

Treatment of pulping effluents by using alum and clay - Colour removal and sludge characteristics

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Abstract

The effect of clay addition during alum coagulation, on the removal of colour from pulp-and-paper industry wastewaters, was investigated. Four types of clay, namely beige-and brown-sepiolites, calcium- and sodium-bentonites of different mesh sizes were used. Different quantities of alum and clay were applied, either singly or in combination, to the effluents of the wood-based pulp-and-paper mill. Colour of the treated wastewater, the sludge volume index (SVI) and sludge cake resistance (SCR) of the sludge produced were monitored. It was observed that the clays tested were not efficient in colour removal when they were applied on their own. When clay was added along with alum, a certain increase in colour removal efficiency was obtained as compared to alum alone. When alum was used in conjunction with clay, settling characteristics of the sludge produced improved substantially, in terms of both SVI and SCR. Acid activation of the clays did not improve the colour removal efficiency further. However, acid activation of sodium bentonite caused the SVI and SCR values to improve considerably compared to virgin sodium bentonite. Use of different mesh sizes of clays did not exert any significant effect on the colour removal. However, it did exert significant effects on SVI and SCR values as such that the increase in mesh size caused the SVI values to decrease and the SCR values to increase.

Introduction

The problem of colour removal from pulp-and-paper mill waste has been a subject of great consideration and investigation in the last few decades. The colouring body present in the wastewater from pulp-and-paper mill is organic in nature and is comprised of wood extractives, tannins, resins, synthetic dyes, lignin and its degradation products formed by the action of chlorine on lignin (Srivastava et al., 1984; Rao and Dutta, 1987; Manivasakam, 1987). Discharge of coloured pulping effluents to the receiving waters inhibits photosynthetic activity of aquatic biota by reducing the penetration of sunlight, besides their direct toxic effects on biota (Zanella and Berben, 1980; Walden and Howard, 1981). The colour compounds also chelate metal ions and may import contamination by heavy metals (Srivastava et al., 1984). It is imperative that the colour present in pulp-and-paper mill effluents be removed before being discharged into receiving waters.

Several studies have been carried out concerning the decolorisation and/or treatment of such waters by biological methods (Bauman and Luts, 1974; Joyce et al., 1979; Bryant et al., 1987; Skogman and Lammi, 1988). These methods such as aerated lagoons and activated sludge systems do not cause sufficient decolorisation mainly because of the high stability of lignin and its derivatives (Livernoche et al., 1983; Archibald and Roy-Arcand, 1995). It has also been investigated by several researchers that kraft mill effluents can be partly decolorised by white-rot fungi (Eaton et al., 1980; Livernoche et al., 1983; Prouty, 1990; Gokcay and Dilek, 1994). However, Gokcay and Dilek (1994) pointed out that this treatment is economically unfeasible due to the need for high glucose concentration by the fungus. They have also reported that the fungus was not effective when bleaching effluents were present.

Several physico-chemical colour removal methods such as chemical precipitation, rapid sand filtration, membrane processes and adsorption have also been developed (Springer, 1985). Adsorption and membrane processes, although they are efficient, are expensive (Manjunath and Mehrotra, 1981). The application of electrochemical methods is another way to treat the wastewaters from the cellulose-paper production (Christoskova and Lazarov, 1988). This method guarantees high treatment efficiency, but its effectiveness depends on the type of electrodes, the construction of electrocoagulators, and the conditions under which the process is run. Chemical precipitation, using alum, ferric chloride, and lime has been studied extensively (Lathia and Joyce, 1978; Dugal et al., 1976; Joyce et al., 1979; Srivastava et al., 1984; Beulker and Jekel, 1993; Stephenson and Duff, 1996); in spite of short detention times and low capital costs, there are some drawbacks reported, such as high cost of chemicals for precipitation as well as for pH adjustment, voluminous sludge production due to heavy dosages, problems associated with dewatering and disposing of generated sludge and high residual cation levels, so that their colour, which remain in the supernatant (Stephenson and Duff, 1996; Srivastava et al., 1984). However, as discharge standards become increasingly strict, chemical precipitation may have a role in the treatment of pulping effluents either upstream of biological treatment or as a polishing operation downstream of biological treatment to remove recalcitrant compounds (Stephenson and Duff, 1996).

From the foregoing discussion, it is clear that all treatment methods in use have some drawbacks, and there is a need to look for other alternative methods. In the literature, there is some evidence that clays, when used in conjunction with alum, result in improved colour removals and sludge characteristics, as compared to alum alone (Mittal and Mehrotra, 1981). However, there are no detailed studies in the literature about the detailed investigation of the subject. So, it is the aim of this study to investigate the decolorisation of wood-based pulp-and-paper industry wastewater by using Turkish clays as an aid to the traditional coagulant, alum.

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