Short communication

Solids removal by coagulation from fisheries waste waters

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Abstract

One of the possible alternatives for reducing the contaminant load from fisheries waste waters is that of coagulation. In this work results are presented on the use of inorganic and organic coagulants, with emphasis on the removal of solids. Also, a comparison is made between the different treatments.

Introduction

The coagulation or chemical precipitation, mentioned as early as in 1762, became widely used in England in the previous century, where lime was used as coagulant, alone or with calcium chloride, or magnesium chloride.

In the last years, several researchers did studies on the design of coagulation-flocculation processes. For example, Leentvaar et al. (1981) studied several criteria for the design of such processes, using inorganic coagulants. With the idea of finding useful applications to fish scales, Welsh and Zall (1980) proposed its use as coagulant in food-processing wastes such as egg-washing waste water, clam-processing waste water, and vegetable-processing wastes. Cheng et al. (1995) recently studied the coagulation mechanism by using aluminum sulphate, a cationic polymer and ferric chloride. They found two main mechanisms of coagulation: At relatively high coagulant dosage and higher pH, the adsorption of particles onto a floc of aluminum hydroxide or ferric hydroxide predominates, while the formation of insoluble complexes in a way that is analogous to that of charge neutralization predominates at low coagulant dosage and lower pH values.

Stroh (1993) and Wu et al. (1982) also studied the characteristics of flocculated suspensions. Gregory and Guibai (1991) studied the effect of dosage and mixing conditions on the flocculation of concentrated suspensions using polymeric coagulants.

With respect to fisheries wastes, Civit et al. (1982) studied the coagulation of liquid effluent from fish-meal processing by heat and pH changes.

Genovese and González (1995) studied the addition of fish scales to enhance the solids removal by dissolved air flotation.

The interest in coagulation processes lies in the fact that in the fish-filleting plants located at Mar del Plata, very limited space exists for a complete waste-water treatment system, therefore the physico-chemical processes were explored first.

Materials and methods

The experiments were run in batch mode using 1 ℓ flasks. The initial mixing, flocculation and settling were carried out in the same flasks. For each data point, the tests were done at least in triplicate.

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The coagulants investigated were: ferric chloride ($FeCl_3$); aluminum sulphate $Al(SO_4)_3$, chitosan and ground fish (hake: *Merluccius hubbsi*) scales. The levels of coagulant investigated were 10, 40, 60 and 100 mg/ℓ. The pHs investigated were 7.2 (that of the effluent without acid addition), 6 and 5.5. The pH was adjusted by adding sulphuric acid.

The effect of the treatments was evaluated measuring the change in total solids of the effluent after the mixing, coagulation and settling sequence. The total solids content was measured gravimetrically after evaporation of a known volume of effluent at 103°C to 105°C (Clesceri et al., 1989). The original solids content was 3 300 mg/ℓ; the BOD5 was 528 mg/ℓ and the grease/oil content was 47.6 mg/ℓ.

The experiments were carried out in batch mode using 1 ℓ flasks to which 850 mℓ of effluent was added, then pH adjusted and the coagulant added. The mixture was vigorously mixed (150 r/min) for 30 s, followed by 20 min of slow mixing to allow for floc growth. Finally, another 20 min of settling without stirring were allowed before taking samples for analysis. All samples were taken from the same depth of the flasks.

Results

The results obtained are presented as per cent of solids removed (with respect to the initial solids content) in Figs. 1 to 4. They are presented as graphics, with solid dots representing the average of at least three experiments.

Analysis and conclusions

For $FeCl_3$, maximum removal (30 to 31%) occurred at pH 5.5 and coagulant dosage of 60 mg/ℓ. No definite trend could be observed using $Al_2(SO_4)_3$ although the maximum removal was obtained at pH 7.2 and coagulant dosage of 60 mg/ℓ.

With chitosan as coagulant, maximum removal of 26 to 28% of total solids was obtained at pH 5.5 and coagulant dosage of 60 mg/ℓ, while with fish scales the maximum removal occurred at pH 7.2 and dosage of 40 mg/ℓ.

Separate measurements of the total solids of the tap water entering the fish-filleting plant revealed that 49% of the total solids present in the effluent from the plant were already in the tap water. Therefore, the removal of solids actually added by the fish-filleting process is even larger. Thus, it is concluded that not only classical inorganic coagulants, but also ground fish scales can satisfactorily be used as coagulant aids in the treatment of the fish-filleting waste water.

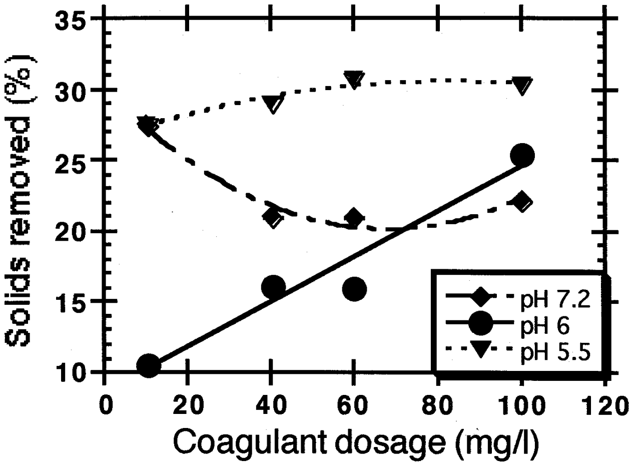

Figure 1
Solids removal as a function of the $FeCl_3$ added

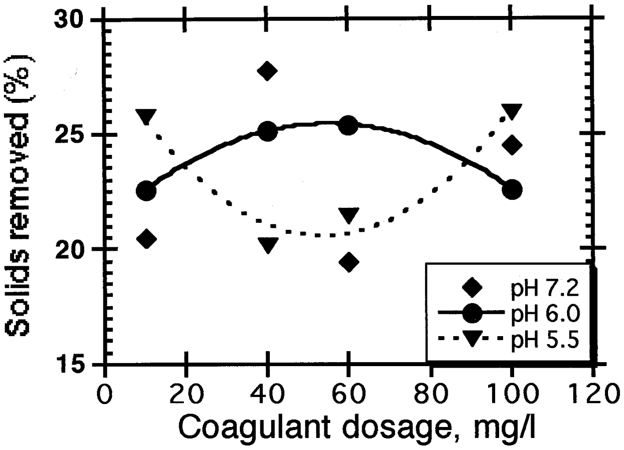

Figure 3
Solids removal as a function of the fish scales added

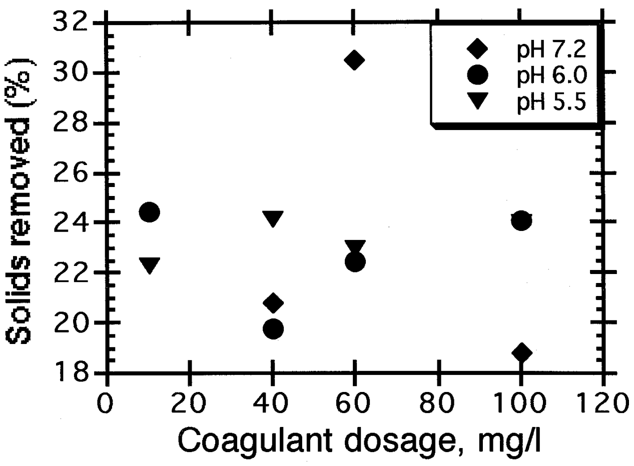

Figure 2
Solids removal as a function of the $Al_2(SO_4)_3$ added

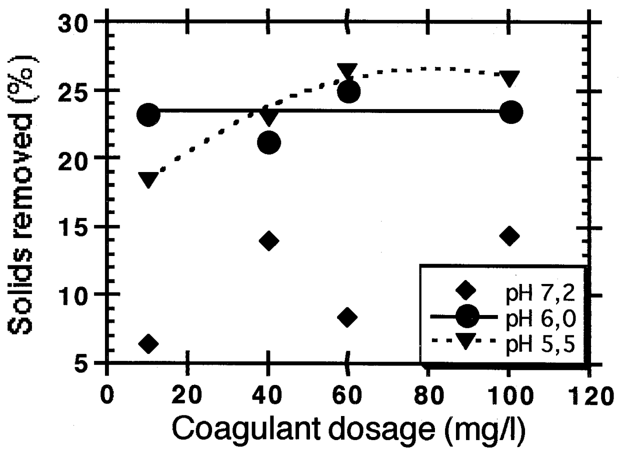

Figure 4
Solids removal as a function of the chitosan added

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