Combined biologic removal of sulphate for tanning industrial wastewaters

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Introduction

Conventional treatment for tanneries wastewaters utilizes chemical precipitation pre-treatment followed by aerobic/anoxic processes for carbon and nitrogen removal. Has several drawbacks related with the cost of the chemicals, increase of waste excess sludge and incapacity to remove sulphates.

Anaerobic process (AD) are an attractive alternative, but often becomes less feasible to apply due to high sulphate concentration that results in Sulphate Reducing Bacteria SRB) out-competing Methanogenic Archaebacteria (MA), generating inhibitory concentrations of hydrogen sulphide (H_2S).

A biological pre-treatment process based on AD reactor followed by aerated tank, for partial oxidation of (H_2S) into Sulphur Sº under oxygen limited conditions for sulphate rich wastewaters. Recycling of aerated sludge into anaerobic reactors allows H_2S concentration control.

Photo1 : Experimental system

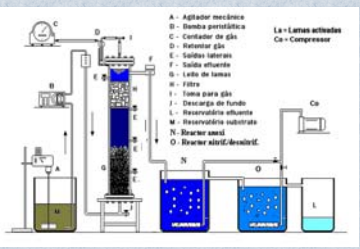

Figure 1: Experimental system

Afterwards, this stage is associated to a sequencing batch reactors for COD and nitrogen removal, in order to achieve high quality and low nitrogen-based compound concentration.

Results & Discussion

Biologic reactions occur in anaerobic/anoxic/aerobic environment, controlled by the REDOX potential. Figure 2, 3 and 4 represent the values of efficiency of removal of COD, VSS and Sulphate and Nitrogen in the following: anaerobic Hybrid Filter (AHF), AHF plus first partial sulphide oxidation (PSO) and the total treatment system (TS).

In terms of COD efficiency removal Anaerobic reactor was more influenced by the temperature and organic load, (COD= 22-62%). AHF and PSO varied in the range 68-82% and the TS sustained remarkable performance (80 - 92 %9, being less affected by temperature changes than the anaerobic step.

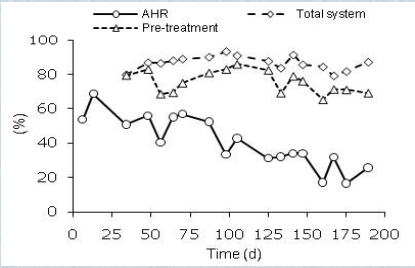

Figure 2: COD Removal

Volatile Suspended Solids (VSS) and sulphate in the AHF, depicts the hydrolytic and BRS activity,

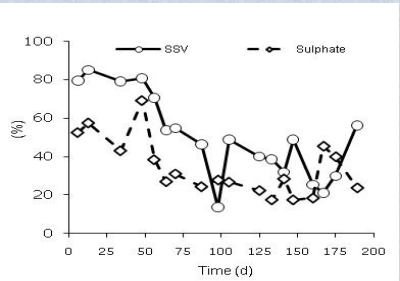

Figure 3: Sulphate and VSS Removal

Figure 4 shows the effect of nitrification/denitrification step on Nitrogen (Kjehldal and ammonia) removal with efficiency range from 60-to 98% for the Organic Nitrogen and 80-93 % for the ammonia nitrogen.

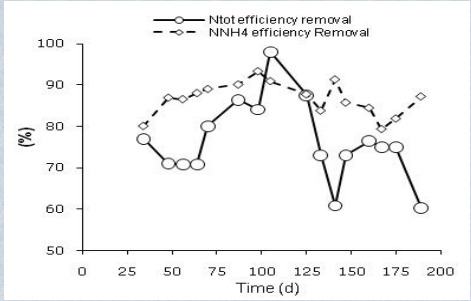

Figure 4: Nitrogen compounds removal

Compared with conventional physico-chemical technology (Current solution in Table 1), the proposed biologic system constituted by anaerobic digestion (AD) followed by partial sulphide oxidation (PSO) AD/PSO process avoided chemical consumption, and removed efficiently COD and sulphate

It reduced energy consumption (about 60 %) in subsequent aerobic/anoxic stages and achieved a small quantity of sulphur rich stabilized sludge, reusable in alkaline agricultural land. Allowed fulfillment of sulphate concentrations lower than 1000 mgSO4=. Enlarged bacterial consortium ensured high stability of pH and Redox values, even in overcharge conditions and finer control of propionate. Some of relevant parameters shown in table 1 are still higher than limits fixed by the environmental authorities and require an additional polishing step. In this case the industry uses also synthetic tanning processing and discharge organic and colored compounds which are very hard to remove completely by biologic processes, requiring chemical oxidation or any other adequate process.

Table 1: Effluent Characteristics

Parameter	Proposed solution	Current solution	Limit for discharge	Parameter	Proposed solution	Current solution	Limit for discharge
TSS	221	337	60	N_{NH4}	4	187	10
COD	587	1019	150	$PO^{4=}_{i}$	19	8	1
BOD_5	80	437	40	Sulphate	434	972	2000
Nt (Kjeldahl)	64	255	15	Cr^{3+}	0.8	1	2

Conclusions

The proposed alternative, based on enlarged anaerobic consortium performed stable and suitably, making further progress on the applicability of Anaerobic Digestion to sulphate rich effluents. It also reduced significantly treatment costs, by savings chemical precipitation agents, eliminating chemical sludge to be dewatered and disposed and by reducing energy consumption in the subsequent secondary treatment process.