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# Study of the scale inhibiting effect of $\text{Cu}^{2+}$ and $\text{Zn}^{2+}$ in synthetic water by FCP and SQCM

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## Summary:

The current study describes the influence of two inhibitors, copper and zinc cations ( $\text{CuCl}_2$ ,  $2\text{H}_2\text{O}$  and  $\text{ZnCl}_2$ ), on the  $\text{CaCO}_3$  scaling process by using Fast Controlled Precipitation (FCP) and Scaling Quartz crystal microbalance (SQCM). Scale formation can be effectively controlled by low concentrations of these ions.

## Keywords:

Scaling inhibitor, Fast Controlled Precipitation, Scaling Quartz crystal microbalance.

## Introduction

Calcium carbonate scaling is often a major problem in different aspects of industrial processes and domestic installations. The influence of metal cations on the precipitation of calcium carbonate has always attracted the attention of researchers (Wen-Jun, 2008). The techniques adopted to examine the effect of these cations are generally based on chemical and electrochemical scaling tests (Ghizellaoui, 2004). In this study, the scaling inhibition on the  $\text{CaCO}_3$  precipitation in bulk and on a metallic surface was studied using FCP and SQCM respectively.

## Material and Methods

The synthetic water was prepared by dissolving solid calcium carbonate in pure water by bubbling  $\text{CO}_2$  gas. The pH of the solution, after the solid dissolution, is about 5.5-5.9. All

tests are carried out at  $\delta = 31.4$  (fixed value lower than  $\delta_{\text{limit}}$ ) with a pH of 7.9. All tests were performed in synthetic water containing  $200 \text{ mg.L}^{-1}$  of  $\text{Ca}^{2+}$  ions.

The anti-scaling effect of copper and zinc ions, in synthetic waters, was studied by using fast controlled precipitation (FCP) method (Gauthier, 2012) and electrochemical quartz crystal microbalance (EQCM). These measurements allow to follow the process of germination and growth of calcium carbonate in solution or on a metallic surface. FCP method consists in degassing dissolved  $\text{CO}_2$  from the synthetic water by moderated agitation to increase slightly the supersaturation coefficient of the synthetic water to a given value.

EQCM is a high-precision instrument for measuring mass variation (Peronno, 2015). This technique was used to deposit a pre-calcified surface with a given thickness and mass on the active gold surface. Scaling quartz crystal microbalance (SQCM), based on QCM, was then used to track the scale deposition rate on the pre-calcified electrode surface. The scale deposition was induced by application of a cathodic potential of  $-1 \text{ V}_{\text{SCE}}$  to the working electrode.

The effectiveness of an anti-scale treatment results in a delay in the precipitation process.

## Results and Conclusion

The results obtained show that  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$  are very efficient scale inhibitors. In addition, it has been shown that  $\text{Zn}^{2+}$  ions were more efficient than  $\text{Cu}^{2+}$  toward scale formation. Indeed, with a hardness of  $50^\circ \text{ F}$ , the optimal dose is  $4 \text{ mg L}^{-1}$  for  $\text{Zn}^{2+}$  and  $5 \text{ mg L}^{-1}$  for  $\text{Cu}^{2+}$ . These results are confirmed by SQCM method. The inhibition efficiency is about 92% with  $4 \text{ mg.L}^{-1} \text{ Zn}^{2+}$  and 93% with  $5 \text{ mg.L}^{-1} \text{ Cu}^{2+}$ .

Both scanning electron microscopy (SEM) and X-ray diffraction (XRD) analysis showed that these ions may affect the crystalline morphology of  $\text{CaCO}_3$ . The deposits formed by two techniques consisted essentially of vaterite in the absence of inhibitor, aragonite in the presence of copper and calcite when the ions were mixed together.

## References

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