5 MINUTE GUIDE

How to improve boilers and steam efficiencies

This 5 Minute Guide examines boilers and their water usage. Boilers are a common major plant item, especially within manufacturing sectors. They use large quantities of energy and water to produce hot water and/or steam under pressure. Ensuring they are operating efficiently can deliver significant water, energy and money savings.

There are a few basic steps that can be taken to optimise the efficiency of boilers.

Steps to reduce the water use of boilers

Step 1: Stop Water Leaks

Check the boiler and pipe system for leaks as these are easily preventable losses. Significant water, energy and heat can be lost due to leaks in boiler and pipe systems. Checks should be done during shut down, maintenance activities and, where possible, on a monthly basis. Reviewing the company's water bills can also identify problems.

Check all valves and levels in the boiler and associated equipment to prevent overfill and overflow situations.

Monitor water flows in the boiler and pipe system as this is the easiest way to detect leaks. Armed with a baseline of the plant at peak performance (e.g. after shutdown maintenance) a mass balance will reveal any leaks immediately. This can be done by installing flow meters and or recording metered volumes on existing meters.

Step 2: Fit Pipe Lagging (Pipe Insulation)

Consider insulating any surface (pipe, flanges, valves etc.) hotter than 50°C as heat losses contribute directly to carbon emissions, energy use and steam lost to condensation.

Lagging or pipe insulation, when correctly applied, can significantly reduce thermal losses resulting in less energy, carbon emissions and water use as there is less steam lost to condensation. It is recommended that any surfaces (pipes, flanges, valves etc.) hotter than 50°C be insulated. Heat losses also increase ambient temperature and impact upon other equipment, especially cooling systems which have to work harder, and staff working conditions which become uncomfortable.

Lagging is relatively easy, low cost and has a reasonable return. Lagging is best done during shutdown. As an example, a typical uninsulated 100mm steam pipe will:

- lose approximately 21GJ/yr in natural gas (heating fuel)
- cost $300 per meter to insulate
- have a payback period of approximately 3 years for the insulation.

Step 3: Improve Feed Water Quality

Use high quality feed water (in this case low dissolved and undissolved solids). Clean water will mean less blowdown is required to prevent scale, fouling, corrosion and blockages. This means less wasted energy, less heat and less trade waste discharges. Low quality feed water can cause unreasonably quick build up of scale. Scale works as an insulator and reduces the effectiveness of the boiler's heat exchanger. This will be seen as an increase in flue gas temperature and will result in lower boiler efficiencies and therefore higher fuel usage, costs and carbon emissions.

Rainwater (which tends to be lower in salts), water softeners or appropriate chemical treatment can be used to improve water quality, reduce the rate at which scaling occurs and decrease blowdown losses. Demineralising and reverse osmosis plants are other options worth investigating.

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Step 4: Fix Steam Traps

Steam traps collect and vent the condensate from the piping system. When steam traps fail they will either stick open or shut, both of which degrade performance and increase fuel and water use.

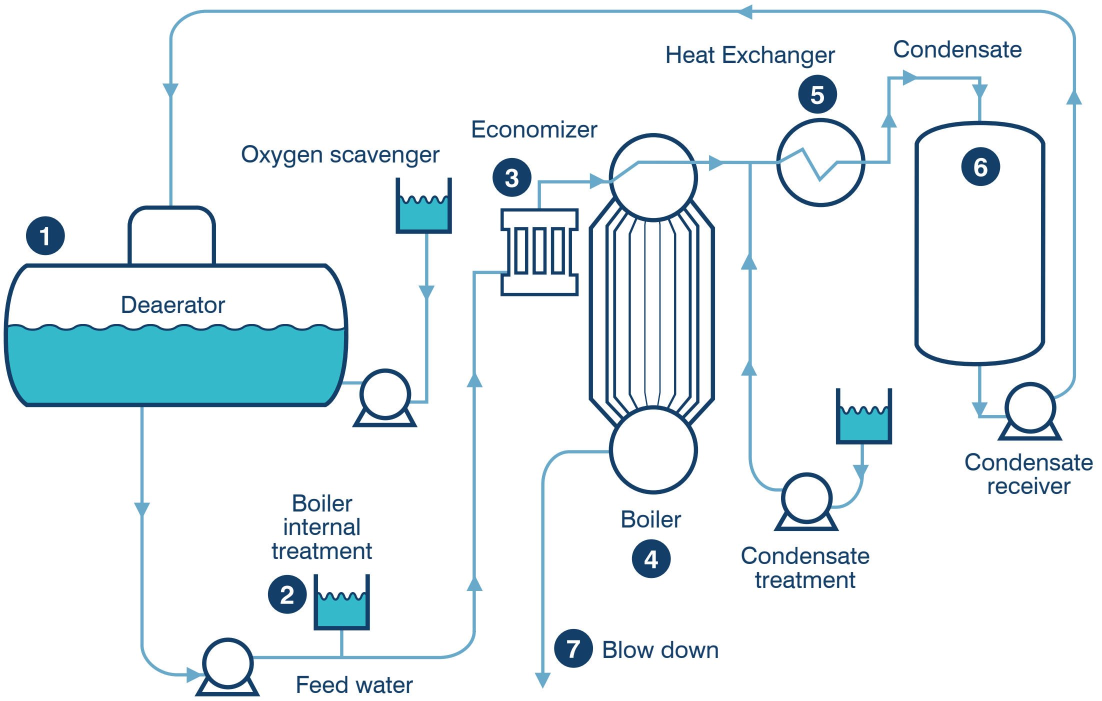
When a steam trap sticks open pressurised steam leaks out of the system and wastes a large amounts of water and energy, sometimes doubling consumption. When a steam trap sticks closed, the system can become water logged causing flow problems and degraded system performance.

Check and maintain steam traps to ensure correct function. Steam traps can be fitted with steam sensors to raise the alarm if stuck open or shut. An operational baseline is invaluable for monitoring plant performance.

As a rule of thumb there is:

- A 30-40% failure rate on systems that have never been maintained; and
- A system as such can cost thousands of dollars per year in water, chemical treatment, energy and trade waste costs.

Fig.1 Boiler Schematic



Typical boiler layout (Source Queensland Government, Boiler Efficiency – M5, ISBN 978–0–9775169–8–8)

Feed water is held in the **deaerator** ❶ tank to help remove dissolved air and is then **treated** ❷ before entering the **boiler** ❹. There are two types of boilers – **water tube** and **fire tube**. **Water tube boilers** heat water in tubes and the hot combustion gasses fill the space around these tubes. **Fire tube boilers** on the other hand have hot combustion gasses inside the tubes and water circulating around them. An **economiser** ❸ pre-heats feedwater using the flue gasses from the boiler's chimney. The water is further heated in the **boiler** ❹ to produce hot water and/or steam that can be used directly or sent to a **heat-exchanger** ❺. The **heat-exchanger** is used to heat air, oil, solvent or other products that must be kept dry. Any **condensate** ❻ (steam that has condensed) is captured and returned to the deaerator for reuse (since it's already clean). Because contaminants build up in the boiler water that can cause biological growth, corrosion and scale, a portion of the water is **blown down** ❼.

Step 5: Return and Reuse Condensate

Water condensate captured from steam traps should be routed back to the boiler. This water is already hot and demineralised and therefore requires less energy to boil than the feed water and requires no treatment, saving on fuel and chemical costs. This is generally an easy to install low cost pipe system. To retain as much heat as possible insulate condensate return lines.

Step 6: Reduce and Reuse Blowdown

The process of producing steam leaves contaminates (dissolved solids) in the boiler which can cause corrosion and scale. To prevent this, water is rejected by blowdown. The blowdown takes with it both water and heat, thereby reducing overall energy and water efficiency. By improving feed water quality (e.g. shandying with rainwater), monitoring conductivity and blowing down the minimum water required to maintain the maximum allowable conductivity, total blowdown can be considerably reduced.

Reducing blowdown reduces energy, carbon emissions, heat losses, water treatment costs and water consumption. It may be possible to process and reuse the blowdown water to further reduce costs. Blowdown can be minimised by automating the boiler blowdown for finer regulation of dissolved solids and hence a higher average value resulting in less wasted hot water. Where possible, the heat in the blowdown water should be reused, e.g. to preheat feed water and the water could be used in other areas such as cleaning.

Further savings exist in passing blowdown water through a flash boiler and returning the steam/demineralised water to the deaerator tank.

Step 7: Reuse Water

Blowdown water can be used for other purposes within the facility where the heat and pressure is useful and the application is not sensitive to the higher concentration of solids. For example, wash down, or certain stages of cleaning cycles may use this water (ensure chemical compatibility).

Checklist for improving boiler water efficiencies

- ✓ Conduct a baseline review of water and energy use for the boilers
- ✓ Monitor the flow of blowdown water and the conductivity to identify any anomalies
- ✓ Undertake a leak detection investigation for both steam and condensate. Fix leaks where possible
- ✓ Invest in lagging of steam pipes to reduce heat loss and condensation
- ✓ Increase condensate recovery where possible
- ✓ Look at reuse of boiler blowdown for preheating the intake, or reuse for things such as toilet flushing, 'wash down', Clean-in-Place (CIP) rinses or other purpose.
- ✓ Investigate capturing and reusing rainwater for use in boilers.

It is recommended that **any surfaces hotter than 50°C be insulated.**

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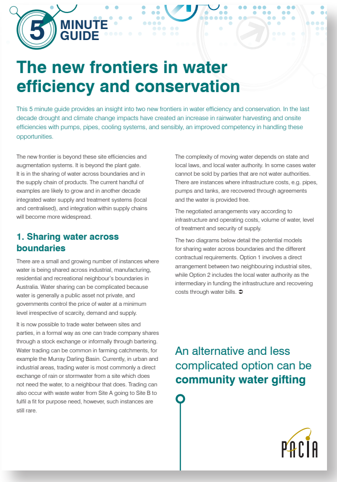
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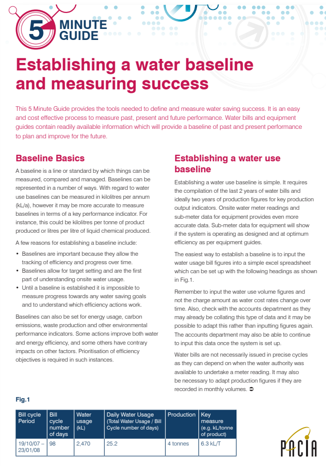
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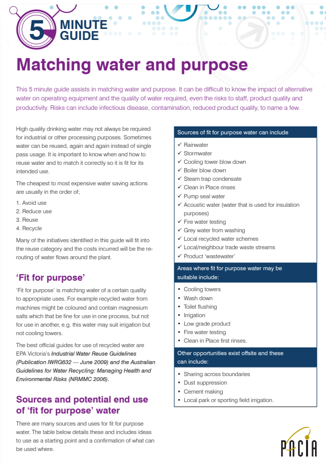
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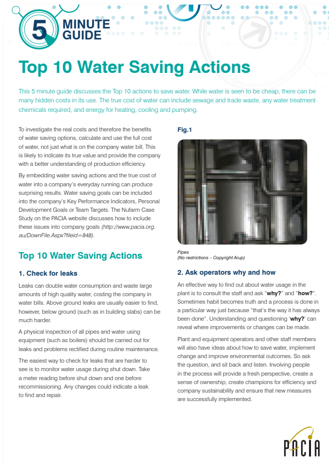
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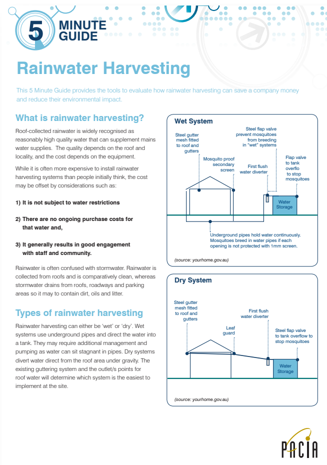
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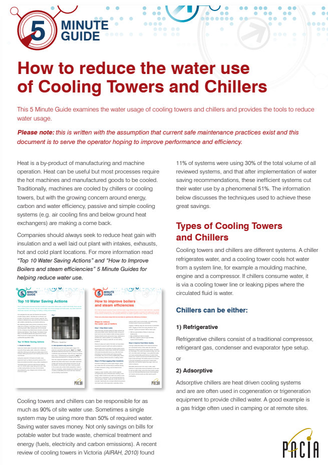
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