Cooling water treatment and biocide use

Holger Ohme

The chemical treatment of cooling water aims to prevent deposits and to ensure corrosion protection, with an increasing focus on controlling microbiological activity. Modern water treatment techniques rely on demand-based dosing of chemicals and biocides through monitoring and automation. Critical deposits, especially biofilms, are caused by microbiological growth and contribute to over 30% of corrosion damage. The use of phosphonates as hardness stabilizers requires formulations that are stable to oxidizing agents, while the demand for biodegradable dispersants is increasing. In addition, fouling by mussels, especially the quagga mussel, poses a challenge for cooling systems. When selecting oxidizing biocides, consumption factors must be taken into account, since various substances can influence the effectiveness. Monochloramine offers an economical alternative to other biocides because it acts selectively and shows fewer side reactions. Advances in technology enable precise control of biocides and inhibitors through maintenance-free sensors and imaging techniques.

The basic principles of chemical cooling water treatment is to prevent deposits, to provide active or passive corrosion protection depending on the water quality, material selection and operating conditions, with increasing focus on controlling microbiological activity and hygiene. When using treatment chemicals and biocides, the focus of modern water treatment is on demand-based dosing by means of monitoring and automation.

In most cooling waters, operators deviate from a non-critical water quality in the area of the lime-carbonic acid equilibrium in order to minimize the required amount of fresh water for the evaporation cooling system while maximizing the cycles of concentration. In addition to the inorganic parameters relevant to deposits, including corrosion by-products (e.g. iron, hardness salts, silicate, phosphate), and especially at higher hydraulic retention times and with other stimulators for microbiological growth (temperature and nutrients), biofilm is a critical and rapidly forming deposit (Figure 1). Furthermore, more than 30 % of corrosion damage in evaporation cooling systems can be directly or indirectly attributed to microbiological activity.

Phosphonate-based hardness stabilizers, which, unlike acids, do not reduce the concentration of carbonates in the circulating water but instead inhibit crystal growth by modifying the surface in line with the threshold effect, must be resistant to oxidizing agents when oxidizing biocides

are used regularly to ensure their full effectiveness. Increasingly stringent requirements are being placed on biodegradability. In particular, the polymers used as dispersants to keep crystals, metal oxides and solids in suspension can now be made available on the market with sufficiently high biodegradability and via fossil-free production methods, for example based on corn starch, while fully retaining their technical properties. At the same time, efficiency in hardness stabilization has been significantly improved in recent years by pure polymer treatment programms. Hardness stabilization can now

■ Inhibition of heat transfer

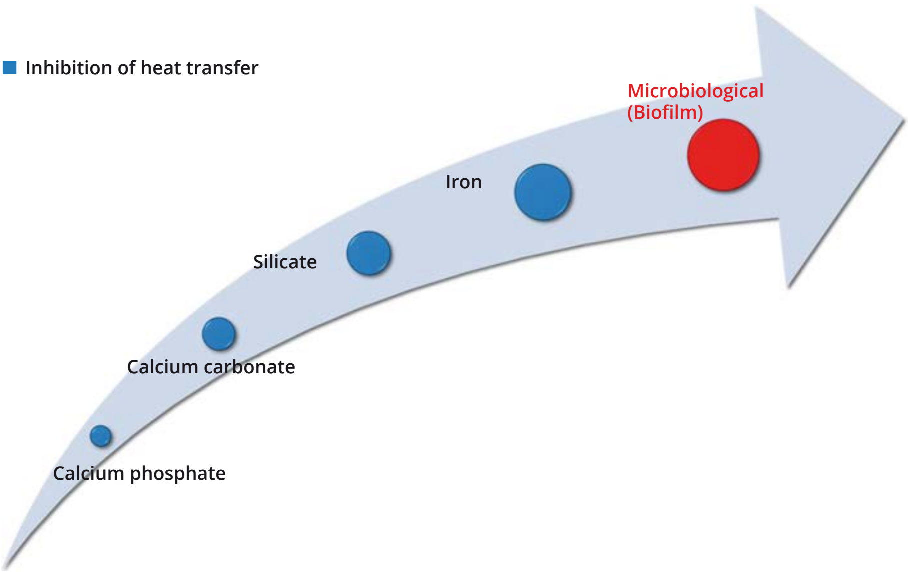

Fig. 1. Inhbition of heat transfer.

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be achieved with moderate concentrations of a few mg/l active substance polymer up to Langlier indices (LSI) of 2.5. An LSI of up to 3.0, as is the case with commercially available phosphonates, is possible, but requires higher polymer concentrations, which reduces economic efficiency and can increase the COD input via chemical conditioning to critical levels when the blow-down is discharged directly. However, in synergy with very low concentrations of phosphonates, operating modes with very low phosphorus concentrations can be achieved. The increasing use of polymers offers great potential for the decarbonization of chemical cooling water treatment. At the same time, the inorganic phosphates used for corrosion protection can be replaced with equivalent technical results or their concentrations can be minimized.

For operators of cooling systems with river water in once-through or circulation mode, the increasing fouling pressure from mussels is a problem. Currently, the quagga mussel (Dreissena rostriformis), which grows at greater depths or at lower temperatures, is becoming more prevalent than the zebra mussel (Dreissena polymorpha), which was previously more common. This should be taken into account when operating heat exchangers and pipe networks with river water flowing through them. Large tube bundle heat exchangers can be protected mechanically by sponge ball cleaning systems. However, larvae can also spread and mussels can also grow in pipe networks and circulating water systems, sometimes all year round depending on the temperature level and nutrient supply. The entry of mussels can be prevented by coarse filter systems, and the entry of mussel larvae can be reduced by up to 80% by sand filter systems. For a higher retention, filter systems with a separation efficiency of < 50 µm must be installed. The demand-driven use of oxidizing biocides is also possible. The concentration of mussel larvae and the fouling intensity often correlate with an increase in chlorophyll concentration in river water and coastal brackish and salt water. An inline fluorometer for continuous measurement of chlorophyll concentrations and biofilm sensors can be useful tools for continuous monitoring. The selection of a suitable biocide is also based on the active ingredients that can be approved for direct discharge at larger water consumers. The required active ingredient concentration and exposure time can vary depending on the mussel species.

When selecting and using oxidizing biocides (Figure 2 and Table 1) for evaporative cooling systems, the degradation characteristic for these active ingredients must be taken into account. This applies to gases introduced via the supply air, such as ammonia, cooling water contaminated with organic substances such as oils, fats, sugars, and substances contained in the make-up water such as iron, manganese and sulfides.

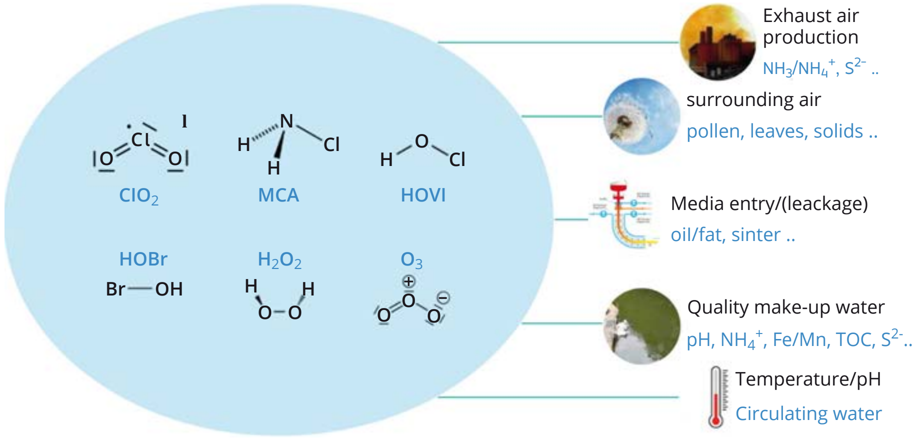

Fig. 2. Oxidizing biocides.

Tab. 1. Oxidizing biocides, Henry constant.

Oxidising biocide	Henry constant at 20°C (relative volatility)
Chlorine dioxide – ClO_2	54
Monochloramine – MCA	0,45
Hypochlorous acid – HOCl	0,08
Hypobromous acid – HOBr	0,04

In dynamic evaporative cooling systems with high circulation rates compared to the system volume, volatility must be taken into account. As a dissolved gas, chlorine dioxide is very volatile compared to chlorine, active bromine or monochloramine. This can increase the treatment costs due to the stripping losses via the water irrigation in order to achieve a sufficient concentration of active ingredient and contact time.

Monochloramine can be an economical alternative, especially in water with a high organic and inorganic load, as it shows hardly any side reactions with oxidizable substances over a wide pH range and reacts very selectively with the disulfide bridges in the cell membrane of bacteria. Despite its comparatively low oxidizing power, monochloramine can be used to achieve very good disinfection results and good biofilm control. The low oxidation-reduction potential at the corresponding concentration of total chlorine in direct comparison sometimes leads to measurably lower corrosion rates with frequent use of biocides. In general, a case-by-case analysis is required when selecting a suitable biocide. The effect on required quantities, in addition to the consideration of the minimization requirement, also influences the total costs of the treatment.

Meanwhile, biocides can be controlled as needed via online measurable parameters such as biofilm growth and legionella concentration. The direct active ingredient concentrations of chlorine dioxide, chlorine or monochloramine can be reliably measured and controlled by maintenance-free sensors with mechanical cleaning systems. Maintenance-free inline fluorometers have become increasingly established for controlling inhibitors. In addition to the continued use of test specimens (coupon method) to determine corrosion rates using the weight loss method, imaging techniques are complementing this method to display the corrosion rate and damage pattern in real time and to evaluate the effects of the use of inhibitors. Online monitors for circuit water quality in evaporative cooling systems are becoming increasingly important for ensuring operational stability and demand-driven chemical dosing.

Kurzfassung

Kühlwasserkonditionierung und Biozideinsatz

Die chemische Behandlung von Kühlwasser zielt darauf ab, Ablagerungen zu verhindern und den Korrosionsschutz zu gewährleisten, wobei der Schwerpunkt zunehmend auf der Kontrolle der mikrobiologischen Aktivität liegt. Moderne Wasseraufbereitungstechniken basieren auf einer bedarfsgerechten Dosierung von Chemikalien und Bioziden durch Überwachung und Automatisierung. Kritische Ablagerungen, insbesondere Biofilme, werden durch mikrobiologisches Wachstum verursacht und sind für über 30 % der Korrosionsschäden verantwortlich. Die Verwendung von Phosphonaten als Härtestabilisatoren erfordert Formulierungen, die gegenüber Oxidationsmitteln stabil sind, während die Nachfrage nach biologisch abbaubaren Dispergiermitteln steigt. Darüber hinaus stellt die Verschmutzung durch Muscheln, insbesondere die Quagga-Muschel, eine Herausforderung für Kühlsysteme dar. Bei der Auswahl oxidierender Biozide müssen Verbrauchsfaktoren berücksichtigt werden, da verschiedene Substanzen die Wirksamkeit beeinflussen können. Monochloramin bietet eine wirtschaftliche Alternative zu anderen Bioziden, da es selektiv wirkt und weniger Nebenreaktionen aufweist. Technologische Fortschritte ermöglichen eine präzise Steuerung von Bioziden und Inhibitoren durch wartungsfreie Sensoren und bildgebende Verfahren.

Flue Gas Cleaning 2025

vgbe Workshop

21 and 22 May 2025 | Riga | Latvia

Flue Gas Cleaning 2025

The annual vgbe Workshop on Flue Gas Cleaning is organised by the vgbe Technical Committee "Chemistry & Emission Control" in order to provide a platform for vgbe members and other interested experts for information about and discussion of developments in pollutant abatement and in the experience gained in operation of flue gas cleaning installations.

This workshop covers all aspects of flue gas cleaning activities for NOx, dust and SO_2 removal as well as of online monitoring and instrumentation for emission detection. Current local and international changes in the operation of power plants are also considered.

Conference programme

WEDNESDAY, 21 MAY 2025

12:00	Opening conference office – Lunch / Welcome
13:00 V01	Operating of flue gas cleaning systems while firing 100 % biomass in coal-fired power stations *Jan Middelkamp, DNV Netherlands B.V., Arnhem / The Netherlands*
13:30 V02	Derisking carbon capture through flue gas characterisation *Marten Kooistra, Hélène Lepaumier, Han Huynh Thi, ENGIE Laborelec S.A., Linkebeek / Belgium*
14:00 V03	SO3 and dual flue gas conditioning technologies: ESP numerical model *Luca Crudeli, Piers de Havilland, Fuel Tech s.r.l., Italy/ USA, H. Suchwani, Jim Ferrigan, Fuel Tech Inc., USA, Henry Krigmont, Allied Environmental Technologies, Inc., USA*
14:30	Coffee break
15:15 V04	SCR DeNOx catalyst design in CHP plants and upstream carbon capture plants *Anders Nielsen, DeNOx Environment Europe S.R.L., Kongens Lyngby / Denmark*
15:45 V05	SCR outside the power sector – valuable experience *Luca Fiandaca, Antonio Alarcon, ENGIE Laborelec S.A., Linkebeek / Belgium*
16:15	Coffee break
17:00 V06	Retrofit and optimization of SNCR systems – flexible solutions for complying with the new NOx limits *Daniel von der Heide, Bernd von der Heide, M&S Umwelttechnik GmbH, Essen / Germany*
17:30 V07	Efficiency increase of incineration plants due to heat recovery from flue gas cleaning systems *Wolfgang Schüttenhelm, WS Management & Engineering UG, Wiehl / Germany*
19:00	Joint Dinner

THURSDAY, 22 MAY 2025

09:00 V08	Flue gas reimagined: turning a waste stream into valuable resources *Laura Kuukkanen, Tarja Korhonen, Valmet Technologies Oy, Tampere / Finland*
09:30 V09	Complex environments generate solutions *Thomas Schröder, Lechler GmbH, Metzingen / Germany*
10:00	Coffee break
10:45 V10	Hydrogen quality effect to generator performance *Kerim Kenan Kiremit, Eren Enerji Elektrik Üretiim A.S., Zonguldak / Türkiye*
11:15 V11	Evaluation of PFAS concentrations at key stages of a waste-to-energy process *Jane Abi Aad, François Vuong, LAB, Lyon / France*
11:45	Discussion / End of lecture program
12:00	Joint lunch
13:00	Visit of the TEC-2 AS Latvenergo combined cycle gas turbine power plant (2x 400 MW) via bus transfer
16:45	End of Workshop

Registration

https://register.vgbe.energy/40225/

Participation – Contact

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PRACTICAL INFORMATION

VENUE
Radisson Blu Latvija Conference & SPA Hotel
Elizabetes 55, Riga, LV-1010, Latvia

REGISTRATION
Registration is requested online. The invoice will be sent to you by e-mail; there will be no separate confirmation. The badges and workshop documents will be handed out to you at the conference office before the start of the workshop.

ONLINE REGISTRATION

https://register.vgbe.energy/40225/

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CONDITIONS OF PARTICIPATION

vgbe members (plus VAT)	690.00 €
Non-members (plus VAT)	890.00 €

The attendance fee includes the workshop programme, all documents, coffee and beverages, lunch buffet and dinner and the power plant visit on 21/22 May 2025.

The company AS Latvenergo invites all interested participants to the TEC-2 AS Latvenergo combined cycle gas turbine power plant (2 x 400 MW) via bus transfer.

CANCELLATION
The following processing fees will be charged for cancellation of the registration:

Up to 4 weeks prior to the conference	50 %
Within 4 weeks prior to the conference in case of non-registration or cancellation on the day of the event	100 %

Only written cancellations are accepted.

HOTEL ACCOMMODATION
Radisson Blu Latvija Conference & SPA Hotel
Elizabetes 55
Riga, LV-1010
Latvia
Keyword: FGC2025
Reservation Link: https://tinyurl.com/vgbe-flga25-h
(external shortlink)
Room rate single: 99 € incl. breakfast
Room rate double: 109 € incl. breakfast

Please book your hotel by end of April!

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Congress/Kongress

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Call for Papers!

11 & 12 September 2024
Potsdam, Germany

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Angela Langen
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vgbe/VEÖ Expert Event
River Management and Ecology

21 and 22 May 2024
Salzburg, Austria

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Konferenzen | Fachtagungen

DIHKW 2024
Energieversorgung Deutschlands – Chancen und Risiken

Fachtagung mit Fachausstellung

16. und 17. April 2024
Garmisch-Partenkirchen, Deutschland

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vgbe KELI 2024
Elektro-, Leit- und Informationstechnik in der Energieversorgung

mit Fachausstellung

14 to 16 May 2024
Bonn, Germany

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vgbe Dampfturbinen und Dampfturbinenbetrieb 2024
vgbe Steam Turbines and Operation of Steam Turbines 2024

mit Fachausstellung/
with Technical Exhibition

28 and 29 May 2024
Würzburg, Germany

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vgbe Chemiekonferenz 2024
vgbe Conference Chemistry 2024

mit Fachausstellung/
with Technical Exhibition

22 to 24 October 2024
Potsdam, Germany

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Seminare | Workshops

Basics Wasserchemie im Kraftwerk

vgbe | Online-Seminar

21. und 22. Februar 2024

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Information on all events with exhibition
Auskunft zu allen Veranstaltungen mit Fachausstellung

t +49 201 8128-310/-299
e events@vgbe.energy

Updates **www.vgbe.energy**

Wasseraufbereitung
vgbe | Seminar

20. und 21. März 2024
Velbert, Deutschland

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Flue Gas Cleaning 2024

Workshop

22 and 23 May 2024
Frankfurt a.M., Germany

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Chemie im Wasser-Dampf-Kreislauf

vgbe | Seminar

13. und 14. November 2024

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Offshore Windenergieanlagen – Arbeitsmedizin 2024

Fortbildungsveranstaltung

6. und 7. September 2024
Emden, Deutschland

Kontakt
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e gregor.lipinski@vgbe.energy

Immissionsschutz- und Störfallbeauftragte 2024

Fortbildungsveranstaltung

26. bis 28. November 2024
Höhr-Grenzhausen, Deutschland

Kontakt
Stephanie Wilmsen
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e vgbe-immission@vgbe.energy

Exhibitions and Conferences

E-world energy & water

20. bis 24. Februar 2024
Essen, Deutschland

www.e-world-essen.com

Enlit Europe 2024

22 to 24 October 2024
Milan, Italy

www.enlit-europe.com/

56. Kraftwerkstechnisches Kolloquium

8. und 9. Oktober 2024
Dresden, Deutschland

https://t1p.de/tud-kwt (Kurzlink)