Long-lasting and controlled-release borate as a biocide against microbial breeding in a recirculating cooling water system

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Abstract: Based on the potential bactericidal properties of borate, we synthesized controlled-release borate (CRB) as a novel biocide to inhibit microbial proliferation in a recirculating cooling water system (RCS). Our results showed that the inhibition rates of CRB on the isolated bacteria and algae reached 80.4-84.0% and 55.0%, respectively. CRB achieved a complete release of antibacterial factor-boron in 20 days in the simulated RCS. The number of heterotrophic bacteria (HB) was reduced to 3.8×103 CFU/mL, which met the requirement of the Chinese national standard GB/T 50050-2017 (< 1×105 CFU/mL). CRB achieved a significant reduction of the dominant species, namely, Pseudomonadota and Chlorophyta. The algae-inhibiting behavior of CRB was mainly reflected in the inhibition of nucleic acid synthesis and photosystem II photochemical activity. Functional annotation of differentially expressed genes revealed that the downregulation of the “photosynthesis-antenna proteins” and “large/small subunit ribosomal protein” pathways was the main inhibitory behavior of CRB; reverse transcription real-time quantitative polymerase chain reaction verified this result. Additionally, the expression of antioxidant enzymes and cell volume-related genes coincided with phenotypic changes. Moreover, CRB exhibited excellent scaling and corrosion inhibition properties. The determination of the biocidal mechanism of CRB in this study will help enhance the practical application of multi-functional water treatment agents in RCS.

Keywords Cellular physiology; Metatranscriptomic sequencing analysis; Corrosion and scaling inhibition; Bacteriostasis; Wastewater emission reduction

Reference