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Inhibition of calcium carbonate crystal growth by organic additives using the constant composition method in conditions of recirculating cooling circuits

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ABSTRACT

The cooling circuits used in power plants are subject to mineral crystallization which can cause scaling on the surfaces of equipment and construction materials reducing their heat exchange efficiency. Precipitated calcium carbonate is the predominant mineral scale commonly observed in cooling systems. Supersaturation is the key parameter controlling the nucleation and growth of calcite in these systems. The present work focuses on the precipitation of calcite using the constant composition method at constant supersaturation, through controlled addition of reactants to a semi-batch crystallizer, in order to maintain constant solution pH. The determination of the thermodynamic driving force (supersaturation) was based on the relevant chemical equilibria, total alkalinity and calculation of the activity coefficients. Calcite crystallization rates were derived from the experiments performed at supersaturation levels similar to those found in industrial station cooling circuits. Several types of seeds particles were added into the aqueous solution to mimic natural river water conditions in terms of suspended particulate matters content, typically: calcite, silica or illite particles. The effect of citric and copolycarboxylic additive inhibitors added to the aqueous solution was studied. The calcium carbonate growth rate was reduced by 38.6 % in the presence of the citric additive and a reduction of 92.7 % was observed when the copolycarboxylic additive was used under identical experimental conditions. These results are explained by the location of the adsorbed inhibitor at the crystal surface and by the degree of chemical bonding to the surface.

Keywords: A1.precipitation, A1.constant supersaturation ratio, A1.scaling, A1.additives, B1.calcium carbonate

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