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# Modelling of Open Circuit Cooling Systems Chemical Emissions to River Water via Blowdown Water and their Impact on the Quality of Effluents Discharged

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## INTRODUCTION & AIM

Open circuit cooling systems (OCCS), integral to industrial processes, often release blowdown water containing high concentrations of treatment chemicals. These discharges, if unmanaged, pose substantial risks to aquatic ecosystems and human health. This study addresses the environmental implications of chemical emissions from OCCS blowdown by developing a predictive model to estimate contaminant concentrations in receiving water bodies (Fig. 1).

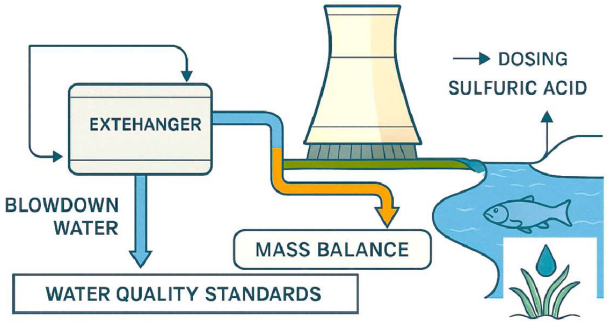


**Figure 1.** *Schematic diagram of an OCCS and general scheme of this study.*

## METHOD

The research employs a computational model based on mass balance equations to simulate the dynamics of chemical emissions from blowdown water. It incorporates key operational variables including flow rates, degradation rates, and volatilization characteristics. The model evaluates two chemical dosing strategies: continuous and fractional and their resultant pollutant dispersal patterns in river systems. Validation was conducted using empirical data from sulfuric acid ($H_2SO_4$) applications at the nuclear power plant between 2015 and 2022.

## RESULTS & DISCUSSION

The model demonstrated strong agreement with observed sulphate ion concentrations in the receiving water body, confirming its predictive reliability. Continuous dosing resulted in stable levels of pollutants, while fractional dosing caused temporary peaks that did not exceed regulatory values (Fig. 2). The assessment frameworks currently in place often underrepresent the complexity of interactions between chemicals and biological systems, that account for varying chemical mixtures and their long-term ecological implications (Fig. 3).

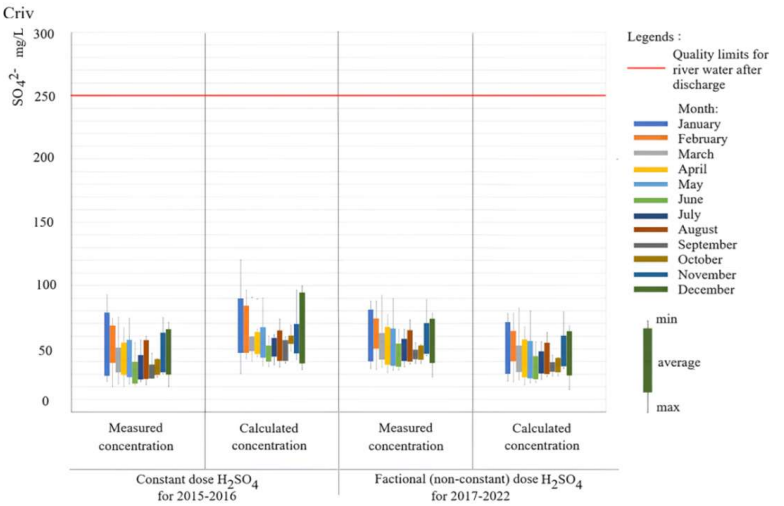


**Figure 2.** *Measured and calculated $SO_4^{2-}$ concentrations in river water following cooling water discharge under constant and factional (not constant) $H_2SO_4$ dosing regimes.*

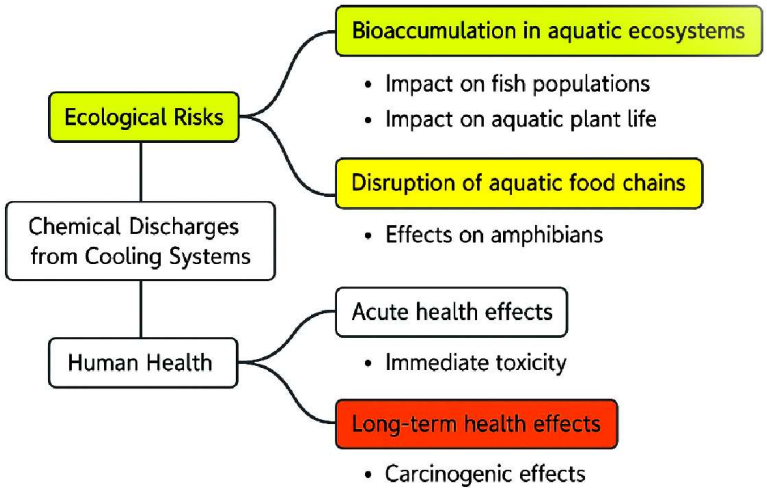


**Figure 3.** *Characterization of the effects of cooling water chemical emissions on river water.*

## CONCLUSION

The modeling of blowdown water reveals significant implications for river water quality and highlights the urgent need for more effective wastewater management strategies within industrial contexts. Validation with measured $SO_4^{2-}$ concentrations confirmed the model's accuracy, making it a valuable tool for guiding regulatory compliance and optimizing cooling water treatment practices.