Optimization of ferric chloride quantity for precipitation of phosphorus in silts

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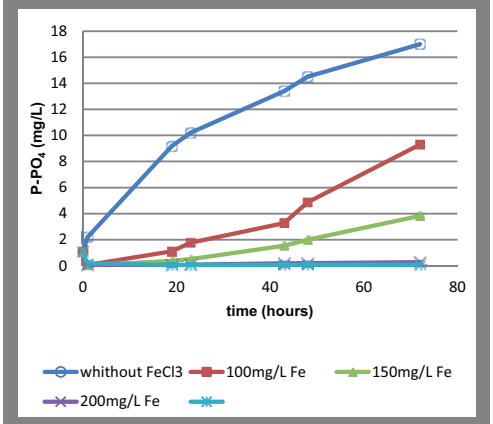
Introduction

In the sewage treatment plant of Saint-Etienne, two types of silts are produced: primary and biological. At the moment, they are concentrated separately, but the goal is to combine them. A study of the impact of this new process is necessary before its realisation. Indeed, in contact with the primary deposits, and without oxygen, the biological silts release phosphorus in the interstitial water. This phosphorus was stored in the bacterial cells present in the biological silts. It must therefore be captured in order not to pollute the treated water. The only solution to absorb PO_4^{3-} is to add ferric chloride ($FeCl_3$) where the Fe^{3+} ions precipitate the ions by forming $FePO_4$ which is not very soluble in water. In order to efficiently trap the phosphorus and reduce the treatment cost, it is necessary to determine the optimal quantity of $FeCl_3$ to be added.

Figure 1 : Figure 1 : Follow up of $P\text{-}PO_4$ concentration in interstitial water



Material and methods

Ferric chloride is a liquid reagent. The commercial solution contains 14% of iron (200g/L of iron).

For the experiments, several 1 litre beakers, containing the same mixtures of primary/biological silt were stirred slowly. Different quantities of $FeCl_3$ were added to each beaker, except for the control, and then measurements of $P\text{-}PO_4$ concentrations in interstitial water were realized.

The measurements were made using micro-methods (Hach Lange) which have the advantage of being rapid. An accurate volume of sample and reagent is sampled and put in a flask and stirred. After ten minutes, the results are available through a DR5000 UV-visible spectrophotometer (Hach Lange) which also detects the bar code on each sample tube. We obtain a value of $P\text{-}PO_4$ concentration, in mg/L, after the measurement of absorbance.

Results and report

As can be seen from Figure 1, the mixtures containing ferric chloride release less $P\text{-}PO_4$ in the water than the control without $FeCl_3$. This proves that $FeCl_3$ traps the phosphorus. Moreover, for 200mg/L or more of Fe, the capture of $P\text{-}PO_4$ is almost optimal. It is therefore not necessary to add any more reagent which would not be used. The blue curve shows that the control releases about 20mg/L of $P\text{-}PO_4$. This value is considerate like the maximal concentration in interstitial water.

Conclusion

To conclude a processing rate of 200mg/L of iron permits the precipitation of 20mg/L of $P\text{-}PO_4$. As the experiments are made in 1-litre beakers, we can be sure that the optimal quantity of ferric chloride is 10mg of Fe for 1mg of $P\text{-}PO_4$.

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