DECERNA

Delivering, unlocking & advancing the low-carbon economy

COMPRESSED AIR SYSTEMS

CASE STUDY

Business Type:	Factory
Location:	Stockton-on-Tees
Existing setup	Aged single speed, three phase compressor
Proposed system:	High efficiency variable speed compressor
Installed cost:	£27,000
Lifetime:	15 years
Simple payback period:	2.8 years

ANNUAL SAVINGS

Electricity:	80,865kWh
Energy costs:	£9,704
Carbon:	24tCO_2e (BEIS 2022)

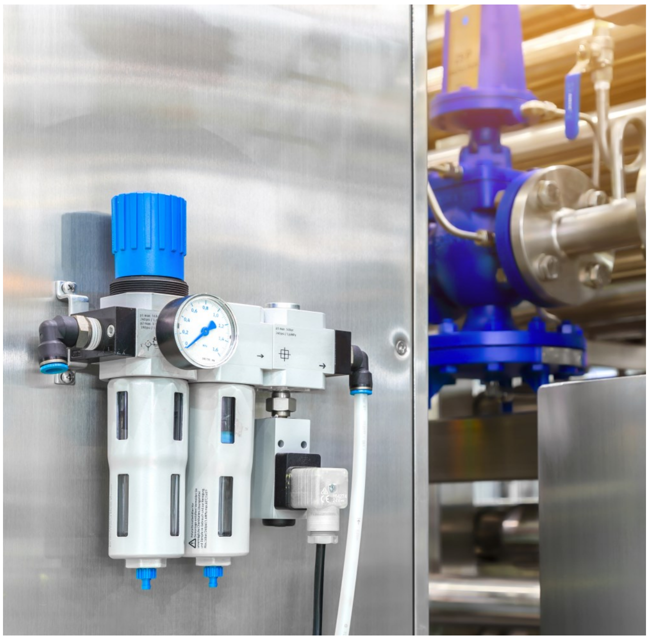
DECERNA

What are compressed air systems used for?

Compressed air is used for a variety of purposes including pneumatic supplies for industrial equipment, spray painting, bead blasting and air powered hand tools; but it's also very popular for light manufacturing and the automotive repair sector to power air tools.

Although it can be very convenient and practical, compressed air can be quite energy intensive and compressing air is an inherently inefficient process that generates waste heat.

A typical compressed air system in an industrial site consists of one or more compressors, a storage vessel which is often called the receiver, and air distribution pipework. Many systems also have a means of drying the compressed air to avoid causing corrosion in the receiver vessel or the equipment that is being supplied with air. The simplest form of dryer is a water separator which can be combined with a regulator and inline lubrication system. Larger and more sophisticated systems use refrigeration systems to dry the air.



AIR FILTER, REGULATOR AND LUBRICATOR

Most compressed air systems have some way of filtering the air before it is used in factory equipment. This is normally a simple inline filter. Compressed air systems that are used for high speed power tools require that some oil to lubricate the tool. In these cases, it is common to find a combined filter, regulator and oiler. The control knob is used to set the outlet pressure and a built in regulator maintains the pressure through varying levels of compressed air load.

REFRIGERATION DRYER UNITS

Larger industrial compressed air systems have vapour compression refrigerators to dry the air before it is used in sensitive factory machinery. The term Clean Dry Air (CDA) is sometimes used.

The refrigeration system can use a lot of energy so it's worth checking if it is working efficiently or considering upgrading to a more efficient unit.

Compressed air energy efficiency basics

ELIMINATE COMPRESSED AIR ALTOGETHER

Firstly, consider if you really need compressed air at all. Businesses can achieve considerable savings by using battery power tools such as impact wrenches rather than air tools. Apart from being much more efficient than air tools, they can also be more convenient and the trip hazard of the air hose is eliminated.

CHECK YOUR PRESSURE

Many sites operate their compressed air systems at a higher pressure than the equipment needs. A small reduction in air pressure can yield significant energy savings.

MAINTENANCE

As with all plant and equipment, regular preventive maintenance of a compressed air system is important to keep the plant running efficiently. This would typically include checking oil/air separators, air inlet filters, drive belts and oil levels. It's also good practice to ensure that the air inlet should be drawing air from the coolest possible location because cool air is easier to compress than warm air.

CHECK YOUR SYSTEM SIZING

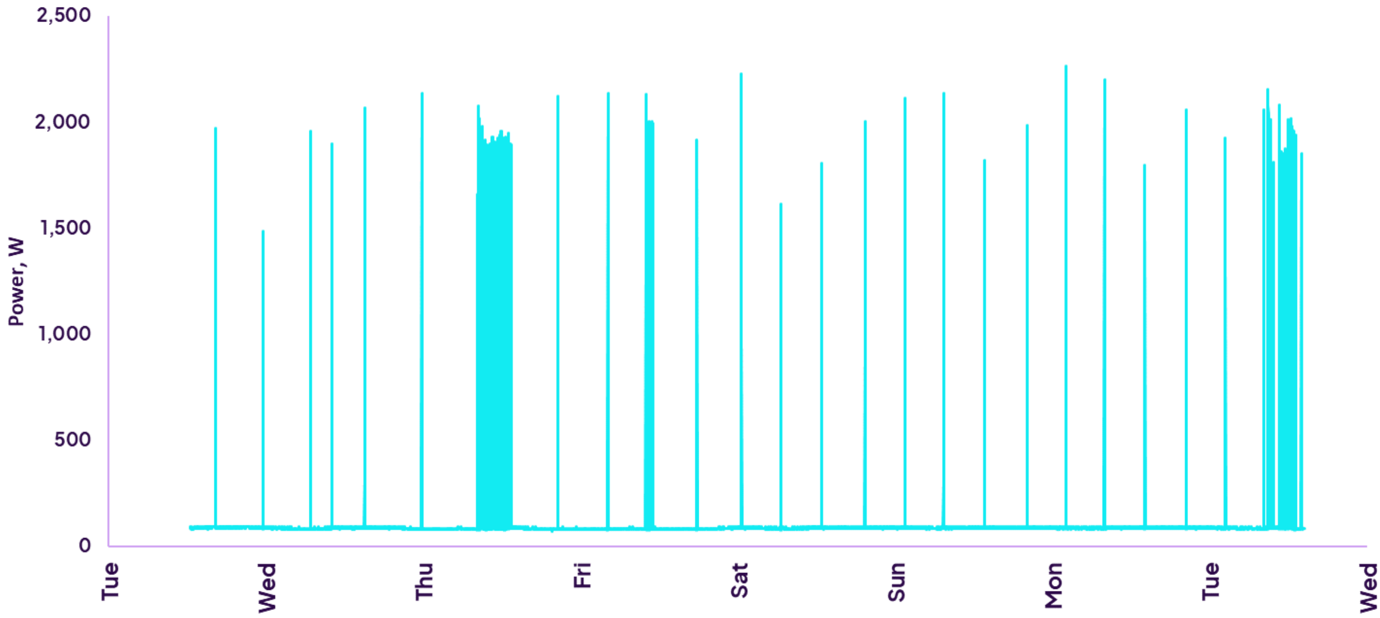
Over time, factory layouts can change and the original compressed air system may no longer be the most appropriate size. A compressed air system that is too big will not operate efficiently so it can be worth considering investing in a new, smaller and more energy efficient compressor system. It's also common to have one piece of equipment such as a bead blaster that uses a lot of compressed air but is used infrequently. In these cases, an experienced compressed air services company will be able to temporarily install pressure and flow sensors together with electricity dataloggers to work out the efficiency of the system. The datalogging can show the peak air flow and the average air flow – giving an indication of how well sized the compressor is relative to the air receiver. Proper sizing is one of the cornerstones of compressed air energy efficiency so if your factory layout has changed or you have added or removed equipment that uses compressed air, your system configuration could now be causing you to use more energy than required.

ELIMINATE LEAKS

Leaks in pipework cause the compressor to have to switch on and re-pressurise the receiver vessel even when no compressed air is being used. Large leaks can often be heard as a hissing sound – it can be useful to walk around the system and distribution pipework when the site is otherwise quiet – often when machines are switched off at the start or end of a shift.

You can buy or hire ultrasonic leak detector gadgets to pinpoint leaks but it's also possible to use soapy water or leak detector sprays.

Some sites that use a lot of compressed air carry out "no load tests" during shutdown periods as part of their regular site maintenance regime. The operative runs a short series of tests with the compressor running and is able to quantify the level of leakage in the distribution pipework.

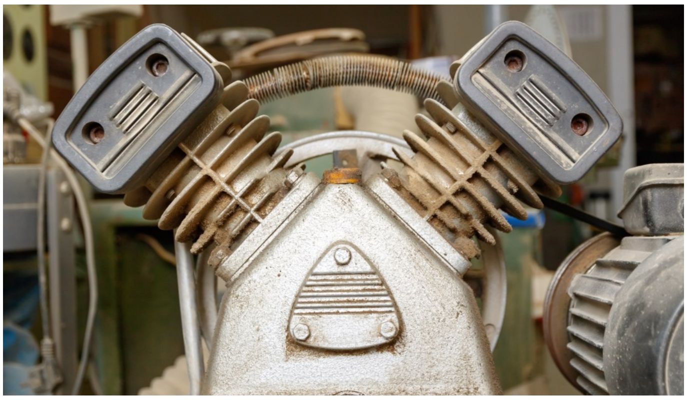


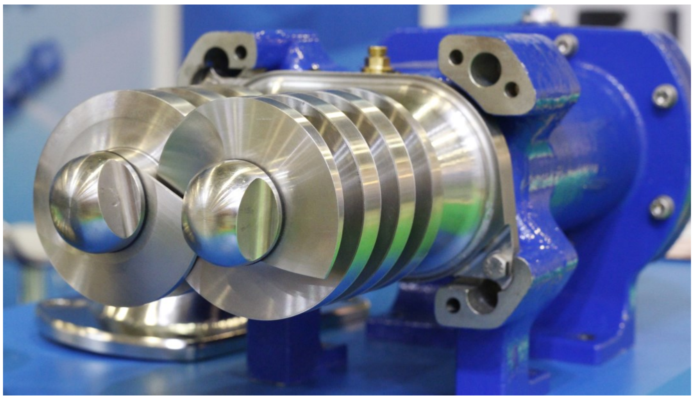
The graph above shows the electricity consumption of a small compressor from an automotive repair garage. The chart shows one week of operation – the compressor was used on Tuesday and again on the following Tuesday, but for the rest of the time it was not being used. The regular narrow spikes in electricity consumption are the result of leaks in the pipework which meant that the compressor had to regularly recharge the air-receiver pressure. In this example, a simple pipework repair was estimated to save over £1,200 per year in electricity.

DISTRIBUTION PIPEWORK

The sizing and layout of the pipework between the air receiver and the points of use can have an impact on the efficiency of the system. A compressed air services company can check how much pressure is lost between the air receiver and the final point of use of the air. If this pressure drop is too high, they may recommend bigger pipework or a ring main.

Compressor Types





RECIPROCATING PISTON TYPE

These compressors work by using a piston to compress the required air. They provide an intermittent flow of air, which is particularly useful during times of peak demands.

Reciprocating piston compressor types are good where high pressures are required, with small piston compressors being very efficient. However, they have high initial capital costs, and often require large amounts of maintenance.

SCREW TYPE

Screw type compressors consist of two rotors rotating in opposite directions, and drawing in air between them as they do so. As the air continues down the rotors, the volume is decreased, compressing the air.

Screw type compressors are particularly good at providing a constant supply of compressed air at a high flow rate. They are best suited for providing large volumes of compressed air, with leakage occurring for smaller rotor sizes.

SCROLL TYPE

Scroll type compressors make use of two scrolls, one rotating and one fixed. As the scrolls rotate, gas is pushed towards the centre of the scrolls, where the volume is reduced, compressing it. Scroll compressors are available in several different varieties, making them well suited for a large range of uses.

Scroll type compressors tend to be more efficient than piston compressors, and are very quiet to operate. As they only have a single moving part, they require low amounts of maintenance.

COMPRESSOR MOTORS AND DRIVES

Some compressors are fitted with sophisticated high efficiency motors which help reduce energy consumption further.

Compressors are also available with variable speed drives (VSDs) which can continuously adjust the motor speed in response to the compressed air load to save energy compared with running continuously at full speed.

DECERNA

Operating mode

Most air compressors have three distinct modes of operation to meet a site's compressed air demand:

Load Mode – When the compressor is running and is building up or maintaining the pressure in the air receiver it is said to be loaded.

Unload Mode – When the pressure in the air receiver reaches a particular setpoint, a valve in the air inlet to the compressor closes and the compressor does not produce any compressed air. The motor continues to run, however, to reduce the number of starts and stops it has to undergo as this can wear the motor out prematurely. The motor uses less electricity during the unload mode, but is still a source of considerable energy waste. A VSD compressor can virtually eliminate all operation in unload mode and therefore save a large proportion of its overall consumption.

Stop Mode – When the compressor has been in the unload mode for some time, it switches off completely to save more energy.

Electrical logging equipment can be used to see how much of the overall time a compressed air system is in the load / unload / stop modes. This information can then be used to assess the potential benefits of changing the size of the air receiver or switching to a different type of compressor.

Heat recovery

A large proportion of the electricity consumed by compressed air systems is wasted as heat. Some larger compressed air systems have heat recovery options which are useful if the site has a demand for low grade heat, such as hot water for an industrial process. Further details can be found in our Heat Recovery factsheet.

Conclusion

Despite their inefficiency, there are numerous opportunities to save energy and reduce your bills as well as your carbon footprint through the correct selection and design of compressed air equipment and regular maintenance. Decerna can provide further information and advice.

DECERNA

Delivering, unlocking & advancing the low-carbon economy

ABOUT US

Decerna provides a wide range of consultancy and development services, to ensure that the right decisions are made, to support our customers in the whole journey, from initial concept through to implementation of low carbon systems and infrastructure. Please get in touch to find out how we can help your organisation to de-carbonise.

www.decerna.co.uk

info@decerna.co.uk

+44 (0)1670 613 270

January 2023