Melbourne University Up Close Episode 41 Transcript

Drinking The Same Water Twice -- Potable Water From Waste

VOICEOVER
Welcome to Melbourne University Up Close, a fortnightly podcast of research, personalities and cultural offerings of the University of Melbourne, Australia. Up Close is available on the web at upclose.unimelb.edu.au, that's upclose.unimelb.edu.au.

SHANE HUNTINGTON
Hello and welcome to Up Close, coming to you from Melbourne University, Australia. I'm Dr Shane Huntington, and today's topic is water recycling. Clean fresh water is arguably the most important resource on the planet. Almost three-quarters of the earth's surface is covered with our oceans, and yet this abundance does not readily translate into rainfall where we need it the most.

In Australia, dry conditions continue to place limits on our water usage. The imminent onset of climate change will further stress our existing water infrastructure, driving us to consider new strategies. In recent years technological advances have opened new ways to conserve water. One exciting area is the technology that involves water recycling. Today on Up Close we are joined by an expert on water recycling, Professor Peter Scales from the Department of Chemical and Biomolecular Engineering here at the University of Melbourne, Australia. Welcome to Up Close, Peter.

PETER SCALES
Thank you Shane, good to be here.

SHANE HUNTINGTON
Why do we need to recycle water?

PETER SCALES
Because we don't generate much new water. Chemically the process of generating water, which is basically taking hydrogen and oxygen and burning them to produce water, is not a process that happens a lot any more. So in terms of our total volume of water in the world, yes it is changing, but it's not changing significantly relative to the rate at which we are using or demand fresh new water.

SHANE HUNTINGTON
Now there are a lot of different areas of technology involved in water recycling, and we are later in the interview going to get to industrial use and

the reclamation of sewerage. What about in the home at the moment; what sort of technology is being utilised in the home when we talk about water recycling?

PETER SCALES
Well very little on average. Typically in a modern home we turn on the tap, we take a glass of water, we probably in turning on that tap flush ten glasses of water down the sink. We take a shower, we use fresh water, we do a whole range of things, and there is nominally very little recycling of that. It goes down the drain and it goes off to a wastewater treatment plant.

There is actually very, very little recycling at a local level. People don't actually say well I'm now going to take the water I just used, put it through a sophisticated process and reuse it and have a closed loop. It's not a closed loop in the home.

SHANE HUNTINGTON
In a city the size of Melbourne, so for our international listeners, we have around four million people, a fairly spread out city, how much water are we talking about?

PETER SCALES
On a daily basis people in the city are using around about 1,000 litres per person per day. And a lot of people will say well I don't use that much, but they do through a whole range of services they use through the industry that is around them. So in their homes they mightn't use that much, but overall they use around about 1,000 litres of water a day.

SHANE HUNTINGTON
Peter, let's consider a typical water recycling plant. What sort of materials are removed from the water? I'm assuming it's not just things that are dissolved. There must be sort of large particles, all different types of suspensions in the water. Take us through how the plant would go about that?

PETER SCALES
If I took a typical water recycle plant rather than a potable water production plant that might come from a reservoir, we've got to look at removing three main components really. The dissolved ions, the dissolved organic materials and the particulate materials.

SHANE HUNTINGTON
So the particulate materials are the bits, the larger chunks that don't dissolve and have a lot of things…

PETER SCALES
The larger chunks that you can see with your eyes basically. In a way, the easiest bit is removing the particulate, because I can take a membrane, something like an ultra-filtration membrane, which has got basically pores or holes in it that are of all diameters in size. And by just forming a barrier, I can basically remove the particulate, but doesn't necessarily remove the organic component and the ionic component. So the first step is a particulate removal step.

The next step is then to start to remove the ions and the organics, and the usual step there is to actually use an ultra-filtration membrane. And these have usually got a lot smaller pores of angstrom size, and they can actually exclude ions and organics.

SHANE HUNTINGTON
So this is actually where you start separating things based on their molecular size, so H2O versus a slightly larger molecule?

PETER SCALES
Yeah, H2O versus a chloride ion or a sodium ion, or a very small alcohol molecule or something like that that's sitting in the solution. And there's now a large number of membranes and people associate them with desalination, but they don't have to be with seawater, they can be with any type of water, for actually purifying water to the point where it's extremely pure. There's very little other than water gets through those membranes.

SHANE HUNTINGTON
Is it fair to say that it is a bit harder to pump the material through those membranes than the first series of membranes?

PETER SCALES
Absolutely, and that's a key issue in energy cost and one of the major energy costs of any recycling process is usually at what quality we want the water, because as we go to higher quality we're going to have to go to higher pressures, pressure costs money. And basically putting the high pressures there, I have to go out and find some power to do that.

And one of the big arguments with recycling water versus perhaps desalinating water is although I'm starting with a material that is not as clean, in terms of pathogens and a whole range of things that could hurt us in the future, then certainly the amount of ionic material that I've got to remove is a lot less. And the pressures I've got to apply are a lot smaller and the energy I've got to use is a lot lower.

SHANE HUNTINGTON
You mentioned a third step. Am I right to assume that's things like bacteria and other organics that we clearly don't want in our supply?

PETER SCALES
The first step will take out most bacteria, and the second step, which is a reverse osmosis or desalination ultra-filtration membrane will take out all viruses and pathogens etc. There is still a possibility that some very, very, very small organic materials could get through and some ionic materials. And it's usual to have a third step just to reduce the risk. They usually use a sterilisation step and an oxidation step.

SHANE HUNTINGTON
When you talk about sterilisation and oxidation, I guess people think of heating things up and burning them. Is this literally heating them up and exposing them to ultraviolet light or that type of process?

PETER SCALES
Normally you would use ultraviolet light as your sterilisation mechanism, and oxidation you would normally use an ozone or a chlorine. Things that people associate with disinfection, but a lot of disinfection with chemicals is actually just oxidation.

SHANE HUNTINGTON
You're listening to Melbourne University Up Close. I'm Dr Shane Huntington, and we're speaking with Professor Peter Scales about water recycling. In industry Peter, I'm assuming there are different requirements for recycling?

PETER SCALES
Most industries require quite low quality water. In actual fact, they're recycling a lot of ... since it only requires that they take some particulates out and take perhaps some organic material out, and a first-pass membrane process – I talked about a dual membrane process – but a first-pass membrane process would often be adequate for most industrial uses.

Some industries elect to have their own treatment facilities and do it. Others say well I'd like to buy that water in, and that's because we don't have multiple pipe systems. One of the big arguments for water recycle within a metropolitan type area is are we going to have multiple pipe systems. In a lot of cases people balked from that because of an expense, but ultimately I think for cities that are short of water, they are going to have to come up with alternatives to every bit of water I use is extremely high quality.

SHANE HUNTINGTON
You mentioned the limits that we need to meet for our drinking water, the highest there are. Presumably there are limits in terms of industry use and their own use, with regards to how the water affects equipment. Is some level required in order to make sure that manufacturing and mining equipment and so forth is not corroded or damaged by the recycling of water?

PETER SCALES
Certainly. I think every industry will have different requirements there. There are some industries such as the power industry that require water for their boilers, that's actually probably higher quality than what we drink, so they have to take it down to an even better quality than what we would expect from a drinking point of view. However, on average the requirement in say the mining industry and a lot of other industries is a reasonably low requirement. They just need material that doesn't block up filters etc, so particulates are usually the main issue. Perhaps some component such as chlorides, which can cause a lot of corrosion, they might not want chlorides in the water. But some industries can actually withstand what we call hypersaline water, which is water that's got a higher salt content than seawater. But providing the chlorine level in there isn't too high, then they can use that for a long time.

So very different requirements for different industries, and different plant and equipment all need different needs. However, I think the overview is that we have Class A and Class B, which is a definition that says it's potable and drinkable, and the other one it's usable for a whole range of secondary operations that are not potable, it's what gets used by industry quite a lot. I think a pipe for Class A and a pipe for Class B water would be very useful domestically in a city.

SHANE HUNTINGTON
Peter, we were also lucky enough earlier to speak to Professor David Fox, who's from our Department of Civil and Environmental Engineering here at the University of Melbourne, Australia. And he had some comments regarding the use of sewerage water for recycling and desalination, and we're going to hear those now.

DAVID FOX
It is a more complex issue to take treated effluent and to overcome some of the psychological barriers to drinking recycled effluent. People still, as we've seen in this country, are struggling to get their minds around the concept of drinking treated effluent, even though this has been done for many years over in other parts of the world, in Europe in particular. Where the usual story, any visitor to London knows that they're told that the water that they're drinking has probably been through seven sets of kidneys.

Those people are well familiar in other parts of the world with drinking treated effluent, and that seems to pose no problems. We saw in South East Queensland where there was ferocious opposition to that concept, but I guess with dwindling water supplies, people are slowly coming around.

SHANE HUNTINGTON
David mentioned the project in South East Queensland in the north of Australia. What are the plans around Australia at the moment to start utilising this water supply for drinking?

PETER SCALES
In the South East Queensland project, it's basically a staged project, the first stage of which produces water for power stations, but the next two stages will actually be to take that water for potable reuse. So it will be put back into one of the dams and diluted back into a dam and actually reused. So despite the ferocious arguments against this process that were ongoing in that area, it's just going to happen. And it basically is a sensible outcome, I believe, ultimately for that part of the world, which is at times very, very short of water.

SHANE HUNTINGTON
Let me ask you, if I took a glass of water from what is being sent to this power station from the new treatment plant in South East Queensland, and a glass of Melbourne tap water, what is different about them?

PETER SCALES
The one going to the power station in South East Queensland is cleaner.

SHANE HUNTINGTON
Is there anything you can do to detect or to determine that it is cleaner; I mean, how do you make people believe that?

PETER SCALES
Well the normal way that you would do it would be that you would measure the components that you would normally try to remove from water to make it clean. So if I boiled water and made it into distilled water, then it would nominally have mainly water in. If I tried to detect ions and organics in it, I might actually detect some organics, because they might all actually boil over as well, but they'd be very low.

And so if I look at the organic content and the ionic content of a Melbourne water versus a water that's been put through a reverse osmosis or desalination process and a membrane process, I would find that in actual fact the membrane treated water had low levels of organics and lower levels of ions. In actual fact, it is normal to put back in components into that treated water to make it taste better, in the sense that purely distilled water or extremely clean water, doesn't have as good a taste probably as ones with ion. So in a sense we have to contaminate it slightly to make it more palatable.

SHANE HUNTINGTON
You're listening to Melbourne University Up Close. I'm Dr Shane Huntington, and we're speaking with Professor Peter Scales about water recycling. Peter, we also heard from Professor David Fox regarding I guess the interplay between these two possibilities of recycling from sewerage and from desalination, and we have those comments now.

DAVID FOX
Again, I think you need to look at it in total package and look at this in the context of not just where you source the water and how you can do that, and sort of plug a gap fairly quickly, but we need to think long term and say let's look at the environmental and ecological impacts associated with desalination. Let's also look at that whole water cycle and think of what we're currently doing and where savings can be made.

Now as in Victoria and in other parts of the country and other parts of the world, we tend still to have a one shot mentality to our water use and consumption. So that we harvest the water in reservoirs and we treat it to high standards. We use it for commercial, domestic, industrial purposes. We then take it, shoot it down the drains to treatment plants, where we treat it before releasing it typically into the ocean.
Victoria, Melbourne, has the Eastern Treatment Plant as it's known, takes roughly half of Melbourne's wastewater, treats it actually to a very high standard and puts it out into the ocean, which is virtually around the corner from where the desalination plant is going to be built.

So if you sort of zoom out, you'd look at it and think well the irony is that we're treating this water to a very high standard, only to dispose of it in a marine environment, where it actually has toxic effects in a marine environment. And then literally suck that water back up and take the salt out of using highly energy intensive processes, and pump it back up into a reservoir.

Now the other strategy is to simply take that effluent and make greater use and reuse of that effluent and look at alternative uses of that. So to reduce our reliance on an engineering solution, which will have some environmental and ecological impacts, but also possibly has a fairly high footprint in terms of greenhouse gases.

SHANE HUNTINGTON
Peter, Professor David Fox there makes some interesting comments with regards to utilising the outputs of our sewerage treatment plants as inputs to our desalination plant. Is this a feasible scenario from a chemical engineering sort of basis; is it easier to do that?

PETER SCALES
Well, I don't think it really makes sense to take the outputs of the sewerage treatment plant and basically put it into a marine environment and suck it back out. Because the single major cost on desalination is related to the fact that we've got to push very hard the water through a membrane to exclude the ions.

Therefore if I can actually just take the material and just put it through a membrane process, the exact same membrane process that we would use in a desalination plant directly, then we finish up with a lower energy outcome for the whole system in terms of the water.

If I go back to a previous point though, in a lot of cases if we took the large amount of water that goes out into the ocean every day disposed of in that way and we said how much of it could be used for potable reuse, versus how much could be used for industrial reuse, the answer is I don't believe that we have to get back to the point where we say 100% of it is for potable reuse. And certainly producing say 50% of that for potable reuse and 50% of it for industrial use or some other ratio, but certainly nowhere near 100%, produces an even lower energy cost. Because for industrial reuse, we would probably put it through a single membrane process, for potable reuse, you'd put it through a dual membrane process. Either way, that process is cheaper than desalination in terms of energy cost.
SHANE HUNTINGTON Peter, which particular part of the process is your research team working on at the moment?
PETER SCALES We're working on the concept of producing fit for purpose water for industry. So looking at how can we clean up water very, very, very cheaply to produce water for industrial environments. I think the whole area of producing potable water from industrial water or

wastewater, a lot of people are working on that. But not as many people are working on the really, really cheap options for taking slightly contaminated water and being able to reuse it.

Once again, getting back to the point that a lot of industries don't need high quality water. They just don't need water with a particular contaminant in it. So we're concentrating on how do we take particular contaminants out of water that will make it reusable, but at a cheap cost and a low energy cost. And certainly water from our wastewater treatment plant for a lot of the reuses that we would need, falls into that category.

SHANE HUNTINGTON
I assume that industry use of water as a percentage of overall use is quite high, so this is a very important area to focus on?

PETER SCALES
Yeah. We tend to focus in a big city on the fact that we have to reduce our water use in the home. In actual fact, if we concentrated more on industry we would make big water savings.

SHANE HUNTINGTON
Professor Peter Scales from the Department of Chemical and Biomolecular Engineering here at the University of Melbourne, Australia. Thank you very much for being our guest today on Up Close.

PETER SCALES
Thank you Shane.

SHANE HUNTINGTON
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