Chapter 12

Swimming Pools

12.1 Introduction

Councils, leisure and fitness centres, hotels and most motels have swimming pools.

Swimming pool water is an expensive commodity given the fact that a large body of water needs to be continually pumped, treated, filtered and backwashed and then heated to temperatures 26°C–30°C (79°F–86°F). In indoor pools the air needs to be ventilated. For this reason swimming pools consume two to three as much energy as an air-conditioned office building per square area. Table 12.1 shows the typical average energy use in sports centres with pools and dry sports centres in the UK [1].

If the values in Table 12.1 are compared against a typical air-conditioned office building in the UK, an office building consumes uses 226 kW/m^2 and a typical swimming pool uses 545–745 kW/m^2 of energy. It becomes evident the energy consumption of swimming pools is two to three times per square metre. Twenty-five per cent of the energy is used to heat pools to maintain these temperatures and another 53% of energy is used for space heating in indoor pools [1]. Therefore minimising water usage results in minimising energy usage and costs.

Figure 12.1 shows the typical breakdown of water usage in large public swimming pools. As the breakdown shows, retrofitting showerheads and minimising leakage will have a significant effect on reducing water use. Sydney Water data indicates that 33% of the water usage can be reduced by instituting good management practices [2].

12.1.1 Swimming Pool Benchmarks

Typical water usage for swimming pools in Sydney is around 70 L/visitor/day. This can be reduced to 40 L/visitor/day [2]. Table 12.2 gives the benchmarks for public swimming pools.

Table 12.1 Typical annual energy use (kWh/m²) [1]

	Sports centre with pool	
Good	Fair	Poor
< 510	510–745	> 745
	Dry sports centre	
Good	Fair	Poor
< 290	290–410	> 410

Courtesy of Energy Efficiency Best Practice Programme. Good Practice Guide 219 – *Energy Efficiency in Swimming Pools – for Centre Managers and Operators*. September 1997.

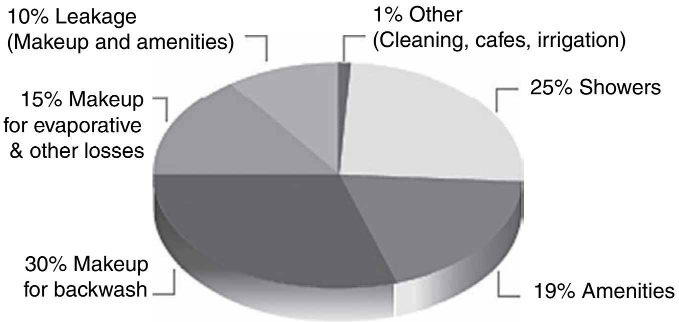


Figure 12.1 Typical water usage breakdown in public swimming pools

Courtesy of Sydney Water. *Saving Water in Community Swimming Pools or Leisure Centres*. March 2005.

Table 12.2 Swimming pool benchmarks

Number of visitors	Benchmark
0–500	60 L/visitor/day
> 500	40 L/visitor/day

Courtesy of Sydney Water. *Saving Water in Community Swimming Pools or Leisure Centres*. March 2005.

12.2 Water Conservation Opportunities

Water conservation opportunities for swimming pools consist of:

- reducing leakage
- installing water-efficient taps, showerheads and toilets
- reducing backwash frequency and time
- reducing pool evaporation.

These are discussed below.

12.2.1 Reducing Leakage

Hidden leaks are common in swimming pools. Leakage from cracks in tiles and more frequently from fixtures such as broken ball valves can waste a lot of water and can go undetected for a long time.

Sometimes leaks are mistaken for water losses from evaporation. To check whether the water loss is due to evaporation or a water leak, place a bucket of water on the top step of the pool and fill it with water to the pools water level. After a day if the water level in the pool is lower than the bucket, there probably is a leak in the pool structure or plumbing system.

To check whether the plumbing system is the cause of the leak, measure the water loss with the pump running for 24 hrs and again with the pump off. If more water is lost when the pump is running, the plumbing system is probably the cause.

To detect leaks in pool walls, a dye is added to the water and the flow of the dye is used to detect any cracks.

More sophisticated techniques consist of inserting television cameras into pipes to spot leaks. The camera delivers a clear picture on a video screen showing the problem while a transmitter shows the location of the leak.

Another method is to use a supersensitive microphone to detect leaks below concrete pool decking or in pool walls. By injecting air or inert gas into a pipe, then listening electronically for sounds of air or gas escaping, the technician can precisely locate the leak.

Case Study: Rooty Hill RSL Club saves A$56 000/yr

Rooty Hill RSL club is one of Sydney's largest clubs with over 38 000 members. An audit revealed that the pool was using over 9 m^3/day – a third of the club's water consumption. A broken ball valve was sending water from the water flow trenches directly to the drains instead of returning to the pool. Fixing this single problem saved over 60 m^3/day.

By installing sub-meters and data loggers base flow can be detected in a timely manner. Refer to Chapters 3 and 4.

12.2.2 Water-Efficient Fixtures

The two previous chapters discussed the importance of installing water efficient fixtures in amenities blocks. In changing rooms it is common to have a long row of showers. Ensure that adequate flow balancing is present to minimise water wastage. Other suggestions are:

- To minimise water and energy wastage for hot water pipes, insulate pipes and locate the heaters close to the showers.
- Use a broom to wipe wetted areas.

- Lower the pool's water level by a few centimetres to reduce losses from splashing.
- Keep the pool and filters clean to reduce filter backwash frequency.
- Regularly check for leaks and cracks in pools and spas. Leaks can occur from cracks in tiles, suction and discharge side of pumps and filters.

12.2.3 Optimising Filter Backwash Cycles

Pool water is continually circulated to achieve the required levels of filtration and disinfection levels specified by health authorities. Swimming pool filters normally consist of pressure sand filters and coated mesh filters. Our focus is on pressurised filters which are the most common in large swimming pools. Pressure sand filters are housed in a cylindrical pressure vessel made of steel or moulded fibreglass. Refer to Chapter 8 for more details. There are predominantly two types of pressure sand filters:

1. Rapid sand filters
2. High rate sand filters

The difference lies in the flow rate. Rapid sand filters are limited to a flow of 200 $L/m^2/min$ (5 US $gal./ft^2/min$). High rate sand filters have significantly higher flow rates of 600–1000 $L/m^2/min$ (15–25 US $gal./ft^2/min$) and therefore suitable for space-constrained areas.

In the sand filters suspended solids are captured and in the process the filter media gets blocked with suspended solids. Consequently filter performance declines over time. This is indicated by an increase in the pressure drop between the inlet and the outlet of the filter. At a given set point the filter needs to be backwashed to remove the trapped particulate matter by running the pool water to waste. At the very minimum, filters need to be backwashed once a week. By doing so the backwash times are kept to a minimum (generally limited to 5–10 minutes) thus reducing the water used. Filter manufacturers specify the minimum backwash period. The end point of backwash cycle is when the water is clear.

When the pool water is used for backwashing it allows for fresh water to be added to the pool. This serves the purpose of diluting the chemical contaminants in the pool that are not removed by filtration such as dissolved solids, chloramines (formed due to interaction of urine with chlorine) and so on.

The example given below in Table 12.3 shows the impact of excessive backwashing on water costs.

It is possible to reuse the filter backwash water for irrigation as well as capture the heat contained in the backwash water by the use of heat exchangers. Water reuse will be dictated by the dissolved solids in the water. If the dissolved solids are high such as in salt water pools which may have a total dissolved solids content between 4000–7000 mg/L the water cannot be directly used for irrigation. Membrane filtration will be required to reduce

Table 12.3 Worked example – Cost of excessive backwash

	Backwash time 5 mins + 2 mins rinse	Backwash time 10 mins + 4 mins rinse
Number of filters	3	3
Area of filters	4.67 m^2	4.67 m^2
Water flow rate required to fluidise the sand bed	2.3 m^3/min	2.3 m^3/min
Backwash + rinse time	7 minutes	14 minutes
Water flow rates m^3	48.3	96.6
Annual cost of water, wastewater discharge plus treatment at A$3.00/$m^3$	A$52,889	A$105,777

the TDS levels to acceptable levels. Refer to Chapter 8 for more details on membrane filtration. Contact the local environmental protection agency for acceptable limits.

Other recommendations are to carryout regular manual cleaning of the pool, skimmer box and other collection points which will reduce the load on the filter. That in turn will reduce the need to backwash.

Case Study – Penrith City Council reduces Swimming Pools

Penrith City Council is one of the largest councils in Sydney. It owns and operates two Olympic sized swimming pools Ripples Leisure Centre and Penrith Swim Centre. The pools have a total volume including of balance tanks of over 1800 m^3 (475.6 thousand US gal.).

An audit conducted by Sydney Water's Every Drop Counts Business Program identified that of all water use in Ripples Leisure Centre, showers accounted for 41.1% and in Penrith Swim Centre, showers accounted for 23.1%. It also identified that make up for backwashing accounted for 28.4% of all water use in Ripples Leisure Centre and 24.1% in Penrith Swim Centre. Reusing backwash water could save Penrith City Council 246 m^3 per week.

After the audit the Council put in place the following measures:

- Installed pressure indicator to reduce length of backwash
- Conducting a regular maintenance program to detect and repair leaks
- Monitoring of water meter on a weekly basis to detect unusual water usage
- Calculating L/patron ratio on a monthly basis and comparing with industry benchmarks.
- Monitoring air temperature and humidity for indoor pool.
- Replaced high flow showerheads with low flow showerheads
- Installed flow control in basins.

These measures resulted in reducing water use by 56 m^3 /day.

Adapted from: Sydney Water. *The Conserver*. Issue 3. 2003.

12.2.4 Minimising Evaporation

For optimum comfort swimming pools are heated to maintain a temperature of 25° C–40° C (77° F–104° F) [3] depending on the type of pool and activity. Air temperatures are maintained at 24° C–29° C (75° F–84° F) at a relative humidity of 50–60% (for indoor pools). Table 12.4 gives the recommended temperatures for pools. Pool temperatures are also a function of the age and gender of the users. Males and the young require less heat. By selecting the optimum temperature for the activity and the age group greater comfort can be provided to customers.

Given these temperatures and the high surface area, a swimming pool is a storage area for energy with heat gains and heat losses occurring continuously. Evaporation accounts for 70% of energy losses in both outdoor and indoor swimming pools as shown in Figure 12.2 [4]. Evaporation reduces the pool temperature. Whilst it takes only 4.2 kJ to heat one litre of water by 1°C it requires a further 2260 kJ to evaporate each kilogram of water. Besides temperature pools also lose water and chemicals. Figure 12.2 shows the major areas from where energy losses occur in indoor and outdoor pools.

Evaporation is increased by:

- high pool water temperatures
- high air temperatures
- low relative humidity
- high wind speed at the pool surface.

In indoor pools, higher the evaporation of water , the greater the concentration of chemicals, heat and humidity in the air. The pool ventilation system is the only means of removing the contaminants and this then increases energy costs. Increasing the pool temperatures by 1° C increases energy costs by 10–15% [5], since increased evaporation leads to increased ventilation rates to maintain the relative humidity at 50–70%.

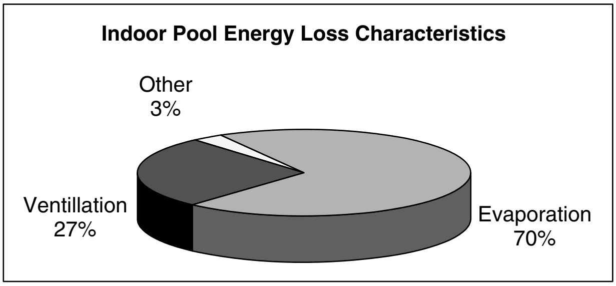
The rate of evaporation in kg/h m^2 can be estimated for a swimming pool in normal activity, integrating splashing due to the bathes on the accesses of a limited zone (Smith, et al., 1993) (ASHRAE, 1995), according to the following formula [6]:

$$w_p = A(p_w - p_z)(0.089 + 0.0782\,V)/Y \qquad (12.1)$$

Table 12.4 Recommended pool water temperatures

Pool type and use	Recommended temperature range (°C)
Spa	32–34
Hydrotherapy	27–30
General swimming	24–27
Competition swimming	20–23

Courtesy of Australian Greenhouse Office. Swimming Pools and Leisure Centres E – 17.



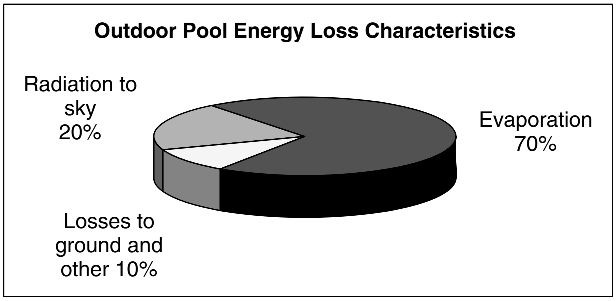


Figure 12.2 Energy loss from indoor and outdoor pools [4]

Courtesy of US Department of Energy. Energy Efficiency and Renewable Energy.

where

A area of pool surface, m^2
p_w saturation vapor pressure taken at surface water temperature, kPa
p_a saturation pressure at room air dew point, kPa
V air velocity over water surface, m/s
Y latent heat required to change water to vapor at surface water temperature, kJ/kg.

In outdoor pools, evaporation is highest when the difference between the water and the ambient temperature is at a maximum – at night. The drier the air (lower the humidity) the greater the evaporation rate.

Higher the air movement above the pool surface increases the evaporation because it removes the warm moist air just above the pool surface. A similar effect is produced by increased ventilation.

For an example, in outdoor pools in Sydney during the warm summer months an average of 6.4 mm of water m^2/day is lost to evaporation [7].

Evaporation can be minimised by installing pool covers. A well-fitting pool cover provides an impermeable layer that virtually eliminates evaporation as well as reducing heat loss through convection and conduction.

Pool covers are made of special materials, such as UV-stabilized polyethylene, polypropylene or vinyl. They can be transparent or opaque. Covers can even be light- or dark-coloured.

Bubble covers are a favourite choice. These have a thickness of 200–500 mm and a life span of 5–10 years. Vinyl covers and insulated vinyl covers have a longer life than bubble covers.

Pool covers are available as manual, semi-automatic and automatic. Semi-automatic covers use a motor-driven reel system. They use electrical power to roll and unroll the cover, but human intervention is required to pull and guide the cover. Semi-automatic covers can be built into the pool deck surrounding the pool or can use reels on carts.

Automatic pool covers are the most convenient of the pool covers for commercial establishments. Automatic covers have permanently mounted reels that automatically cover and uncover the pool at the push of a button. They are the most expensive option, but they are also the most convenient.

The benefits of using pool covers are

- 95–97% of the water loss from evaporation leading to a saving in make-up water of 30–50% [4].
- Reduces energy consumption by 50–70% [4].
- Reduce the pool's chemical consumption by 35–60% [4].
- In outdoor pools, reduces the cleaning time by keeping dirt and other debris out of the pool.

Points to consider when purchasing a pool cover are

- Storage place for the pool cover. The location can increase installation costs.
- Not all pools will be suitable for pool covers. Leisure pools that have complicated contours will be difficult to cover.
- The number of pool attendants present at night will dictate whether a manual or an automatic system is suitable. For example, if only one or two pool attendants are present, then an automatic system may be the most suitable. This is an important decision since if the pool cover is not used then no savings can be expected.
- Increased savings can be expected if the ventilation fans are single-speed rather than variable-speed drives.
- Safety aspects need to be investigated. Can the pool cover support the weight of a person in case someone accidentally fell into the pool?

Case Study [8]

Eastern Leisure Centre in Cardiff, UK, has shown that by installing a semiautomatic pool covers the Centre was able to reduce its energy consumption by 22% and 15% of its energy cost. The staff covers the pool every night for 8 hrs and switch off the heating and ventilation systems.

This has resulted in a saving of £80 000 over a 10-year period. The payback for the original pool cover was 1.6 years.

Another observation was that over this period the Centre has noticed a marked reduction in the deterioration of the building fabric.

References

[1] Energy Efficiency Best Practice Programme. *Good Practice Guide 219. Energy Efficiency in Swimming Pools – for Centre Managers and Operators*. Hartwell Oxfordshire. September 1997.

[2] Sydney Water. *Saving Water in Community Swimming Pools or Leisure Centres*. March 2005.

[3] Energy Efficiency Best Practice Programme. – CTV 006. *Sports and Leisure Introducing Energy Saving Opportunities for Business*. www.carbontrust.co.uk/energy. March 1996.

[4] US Department of Energy. *A Consumer's Guide to Energy Efficiency and Renewable Energy: Your Home – Swimming Pool Covers*. www.eere.energy.gov/consumer/your_home.

[5] Energy Efficiency Best Practice Programme. *Good Practice Guide 228 – Water Related Energy Savings – A Guide for Owners and managers of sports and leisure centres*. Hartwell Oxfordshire. March 1996.

[6] Lund J.W. *Design Considerations for Pools and Spas*. Geo-Heat Centre Bulletin. Oregon Institute of Technology. Klamath Falls, Oregon. September 2000.

[7] Dawson P. *How Much Water Does a Pool Use after Filling*. Sealed Air Corporation Australia.

[8] Energy Efficiency Best Practice Programme. *Good Practice Case Study 76 – Energy Efficiency in Sports and Recreation Buildings: Swimming pool covers*. Hartwell Oxfordshire. September 1994.