Turn your swimming pool into a swimming pond

ReNew looks at a unique natural filtration system that can be retrofitted to your existing swimming pool

It's 6:30 am and the rest of the family is still asleep but Dave Keenan can't stay in bed. He can hear the pipes a calling. Downpipes, drain pipes, ag pipes, electrical conduit. According to Dave, this is the stuff that energy-efficiency revolutions are made of.

Not to mention gravel, builder's plastic, geofabric and trellis mesh. Bilge pump motors with model-boat propellers, ultraviolet lamps with 12 Volt inverters, and living organisms including fish, aquatic plants, aquatic invertebrates and last but very far from least, zillions of microorganisms.

These are the components Dave uses to turn what he calls 'those fake blue toxic waste dumps' into freshwater aquatic habitats that are a joy to swim in. In other words, to retrofit standard swimming pools, above or below ground, and turn them into low-energy, biologically-filtered, chemical-free 'swimming ponds'.

The Australian Greenhouse Office (AGO) estimates that a typical unheated 50 kilolitre swimming pool (approximately 9m x 4.5m x 1.2m deep) will use 2,200 kilowatt-hours of electricity per year when operated in the recommended manner. Most will use far more, but even at 2,200kWh this will generally be the single largest user of electricity in the household, and therefore the household's single largest contributor to global warming.

The AGO estimates that there is scope to reduce the energy consumption of swimming pools by 10 to 15%, mainly by attention to the pump and its motor.

Chemical-free swimming in your own backyard.

But Dave has proved it's possible to do much more than that. His 'living' swimming pool uses about one quarter of the energy of a typical 'dead' swimming pool.

How is it possible?

'It becomes possible when you look not only at efficiency, but at efficacy, and when you pay attention to where all that energy is actually going,' explains Dave.

Engineers define energy efficiency as useful-energy-out divided by energy-in. This is an appropriate measure for a component such as a pump, which converts electrical energy to a different form of useful energy, namely that of the pressure and flow of water.

But how do you measure the energy efficiency of a whole swimming pool filtration system? You certainly put energy into it; however, the useful product of that energy is not another form of energy, but the cleanliness of a certain volume of water for a certain length of time. So perhaps we should instead speak of its efficacy in litres per watt.

A carefully operated conventional filtration system has an efficacy of around 200 litres per watt. Dave's living system currently cleans about 800 litres per watt.

So where is most of that 2,200kWh going? That's an average of 6kWh per day. Most of it is not being lost in the pump, or motor, or chlorinator. Most of it is turned into unusable low-temperature heat due to flow resistance in the filter. Why is that? 'Because the filter must have pores that are small enough to mechanically stop the particles it is intended to filter out. It has a cross-sectional area of only about one square metre and is about a metre deep. It soon clogs and has to be backwashed,' says Dave.

The filter in a living system consists

of rounded pebbles between about 5 and 7mm in diameter, so the passages between them—or the pore size—is about 1mm. This is at least 10 times larger than the pore size of a conventional pool filter, yet it can filter out single-celled algae one thousandth of a millimetre (a micrometre) in size, and effectively clear the water in a single pass. And it doesn't clog or require backwashing. How can this be?

'It has at least two things going for it,' says Dave, 'gravity and evolution.'

'It's at the bottom of the pond so the larger particles just settle there anyway, and it is colonised by microorganisms that have evolved for billions of years to grab hold of anything that goes past that looks remotely like food. You just need to give them something to attach themselves to and plenty of oxygen, and take away the carbon dioxide, nitrate and phosphate that results from the breakdown of this unwanted organic matter.'

Once you have the flow resistance of the filter reduced to negligible proportions by going biological, the pipes start calling. Flow resistance of pipework can be reduced by increasing its diameter, shortening it and reducing the number of bends. Using an extra low-voltage submersible pump means the whole system can actually be *in* the pool and the pipework can be reduced to a single short, straight, large-diameter piece going from bottom to top.

There is often a sort of multiplier or feedback effect that happens when you start on these efficiency (or efficacy) crusades. Amory Lovins' group (from Rocky Mountain Institute in the USA) found that when you lighten the body of a car and reduce its drag and rolling resistance, you not only get to have a smaller engine because you've reduced these losses, you get to have an *even smaller* engine because you've reduced the size of the *engine* (and therefore the losses due to *its* size and weight).

A similar thing happens here with the pump. Standard pool pumps are of the kind we call centrifugal. The water comes into the centre of a rotating impeller that has radial fins or vanes, and is thrown outward by centrifugal force. It is then collected and funnelled to the outlet pipe. This in itself involves a right-angle bend in the water path and enormous turbulence, but for the pressures required to overcome the filter resistance in a standard pool filtration system (typically 100kPa) these are the most efficient kind of pump.

You've already heard how reducing the filter resistance meant that Dave's pump became small enough to conveniently power it from extra low-voltage (12 or 24 Volts). This made it safe to put it *in* the pond, thereby allowing him to reduce the pipe resistance. Because these modifications drastically reduced the pressure requirement of the pump, Dave found that he could then use an entirely different kind of pump, called an axial or propeller pump, which produces two to four times the flow for the same amount of power.

An early model pump shown operating inside the fish and plant refuge.

How does the living system work?

The large surface area of the gravel provides many sites for aerobic bacteria and other useful microbes to attach themselves. By spreading the filter over the entire bottom of the pool, we can turn over the whole volume of the pool in two hours (that's twice as fast as a typical chlorinated pool), while keeping the water velocity through the gravel at less than a millimetre per second. This low velocity allows the microbes to stay attached to the gravel, and to grab their food (algae and planktonic bacteria et cetera) as it goes past.

The oxygen the microbes need is dissolved at the water surface. The pump draws the water down through the gravel via a manifold of slotted pipes underneath and returns it to the surface to lose its carbon dioxide and regain oxygen. Most of what is normally done by highly corrosive chemicals such as chlorine or ozone, the aerobic bacteria do using ordinary oxygen.

It is important for the surface to be agitated by the returning water, to get rid of the invisible film of dust, oil and microorganisms (mostly unicellular algae) that would otherwise prevent gas exchange.

The pump must run 24 hours a day to keep the good microbes alive, but its speed can be greatly reduced at night and when no one is swimming, to save energy.

What about leaves falling to the bottom of the pond? What could look more natural on a gravel bottom? And the good microbes soon decompose them. At present, Dave just removes any floating debris with a net before swimming. He's also working on a 12 Volt powered floating skimmer.

The nitrate and phosphate are removed from the water by growing plants, which must be periodically harvested and thrown on the garden. At present Dave uses a submerged, free-floating plant called Foxtail (*Ceratophyllum demersum*).

Sometimes the influx of nutrients is too rapid for these plants to keep up, such as when lightning produces nitrogen oxides which come down as nitrate in the rain. In that case, when the sun comes out again, the filamentous (stringy) algae, which normally exists as green velvet on the walls, grows rapidly until it has consumed the excess nutrients. Unlike the unicellular or planktonic algae, this filamentous algae (sometimes called blanket weed) avoids being drawn into the gravel filter by attaching itself to the walls. It is quite harmless—in fact you can eat it—but but before the streamers start to interfere with the enjoyment of swimming, brush the walls to set them adrift and remove them with a large net.

Because the water in a swimming pond is free of toxic chemicals, it is possible for mosquitoes to breed, so Dave also adds mosquito-eating fish: native Firetail Gudgeons (*Hypseleotris galii*). The fish do not need feeding at the very low stocking rates used: about 10 fish per square metre of surface. A fence made of plastic mesh holds the plants within a strip about 300mm wide along one side of the pool. The fish can swim through the mesh and this gives them a refuge when people are swimming.

A layer of the same mesh is tied down just under the surface of the gravel. Dave calls this 'boy-proofing'. It prevents active human feet from churning up the gravel and thereby destroying its microbe population and clouding the water.

Dave also employs a backup system consisting of a germicidal ultraviolet lamp. It uses a more energetic wavelength than any that reach the Earth's surface from the Sun, called UV-C. This should kill any remaining pathogens in the water, although for very resistant organisms, it may take several passes.

Maintenance

How does the amount of maintenance compare with a standard pool? Dave reckons it's probably about the same. The irregular jobs of removing filamentous algae a week or so after rain, and harvesting the plants, are offset by the absence of regular maintenance. The ultraviolet lamp and pump motor need replacing about once a year. This costs around $150, but you should save twice that on electricity and pool chemicals.

How much does it cost?

Dave's system is modular. He suggests one lift-tube, with its own independent under-gravel intake manifold, for every 15 to 20 kilolitres. The materials cost about $1000 per module. It's fairly labour intensive to build, but should be no problem for a competent do-it-yourselfer with friends and family to help out.

If you're building a new pool, you could save the cost of the standard filtration system. But be aware that a flat or stepped bottom is a *lot* easier than a sloped bottom, for building and maintaining the gravel filter.

Is it safe?

At this stage, nobody can say for sure whether a swimming pond is as safe for our health as a standard chemically treated pool, but according to Dave, 'there's no such thing as complete safety, only various compromises.'

'The pursuit of *extreme* safety, whether in health or national defence, generally results in *less* safety, not more,' he says. 'For example, both chlorine and ozone react with organic matter to form substances that are know to cause cancer.'

Waterborne diseases can be classified as bacterial (such as cholera, typhoid and dysentery), protozoan (such as giardia and cryptosporidium) or viral (such as hepatitis A and E, polio and various minor gastrointestinal diseases). Most waterborne diseases are transmitted faeco-orally, which means an infected person would have to leave some faecal matter in the water and someone else would have to swallow the water before the infectious organisms were removed or destroyed by the filtration system. Ear infections can also occur. Some people can continue to carry some of these diseases without showing any symptoms. Fortunately, for normal healthy people, these diseases are either extremely rare, not serious, or readily treated.

Chlorine takes less than an hour to kill most pathogens, but *cryptosporidium*, or 'crypto' for short, can survive for days. Crypto causes watery diarrhoea and abdominal cramps. A person with a normal, healthy immune system can expect symptoms to last for a week or two. High-dosage-rate UV-C is more effective than chlorine against crypto, because the level of chlorine needed to achieve the same kill-rate is unacceptable to humans. However, Dave estimates that the UV-C dosage rate of his current system is about as effective as standard chlorine levels. Dave is concerned that excessive use of UV-C may cause other problems, because in the words of Robert Heinlein, 'there ain't no such thing as a free lunch'.

He points out that the developed world seems to be seeing more and more health problems caused by exces-

Laying the gravel filter in the bottom of the pool.

sive hygiene: 'Polio itself was such a disease. Infection normally occurred when children were young and the symptoms mild. Immunity followed. But with sanitation, first contact started to occur later in life when the disease can have serious consequences. There is also increasing evidence that occasional mild infections of various kinds, may be beneficial in preventing your immune system from becoming overactive and turning against you, as seems to happen in the case of asthma, allergies, inflammatory bowel disease and others.'

However, swimming ponds should be avoided by pregnant women and people who have weakened immune systems, such as infants and those who are very old, malnourished, have HIV/AIDS or an inherited immune deficiency; and cancer or transplant patients taking immunosuppressive drugs. Of course people who have any disease that involves diarrhoea or vomiting should not swim, so as to avoid infecting others. If you're worried, says Dave, the simplest thing to remember is 'don't drink the water'. Public health authorities issue exactly the same warning for standard chlorinated and ozonated pools.

For those seeking further assurance, a simple test kit called 'Bacteria Check' is available from EnviroEquip for $28. It cannot tell you whether any human pathogens are present—such tests are very expensive and time consuming—but it will reveal the presence or absence of *total coliform* bacteria. These are not dangerous in themselves—they occur naturally in huge numbers in the gut of all animals, including humans—but high levels are an indicator of possible faecal contamination or filtration failure, and therefore possible risk of disease.

It is safer to swim in a bio/UV-filtered swimming pond than in most lakes, dams, rivers and creeks in which humans swim, so if you're happy to swim in these, you shouldn't have any worries about a swimming pond.

Now that we've got all that heavy stuff out of the way, we can tell you that swimming ponds are *fun*! After swimming in one, it's hard to go back. Chlorinated pools suddenly seem so offensive in the way they affect your skin, hair, nose and eyes. And they start to look so unnatural you feel they might as well be painted bright orange. Swimming in a swimming pond is like swimming in a creek—a particularly *clean* creek. The gravel under your feet feels good and there are things to see.

The Future

Dave Keenan isn't the only one thinking about swimming pool conversion. Try google searches on "swimming pond" and "natural swimming pool" (with the quotes), and you'll see there are other ways of obtaining chemical-free swimming.

However, Dave's achievement of extremely low energy consumption and the ability to retrofit existing pools appears to be unique. Others have concentrated on obtaining a natural look in a purpose-built swimming pond. There's no reason why these things can't be combined. Dave has started a 'swimming-ponds' Yahoo! group for exchanging information. These are early days for the field and there is plenty of scope for you to make a contribution. ✱

For more information contact Dave through his website: www.users.bigpond.net.au/d.keenan, or join the swimming ponds e-list by visiting www.groups.yahoo.com/group/swimming-ponds/, or sending an empty email to swimming-ponds-subscribe@yahoogroups.com

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