COOLING TOWER EFFICIENCY – U2

Eco-efficiency resources for the food processing industry

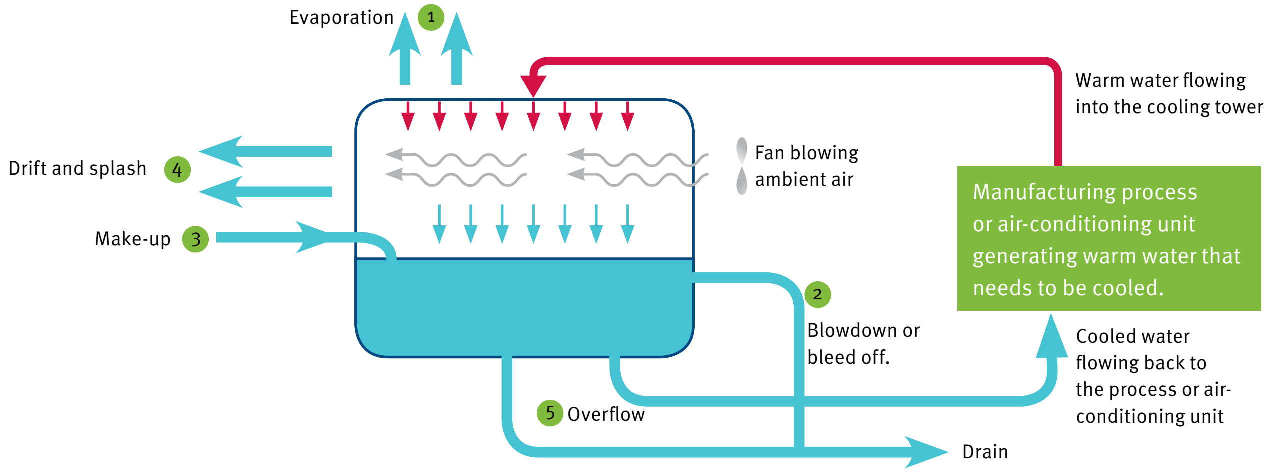
Cool savings

Many food processors operate cooling towers to meet the cooling needs of the factory. Cooling towers supply cold water through an evaporative process (described below). This cold water is then used to quickly remove heat from areas such as:

- hot refrigerant gas from the freezers and refrigerators (refer to *Refrigeration efficiency (U5)* fact sheet for more information on refrigerators)
- hot gas from the air conditioning units used to regulate the temperature within the factory
- hot process equipment and contents such as kettles
- products immediately after packaging such as hot products packaged in cans.

Cooling tower operation is one of the largest water and energy consuming activities within many food processing factories. Often the towers are managed by third-party service providers without question by food processors. This fact sheet provides a basic description of cooling towers to assist food processors in understanding how cooling towers operate. It also provides a list of opportunities that can help food processors to save water, energy and money through more efficient operation. Discussing these opportunities with the service provider is a good way to start improving cooling tower efficiency.

Note: It is extremely important that any changes are carried out in consultation with the cooling tower service provider.



1. As pure water is evaporated off in the cooling tower, salts and minerals are left in the circulating water. These contaminants can cause biological growth, corrosion and scale build up. Therefore these contaminants are removed through the 2. blowdown of the circulating water. To replace the lost blowdown water 3. makeup water is added.

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

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Reduce blowdown losses

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 makeup 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 build up of these dissolved solids, a portion of the water in the tower is bled off (blowdown). This water loss from the tower is then replaced with fresh incoming makeup water.

A conductivity probe 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 makeup water to the level of dissolved solids in the tower's bleed water.

$$\text{Cycles of Concentration} = \frac{\text{Total dissolved solids in the makeup water}}{\text{Total dissolved solids in the bleed water}}$$

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 five are considered to be efficient but are not always achievable.

INCREASING CYCLES OF CONCENTRATIONS SAVES WATER

Prepared Foods, a supplier of pre-prepared foods and value-added products, increased the CoC on its cooling tower that serviced a large freezer storage area and the site's blast freezer (used for the initial cooling of products) as part the Water Efficiency Management Plan. By increasing the cycles from 2.6 to five the company was able to save 163 kL annually. (Prepared Foods is an ecoBiz participant.)

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

Reuse blowdown

Blowdown water can be reused for other uses around the plant such as cleaning or for toilet flushing, provided it is of sufficient quality and any chemicals, salts and minerals in the blowdown water are compatible with equipment and existing pipework. Table 1 provides an example of corrosion rates for various metals typically used within cooling tower systems.

Table 1: Example of corrosion rates[1]

Metal	Corrosion rate (1 MPY* = 25 microns/yr)
Stainless steel	< 1 MPY
Mild steel	< 3 MPY
Copper alloys	< 0.2 MPY

*MPY – mils (thousandths of an inch) per year penetration

A risk assessment of the intended end use of the blowdown water and also the management of the cooling tower as a whole should be undertaken.

1 Sydney Water Best Practice Guidelines for Cooling Towers in Commercial Buildings, www.sydneywater.com.au/Publications/FactSheets/SavingWaterBestPracticeGuidelinesCoolingTowers.pdf

Accurate conductivity probes

Conductivity probes which are clean and calibrated to the manufacturer's specifications prevent damage to the tower and excessive blowdown.

Alternative water sources such as rainwater, condensate, recycled water, process water and bore water can be substituted for mains water where appropriate.

COOLING TOWER SAVINGS

A brewery, Foster's Australia, uses recycled water treated by reverse osmosis (RO) in its cooling towers, saving $50,000 annually. This water use allows the cooling towers to be run at between 10 and 12 CoC (five CoCs is considered efficient). Chemical use has also been reduced by more than $300,000 annually due to the high quality of the RO water.

WATER SAVINGS IN COOLING TOWER

SnapFresh a prepared meal processor installed three 22,000 L rainwater tanks to supplement makeup water to its cooling towers. By utilising the site's large roof area the company was able to collect 700 kL in the first quarter of 2008, saving almost $1,000 in just three months.

SnapFresh also found its air conditioning unit was producing 3,000–4,000 L of condensate per day. This was captured and put into the cooling towers. As the water quality was close to distilled water with a lower TDS level than mains water, it also allowed a reduction in chemical use. The system cost $20,000 to install but saves approximately $100,000 per year in water and chemical costs giving a payback period of less than three months.

Addition of chemicals such as biocides, acids and alkalis to the make up water contributes to the TDS levels in the water. These chemicals are used to control scale, corrosion and biological growth which if not prevented have the potential to damage the system and produce health risks from the growth of harmful bacteria such as *Legionella*. Alternatives to chemicals are available such as UV radiation and ozone which kill bacteria, and hydrocavitation which can reduce or even remove the need for chemical treatment. Fact sheets *Cleaning and sanitising options (W6)* and *Other treatment options (W9)* provide more information on alternatives to chemical addition, including a case study on the use of hydrocavitation in a cooling tower.

Side-stream filtration with a rapid sand filter or a high-efficiency cartridge, draws water from the basin and filters out sediment before returning the filtered water back to the tower. These systems are particularly useful if fine dirt, dust, smoke and organic particles in the atmosphere collect in the water.

Reduce water losses

Leaks

Regular monitoring and repair of leaks in the tower casing, basins, connections, pump gland seals, air intake or exhaust ducts is an essential first step for reducing water loss.

Splashing

Splashing from the tower can be minimised by checking that:

- the water flow rates or fan speeds are not too high
- windy conditions are not causing splashing (consider anti-splash louvers or wind beaks).

Drift

Drift from the towers can be reduced by:

- installing drift eliminators
- repairing damaged drift eliminators.

Overflow

Unnecessary overflow can be prevented by checking that:

- the make-up ball float is not too high, allowing water to flow into the overflow drain
- the water level in one basin is not higher than any connected basins as the water will flow to the lowest basin when the pump is turned off. Adjust the ball float if necessary.
- most of the tower's piping is below the tower so when the pump is turned off it does not flow into the basin and overflow
- the overflow pipe is not leaking
- the fill pipe has not been left on after cleaning.

Reduce energy consumption

Variable speed drive

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

Air chillers

Replacing water cooling towers with air cooled chillers saves water, maintenance and chemicals. However possible additional energy costs should be factored into a facilities' decision to take this course of action.

REPLACEMENT OF COOLING TOWERS WITH AIR CHILLERS

Prepared Foods, a supplier of pre-prepared foods and value-added products, has replaced two of its energy intensive cooling towers (that provide cooling for the condensers of two large freezers covering 696m^2) with energy efficient air-cooled condensers. The new condensers will save the site around 3.19kL a day in potable water.

When water savings, water treatment and power costs were considered, less the running costs of the new condensers, the site estimates it will save around $7,200 annually. (Prepared Foods is an ecoBiz participant.)

Control sequencing

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

RESPONDING TO LOAD SAVES MONEY

Australian Country Choice (ACC), an integrated meat processor, replaced inefficient cooling towers with more efficient models. The towers were set up to allow each one to be turned on and off individually depending on load on the plant. A base load is maintained but towers can be turned off at night or in winter when the load is not as high. This system is currently manually operated but ACC have considered control wiring the cooling towers to allow electronic monitoring and control. This new method of operation saves approximately $1,000 per year.

Reduce the load

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 temperature by 3°C will reduce water consumed in the cooling tower by approximately 15 per cent.[2]

2 Brisbane Water, 2007, Water Sense Factsheet: Cooling Towers, www.brisbane.qld.gov.au/bccwr/lib199/cooling_towers_factsheet.pdf

Improved maintenance and operation

On site monitoring and performance contracts with cooling tower service providers

Staff responsible for the maintenance and operation of the cooling tower should:

- read water flow meters on both the makeup and blowdown lines weekly to enable normal patterns of consumption to be established and abnormalities quickly identified (usually a good indication of losses in the system)
- measure the conductivity of the makeup and bleed lines fortnightly using a conductivity probe (around $150). Probes are also available that measure temperature at the same time.
- check for any leaks or faults while reading the meters
- be provided with a report after each service provider visit and analyse the tests results
- know what chemicals are being used in the cooling tower and their purpose.

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.

This series of fact sheets provides examples and suggestions to the modern food processor 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.

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