INDUSTRIAL WATER TREATMENT:

TOWARDS SMART CHEMICAL WATER TREATMENT

BASED ON THE PAPER "EFFICIENT CONTROL OF CHEMICAL TREATMENT FOR WASTEWATER REUSE IN COOLING TOWERS" (DECHEMA INDUSTRIAL WATER 2020 17-19 NOVEMBER, FRANKFURT)

INCREASE RELIABILITY **MINIMISE** RISKS **AUTOMATE** REPORTING

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INTRODUCTION

Whenever we use water, we also change the content and thus the water quality. In many countries the water needs to be treated afterwards to avoid contamination of the water cycle by industrial substances. A focus area for Grundfos is to help industry in reducing total water consumption within a water reuse system and to increase system performance and reliability by rethinking decentralised water treatment processes.

PURPOSE

This article discusses the important role of water in industrial markets as a solvent, cooling liquid, wash and clean liquid and in many more applications. The article is based on a paper presented at DECHEMA Industrial Water 2020 17-19 November, Frankfurt, entitled "Efficient control of chemical treatment for wastewater reuse in cooling towers." The specific example from this paper shows how the disinfection concept using chlorine dioxide in an industrial facility's cooling tower enables the owner and operators of the building to maintain the cooling system in a safe and reliable way. Finally, we look ahead to the potential with remote monitoring from a chemical management system to further reduce scaling and fouling in pipes and systems and reduce resource demanding compliance reporting.

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By **Pablo Andres Tojo**, Application Specialist, **Marco Witte**, Application Manager and
Dr. Carsten Persner, Business Development Manager – Industrial Water Treatment, Grundfos

CHALLENGES FACING THE INDUSTRY

Industrial manufacturers are in constant search of operational cost reduction that allows them to stay competitive. However, two other aspects are becoming more relevant nowadays: compliance with regulatory requirements, conservation and corporate responsibility.

The costs associated with different water treatment steps to achieve a required water quality can be different, depending on its source and the purpose of utilisation. Therefore, the concept fit-for-purpose becomes relevant from an economical aspect.

In the regulatory requirements field related to wastewater and reuse, companies face two challenges. On the one hand, the properties of the wastewater produced and eventually discharged to public sewers or the environment must comply with strict national or local regulations. And on the other hand, the volume reduction of wastewater which is allowed to be discharged must be achieved.

Finally, water scarcity and the image perception from stakeholders for sustainable operations are fundamental reasons for industries to look into new alternatives or methods to reduce their water consumption, for example by implementing water reuse practices.

AN INDUSTRIAL FACILITY'S COOLING TOWER

Let's examine the example of a cooling tower case within an industrial site in Singapore. In this specific case, the reused water was not treated and reused on site but was so-called 'new water' – a wastewater centrally treated and distributed throughout the city as technical water – which has a high quality but also a high biological regrowth potential [1]. The cooling tower is installed as an open system on the roof of an industrial building. The building hosts office and production facilities for approximately 200 people. The location of the system in Singapore is on the equator with an average outside temperature of 25-30° C.

This means the building needs constant climatization, so the system must provide cooling 24/7. The system consists of two towers and two chillers with a system flow of 26 l/s.

THE ORIGINAL TREATMENT SOLUTION

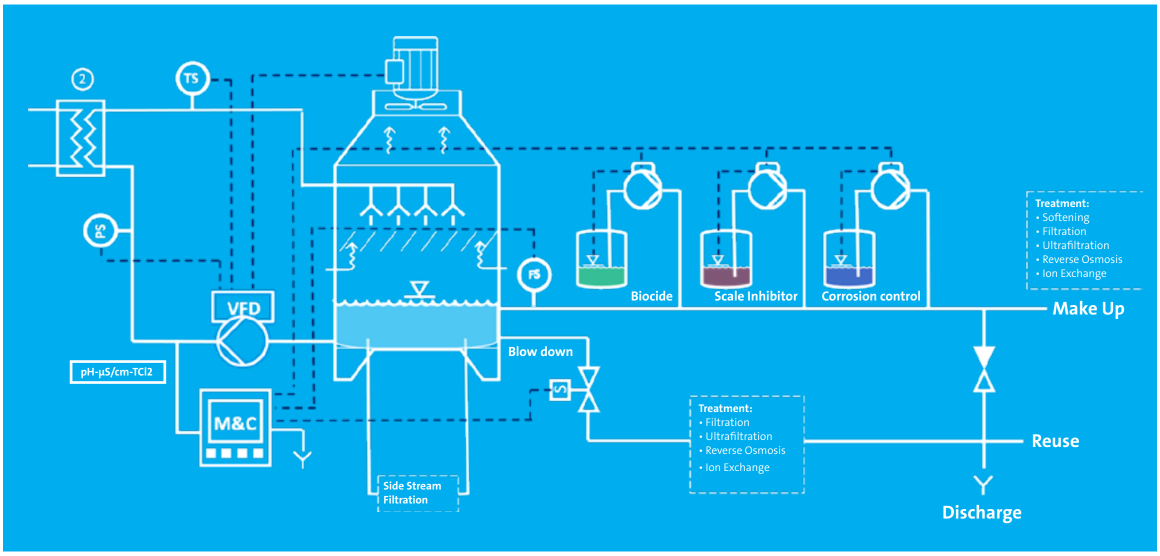
In the original system, water quality was maintained with an UV system operated in a bypass. Furthermore, the cooling tower was manually cleaned in monthly intervals by operations personnel, and the water was exchanged in bi-weekly cycles. The whole system was set up as a duty standby system. The system was built in 2013, and the growth of biofilm was observed after half a year.

The evidence was that the installation of the UV system in a bypass didn't provide any disinfection effect at all. The whole set-up was built without remote control options, which means that the company responsible for the operation and functioning of the cooling tower had to visit the site on a regular basis for inspections and potential actions, which is costly and not effective. The risk of missing events and contaminations is quite high in a manual process such as this.

Biofilm growth at the pipes and the reservoir of the cooling tower

THE NEW CHLORINE DIOXIDE SOLUTION

The solution chosen to solve the biofouling problem and also to remove the existing biofilm was an on-site chlorine dioxide generator to dose chlorine dioxide instead of UV disinfection in a bypass. Chlorine dioxide is a proven method to avoid biofouling in cooling towers. It also allows a reduction of cleaning intervals which are done manually by the facility management. Furthermore, we proposed digital dosing pumps for dosing anti-scalants and for pH correction. All three chemicals are monitored by a chemical measurement system, which measures chlorine dioxide concentration, pH and conductivity in the recirculation loop. Instead of a continuous dosing rate, a shock dosing strategy is applied. The number of shots per day is calculated as four times. However, the concentration in the water is measured continuously online and the four shots are only done if the chlorine dioxide concentration drops below a certain level. The strategy behind this is to minimise the use of chlorine dioxide as much as possible.



Generic set-up of chemical dosing in an industrial cooling tower

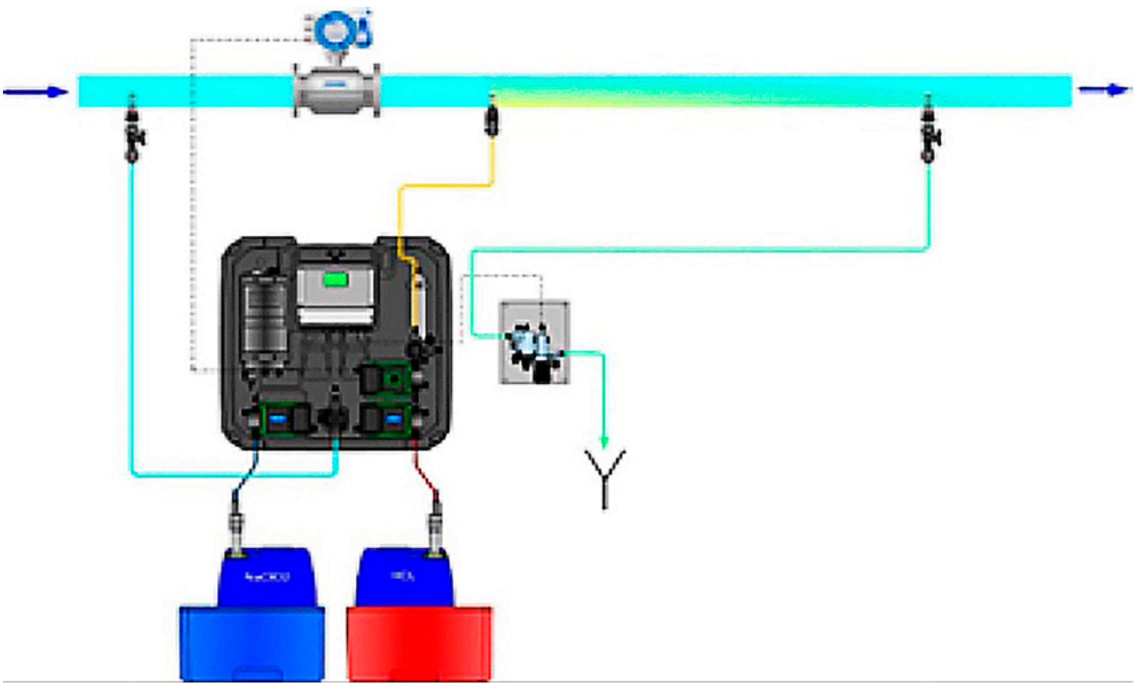
The goal for this new operation mode is a reduction of energy losses due to the biofilm, a reduction in the use of cleaning chemicals and, last but not least, a reduction in labour hours for monthly cleaning. Savings in terms of water usage are achieved, as the interval of bi-weekly replacement of all water in the tower should be avoided. Furthermore, the system is kept clean to avoid microbiological contamination as far as possible. A last manual cleaning of the system was performed to start with a contamination-free system. The dosing point is located in the cooling water supply line. The measurement of the chlorine dioxide is done in the reject line of the cooling water.

CHEMICAL PREPARATION FOR COOLING TOWERS

In detail, this is how the technical solution was put together. The selected system generates a chlorine dioxide solution with a concentration of maximum 2 g/l and a capacity of maximum 60 g/h. The system is specified as shown in the table.

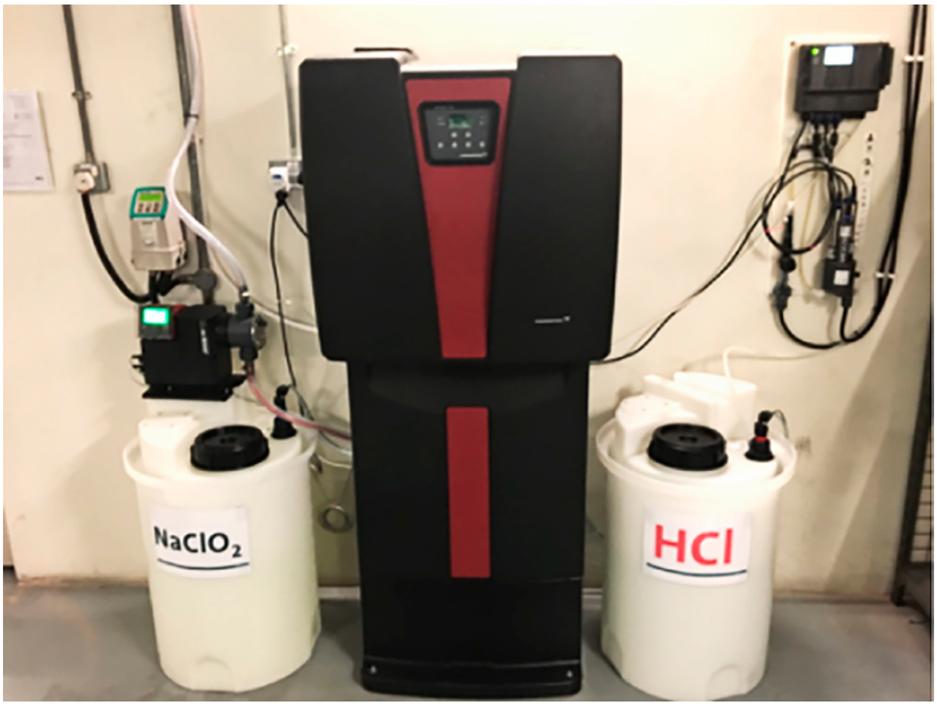
SIZING	
26 l/s	CW flow
93.6 m^3/h	CW flow
0.5 ppm	Concentration of ClO2 required during operation
46.8 g/h	Max. ClO2 capacity expected
SYSTEM SELECTION	
60 g/h	Oxiperm Pro 60
2 g/l	[ClO2]
60 l/h	Dosing Capacity
DISINFECTION STRATEGY	
4 n/day	Numbers of shots per day
2 h	Running time per shot
46.8 L	Volume required per shot
4 h	Hours between shots
120 L	Production capacity between shots (from final of first shot to start of second shot)
CHEMICAL CONSUMPTION	
187.2 L	Daily consumption of ClO2 solution
374.4 g	Daily consumption of ClO2
11.5 L	Daily consumption of NaClO2 (EN 938) 7.5%
10.2 L	Daily consumption of HCl (EN 939) 9%

System specification for the chemical preparation



Installation of the disinfection system including flow and chemical measurements

A measurement and control system was installed to control the dosage of the biocide. The whole system is connected to the Building Management System (BMS) for the building to provide documentation and evaluation. The installation and the results from cleaning are shown in the pictures.



The cooling tower after cleaning and the installed Grundfos Oxiperm chlorine dioxide generator

LOOKING TO THE FUTURE OF REMOTE MANAGEMENT

As mentioned above the initial whole operation was built on manual operation and supervision. Site visits were needed, and high levels of activity required by service providers for facility management. Of course, this was not foreseen when the cooling tower solution was originally installed. However, the owner insisted on a remote-control solution. One of the major issues that we expect to be resolved by implementing the remote management tool is the resource-demanding and occasional compliance reporting. This was previously carried out manually and prone to human error; remote monitoring will ensure that evidence is logged that chemical treatment is carried out correctly. This can then be utilised for internal records or to present to the authorities when required.

Another obstacle faced is the chemical storage and preventive action to monitor the chemical levels before running low, to ensure stop-free treatment. Chemical handling (sometimes hazardous) requires trained personnel onsite for control and exchange of the chemical canisters.

We continue to work with the owner and operator of the cooling tower to ensure smarter monitoring and control of dosing and safer chemical handling.

CONCLUSION

Using the method described to further treat reused water for the industrial facility's cooling tower, we enable the owner and operator to maintain the cooling system in a safe and reliable way. The first available data has already shown positive effects; however, long-term monitoring is needed for this installation to reduce operational cost even more and at the same time increase the reliability of the system.

Source

[1] https://www.pub.gov.sg/Documents/PUB_NEWater_Quality.pdf

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GRUNDFOS PUMPS LTD
Grovebury Road, Leighton Buzzard
Bedfordshire LU7 4TL
Tel: +44 (0)1525 850000
Email: grundfos-uk@sales.grundfos.com
www.grundfos.uk

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