

MANAGING THE 'FOURTH UTILITY'

Exploring the potential for significant energy savings through managing compressed air more efficiently – an update.



Fonterra's Te Rapa plant, where research has found energy required for compressed air could be significantly reduced.

Compressed air is often called the fourth utility, after electricity, gas and water. It's a valuable utility with many uses and it plays an important role in a number of industries.

An ongoing research project supported with funding from the Energy Efficiency and Conservation Authority (EECA) and the Foundation for Research, Science and Technology (FRST) is looking at compressed air usage within Fonterra.

This resource draws on that work.

It looks first at general issues involved in optimising a compressed air system and identifies some of the key steps businesses can take to create often quite easily-won savings. It then overviews the results of applying some of those principles at Fonterra's sites.

The Fonterra project has already achieved direct power savings of 29%, and the lead researcher believes there is potential to increase the savings to 40% or more.

Clearly, compressed air usage is an area with a lot of potential many businesses could benefit from.

Background

Most industrial compressed air systems are designed with spare capacity to insure against the significant costs of system failure. Additionally, many systems are built piecemeal, which can lead to safety margins being added to safety margins. These issues lead to compromises in an installation's energy efficiency.

Rising energy costs have put renewed focus on the considerable potential that exists to make savings in this area while still maintaining operational capacity.



Research team leaders John Herbert, Fonterra Te Rapa site services manager and James Neale, research fellow, University of Waikato Energy Research Group.

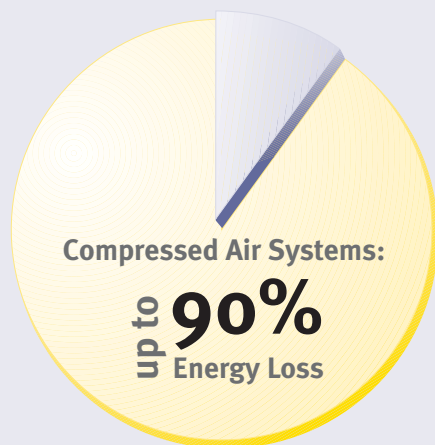


Improving energy choices

A very expensive utility

New Zealand businesses pay around \$70-100 million a year for electricity to produce the compressed air they need. They get a very poor energy return for their expenditure – only around 10% to 15%.

Losing 85% to 90% of the energy makes compressed air probably the most expensive utility per unit of work it delivers and a fruitful place to start looking for worthwhile energy savings.



A great deal can be done to improve the efficiency of compressed air processes.

Other good reasons for looking closely at your compressed air include:

- Leakages of 25% or more are common
- A small air leak – say 3mm – could cost \$700 a year*. A hole the size of an old 5 cent piece could cost \$30,800 a year*
- Every extra 0.13 bar of pressure required equates to a 1% increase in operating costs
- As pressures rise, so too does leakage
- Optimising a system and repairing leaks means pressures can be reduced and operate within a narrower band, reducing energy consumption
- Modern compressor control systems make it relatively easy to optimise a system for different situations.

* based on 7 bar pressure, operating 40 hours a week at 10c/kWh

Putting the focus on demand

Most expertise available in this area so far has been focused on the supply side.

The researchers note that it's pointless looking at supply before it's really known what happens with demand: supply can't be optimised without looking at demand or, in other words, where the compressed air is going.

A better way of auditing demand

As with any project to improve energy efficiency, auditing current usage of the resource is a critical and highly productive first step.

Standard auditing practice tends to focus on the plant room ie. the supply side. For their project the researchers developed a more inclusive systems approach that worked 'backwards', starting with end use then going back to supply.

They considered three auditing tool options – inline meters, insertion meters or external ultrasonic meters. They concluded the ultrasonic meters were the most practical, and these are forming the backbone of the new audit methodology they are developing.

MANAGING AIR LEAKS PRODUCES EASY WINS

The single largest energy saving opportunity in most compressor installations is managing air leaks effectively. A best practice target for air leaks is 10% of total air demand. Experience has shown that much higher losses, from 20% to 30% are very common. Other sites tested by the researchers have been suffering losses from 63% to as high as 89%.

Quantifying air leaks is quite straightforward using ultrasonic leak detection or direct measurement, ideally out of production hours.

LEAKS NEED ONGOING TESTING

Leaks can occur easily. Often, the act of simply repairing leaks, or doing routine maintenance, can create new ones. So the researchers have found that businesses need to implement an on-going air-leak management plan.

At Fonterra's Te Rapa site, for example, testing just before the ten week winter shutdown found around 350 air leaks, which were fixed. Further testing towards the end of the shutdown found 300 more. That was partly because there was less background noise so new, less severe leaks could be identified. However a number of leaks were found where compressed air machinery had been taken apart and reassembled.

Based on these results, the company's management now encourages its sites to test and re-test for compressed air leaks.

ELIMINATING 'ARTIFICIAL DEMAND'

Artificial demand includes any use of compressed air that is inappropriate or could be replaced with something more efficient.

Examples of artificial demand that can often be reduced include:

- Tank agitation
- Vacuum generation
- Dusters/blow down lances
- Powder transport.

REDUCING 'PEAK LOAD'

Peak load, or the maximum airflow required, is a key design specification for a large compressed air installation. Large demand fluctuations can result in peak loads – often required for quite brief periods – being significantly higher than average requirements. The net result can be that a system is over-designed and left running at an inefficient level for much of the time.

Large demand fluctuations can also lead to excessive pressure drops, causing critical components or processes to fail. Increasing total system pressure is the usual 'quick fix' solution.

A more efficient approach is to install additional air receivers (ie. storage capacity) adjacent to large air users to minimise the disruption to local pressure and reduce peak load sizes.

If peak load comes on for longer than a local receiver can handle, a dedicated local compressor should be considered.

REDUCING PRESSURE

Once leaks, artificial demand and peak loads have been addressed, total system pressure can be re-evaluated. Typically, pressures are set higher than need be and reductions of anywhere from 0.5 to 1.0 bar are feasible. Depending on the technology involved this can deliver direct power savings of from 4.5% to 9%.

Optimising the supply side

Businesses typically spend more time optimising the supply side of a system than the demand side. This can lead to bad decisions.

For example, a modern variable speed compressor may have the potential to save 30% to 35% in energy, but

the true savings will depend on the demand profile of the site and also on ensuring the new technology is properly integrated into the overall system.

However, a review of the supply side area can yield good results, particularly if it includes these issues:

- Compressor sizing and control
- Drier efficiency
- Maintenance practices
- New technologies.

COMPRESSOR SIZING AND CONTROL

The easiest and usually biggest savings come through correctly sizing and controlling the compressors.

Fixed and variable control machines both have optimum operating ranges. Outside these bands, there can be significant losses.

In systems using multiple compressors, the 'run order' can be arranged to keep individual machines operating as far as possible at optimum levels.

Sizing machines too conservatively can mean compressors will run only partially loaded.

DRIER EFFICIENCY

Correctly selecting and sizing driers (when used) affects the efficiency of the overall system. Over-drying air wastes energy. However, a faulty drier can cause excessive pressure drops, requiring the compressor to use more energy to compensate.

MAINTENANCE PRACTICES

Maintenance is probably more of an issue in smaller installations where less attention is paid to the system.

Regularly changing filters, oil separators and other components is often neglected to save money in the short term without regard to the hidden costs.

APPLYING NEW TECHNOLOGIES

Applying new technologies can often lead to savings. However many businesses don't get a true picture of the total potential for savings because they view new technologies in isolation. It's necessary to take a 'system approach' to ensure the correct technology is properly integrated into the existing system to achieve the best results.

One technology that could be of interest in many businesses involves recovering waste heat from the air compressor.

Delivers real savings

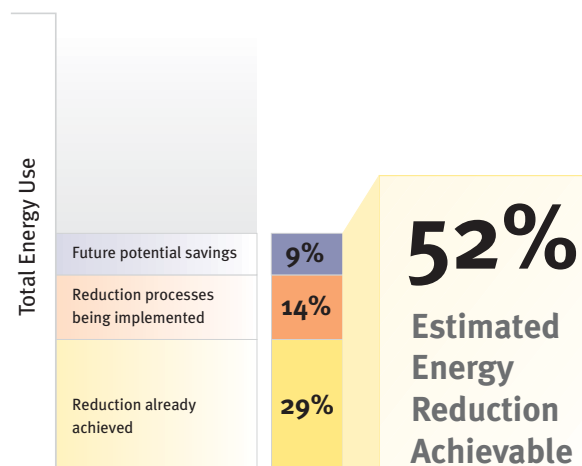
A thorough, methodical look at your compressed air installation can yield worthwhile savings, as the Fonterra case study has shown.

On its Te Rapa site for instance, a 29% reduction in power requirements has already been achieved. A further 14% is in the process of implementation, while future potential savings are estimated at 9%.

Savings achieved or in implementation at other sites range from 14% to 37%.

Across all sites, it's estimated there is potential to save 2 – 3 gigawatt hours per annum.

Fonterra's potential savings



At its Te Rapa site, Fonterra is achieving big savings already, with potential for more to come.

The project

The research project at Fonterra has been established to 'critically review ongoing energy audits of compressed air systems in each of the five large Fonterra sites' and to develop a generic spreadsheet-based benchmarking system for use at these sites. When complete, this will provide a useful tool to include in any national energy efficiency programme.

The research team is led by James Neale of the University of Waikato, with support from consultants the Energy Research Group. Aspects of the project are receiving funding from EECA and FRST.

Further developments

Later, the project will develop a process of computer modelling of a plant's compressed air installation. The model will encompass types of compressors, pipe sizes and layouts, valve types, positions and sizes, and buffer tank sizes and positions. It can then be used to calculate the impact of making changes to various elements in the model to evaluate the potential of energy-saving projects.

It will also allow 'actual' savings from improvements to be tested against theoretical savings, building confidence in the ability to calculate a rate of return.

Acknowledgements

This document brings together information from previously published material drawing on the experience of a number of industry players including Barry Sinclair of CompAir New Zealand Ltd., Ian Cherrie of Atlas Copco and Kelvin Blackwell of Demand Response.



Members of the combined Fonterra and Waikato University research team. From left; John Herbert, Fonterra Te Rapa site services manager; Jonas Hoffman-Vocke, research student; Chris Burrell, assistant engineer; James Neale, research fellow; Lance Wong, project engineer.