressor types

The main types of compressor are shown in Figure 1 below:

Figure 1 *Types of compressor*



The majority of compressors currently being used on general purpose compressed air systems are oil injected screw machines.

- For smaller applications sliding vane are also popular.
- Oil free screws are used extensively in a range of sizes where oil free air is required and also for general purpose air above a motor size of around 200kW.
- Centrifugal compressors are limited to the larger end of the market, generally above a motor size of around 300kW, and oil free applications.
- The installation of new reciprocating compressors now tend to be limited to smaller garage type locations, high pressure applications and specialist gas compression units, although the older industrial reciprocating compressors can still be reliable efficient machines if well maintained.

Depending on the application more than one type of compressor may be considered. When considering which type of compressor is best you should look at the control characteristics, output and efficiency, type of cooling system, main motor voltage and maintenance costs to see which is most appropriate to your site and gain a full life cycle view of the potential installation.

Factors to consider

The first step in determining whether the installation of new compressors would be justified is to study the existing system and answer the following questions:

- Do the existing compressors meet the demand at all times?
- Are the compressors well matched to the demand at all times, with small amounts of off load or inefficient running? (less than 30% off load running on the duty compressor).
- Are the compressors reliable and economical to maintain?
- Do the compressors supply air at the same pressure as it is used throughout the site? (Within 1 bar or so).
- Do the compressors supply oil free air if the end users require this?
- Are the compressors less than ten years old?
- If the answer to all of the above questions is 'yes' it is unlikely that the installation of new main compressors would generate major savings. However, there may still be opportunities for targeted machines e.g. a new small compressor for overnight supply of a 24 hour user, combined with zone isolation of the main system. If the answer to any of the above questions is 'no' then further investigation may be worthwhile to determine if compressor replacement is justified.

Analysing the demand

To decide what size compressor you need you first need to analyse the demand. Find out how it varies over a representative period, and how the existing compressors meet that demand.

Do this by installing recorders to log one or more of flow, power consumption or the on/off load pattern of the compressors. This can be done in-house, by compressor manufacturers/distributors or using specialist contractors. Be sure that this data is analysed correctly as mistakes can be made when correcting power consumption to flowrate – for example if the operating characteristics of the compressor are not properly understood. As an alternative taking regular readings of the compressor operating pattern based on on/off load running, at various times of the day, will allow a knowledge of the demand pattern to be built up, although clearly it will not be as accurate as a full measurement survey.

The results of the survey should provide data on the demand pattern and the current cost of meeting that demand. Using the same data you can also analyse the savings potential of replacing old compressors with new units.

Specification and analysis

When you are trying to determine the correct compressor size work with suppliers to ensure the compressors are sized to run efficiently across the range of demands not just at peak flows. This can often be achieved using VSD see below, but a range of fixed speed compressors with a good control system can also work well.

- Remember that you will normally have to work within the standard ranges supplied which are based on motor sizes so – for example – if you think you need around 600cfm, you will need to choose between a 90kW compressor at around 550cfm or a 110kW machine at around 650cfm.

- If you have critical plant make sure you have standby capacity for the largest compressor to be taken out of service.
- When you are considering new compressors don't just look at the current demand, consider an allowance for future expansion.
- You should also take into account that when manufacturers quote to a standard, normally ISO1217 or PN2PTC2, they are allowed an acceptance tolerance on new machines depending on size, varying between 4 and 6 per cent.
- Inlet conditions can make a big difference to output. If you ask for a compressor sized in Nm^3/hr (Normal cubic meters per hour) this is basically a mass flow and most compressors are fixed volume. The difference between m^3/hr and Nm^3/hr can be up to 15 per cent depending on inlet conditions.

When analysing the savings potential of new compressors ensure that each quotation provides the same data and in particular that power consumption figures at both full, part and no load are all total package power, i.e. the power measured at the main supply to the compressor. Sometimes shaft power is quoted which does not take into account the main motor efficiency or ancillary usage e.g. cooling fan or just main motor rated power is stated. For an air cooled screw compressor it is not uncommon for package power to be 10-20 per cent higher than motor rating.

Also consider the cost of running system ancillaries e.g. air cooled compressors use slightly more energy than water cooled due to the internal fan, but taking into account the cost of running pumps and fans on the cooling water plant, as well as chemicals and other maintenance costs, the saving from the change can be considerable.

Maintenance costs between different compressors can also vary considerably. Therefore, when selecting an air compressor, it is important to look at the total cost across the system, over the life cycle of the equipment. Manufacturers or agents are now able to routinely offer service contracts that run for one, three or five years. Some will even offer 10-year contracts. These contracts can either be routine basic maintenance or all-inclusive packages which cover all parts and labour costs as well as any breakdown/repair costs.

VSD compressors

The installation of a new VSD compressor is often seen as best practice however, it is not a universal solution. VSD compressors are not suited to every installation and if run heavily loaded can cost more to run than a fixed speed compressor. Most installations also only require one VSD machine to control to the demand – standard drive units should always be used as base load machines. If a site already has a mixture of different size compressors a good group control system can provide similar savings to a VSD at much lower cost. Note that there is also a premium to be paid for VSD machines, typically around 25 per cent, although if correctly applied this is paid back many times over the life of the compressor. For more information on VSD compressors see – How to utilise variable speed drives with air compressors – CTL167 .

Configuration considerations

For a standard 7 barg general purpose compressed air system where all users operate the same hours it is best practice to centralise the compressors and generate all the air at a single pressure as close as possible to the minimum user pressure. Where the requirements are different it can be more efficient to consider specific compressors to meet the needs of those areas more efficiently, for example:

- If only a proportion of the site needs air overnight think about using a small compressor for overnight supply of a 24 hour user plus zone isolation of the main system. Alternatively if the use is large enough, zone isolation of non-using areas, whilst still feeding the 24 hour production areas from the main compressors may be more appropriate.
- If a system requires air at significantly lower pressure, normally less than 2 barg or so, a blower or low pressure compressor generating at that pressure may be more appropriate. You could still retain a link to the main system for standby capacity.
- If you need a percentage of air at significantly higher quality for example in food and drink or pharmaceutical sectors, it may be more efficient to install a small oil free compressor. This is often better than relying on filters and dryers that can introduce a pressure drop and require the entire system pressure to be increased to cope. There is also less risk of contamination.

Treatment systems

If you are looking to install a new compressor there is a good chance you will also be looking at treatment systems. Compressed air is treated in two main ways; drying and filtration.

- Dryers reduce the dewpoint of the air by removing water from it.
- Filters remove other contaminants, mainly particles and oil.

The direct running costs of treatment are electricity to run the dryer and compressed air or external heat for regeneration if you have desiccant dryers. There is also an indirect cost from running the compressors at a higher pressure to overcome the pressure drop across a treatment system.

The main types of treatment system, with typical running costs are shown in Table 1:

Table 1 Summary of dryer types

Pressure dewpoint, C	Dryer type	Filtration	Additional cost	Comments
+3	Refrigerant	General purpose	3%	The most common type of dryer available for almost any demand
-20	Sorption	None	<3%	Drum type dryer specific to oil free screw compressors, very low running cost
-40 to -70	Desiccant	Pre & After	10-20%	Most common for lower dewpoints. Use heat or air to regenerate. Consider other heat sources eg steam to minimise running costs
+5 to -40	Membrane	None	10-25%	Small sizes only, purge losses very high at low dewpoints

The running costs given above are typical but if they are incorrectly sized or not properly controlled these costs can be much higher.

Selecting and sizing a treatment system

When assessing a compressed air system think about what air quality you need across the site.

- Does all the air need to be dried to desiccant dryer levels? In most cases the lower the dewpoint the higher the running cost. If only certain areas or systems require the very low dewpoints consider treating all the air to a lower quality level, usually with a refrigerant dryer, and then installing smaller desiccant or membrane dryers close to the point of use or just on the relevant system.
- Apply the same thinking to filtration. Extra filters means extra pressure drop and higher running costs. Can you use general purpose filters at the compressor house and high efficiency filters only at key users?
- If treatment systems are too small they may not meet the specification you need at all times. This may sound obvious but high temperatures & low pressures reduce their capacity and increase pressure drop. Dryers and filters are normally rated at 7 barg and 35°C inlet temperature. A pressure reduction of 1 bar combined with a temperature increase of 5-10°C can reduce capacity by over 25 per cent, making what seems like a well sized package undersized.
- If oversized running costs can become very high, although control systems can help minimise this.

Refrigerant dryers

To minimise running costs with refrigerant dryers consider the following:

- Select a unit with a control system or VSD on the refrigerant compressor to match running costs to compressed air demand. These units are on the Energy Technology List and can be purchased under the ECA scheme.
- Ensure cooling is good – high ambient and inlet temperatures will affect dewpoint and therefore running cost.

Desiccant dryers

If specifying a new desiccant dryer consider the following more energy efficient options:

- Dewpoint control. Standard dryers use a time based regeneration cycle, which do not take into account any variations in load. Dewpoint control systems monitor the dewpoint and only change duty when reaching a full moisture load. As dryers are normally sized to cover the peak demand this can give significant energy savings, up to as much as 70 per cent by matching regeneration energy to the demand.
- A heat regenerated dryer with an external blower or vacuum pump and heater elements. These draw in and heat atmospheric air and can run without any compressed air purge.
- Steam regeneration. Using a steam:air heat exchanger in conjunction with a blower can significantly reduce running costs, especially if excess steam is available on site at low cost.
- Using waste heat of compression. With this option some or all of the air from the compressors is delivered to the dryer without aftercooling. Heat exchangers on the dryer remove the heat for regeneration and cool the air sufficiently to pass through the duty desiccant bed. These dryers run at very low cost but need careful engineering specific to each installation.