POOLSENTRY

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The Case for Energy Management in Wet Leisure Centres

Introduction

There is no doubt that the world has reached a climate crisis. It is incumbent on all building owners to take action to reduce their carbon footprint which will be primarily by reducing their energy use via better energy management, with the bonus that this will also reduce costs of operation, at least in the medium to long term. Where sites are being operated on a landlord/tenant basis, landlords need to be mindful of the need for there to be sufficient time for tenants to recuperate any investment they make in energy management.

In the public buildings sector, leisure centres with swimming or leisure pools have an unusually high carbon footprint for several reasons:

- Air and water temperatures in pool halls are higher than in most public spaces (typically 30/31°C).
- Large amounts (often > 3 tonnes per day) of water are evaporating, requiring substantial power consumption (> 75 kW per day), much of which will be wasted if water vapour is allowed to escape from the building.
- There is rapid circulation of water for water treatment (and often in water features), and the pumping of this water is very demanding of energy.

Reducing the energy requirements for maintaining the target air and water quality involves a complex array of interacting processes that need to be understood in a holistic way in order to identify how energy consumption can be optimised (and carbon footprint minimised). As in every sector, there is no shortage of items of plant (e.g. pumps, filters, filter media) that make extravagant claims about energy savings, but though these might have a role, their benefit, if any, can only be assessed through understanding how they fit in to the system as a whole.

Pool Sentry is leading the way in developing methodologies to assess and optimise the consumption of energy in maintaining acceptable water quality targets. To illustrate our holistic approach, we have adopted the approach of Passive House, a German Institute whose aim is to produce utopian and challenging benchmarks for low-carbon building design that are only just starting to gain traction in the UK[1].

In the context of water treatment in swimming pools, the energy required to achieve satisfactory water treatment depends on three quite independent factors, each of which are not well understood. The total power consumption involved in water treatment is obtained by multiplying these three factors together:

[1] https://passiv.de/downloads/05_guidelines_for_Passive_House_indoor_pools.pdf

- How much 'hydraulic' power (in kW or Watts) is required to circulate each 1 m^3/h of flow rate?
- How efficient are the circulation pump(s) in converting electrical power to hydraulic power?
- How much flow rate is required to achieve excellent water treatment?

The first two items on this list combine to determine the amount of electrical power that is required to deliver each 1 m^3/h of circulation rate. Though this is clearly an absolutely crucial performance indicator in the context of leisure centre energy requirement, we are not aware of it ever being routinely measured, except by Pool Sentry.

Energy used to circulate water in wet leisure centres

The chart below shows the results of surveys Pool Sentry has carried out in England and Wales, which show a wide variation in the amount of electrical power consumed per 1m^3/h of water circulation. A key target in the Passive House document is that the amount of electrical power required to circulate swimming pool water should be no more than 25-40 W per m^3/h of flow[2]. Figure 1 shows how this target compares with data Pool Sentry has obtained from surveys of leisure centres across the UK. The green and purple lines show the Passive House targets of <40 W of power per m^3/h flow rate, and the more ambitious target of 25 W per m^3/h which is theoretically possible. Only 20% of pools were achieving the Passive House target, most of which were pools where pumps had been slowed down using variable speed drives for energy management. Most of the points were well to the right of the purple line, and so using far more energy than the Passive House minimum benchmark.

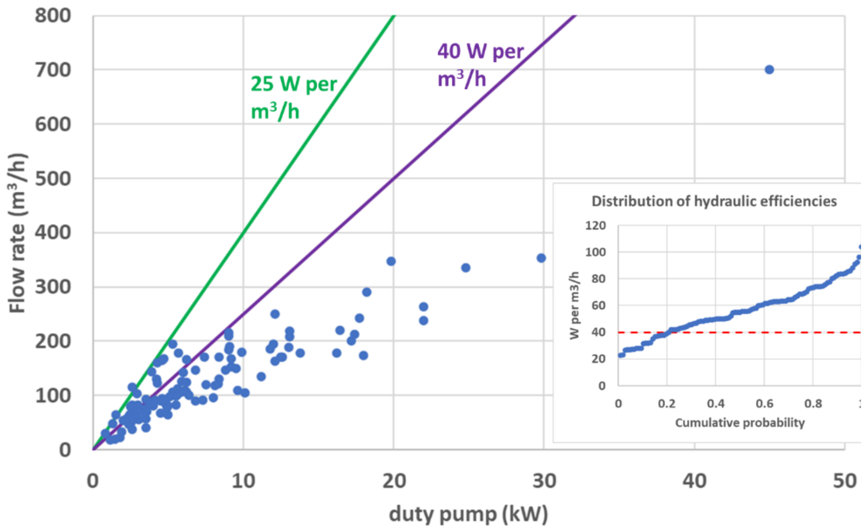

Figure 1: Results of a survey by Pool Sentry of the power used to circulate swimming pool water in Leisure Centres in England and Wales, and comparison with the Passive House target of using 25-40 W per m^3/h of circulation

[2] 1 W per m^3/h of flow is equivalent to using 3600 Joules of electrical energy per m^3 of water being circulated

As part of the Dŵr Uisce project on Distributing our Water Resources: Utilising Integrated, Smart and low-Carbon Energy[3] ,and in conjunction with the University of Loughborough, we have shown the theoretical basis for the relation between power consumption and circulation, which has revealed the challenges of achieving the Passive House guidelines, and how they might be overcome within the limitations of the design of the circulation system.

So what is the reason for such poor efficiency? It is rather akin to having a supposedly economical family car that is only doing 10 miles to the gallon. In the case of car fuel consumption we would be acutely aware if fuel consumption is excessive. But in the case of swimming pool circulation systems we are not used to having benchmarks to judge the 'fuel efficiency' of our pools, and so we might be blissfully unaware of the energy being wasted. If the energy consumption is way too high for the work being done, then there could be a wide range of factors that are contributing to a greater or lesser extent to the inefficiency. In the case of anomalously high power requirements for water circulation the two general areas to consider are:

- Unnecessarily high resistance to flow through the system, requiring the pump to generate large pressure to achieve the flow rate.

- Very low efficiency pumps in terms of converting electrical energy to hydraulic power (we see circumstantial evidence of pumps 'competing' for limited water supply which can result in partial cavitation, very low pump efficiency and pump damage).

Within each of these areas there are a number of complex elements to investigate. Hence the need for a holistic approach to properly understand the pool system before knowing how to make it more efficient. One of the particular challenges in this is that the more you reduce the amount of energy required to circulate water by making water more 'free-flowing', the greater the difficulty in maintaining pump efficiency in low pressure systems.

Circulation rate required to achieve excellent water treatment

The other quite separate issue affecting the energy use is the flow rate that is required to maintain excellent water quality. This is an area where there has been a lack of any scientific basis, until our recently published research which relates water quality to circulation rate, filter efficiency, pool mixing characteristics and bathing load[4]. This shows clearly how bathing load and circulation requirements are linked, and supports the recommended practice of circulating 1.7 m^3 pool water per bather.

This opens the way to implementing the suggestion by Passive House[5] that "electricity consumption can be decreased through partial load operation outside of the operating hours or when there are few pool visitors." Pool Sentry is leading the way in the practical implementation of such a strategy that alone can reduce electricity consumption by as much as 50%, in addition to any benefits from

[3] https://www.dwr-uisce.eu

[4] Simmonds L.P., Simmonds G.E., Wood M., Marjoribanks T. I. and Amburgey J.E. (2021) Revisiting the Gage-Bidwell Law of Dilution in relation to the effectiveness of swimming pool filtration and the risk to swimming pool users from *Cryptosporidium*. *Water, 13*, 2350. https://doi.org/10.3390/w13172350

[5] See page 29 of https://passiv.de/downloads/05_guidelines_for_Passive_House_indoor_pools.pdf

opportunities for reducing the power requirement for water circulation (such as improved filter performance).

Next step

It's clear from the above that the next step towards making sites as energy efficient as possible is to identify the factors that are currently limiting energy efficiency in order to be in a position to make recommendations as to what might be done, and what the potential savings might be.

In the first instance we can make a cautious projection as to what can be achieved by targeting the 'low hanging fruit', and this will normally be quite sufficient to warrant further investigation.

In addition to any obvious works (such as installing variable speed drives if not already present) and installing our Sentry Box (to enable local monitoring and intelligent controls), we would advocate a more detailed study of the pool than can be achieved in an initial survey. This initial study would include:

- Experimentation to assess the impact of pump speed (with 1 or 2 pumps circulating water) on the pressures at the pump inlet and outlet, filter inlet/outlet pressures, flow rates and power consumption. The methodologies we have developed use detailed forensic analysis of these data to provide insights into the factors contributing to the observed power requirement for water circulation, and point to where there are opportunities to significantly improve performance.

- Assessment of the hydraulic resistances in the pool water circulation, and the identification of any sources of significant impedance to water flow that can be rectified. These are not always obvious, and we have a number of examples of some very surprising findings.

- Assessment of the rate of circulation of water in different parts of the pool in relation to the local maximum bathing load. We often find that although there might be seemingly adequate circulation through the pool as a whole, there can be very limited circulation in some parts of the pool where bathing loads can be high, resulting in inadequate localised water treatment. We have some spectacular results where pools that have previously struggled with water quality during busy times can be dramatically improved by addressing this issue, even with reduced overall circulation.

All of the above are examples of where a holistic approach is necessary to evaluate the energy requirements for water treatment, and to make changes that can achieve the dual aim of improving water quality and reducing energy costs (and associated carbon footprint). It is this holistic approach to the management of pools which positions Pool Sentry as the industry leader.

Contact us

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