



# ENERGY SAVINGS DRIVE PILOT OF DISRUPTIVE TECHNOLOGY IN SURGICAL BUILDING HVAC SYSTEM

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## CASE STUDY

Electro-chemical treatment of  
cooling water  
Waikato DHB,  
Hamilton Hospital

# ENERGY SAVINGS DRIVE PILOT OF DISRUPTIVE TECHNOLOGY IN SURGICAL BUILDING HVAC SYSTEM

As the Maintenance and Facilities Engineer at Waikato Hospital, Stefan van Rooij is always on the look-out for energy savings, so when a new cooling system scale management technology caught his attention, he was keen to find out more.

Stefan says he had heard about the electrolytic water treatment technology from a colleague. "I'm always looking for energy savings that allow us to keep on improving. New technology is where the significant energy savings are. On hearing about the DeCalon™ DCI technology, I was keen to trial it as there seems to be a lot of benefits in it." A mechanical engineer, who thrives on providing smart design solutions, Stefan was impressed from the outset on the potential hard and soft benefits. "We want to reduce power, water and maintenance costs of course but also not having to handle chemicals, risk chemical spills and not having to dump chemicals are all solid benefits too. Maintenance wise there's a lot less involved too. That's why we like it."

Of the 4 water cooled systems on the Hamilton campus the control of RH and temperature for the Kempthorne Surgical building presented the greatest technical challenge. For this reason, the Kempthorne building was chosen as the best site for the trial. "We'd been struggling to control humidity in the surgical theatres in the building for some time. The chiller pumps were undersized so we needed to address that, but at the same time, being able to conduct the trial, appealed. If we could combine the pump upgrade with the implementation of the new technology and it ticked all the right boxes, then I was keen to see what benefits we could achieve."

Stefan says the combination of the two has put them in a great position. "My understanding was that this new technology would keep our chillers in a new state which translates into significant energy savings, on an annual basis. What we have seen through the trial is that we don't have degradation which is worth quite a lot to us in terms of energy savings. Add to that the fact that the surgeons say the theatres are now more pleasant than they've been for as long as they can remember. So I would go so far as to say the combination of the upgrade to the chiller pumps and the DCI machine has worked brilliantly."

Gavin Cherrie from 2Plus, the New Zealand distributor of the DCI system, met with Stefan in 2016 to discuss the new technology and plan the trial. "Stefan's role is quite challenging, ensuring that mechanical services are maintained to really good standards so as to provide a world-class working environment for the medical staff,



Waikato District Health Board Maintenance and Facilities Engineer Stefan Van Rooij with the DCI machine.

and at the same time, having to reduce the cost of maintaining and operating of those services.

Baseline data was collected from October through to December. The DCI was installed and commissioned on site in December 2016. Shortly afterwards Excel Refrigeration completed the chilled water system upgrade. Performance monitoring continued through to late March with energy, waste and water data being collected.

## Promising findings to date from the trial

Gavin says, while the data is now going through full statistical analysis, indicative findings are pleasing. "In conventional water treatment systems, we expect to see an annual 15% decline in coefficient of system performance (COSP) due to scale build up. At the Kempthorne site, we have seen a small improvement in COSP over the 3 months of operation of

the DCI from an average of 3.23 to 3.50 (fig. 1). This is backed up by a measured 1.5°C reduction in Condenser Approach Temperature and a 2.5 °C reduction in Cooling Tower Approach Temperatures over the duration of the trial. That spells energy savings of better than 10% pa. As the plant has stayed clear of scale only the mandatory cleaning is now required to be done, reducing maintenance costs. Cycles of concentration have increased from 4.5 to 9, so we have halved the blowdown volume saving around 1.5 m<sup>3</sup>/day, in waste and make up water (fig 2). With no chemical costs, there's another substantial saving. The total financial benefit equates to a simple payback of well under 3 years on the investment."

Gavin says the much-improved chilled water system has increased the amount of heat removed from the theatre block. "This is being

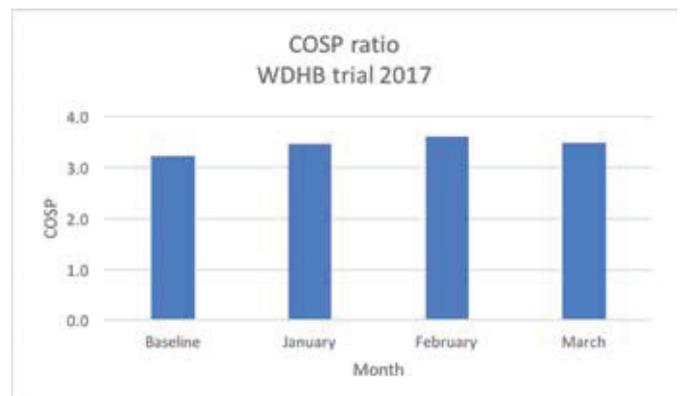


Fig. 1 Coefficient of system performance trend.



Fig. 2 Concentration ratio trend.

expelled through the cooling towers which are being maintained in near new condition by the DCI. Add to that the fact that the handling of packaged chemicals by staff and contractors on site has been eliminated for the Kempthorne Building which has eliminated safety hazards for chemical exposure and manual handling.”

Gavin adds the outcomes are similar to 2Plus findings from an independently monitored trial of the DCI conducted at Lakes District Health Board between November 2015 and March 2016. Rotorua Hospital has four water cooled package chillers supplying water at 6°C to the hospitals HVAC system. “Those results were close to what has been achieved at Kempthorne. A 17% reduction in electrical energy requirement across the total system, a 45% saving in water blow-down volume, descaling chemicals were eliminated and carbon emissions were reduced by 27,000kg CO<sub>2</sub>-e per annum.”

2Plus’s Andrew Coker says this DCI trial at Waikato Hospital has been exceptionally good for 2Plus, allowing them to put their technology stringently to the test. “The fact Waikato Hospital was prepared to trial the new disruptive technology, knowing their need to mitigate risks in the best interests of safety, affirms our strong confidence in the DCI technology to deliver significant financial and environmental benefits. As Maintenance and Facilities engineer at Waikato DHB we were immediately struck by Stefan’s drive to seek continuous improvements. He was prepared to trial new disruptive technology. 2Plus has been the beneficiary of that...and so has Waikato DHB.”

Back at Waikato Hospital Stefan says the partnership to date with 2Plus has been a very positive one. “I have worked closely with them on the trial. It has to be right. It’s got to work for us if we are to consider it. They know their stuff and are very responsive to deal with. The trial has just concluded and we all need to agree on the data from the findings but indications are certainly good and if it ticks all the boxes, which it looks like it might, then sure I’d be keen to roll it out across the site.”



Andrew Coker and Gavin Cherrie with the new technology DCI machine.

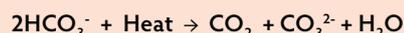
## THE DCI TECHNOLOGY EXPLAINED

### Electrochemical control of water scale for cooling towers.

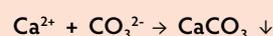
#### Water Scale.

Naturally occurring ions seen in New Zealand cooling tower make-up water (collectively termed water hardness) include, calcium (Ca<sup>2+</sup>), magnesium (Mg<sup>2+</sup>), sodium (Na<sup>+</sup>), chloride (Cl<sup>-</sup>), sulfate (SO<sub>4</sub><sup>2-</sup>) and bicarbonate (HCO<sub>3</sub><sup>-</sup>).

Bicarbonate ion is soluble but thermally unstable and, under the conditions found in cooling systems, quickly degrades into carbon dioxide and carbonate ion according to;



Recirculating water in the cooling loops rapidly becomes supersaturated in calcium and carbonate ions and calcium carbonate precipitation can occur.



The effect of mineral scale on system energy consumption is pronounced. A technical review by Dr Akira Nakayama, Professor of Mechanical Engineering at Shizuoka University (Japan), concluded that a 0.1 mm scale deposit could increase refrigeration system energy consumption by up to 15%.

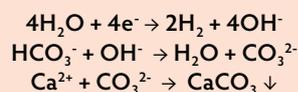
#### Traditional scale deposit control strategies.

Conventional cooling tower treatment makes use of blow down to reduce accumulated solids in combination with chemical additives. Demand to cut costs, reduce resource consumption, health and safety risks and concerns about discharging chemical additives which eventually make their way to sanitary or surface waters has resulted in greener alternatives to chemical additives being investigated.

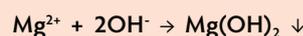
#### A new deposit control strategy.

A new strategy for controlling calcium carbonate deposition relies much less on blow down for calcium removal. This approach employs electrolysis to provide both the chemistry and removal facility to capture calcium carbonate fast enough to effectively limit micro crystal development.

In the past water hardness deposits have been troublesome in electrochemical processes such as chlor-alkali production. The cathode of an aqueous electrolytic cell forms hydroxyl ions that freely act to increase carbonate activity and scaling.



Magnesium hydroxide is created in a similar fashion.



A mechanism problematic in one application pointed to a means of beneficially capturing scale forming ions in another. A continuous side stream electrolysis unit can be incorporated into a cooling loop. The cell accumulates scale deposits which can be periodically removed (by electrode polarity reversal) and safely discharged from the cooling water loop. Electrolysis provides a means for clean capture, fixation and removal of scale forming minerals that requires no chemical introduction or handling, reduces blow down volumes by up to half, reduces maintenance costs and improves energy efficiency in water cooled refrigeration systems.

# DISRUPTIVE NEW TECHNOLOGY DELIVERS SIGNIFICANT COOLING WATER TREATMENT ADVANTAGES

Since launching the DeCalon™ (DCI) 18 months ago 2Plus has been changing the way big industry and building owners are managing their cooling water and delivering impressive energy, water, waste, chemical and maintenance savings.

2Plus is the New Zealand distributor of descaling, corrosion and biological-control technologies that eliminate the requirement for chemical treatment in evaporative cooling systems. The technology was developed in Singapore, and has Singapore Green Building Certification.

The DCI is a rethink on the way water is treated. It is green chemistry in action and in trials across the North Island the system is producing impressive results.

## Eliminating scale from water cooling systems without chemicals

Through applied electro-chemistry and a patented intelligent controller, the DCI system removes water hardness from cooling systems without the need for hazardous chemicals.

It's a revolutionary approach that removes existing scale deposits and prevents further scale formation by driving a non-spontaneous redox reaction. The main causes of scaling  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$ , are precipitated in a side stream well away from critical heat transfer surfaces.  $\text{CaCO}_3$  and  $\text{Mg(OH)}_2$  are then removed from the recirculating cooling water. Silica ( $\text{SiO}_2$ ) is also removed.

The DCI operates continuously ensuring peak heat-transfer efficiency is maintained at all times. The result is a saving of between 15% - 25% in energy use in the chiller circuit when compared to chemical-based treatment systems. The need for non-regulatory shut-downs for cleaning and descaling is removed, and water and waste-water quantities are significantly reduced.

The DCI process is electrolysis, basic electro chemistry. What differentiates the DCI is its intelligent controller and its ability to remove only the scale forming ions to maintain good heat transfer but without the risk of corrosion.

On-going maintenance of the DCI system is minimal, and principally limited to the regeneration of the electrodes following



A DCI unit in action at Scales Corporation's Whakatu Coldstores site.

150,000 amp-hours of operation – approximately every two years. The system can be connected to building and operations management systems through a communications port within the unit.

An independently monitored trial was conducted at Lakes District Health Board between November 2015 and March 2016. Rotorua Hospital has four water cooled chillers supplying chilled water at 6°C that is distributed throughout the hospital's HVAC system.

The trial was conducted on Chiller Nos 3 and 4, which are Carrier Model 30XWO552P water cooled package units using refrigerant R134a and have a cooling capacity of 571kW each.

Pre-trial monitoring ran for 12 days to set a baseline energy consumption. The DCI unit was then installed and the trial ran with continuous monitoring of key parameters such as COP, condenser and cooling tower approach temperatures and concentration ratio. Throughout the trial the existing chemical treatment system was isolated as the descaling process was taken over by the DCI units. pH was maintained between 8.5 and 8.8. Oxidation Reduction Potential, an indicator of corrosion, was maintained at less than 150mV.

Trial findings were impressive:

- 17% reduction in accumulated electrical load across the total system.
- 50% saving in water blow-down volume
- Descaling chemicals eliminated
- Carbon emissions reduced by 27,000kg  $\text{CO}_2\text{-e}$  per annum

A trial just completed at Waikato District Health Board's Hamilton Hospital, while still being evaluated, is demonstrating similar results to those seen at the Rotorua hospital. With results like these it's little wonder 2Plus is creating ripples across the industry sector with their restorative solutions through science that are changing the way we manage water – for good.

## THE DCI DEVICE IS GREEN CHEMISTRY IN ACTION AND DELIVERS SIGNIFICANT BENEFITS

**6-10**  
% LESS  
WATER

**10-25**  
% LESS  
ENERGY  
CONSUMPTION

**30-50**  
% LESS  
WASTE

**100%**  
LESS  
CHEMICAL  
COSTS

For more information please visit [www.2plus.co.nz](http://www.2plus.co.nz)