COOLING TOWER EFFICIENCY – F9

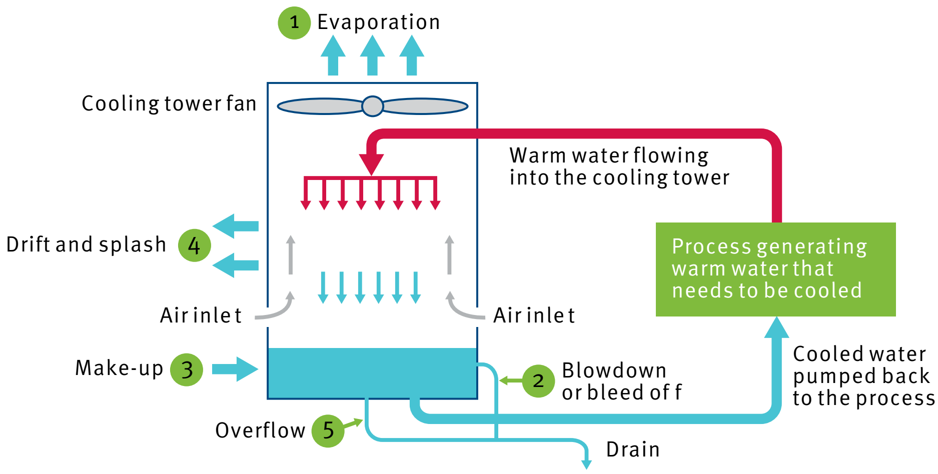
Energy eco-efficiency opportunities in Queensland Foundries

Chill your bill

Cooling water in foundries is used for operations such as mould sand reclamation, electric arc and induction furnaces, in shell mould and shell core machines, permanent moulds cooling and quenchers. Cooling towers produce cooler water through an evaporative process (described below).

Cooling tower operation can be one of the largest water and energy consuming activities for many foundry operators. Cooling towers can account for up to 60 per cent of a manufacturing site's water use.[1] Often the towers are managed by third party service providers.

This fact sheet provides a basic description of cooling towers to assist manufacturers in understanding how cooling towers operate. It also provides a list of opportunities that can help to save water, energy and money and reduce chemical use through more efficient operation. Discussing these opportunities with the service provider is a good way to start improving cooling tower efficiency.



As water is **evaporated (1)** in the cooling tower, salts and minerals remain in the circulating water. The build up of these contaminants can cause biological growth, corrosion and scale therefore these contaminants are removed through the **blowdown (2)** of the circulating water. **Make-up water (3)** is added to replace the lost blowdown water.

Additional water can also be lost as **splash or drift (4)** (water lost as droplets carried out of the cooling tower with exhaust air). Water can also be sent to drain through the **overflow (5)** pipe when the level of water in the tower basin rises above a predetermined level, or through overflow of the basin if the inlet valves are incorrectly set.

1 Brisbane City Council, June 2008, Water Sense: Creating Sustainable Solutions: Fact sheet 7: Cooling towers, www.brisbane.qld.gov.au/bccwr/lib199/watersense_fact_sheet_cooling_towers.pdf.

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Water Use

The hierarchy of opportunities approach can be used to identify and prioritise water efficiency opportunities

Hierarchy of opportunities

- Reduce water loss
- Reduce blowdown
- Alternative water supplies
- Reuse blowdown

Installing drift eliminators promotes air circulation and reduces drift losses.

Reduce water loss

Reducing water losses reduces the quantity of make-up water required for the system. Potential opportunities to reduce water loss include:

- fixing leaks
- reducing splash
- optimising overflow
- eliminating drift – drift losses should be maintained at less than 0.002% of cooling water circulation rate.[2] Repair or install new systems to achieve best practice.

Losses = (Quantity of make-up water/Cycle of concentration) – Quantity of blowdown

Reduce blowdown

Increase cycles of concentration

As water evaporates from cooling towers the contaminants, salts and minerals measured as total dissolved solids (TDS) that accumulate can cause biological growth, corrosion and scale resulting in tower damage, poor heat transfer and possibly the growth of harmful bacteria such as Legionella. The sources of contaminants include:

- salts and minerals already in the make-up water
- chemicals added to reduce corrosion, scale and biological growth
- pollutants entering the water during the evaporation phase from the surrounding air such as dust.

To reduce the build up of these contaminants, a portion of the water in the tower is bled off (blowdown). This water loss from the tower is then replaced with fresh incoming make-up water.

A conductivity probe or sensor in the tower basin initiates blowdown when the levels of dissolved solids exceed a set value. 'Cycles of concentration' (CoC) compare the level of dissolved solids in the tower's make-up water to the level of dissolved solids in the tower's bleed water.

$$\text{Cycles of Concentration (CoC)} = \frac{\text{Total dissolved solids in the make-up water}}{\text{Total dissolved solids in the bleed water}}$$

Increasing the number of CoC will reduce the volume of blowdown and consequently the volume of make-up water required by the tower. The maximum CoC for a tower will depend on the quality of the make-up water and the corrosion resistance of the tower's basin and condenser. CoC over 5 is considered to be efficient but this is not always achievable.

Scale forming ions such as calcium and magnesium can often be precipitated out (by water softeners) or kept in solution (by acids) through effective water treatment enabling the tower to operate at higher cycles of concentration.

2 AS/NZS 3666.2:2002: Air-handling and water systems of buildings – Microbial control: Part 2 Operation and maintenance, Standards Australia, 2002.

According to the Queensland Water Commission, a cooling tower is considered inefficient if:

- the system is operating at less than 5 CoC or 1850 mg/L TDS/2750 µS/cm conductivity (allowed only in documented instances of high-TDS make-up water); and/or
- system losses are greater than 8% of the make-up water.[3]

Use alternative water supplies

Alternative water supplies have the potential to reduce potable water requirements in cooling towers, through direct substitution and by reducing the cycles of concentration. Alternative water supply options include recycled water, process or rainwater.

Note that health risks need to be considered when assessing the viability of alternate water supplies. Additional water treatment may also be required depending on the quality of water available.

Reuse blowdown

Potential opportunities to reuse cooling tower blowdown include:

- toilet and urinal flushing (treatment may be required)
- landscape irrigation (may require dilution with potable or rainwater due to salt content or treatment)
- cleaning (health risk assessment may be required and the impacts of corrosion should be considered).

The Guide to Legionella Control in Cooling Water Systems contains a risk management and water quality standard for the reuse of bleed/blowdown water from cooling towers. This guide is available from the Queensland Department of Justice and Attorney-General website **www.deir.qld.gov.au/workplace/resources/pdfs/legionellaguide.pdf**

Water treatment

Water treatment is required in cooling towers to prevent corrosion of the system, build up of scale and for microbiological control. Typically this is carried out through one of the following:

- direct chemical dosing (to prevent scale and prohibit corrosion)
- acid dosing (to control pH and scale)
- ozone dosing (or other microbial treatment to prevent microbial growth)
- pre-treatment of make-up water (e.g. water softening, reverse osmosis)
- side stream filtration (to prevent solid build up)
- cover exposed areas of cooling towers (to reduce algal growth).[4]

For more information visit: JEA, Best Management Practice and Guidance Manual for Cooling Towers, **www.jea.com/about/pub/downloads/pollutionprev/CoolingTowerBMP.pdf**

Energy

Variable speed drive

Installing a variable speed drive on the electric motor of cooling tower fans can reduce drift and save energy.

Installing a variable speed drive on the fan to reduce drift and save energy.

VARIABLE SPEED DRIVES SAVINGS

Tyco Water in Currumbin is a ductile iron foundry, machining, coating and assembly components for large diameter pipelines. The site installed variable speed drives on its electric induction furnace cooling towers so the fan speed would automatically adjust according to the temperature of the water rather than operating at full speed continually. The site estimates the initiative has reduced the fans power consumption by 15%.

3 Queensland Water Commission, Cooling Tower Guideline WG-2, **www.qwc.qld.gov.au**
4 JEA, August 2005, Best Management Practice and Guidance Manual for Cooling Towers, **www.jea.com/about/pub/downloads/pollutionprev/CoolingTowerBMP.pdf**

Control sequencing

Reconfiguring or installing controls to shut down one or more towers to match demand is a proven strategy to achieve efficiency savings.

Reduce the load

Savings can be made by not cooling excessively or un-necessarily. For example, the load on air conditioning cooling towers can be reduced by setting thermostats at 25°C in summer and 20°C in winter. Simply raising the air conditioning set point temperature by 3°C will reduce water consumed in the cooling tower by approximately 15 per cent.[5]

Maintenance and optimisation

Appropriate maintenance and optimisation of cooling tower systems can increase the longevity of the systems.

Check the make-up ball float and valve are performing at the optium level to reduce unnecessary blow down.

Regular maintenance

According to the Australian standard for air handling and water systems,[6] cooling water systems and their water treatment systems should be inspected on a monthly basis and cleaned at least every six months. Each month the drainage system should also be inspected, operated and flushed. Maintenance should include:

- Checking
  - for any damage or leaks from seals, pumps, tower casing, air intake or exhaust ducts
  - make-up ball float and valve to ensure optimum performance and adjust if necessary
  - drift eliminators are promoting optimum air circulation and are in good working order
  - fill media within the tower is in good condition for optimum water cooling
  - water distribution feed system is clean and maintains even, consistent flow across the cooling system (this includes across multiple towers).
- Servicing and cleaning
  - conductivity probe to reduce unnecessary blowdown and recalibrate if necessary
  - blowdown line to avoid fouling
  - tower and fill material according to manufacturers specifications.

Metering and monitoring

It is good practice to:

- install flow meters on both the make-up (inlet) and blowdown (outlet) lines and monitor weekly to enable normal patterns of consumption to be established and abnormalities to be quickly identified (usually a good indication of losses in the system).
- install a conductivity probe on the make-up and bleed lines and monitor fortnightly.
- ensure appropriate procedures and actions are in place if monitoring picks up abnormal operating conditions.
- connect metering systems to a Building Management System (BMS) to enable continuous monitoring and alert systems for abnormal circumstances.
- check for any leaks or faults while reading the meters.
- know what chemicals are being used in the cooling tower and their purpose.

Many of these practices are mandatory for cooling tower operators within the South East Queensland region. Operators with a Water Efficiency Management Plan (WEMP) for their cooling towers should refer to the requirements specified in the WEMP guidelines.[7]

5 Brisbane City Council, June 2008, Water Sense: Cooling towers.
6 AS3666.2:2002: Air-handling and water systems of buildings – Microbial control: Part 2 Operation and maintenance.
7 Queensland Water Commission, WEMP Guidelines WG-1 Water Efficiency Management Plan, **www.qwc.qld.gov.au**

Service providers

Cooling tower service providers should understand that water efficiency is a priority.
This can be achieved through:

- performance-based contracts related to reducing water consumption while still keeping scale, corrosion and fouling at an acceptable level
- occasional independent testing to verify the performance of the cooling tower and provide a second opinion on the operation of the system
- specifying all proposed treatment regimes to include water and wastewater savings/costs as well as chemical costs
- understanding the cooling tower system and having the service provider explain the purpose of the chemicals in use and any adjustments made to the system
- Requiring a report to be provided after each service provider visit and analysing the test results.

This series of fact sheets provides examples and suggestions to the modern foundry operator on how to achieve both economic and environmental benefits from eco-efficiency. Visit the project website **www.ecoefficiency.com.au** for more ideas and case studies.

ISBN 978–0–9775169–9–5

The eco-efficiency for the Queensland manufacturers project is an initiative of the Department of Employment, Economic Development and Innovation and the Department of Environment and Resource Management with technical information provided by UniQuest through the Working Group for Cleaner Production. For further information visit the project website www.ecoefficiency.com.au

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