

Most domestic swimming pools use electricity very inefficiently. Close analysis of one typical pool installation brings very insightful conclusions to the fore.

Energy efficiency of swimming pools

by Theunis Verster, Electune

There are more than 500 000 domestic swimming pools in South Africa, and practically all of them are fitted with filtering equipment designed for the pre-2008 era when electricity consumption was a secondary consideration. For many home-owners this means that the cost of maintaining a clear pool can exceed the cost of hot water production. For Eskom this represents a big slice of the supply to such households, and little has been done to tap this potential source of electricity savings to ease their precarious supply margin.

Many pool owners are, however, beginning to feel the need not only to save cost, but to make their pools more eco-friendly. This includes reducing both their carbon footprint and the use of harmful chemicals to sanitise the water.

The loose existing guidelines for pump motor size and operating periods (e.g. eight hours/day in winter; 16 hours/day in summer) are the main cause of costly wastage of electrical energy, and significant improvements can be made with some basic know-how. In addition, a new variable speed pump motor has appeared on the market which offers new possibilities for energy efficient water filtering.

An investigation was carried out at an existing swimming pool to determine the criteria for minimising energy usage without compromising water quality.

If such guidelines could be disseminated more widely for new pools or the replacement equipment market, this sector could become the prime success story in domestic appliance greening.

Comparing different pumps

The scientific way of comparison would be to install a number of different pumps,

one at a time, in the same filter installation, and to measure directly the energy they consume to perform the same task. The task chosen in this instance was to pass all the water of an existing 50 000 l domestic pool through the sand filter once while driving the automatic cleaner. The comparison is therefore on the basis of the same volume of water filtered, not the same time period of operation.

An example of a new type of swimming pool pump was obtained and put through the same test at three different speed settings. This pump is driven by a brushless DC motor, the rotational speed of which can be varied digitally over a range of between 2000 and 2840 rpm, corresponding to a much wider power range of 300 – 900 W. This is in contrast to the fixed speed and fixed power of the conventional swimming pool pump driven by an AC induction motor. Three conventional type pumps, rated 450 W,

750 W and 1100 W respectively, were also put through the same test.

As expected, the stronger pumps completed the task in less time than the lower power pumps, but what was not so easily foreseen was the disproportionate increase in energy consumption to achieve this.

Observations

The first observation is that a strong pump is very wasteful in energy usage, and even by just downsizing the conventional pool pump from a nominal 1100 W (P22) to a smaller nominal 450 W (P10) the same volume of water will be moved through the filter at only 50% the energy consumption. Filtering will also be more effective because the water movement through the sand is slower. The smaller pump motor is able to drive the automatic cleaner as effectively as the larger motor.

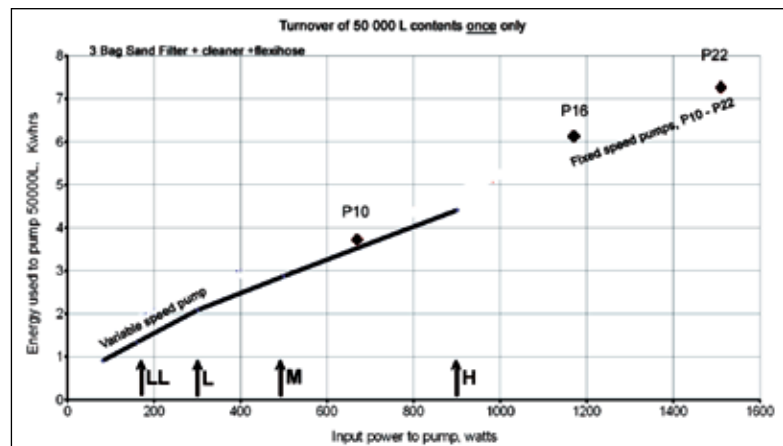


Fig. 1: Energy cost to filter a swimming pool.



Fig. 2: The eight-month study was conducted in a standard, 50 000 l suburban swimming pool.

An important observation was that there seems to be no real lower limit to the energy required to reticulate the water for filtering. A variable speed pump with digital control can be set to run continuously at very low speed/power, and to only speed up occasionally for a short period to operate the automatic cleaner, which needs at least 100 W to function. In water-flow terms, the cleaner needs at least 3000 l/h. At a lower flow rate than this the cleaner stops moving, but filtering and other functions carry on.

Reduced filtering and cleaner time

In an eight-month study (four winter months and four summer months) of the same 50 000 l pool in a city garden, an effort was made to maintain it to a standard similar to neighbourhood pools while using only 5% of the energy. Energy is basically required to clean the bottom and to deposit the waste material into a strainer or filter, and to circulate water through a fine filter to catch suspended particles. An automatic pool cleaner was attached during this experiment and sanitising and algae control was conducted manually. The same adjustable, three-speed pump was used for the experiment, and it was found that the lowest setting (300 W) could still drive the pool cleaner, achieving a circulation through the system of 7300 l/h.

The cleaner moves at a speed of 4 m per minute, and can theoretically sweep the pool in under 30 minutes. In practice, one hour is sufficient. The clarity of the water was as good as that of neighbouring pools that filtered for extensive periods daily. It was thus demonstrated over a prolonged period that it is possible to maintain this pool while running the filter pump for only one hour per day on average, and using under 10 kWh per month.

This experiment determined a very low minimum energy requirement for a pool with manual water sanitising. "Unintended energy demand result" of automated sanitisers like salt water chlorinators, UV exposure, and oxygenator/ionisers, which prescribe varying, but long periods of water flow irrespective of the strength and consequential energy usage of the pump, must be borne in mind. A minimal energy pump setting seems to be the answer to this dilemma, and will enable eco-friendly swimming pools that have very small carbon footprints and chemicals-free water.

Hard figures

If the automatic cleaner is unplugged at the weir basket, the flow rate through the sand filter increases from 7300 – 10 000 l/min, with the Eco Touch pump set at minimum power (300 W). Therefore, a large, 100 000 l domestic pool can be reticulated 2,5 times per day, which

is more than adequate for filtering and automatic sanitising. For a pool half this size, the same can be achieved with the pump operating only half the time. In practice, most domestic pools have a light bather load, and much shorter sanitising and filtering times are adequate, e.g. one circulation of the water load per day (five hours for 50 000 l). This translates to energy consumption of 45 kWh per month, which is still quite a bit higher than the figure of 9 kWh per month found to be adequate for manual dosing.

Table 1 shows the range of energy cost across different sizes of pump motor, run over different periods of time.

Comparative energy use

In principle, the lowest setting of the variable speed pump (300 W) can be reduced to less than 100 W, at which point it becomes too weak to drive an automatic cleaner, but can carry on filtering and sanitising the water continuously at very low electricity consumption and cost. Remote digital programmers will become available to manage the pool's operation and carbon footprint from inside the home.

Most household appliances designed as energy efficient replacements for inefficient appliances cost more, and the same is true of the variable speed pool pump, which is about twice the cost of the 1100 W single speed pump. It has been proven that it can execute all requirements as effectively as this conventional pump while using only 27% of the energy. In some cases its higher cost can be recouped through electricity savings in under six months, but commonly in less than 18 months.

The variable speed pump can therefore lead to huge savings in the long term, and although it runs mainly in low-energy mode, it can be switched to a higher speed for ad hoc tasks requiring higher pressure or suction capability. Such tasks (robust back washing, vacuuming and pool emptying) are usually of relatively short duration and do not increase long term energy usage significantly.

In the final analysis, the stage is set for the domestic swimming pool to become more frugal in energy usage (< 50 kWh per month) than the family fridge. The guiding principle towards this ideal is to keep in mind that powerful pumps waste most of their energy in hydraulic friction losses, which increase exponentially as the flow speed is pushed higher, while energy efficiency becomes much higher at low flow speed.

Contact Theunis Verster, Electune,
Tel 073 334-8753,
electricitytuning@gmail.com

Pump motor size	1 hour kWh	2 hours kWh	4 hours kWh	8 hours kWh	16 hours kWh	24 hours kWh
300 W	9,0	18,0	36,0	72	144	216
450 W	20,1	40,2	80,4	160	322	485
750 W	32,0	51,1	102	204	409	613
1100 W	45,2	90,5	181	361	720	1083

Table 1: Daily operation of filter pump, and monthly energy usage, kWh/month.