

Sound

- Acoustics considered part of a sustainable environment
- Many options for sound control for heat rejection equipment

First option to consider:

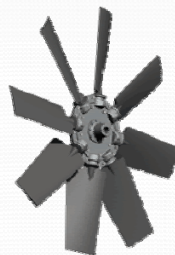
Oversize and slow down

Saves energy too!



Sound

- Variable speed drive on fans
 - Smooth starts and stops
 - No abrupt speed changes
 - Other benefits:
 - Saves energy
 - Closer temperature control
 - Reduced maintenance



Sound

- Unit design
 - Centrifugal
 - Axial
- Note that axial designs are about 50% of the fan kW as compared to an equivalent tonnage centrifugal model



Sound

- Layout
 - Face quiet sides towards noise sensitive areas where possible



**Counterflow design with
four sided air inlet**



**Crossflow design with
double sided air inlet**

Sound

- Watch out for water noise, especially on counterflow
 - Becomes predominate sound when tower equipped with VFD



Counterflow design



Water Silencers for Basin

Sound

- Use higher solidity axial fans
 - More blades
 - Wider chord blades
 - Slower speed to move the same air
- Often can achieve sound levels of centrifugal designs



Sound

- Consider attenuation
 - Lowers sound levels but comes with a performance penalty ranging from 2% to 5% or more



Water Use



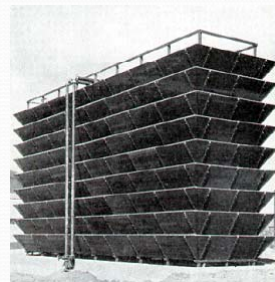
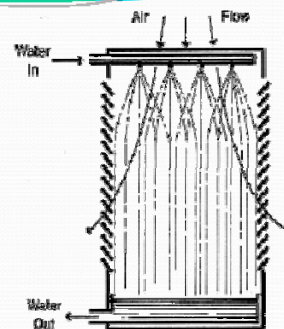
Water Use

- Once through systems were once the norm
- Cooling towers were developed as the first water saving devices to recycle water



Water Use

- Early tower designs mimicked nature



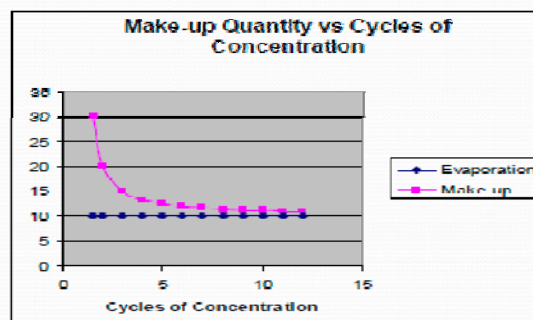
Water Use

- Water required by the cooling tower
 - Evaporation
 - Bleed to maintain water quality
 - Drift
 - Actually not a loss, but part of the bleed
- Total water use is typically about 5% of the water flow rate



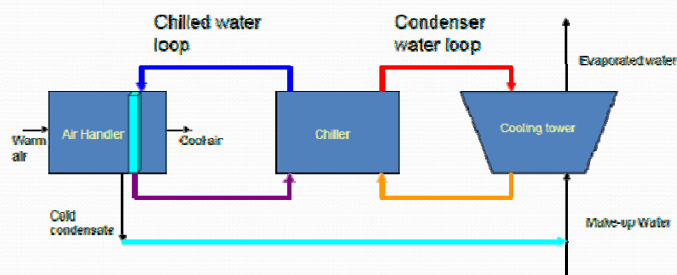
Water Use

- Operate tower at proper cycles of concentration (COC)
 - Diminishing water savings beyond 4 or 5 cycles
 - The higher the COC, the greater the risk in terms of scaling and corrosion



Water Use

- Consider alternative water sources such as:
 - Reclaimed water
 - Condensate collection
 - Recycled blowdown (RO)
- Critical to provide proper treatment and monitoring



Water Use

- Wide range of material of construction options available to handle higher COC as well as alternate water sources



Water Use

- Water saving heat rejection designs
 - Combine wet and dry heat transfer



Total Cost of Ownership



Purchasing Considerations



Lowest Total Cost of Ownership
=
Lowest Environmental Impact

TCO

- Sum of all costs over the life of a system
 - Acquisition
 - Operating
 - Replacement
 - Upgrades
 - Decommissioning
 - Environmental



TCO

- TCO is useful to compare alternatives
 - One cooling system versus another
 - Choice between equipment types
- Many costs are the same between two alternatives so these drop out of the analysis
- TCO tools are available to assist in this analysis



TCO

- Purchase price
- Electricity
- Water & water treatment
- Maintenance
- Replacement
- Carbon Tax
- Refrigerant GWP

Condenser Life Cycle Cost - Input Sheet

Version: 1.0.0 (2011-09-13)

Author: [Name] (Date: 2011-09-13)

Project: [Name]

Location: [Name]

Design DBT: 37.5 °C

Design WBGT: 25.5 °C

OTI Correction Factor: 1.25

Design Condensing Temp: 35 °C

Condenser Relief ST: 0 °C

Condenser Load TON: 100

Refrigerant: R134a

Refrigerant GWP: 1300

Refrigerant Cost: 25.00 \$/kg

Electricity Unit Cost \$/kWh: 0.20

Water Cost \$/m³: 0.00

Carbon Cost \$/tonne CO₂: 13.00

Interest Rate: 7.75% p.a.

Inflation Rate: 3.50% p.a.

Equipment Life: 15.0 yrs

Cycles of Cost: 10.0

Message Bar

Equipment Input Data

Type of Condenser	Select	Model	No. of Units	Total KW Capacity	Initial Capital Outlay	Annual Maintenance/Year
Air Cooled	<input checked="" type="checkbox"/> Air Cooled	100-100	1	100.0 KW	100,000 AUD	10,000 AUD
Water Cooled	<input type="checkbox"/> Water Cooled	100-100	1	100.0 KW	100,000 AUD	10,000 AUD
Hybrid	<input type="checkbox"/> Hybrid	100-100	1	100.0 KW	100,000 AUD	10,000 AUD
Evaporative	<input type="checkbox"/> Evaporative	100-100	1	100.0 KW	100,000 AUD	10,000 AUD

Supplementary Input Data

Design Approach: [Name]

Water Treatment Cost/Year: 11,500.00 AUD

Air Cooled Condenser: [Name]

Hybrid & Evaporative: [Name]

Calculate

TCO

- Other factors to consider:
 - Cycles of concentration
 - Inflation rate
 - Equipment lifetimes
 - Load profile

Condenser Life Cycle Cost - Input Sheet

Assess the different condenser types, technologies and capacities.

Global Input Data

Assessment Location Wellhouse VIC
 Design DBT 37.5 °C
 Design WBST 25.5 °C
 City Elevation Factor 7.32 kg/kWh

Condensate Loads TWh/yr
 Summer (Peak) Load 855 MW
 Winter (Base) Load 290 MW

Utility Costs
 Electricity Unit Cost \$/kWh 0.20
 Water Cost \$/kWh 0.20
 Carbon Cost \$/tonne CO₂ 25.00

ACC Analysis (NPV)
 Interest Rate 3.75%
 Inflation Rate 2.50%
 Equipment Life 25.0 yrs
 Cycles of Use 88.8

Design Conditions
 Design Condensing Temp 35 °C
 Condenser Relief ST 7 °C

Refrigerant R134a
 Refrigerant GWP 1300
 Refrigerant Cost 25.00 \$/kg

Message Bar

Equipment Input Data

Type of Condenser	Select	Model	No. of Units	Total PCR Capacity	Initial Capital Outlay	Annual Maintenance/yr
Adiabatic	<input checked="" type="checkbox"/> KTC	HTB 0736	3	615.0 MW	\$60,000 AUD	\$5,000 AUD
Air Cooled	<input type="checkbox"/> Stream-cool	HTB 0736	2	646.2 MW	\$70,000 AUD	\$700 AUD
Hybrid	<input type="checkbox"/> HWC	HWC 111	1	654.8 MW	\$40,000 AUD	\$1,000 AUD
Evaporative	<input type="checkbox"/> CW	CW 147	1	676.7 MW	\$40,000 AUD	\$1,000 AUD
	<input type="checkbox"/> HWC	HWC 110	3	646.2 MW	\$42,000 AUD	\$1,000 AUD

Supplementary Input Data

SO₂ Adiabatic Chloride SPPT 7 °C
 Air Cooled Condenser Design Approach 7 °C
 Hybrid & Evaporative Water Treatment Cost/yr \$1,500.00 AUD
 ACC Fee Control \$50

Estimate
 \$635,000

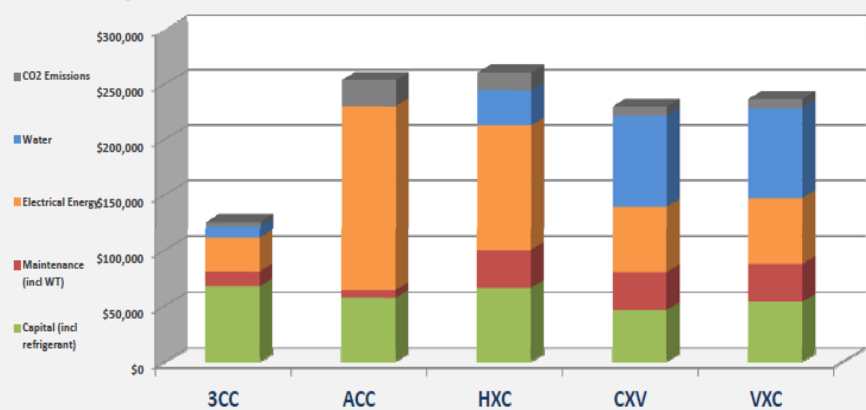
TCO

- Example:
 - Compare TCO of a air cooled condenser, adiabatic condenser, evaporative condenser, and hybrid wet / dry condenser



TCO

Total Life Cycle Costs [in NPV AUD]



Sustainability in Heat
Rejection

Thank You!