

EFFICIENT THERMAL SYSTEMS

Thermal systems (such as steam boilers, hot water heaters and thermal oil heaters) typically account for over 50% of energy use in a textiles manufacturing plant. The majority of this energy is often used in the Dye House, where a large amount of heat can be required during the dyeing process.

The energy and maintenance cost of a boiler over its life often far exceeds the upfront capital cost. It is therefore important to design and install the system correctly from the outset. Given the large amount of energy these systems use, small improvements in energy efficiency can often result in large energy savings.

This best practice guidance note provides some simple tips and real-world examples of how to design and use thermal systems more efficiently in a textiles plant.

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There are three key questions to ask when investigating a thermal system's efficiency;

1. Is your thermal energy being used efficiently?

Before reviewing how your thermal energy is being generated, assess your thermal energy use and whether it is actually required. Often, the largest energy savings can be achieved through thermal demand reductions with little to no capital cost involved.

2. Is your thermal energy being transported efficiently?

Once your thermal energy use has been assessed, you can look at its transportation and distribution. You should ensure that your supply pipes are adequately sized and well insulated to reduce transportation losses.

3. Are you generating thermal energy efficiently?

Once your demand and network initiatives have been addressed, you can investigate the efficient generation of thermal energy.

1. Eliminate unnecessary thermal energy use

Unnecessary thermal energy use can lead to higher demands and put strain on the network and supply of the thermal system, causing follow-on inefficiencies in the system.

If your facility's supply system is struggling to cope or your network is experiencing high pressure drops then your thermal energy use should be investigated before making any upgrades to the plant.

Operator training saves \$22,698 of natural gas per annum

A company that operated 24 hours per day had several shift workers operating the same piece of equipment. Through observations over several days, it was noted that each worker was operating the equipment slightly differently.

Simply by bringing all the operators together and sharing their knowledge, the equipment was able to be run at its optimal efficiency. This simple training session saved \$22,698 of natural gas per annum.

End use

When assessing demand savings, it is important to investigate how the thermal energy is being used. If the thermal energy is used for heating then both the temperature to which the process is heated and the insulation of the end use can be investigated.

Small decreases in the operating temperatures and improvements in insulation can provide significant thermal energy savings.

Steam leaks

Steam leaks and malfunctioning steam traps commonly result in a significant thermal system demand increase.

Steam leaks are often easily identified but usually ignored. Up to 20% of a facility's steam use can be through steam leaks, though this varies widely depending on the site's operating characteristics.

Steam traps

Failed steam traps are significantly more difficult to identify. There are many different types of steam traps, all of which will fail after some time. Often a steam trap will fail in the open position, letting large quantities of steam into the condensate lines. Periodic steam trap testing is an important part of any steam system's maintenance regime. Your boiler maintenance provider should be able to offer a steam trap testing service.

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Repairing steam leaks and replacing failed steam traps not only saves energy but also results in significant make-up water and treatment savings.

Condensate Return

If your facility does not already do so, you should consider the economics of condensate return.

Increasing the amount of condensate returned to the boiler can provide significant savings in both make-up water and treatment costs.

Heat recovery

Often, textiles sites are unable to directly reuse condensate, as the steam is directly injected to provide heat. In this case, grey-water heat recovery can provide significant thermal energy savings as well as providing a means to reduce the wastewater temperature before it is discharged.

Savings for condensate and grey-water heat recovery can be up to 10% of the system's total energy use

New Zealand textiles manufacturer saves 7% of the natural gas bill through grey-water heat recovery

A New Zealand textiles company was using large quantities of steam for heating in the dye house. The grey-water produced from the dye house was being discharged directly without cooling.

To meet consent requirements, the site needed to cool the grey water before discharging it. To accomplish this and to save energy it was decided to put in a grey-water heat recovery system. This system resulted in a total natural gas reduction of 7%, giving **savings of \$6,211 per annum.**

2. Reducing network losses

Once the thermal energy system's demand side has been addressed, the network losses can be investigated. Improving the condition of the distribution network can result in an improved quality of thermal energy supplied and may result in additional end-use efficiency gains.

Pipe design

When designing thermal system pipes, it is important to ensure that they will be adequately sized for any foreseeable growth in the facility. Undersized network pipes can increase pumping energy use, and in a steam system results in an increased pressure drop, increasing the rate of condensation.

It is important that the facility's thermal system pipes are correctly sized from the outset, as redesigning the system is often costly.

Insulation

On thermal networks, it is important that all hot sections are adequately insulated. For steam systems, insulation often has a payback period of less than 6 months, and hot water systems often have a payback period of less than 12 months. In some extreme cases where there is little or no insulation, heat loss over the distribution network can account for up to 40% of a site's total thermal energy use.

It is also important to insulate any thermal system return lines on a facility. As a rule of thumb, insulating any section with a temperature of above 40°C will have a payback period of 24 months or less in a facility which operates continuously.

Pipe insulation pays off quickly

A South Island dry cleaning company had a number of uninsulated areas on the steam and hot water networks. These uninsulated sections were causing the boiler to work harder in order to deliver the required thermal energy to the end users.

Although the site only operated between 5:00am and 4:30pm, the high temperatures involved and the high thermal energy cost meant that this initiative still had a payback period of less than 12 months.

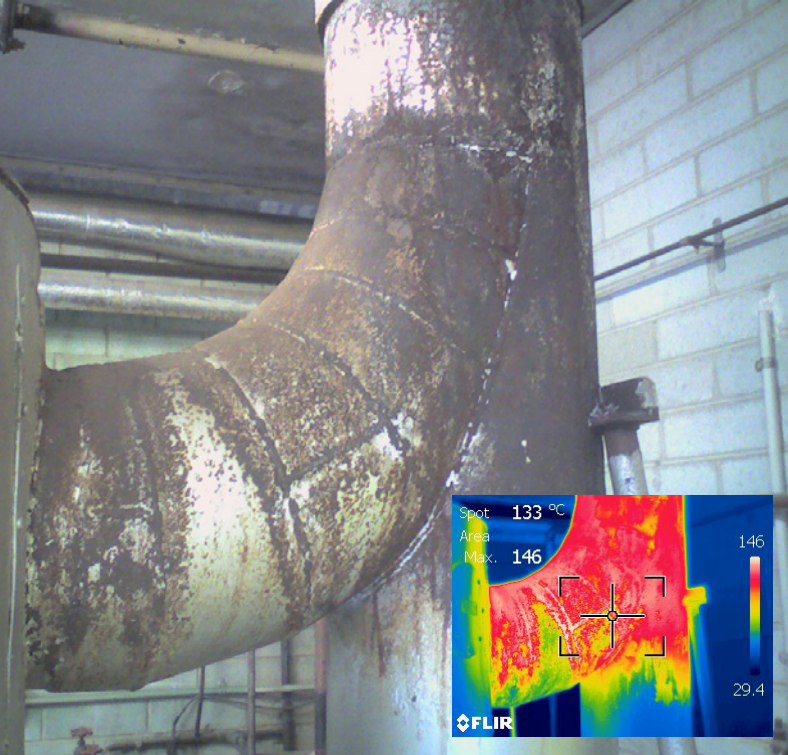
Through insulating these sections, the dry cleaners **saved \$3,681** in diesel costs per annum and reduced the risk of workers being scalded on hot surfaces.

Facilities often insulate pipes but leave valves and joints uninsulated to provide easy access. In these situations, removable thermal jackets can be custom-made to fit these sections. These jackets provide a good level of insulation as well as allowing easy access when necessary. The payback period for these jackets on steam systems is often less than 12 months.

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3. Generating thermal energy efficiently

Once all demand and network savings have been implemented, the efficiency of the supply side of the thermal network can be investigated.

Significant energy savings can usually be achieved through small improvements to control and boiler maintenance without the need to completely redesign the thermal system. These options should be investigated before significant changes to the thermal system are considered.

Combustion testing

Facilities commonly do not conduct regular combustion analysis testing. This testing ensures that the boiler is operating at its optimum efficiency through measuring the exhaust temperature and looking at the flue gas composition.

Periodic combustion efficiency testing is an important part of any boiler's maintenance regime. On boilers which have had not had any combustion efficiency carried out for a number of years, a 10% loss in efficiency is not uncommon.

For larger boiler installations, oxygen trim sensors should be considered. Trim sensors measure the exhaust gas composition and automatically adjust the air/fuel ratio to ensure the boiler is operating optimally.

Auckland manufacturing company saves \$36,448 per annum through boiler tuning alone

An Auckland-based manufacturing company used large quantities of process steam. To supply this, a 6.0MW boiler was run six days per week.

During an energy audit, it was identified that the boiler was operating lean, with an excess oxygen level of 11%. For a boiler this size, the optimum excess oxygen level is 2% - 4%.

Simply by re-tuning the boiler, the site saved 1,248,211kWh of natural gas per annum, reducing their gas bills by **\$36,448 a year**. This initiative also resulted in an annual CO2 emission reduction of 235 tonnes.

System controls

When the facility's final thermal demand has been calculated, the optimal boiler control methodology can be determined.

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On small installations, the high-fire / low-fire pressure setpoints can be adjusted to reduce the amount of on/off cycling, thereby reducing the amount of purge losses.

On large boiler installations, VSD (variable speed drives) and modulating burners should be considered. These burners provide optimal efficiencies over a wide range of operating conditions and can result in significant energy savings, particularly during times of low thermal load.

Steam vs. hot water

If your facility contains a lot of hot water generation which is currently supplied by a steam boiler, you may want to consider a dedicated hot water heater.

As hot water heaters generate hot water at a lower temperature than steam, it is possible to do so at a higher efficiency than a standard steam boiler. Although there should typically only be a 5% - 10% increase in efficiency of a hot water heater over a steam boiler, depending on the temperatures involved, this efficiency improvement can be significant on a large facility.

A small textiles company saves \$2,360 per annum through simple boiler control changes

A small South Island textiles company used a boiler which was significantly oversized for their operation. The boiler was rated at 593kW, while the site's average steam load was only 161kW.

The burner was a two-stage diesel unit which turned on and high-fired before turning down to low-fire and then off. The pressure setpoints meant that the burner was short cycling. This short cycling was causing a high energy loss due to the purge cycle, which blew cold air through the boiler for 15 seconds before the burner would start.

Simply by changing the pressure setpoints of the burner, the cycling rate of the burner was minimised by ensuring that the burner only low-fired during normal operation and the high-fire rate was only used during times of unusually high demand. This resulted in annual energy cost savings of \$2,360.

Hot water heater saves \$21,000 per year through improved efficiency

An Auckland manufacturing company has changed its plant significantly over a number of years. The result of this was that the large steam boiler was now only used to produce hot water for cleaning.

The site opted to install a dedicated hot water heater. Instead of producing steam at 175°C, the water heater produces water at 95°C. The result of this was a generation efficiency increase of just under 12%.

The new water heater cost \$55,000 and resulted in a natural gas energy use reduction of 479,000kWh, for annual energy cost savings of \$21,000. This gave the project a simple payback period of 2.6 years.

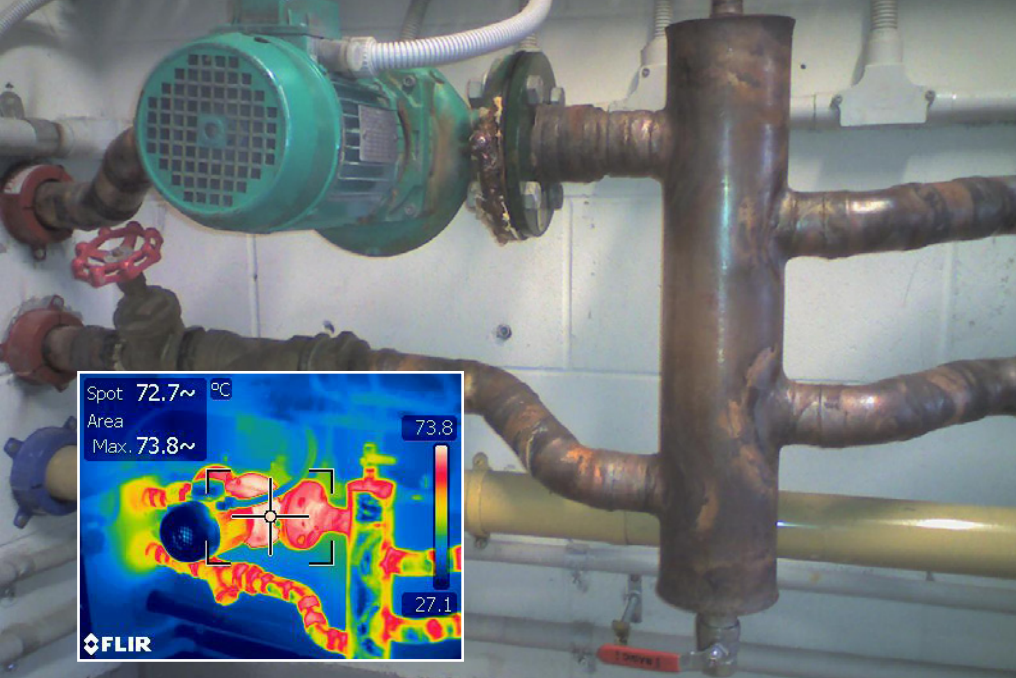
Economisers

On large installations, economisers should be considered for improving the efficiency of the steam system. An economiser is installed on the exhaust stack of a boiler, and water is passed through it from the deaerator tank before it enters the boiler.

An economiser increases the effective heat-exchange area, increasing the amount of energy transferred from the exhaust gas and lowering the exhaust temperature. As the economiser is located after the boiler feedwater pump, the feedwater is pressurised and it is possible to heat the feedwater to above 100°C without it flashing.

Economisers can improve boiler efficiencies by up to 10% and can have payback periods as low as 24 months on large installations. The economics of installing an economiser are often much better on a new installation than as a retrofit.





Textiles Energy Efficiency Programme

This information has been made available thanks to Textiles NZ and the Textile Care Federation working with EECA to deliver energy efficiency to New Zealand textiles companies.

Textiles NZ membership comes from four contributing sectors: textiles, carpet, footwear and apparel. Textiles NZ works with companies to build a sustainable industry that can successfully compete in the international marketplace.

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Economisers recover \$27,659 of waste heat as well as increasing steam generation capacity

A manufacturing company had two steam boilers, with one 4,000lb/h and one 2,500lb/h. Recent plant upgrades had resulted in an increase in steam use and more capacity was required.

Instead of installing a new boiler, it was decided to install economisers on the two existing boilers. The site went with two-stage condensing boilers which, despite being more expensive than the single-stage non-condensing alternative, provided more heat recovery and hence greater energy savings and an increased capacity.

The economisers gave an efficiency improvement of 9% as well as a significant capacity increase. The cost of these economisers was \$115,600, and they resulted in **annual energy cost savings of \$27,569**, giving a simple payback period of 4.2 years.

Energy sources

Assessing the type of thermal energy used can also provide significant cost savings, even if no actual energy-use reductions are achieved.

In the South Island in particular, where there is no reticulated natural gas supply, the cost of thermal energy can be significant. Instead of using thermal energy sources such as diesel, fuel oils or LPG, plant operators could consider wood-mass boilers or the use of recycled oil.

Although most of these alternative fuels require additional measures to use, such as increased maintenance and consenting costs, reductions of 50-75% in cost per unit of energy over diesel or LPG are common. For systems with high energy consumption that are currently using liquid fuels or LPG, these reduction figures can be used to make a quick estimate of the potential savings and determine if further investigation is warranted.

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