

Biofilm effect on Cooling Towers for industrial purpose



Cooling towers are used widely in the industry for cooling down a process, there exist many version or types of cooling towers, and each designed with its advantages for the process. The generic term "cooling tower" is used to describe both direct (open circuit) and indirect (closed circuit) heat rejection equipment. While most think of a "cooling tower" as an open direct contact heat rejection device, the indirect cooling tower, sometimes referred to as a "closed circuit cooling tower" is nonetheless also a cooling tower. In this case it will be focused on open circuit cooling towers where biofilm is created because of direct contact of the air and water.

In cooling towers 3 major issues has to be taken into account to withstand an efficiency and lifetime reduction

1. Growth of Biofilm
2. Scaling and fouling
3. Corrosion

In this abstract it will be focus on biofilm because of its major impact on the efficiency of cooling towers.

Biofilm is a major concern in cooling towers because of the reduction of efficiency and bacteria growth as Legionella. The water system provide a favorable environment for the growth of microorganisms. The microorganism growth on the wetted surfaces who cause formation of biofilms. The reason why biofilm is an important matter in cooling towers is the fact, that it will create fouling, this will affect the performance of the equipment, and will lead to metal corrosion. The harbored microorganism and the following fouling will take place at any surface in the whole construction system, from tower over pipe line and the refrigeration system e.g. with build in Chiller or heat exchanger.

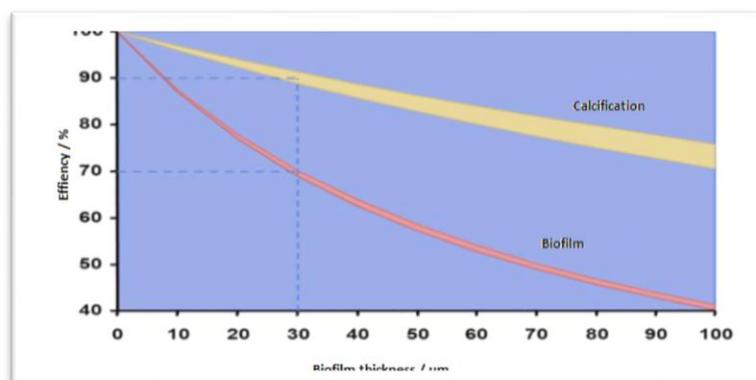
Below figures show the 3 stages of how biofilm grows in a cooling tower system. First it will attached to surface, where e.g. the Legionella bacteria grows in biofilm, this lead to increased thickness, the efficiency will drop and at the same time risk of Legionella infection will increase



Biofilms develop slowly at first, because only a few organisms can attach, survive, grow, and multiply. As populations increase exponentially, the depth of the biofilm increases rapidly. Biofilm polymers are sticky and aid in the attachment of new cells to the colonized surface as well as the accumulation of nonliving debris from the water. Legionella bacteria will be airborne and can course Pontiac disease, or even worse Legionella disease who in worst case lead to death. The growth of Legionella Bacteria in cooling towers and its effect on the surrounding environment are enrolled in legislation and under discussion in many countries.

Control biofilm growth is equal to Legionella control.

Below figure show the relationship between thickness and efficiency of calcification and biofilm, where the thickness of the biofilm has greater impact as scaling on a wetted surface. Scaling typically occur if not treated water is used, scale inhibitor are widely used in cooling tower systems,

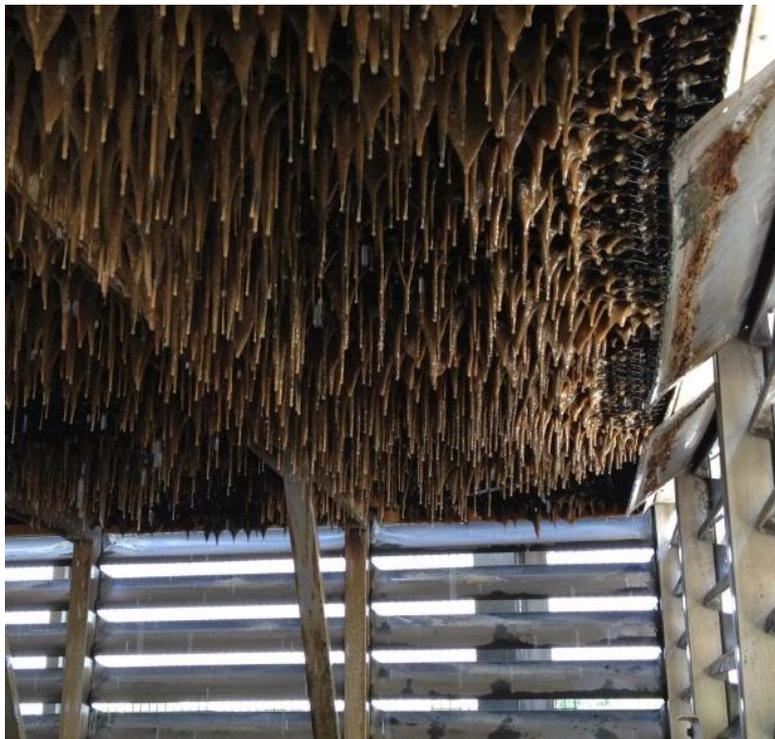


Fouling is deposit in the cooling tower, this can occur in the whole system as earlier described. Fouling occurs when insoluble particulates is suspended in recirculating water.

Handling of corrosion need a change in either the used metal of a cooling tower, this is not practical because of cost, or the environmental internally in a cooling tower has to be changed, this is widely done be using corrosion inhibitors. To use a sacrificial anode is also a way to overcome corrosion.

Cooling tower water contain both fresh make up water and recirculating water, the relationship between this differ in relation to the environment in the cooling tower.

Reduced heat transfer in cooling tower due to biofilm is a problem in many installations, and need attention.



Because of biofilm build up on the surface a dramatic drop in efficiency occur. It has been shown that the efficiency typically can be reduced with up to 15%, above picture illustrate how a cooling tower can harbor biofilm. A reduction of efficiency is obviously.

Technologies in use for obtaining the right environment in cooling towers.

Comparison of technologies used in Cooling Towers are highlighted in below sheet.

Comparison of technologies						
	UV	Sodium Hypochlorite	Chlorine Dioxide	Ozone	Silver Nano Particles	DCW Danish Clean Water
Prophylactic effect	No	Yes	Yes	Limited	Yes	Yes
Destroys biofilms	No	Limited	Yes	Limited	Limited	Yes
Safe for operators	Yes	No	No	Yes	Yes	Yes
Effective against legionella colonization	No	Yes	Yes	Limited	Yes	Yes
Environmentally safe	Yes	Yes	Yes	Yes	Strong concerns	Yes

DCW Technology

DCW generators use the ECA technology to produce the non-toxic, close to pH neutral, safe disinfectant - NEUTHOX®, in which hypochlorous acid is the active substance. Hypochlorous acid is highly effective in eliminating most infection causing bacteria such as Legionella, E.coli, Listeria and Salmonella.

NEUTHOX® is therefore powerful enough to eliminate dangerous bacteria in water systems, and on work surfaces, while being completely safe for humans, and animals, and having close to zero impact on the environment.

Neuthox® is made out of Salt + Water + Electricity,



Neuthox® is generated onsite, this mean no cost or purchase of biocide

DCW Neuthox[®] generator are showed below, the system is built on 3 main parts

1. Neuthox[®] Generators, containing the process and electrical control
2. Container with salt (ordinary salt)
3. Container for produced Neuthox[®]



DCW System Features

- Generator for constant production of Neuthox[®] in a range from 6 – 8,6 pH
- Build in salt container
- Buffer tank for Neuthox[®] with build in level sensor
- Build in water softener and build in descaling system
- Fully automatic operation
- Multiple language, (German, English, Danish, Polish, Portuguese, Italian, France, Netherland, Swedish, Hungarian, Turkish, Slovenian, Finnish, Rumanian)
- Ease of use, PLC controller with build in touch screen
- External communication: Modbus TCP/IP communication, Ethernet, GSM
- Local alarm management: Onside alarm indication, Zero potential output
- 15,000 hour guaranteed operation time for build in Electrolyze cell
- Corrosion resistant cabinet

Use of Neuthox[®] in Cooling Application

Neuthox[®] contain Free Active Chlorine (FAC) and chloride, and used in cooling water application with a Oxidization Reduction Potential (ORP) set point of 520 mV, this will contribute with 0,1 -0,2 ppm FAC into cooling water.

No corrosion due to the use of Neuthox[®] at all.

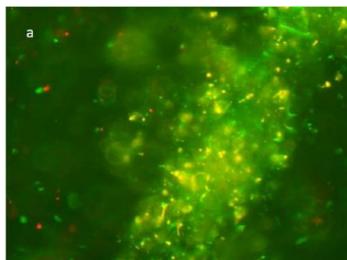
By dumping 15 liter basin water extra per liter Neuthox[®] added, the chloride level will be kept below corrosion risk level

If the usage of corrosion inhibitor for cooling tower is wanted, inhibitor for system with traditional chlorine disinfection products is needed.

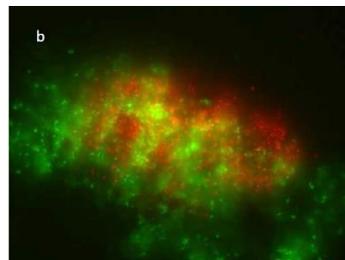
Destroying of bacteria and biofilm

Neuthox[®] secures a total elimination of biofilm in cooling tower application and it can take up to several month before all biofilm is removed, therefor operation manager has to secure that extra water is dumped because contaminated water with destroyed biofilm.

Increase of dead cells in biofilm under the influence of Neuthox[®]



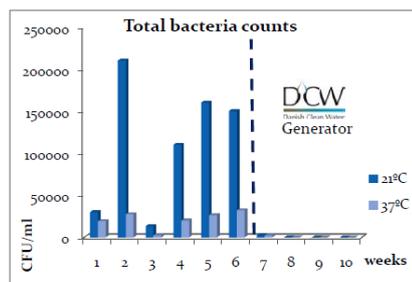
(Figure a)



(Figure b)

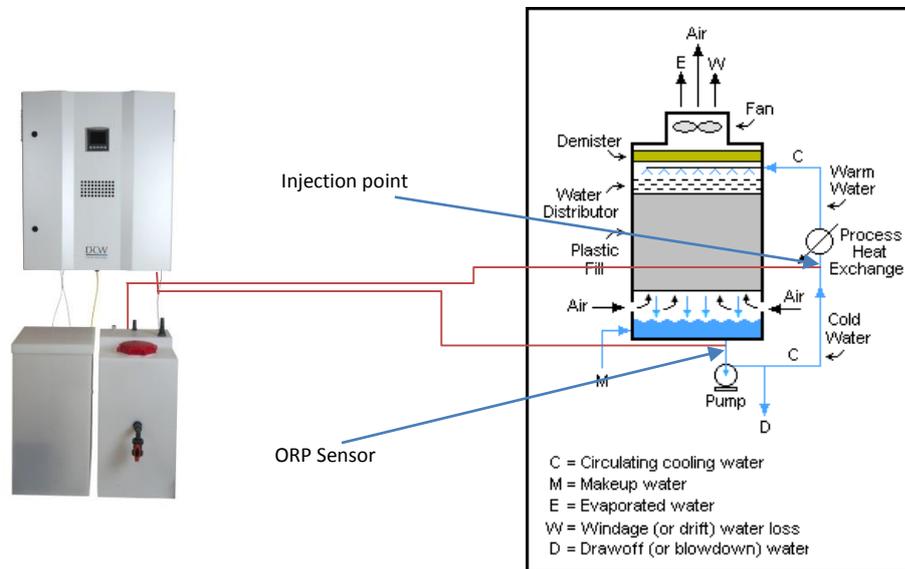
Figure a, show untreated biofilm. After two hour treatment with Neuthox[®] with 0,5 ppm FAC the red areas in Figure b indicate dead cells in biofilm.

Below sheet shows the bacteria count, before and after DCW generator was installed.



The DCW technology is based on continuously water treatment to secure a constant drop to zero in bacteria growth.

Schematic Installation overview



The DCW Generator have 2 points of connection with the cooling tower

1. ORP sensor
2. Injection point for Neuthox[®]

Conclusion:

DCW Neuthox[®] Generator destroys biofilm in cooling tower application, this has been demonstrated in many application, and a reference list can be handed out if needed.

Destroying the biofilm support the goal of getting a more effective cooling towers in two ways.

1. Control biofilm growth is equal to Legionella control.
2. Control biofilm growth increase the efficiency

Danish Clean Water is always obliged to develop a project who contain a test run to show the effectiveness of the system.

The ECA technology is not a new technology and not invented by DCW, it is a technology who is on its rise because companies needs for chemical reduction and increased efficiency. Reducing the amount of chemicals is obviously by installing the DCW system.

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