UTILIZATION OF BY-PASS KILN DUST FOR TREATMENT OF TANNERIES EFFLUENT WASTEWATER

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ABSTRACT

The present study is to investigate the ability of by-pass kiln dust to decolorize and decrease COD, TSS and heavy metals levels to accepted limit for industrial effluent of Abu-ElSoud tanneries area end-of pipe at Cairo city. The effect of different dosages of by-pass kiln dust ranging from (0.5-3.5) gm/L has been discussed on bench-scale tests. The results showed the feasibility of using kiln dust with optimum dose of 2 gm/L as a good coagulant for Tanneries wastewater.

KEYWORDS: Tannery, Wastewater, Kiln Dust, Cement Industry, COD, TSS, Colour, pH, Heavy Metals.

INTRODUCTION

Cement manufacture in Egypt approximately discards annually 1.0 million tons of cement dust collected from exhausted gases of cement kilns, which contains excessive concentrations of alkalis and make it unsuitable for return to the cement making process. In addition, these amounts of cement dust results in serious impairment of air quality particularly in densely populated areas in the vicinity of these plants [3].

In Tourah Portland Cement Factory, the production of by-pass kiln dust per day is about 5.3% of the total production of the rotary kiln which is about 9000 ton/day. So the amount of by-pass kiln dust is about 477 ton/day [4].

Chemical coagulation, biological treatment and adsorption are the methods for the treatment of wastewater from tanneries for organic substances and heavy metals removal [7].

The present study investigates the possibility of utilization of by-pass cement kiln dust as a coagulant for tanneries effluents and discuss the optimum dose to obtain maximum removal efficiencies of COD, TSS, heavy metals and good decolorization [2].

EXPERIMENTAL MATERIALS AND METHODS

The chemically assisted sedimentation by cement dust kiln of doses (0.5, 1.0, 2.0, 2.5, 3.0, 3.5) gm/L was investigated using a standard bench-scale (jar test) apparatus. The experiments were applied on end-of-pipe effluent from Abu-El-Soud tanneries area at Cairo city.

Flash mixing was started at 300 rpm and continued for one minute during which the by-pass cement kiln has been added at concentrations of 0.5, 1.0, 2.0, 2.5, 3.0 and 3.5 gm cement kiln/l. Following the flash mixing a flocculation for 10 minutes gentle stirring (10 rpm) is done after which sedimentation for 20 minutes is carried out, then the samples have been drawn and analysis is then proceeded.

The parameters investigated were pH, TSS, COD, colour and heavy metals.

All physical and chemical parameters were performed in accordance with the "Standard Methods for the examination of water and wastewater" [1].

PROCESSES DESCRIPTION

Tanneries main processes are as following [5],[6]:

- Re-hydrating and washing the crude hide.
- Unhairing and liming to remove hair and epidermis bysodium sulphide or hydrosulphide mixed with lime. (Effluent pH reaches 12).
- Mechanical and splitting of limed pelts.
- Deliming to neutralize the alkalies by using ammonium chlorides (effluent pH reaches about 8.5) which is suitable for enzyme bats operation to hydrolyze certain elastic fibers in the hide.
- Pickling by NaCl salt, formic acid and sulphuric acid to acidify the hide to prepare it for tanning.
- Tanning by chromium by trivalent basic chromium sulphate salts where the effluent pH reaches 5.5 to 6. The wastewater effluent contains mainly chromium sulphate used in tanning and some other agents.
- Dyeing using direct, anionic or metallised dyes and fixed chemicals.
- Finishing operations to protect and embellish the leather.

RESULTS AND DISCUSSIONS

A by-pass kiln dust sample collected from Tourah Portland Cement Company was analysed by x-ray diffractmeter and DTA analysis as shown in Table 1.

Table 1: Chemical Analysis of By–Pass Kiln Dust

Oxides	Composition (wt%)
SiO_2	14.54
Al_2O_3	3.44
Fe_2O_3	2.35
CaO	57.24
MgO	2.14
Na_2O	2.41
K_2O	2.7
SO_3	3.71
Cl^-	4.75
Loss in ignition	12.6
Free lime	25.08
Density (kg/m^3)	843
pH	13.4

Three composite wastewater samples from Abu-ElSoud Tanneries (End of Pipe) at Cairo city were analysed. The results of extreme analysis are shown in Table 2.

The results of jar test for raw wastewater and after adding different concentrations of 0.5, 1, 2, 2.5, 3, and 3.5 gm cement kiln /L are shown in Table 3 and Figures (1-6).

As shown in Table 3 and Figure 1, the pH increased with increasing dust kiln dosages due to alkaline nature of dust kiln.

As shown in Table 3 and Figures 2 and 3 the removal efficiencies of TSS and COD were increased significantly by increasing cement dust kiln dosages till dose 2 gm/l and then decreased after 2 gm/L dosage.

Table 2: Extreme Analysis of Composite Wastewater Samples

Item	Concentration
pH	5.40
TSS (mg/l)	6824
COD (mg/l)	11480
True Colour (Pt/Co)	860
Pb(mg/l)	0.123
Cr^{+6} (mg/l)	38
Cr^{+3} (mg/l)	11
Cr_{total} (mg/l)	49
Cd (mg/l)	0.42
Ni (mg/l)	0.321
Cu (mg/l)	2.54
Total heavy metals (mg/l)	52.664

The decreasing removal efficiencies of TSS and COD at dose more than 2.5 gm/l are due to formation of small flocs which can not easily precipitated and remain floated.

The good coagulation effect of cement kiln dust is due to containing of 25% of its weight as lime which is reacted with the acidic wastwater effluent to form large flocs.

As shown in Table 3 and Figure 4, the removal efficiency of colour was increased significantly by increasing cement dust kiln dosages till dose 2 gm/l and then remain constant by increasing dossages.

As shown in Table 3 and Figure 5 the concentrations of Pb, Cd, Ni, Cu were significantly decreased with increasing cement kiln dust dosages till dose 2 gm/l and then increased after that dosage.

As shown in Table 3 and Figure 6 the concentrations of Cr^{+3} and Cr^{+6} were significantly decreased with increasing cement kiln dust dosages till dose 2 gm/l and then increased after that dosage. The cement dust adsorbed Cr^{+3} and reduced Cr^{+6} to Cr^{+3} and then adsorbed.

As shown in Table 3 and Figure 7, the removal efficiencies of total heavy metal was increased significantly by increasing cement dust kiln dosages till dose 2 gm/l and then then increased after that dosage.

CONCLUSIONS

In conclusion, the most important findings in this study:

1. By-pass kiln dust with dose of 2 gm/l, is able to remove about 75% of initial true colour of the industrial tanneries effluent.

2. The optimum dose of By-pass kiln dust is 2 gm/l for TSS & COD where the removal efficiencies were 92.1, 91.3% respectively.

3. The optimum dose of By-pass kiln dust is 2 gm/l for for total heavy metals where the removal efficiency was 33.2%.

4. The optimum dose of By-pass kiln dust is 2 gm/l for for chromium removal where the removal efficiency was 31%.

5. In general, the optimum dose, which satisfies high removal efficiencies and good decolorization is 2 gm/L as pH of wastewater effluent 8.00.

LIST OF ABBREVIATIONS

COD	Chemical Oxygen Demand (mg/L)
TSS	Total Suspended Solids (mg/L)

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Table 3 : Jar Test Results for Raw Wastewater& Chemically Assisted Sedimentation of Doses (0, 0.5,1,2,2.5,3,3.5) gm Cement Dust /L

Cement dose	0	0.5 gm/l	1 gm/l	2 gm/l	2.5 gm/l	3 gm/l	3.5 gm/l
pH	5.40	6.95	7.52	7.98	8.33	8.90	9.46
TSS (mg/L)	6824	4417	1860	540	975	1050	2100
η %	-	35.3	72.7	92.1	85.7	84.6	69.2
CODcr (mg/l)	11480	9100	2600	1000	3420	4090	4220
η%	-	20.7	77.4	91.3	70.2	64.4	63.2
True Colour (Pt/Co)	860	720	600	205	220	200	205
η%	-	16.3	30.2	76.2	74.4	76.7	76.2
Pb (mg/l)	0.123	0.12	0.1	0.1	0.13	0.132	0.132
η%	-	2.4	18.7	18.7	-5.7	-7.3	-7.3
Cr +6 (mg/l)	38	35	30	25	32	33	35
η%	-	7.9	21.1	34.2	15.8	13.2	7.9
Cr +3 (mg/l)	11	14	12	9	13	14	13
η%	-	-21.3	-6.6	21.8	-15.5	-27.9	-15.5
Cr total (mg/l)	49	49	42	34	45	47	48
η%	-	1.2	14.7	31.0	8.6	3.8	2.6
Cd(mg/l)	0.42	0.4	0.21	0.13	0.21	0.22	0.22
η%	-	4.8	50.0	69.0	50.0	47.6	47.6
Ni (mg/l)	0.321	0.32	0.101	0.096	0.315	0.316	0.32
η%	-	0.3	68.5	70.1	1.9	1.6	0.3
Cu (mg/l)	2.54	2.5	1.397	0.842	2.1	2.2	2.281
η%	-	1.6	45.0	66.9	17.3	13.4	10.2
Total heavy metal	52.664	52.000	43.808	35.168	47.755	50.268	50.953
η%	-	1.3	16.8	33.2	9.3	4.5	3.2

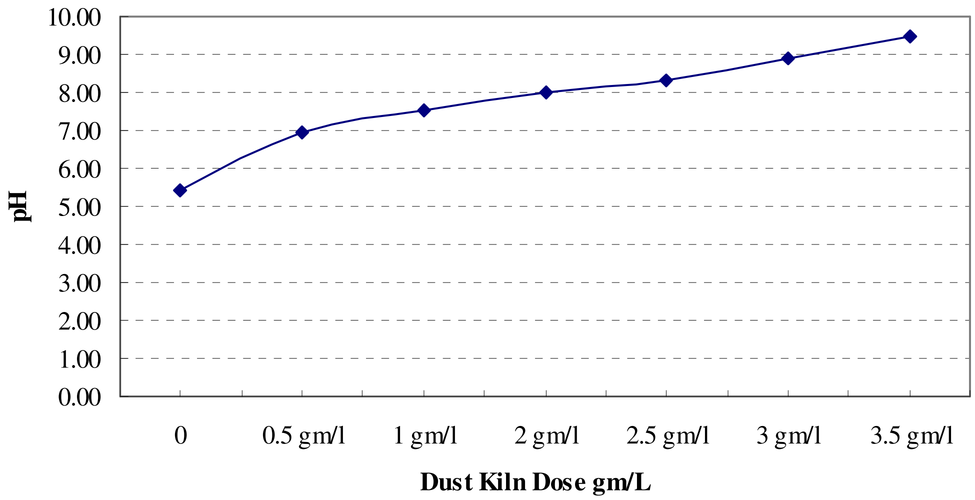

Figure 1 : Effect of Dust Kiln on pH

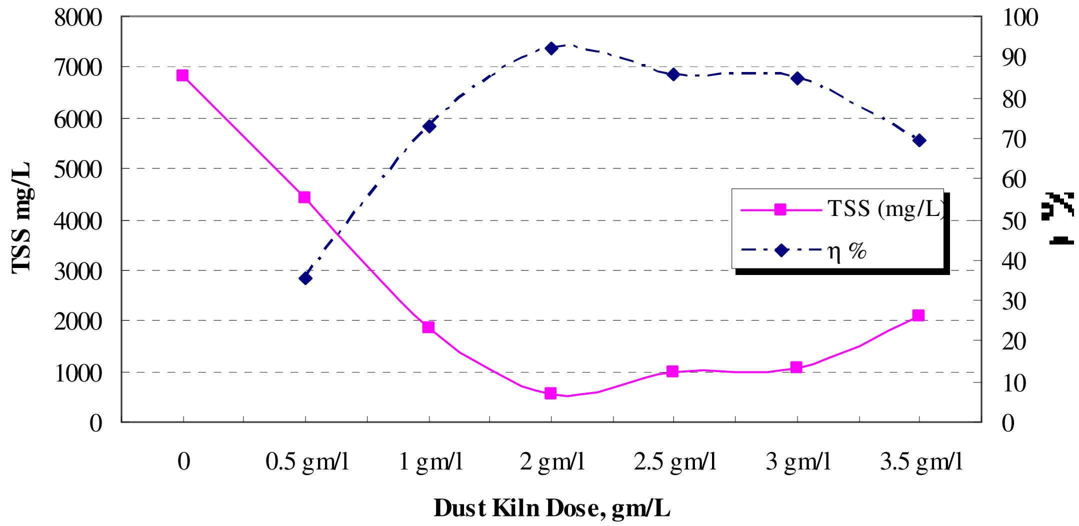

Figure 2 : Effect of Dust Kiln on TSS Concentrations and Removal Efficiency

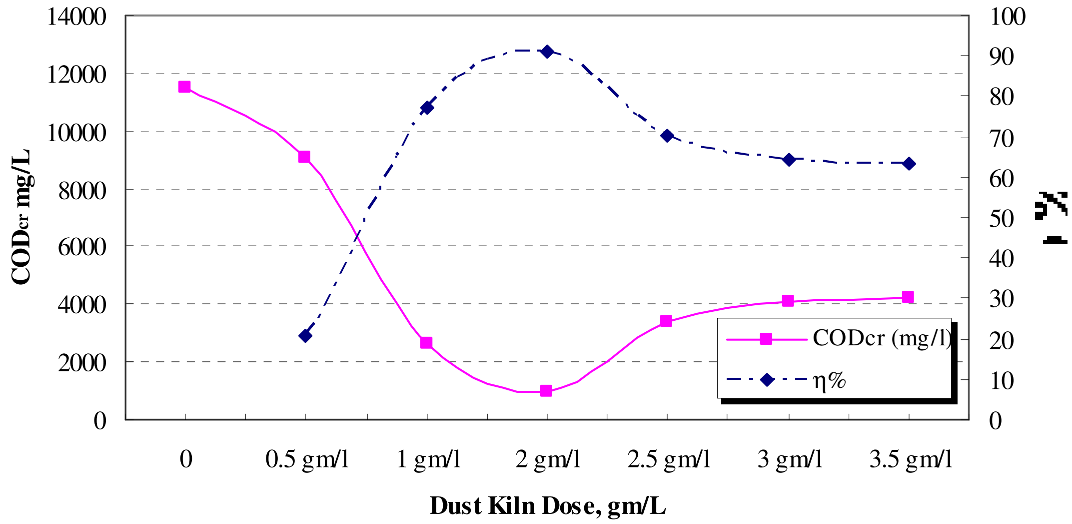

Figure 3 : Effect of Dust Kiln on COD $_{cr}$ Concentration and Removal Efficiency

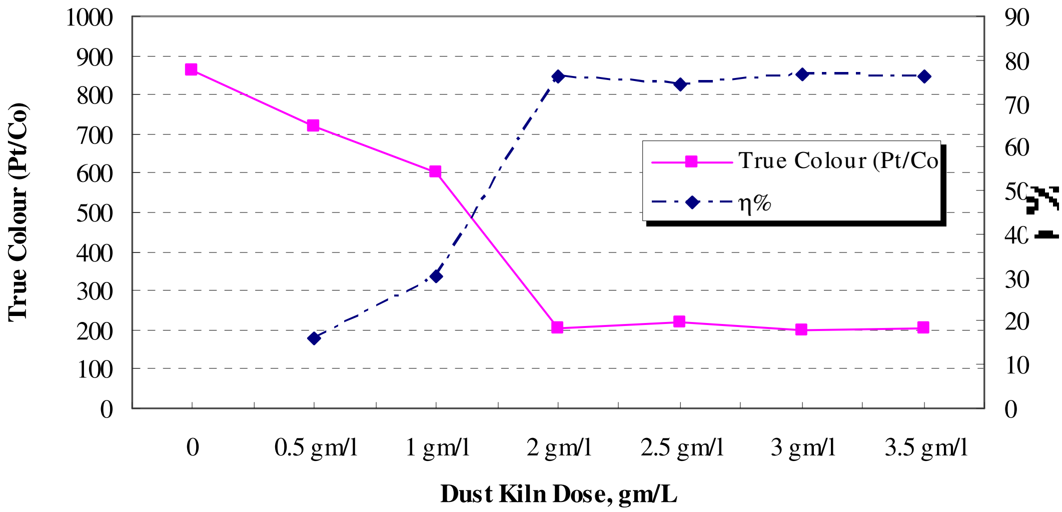

Figure 4 : Effect of Dust Kiln on True Colour & Decolarization Efficiency

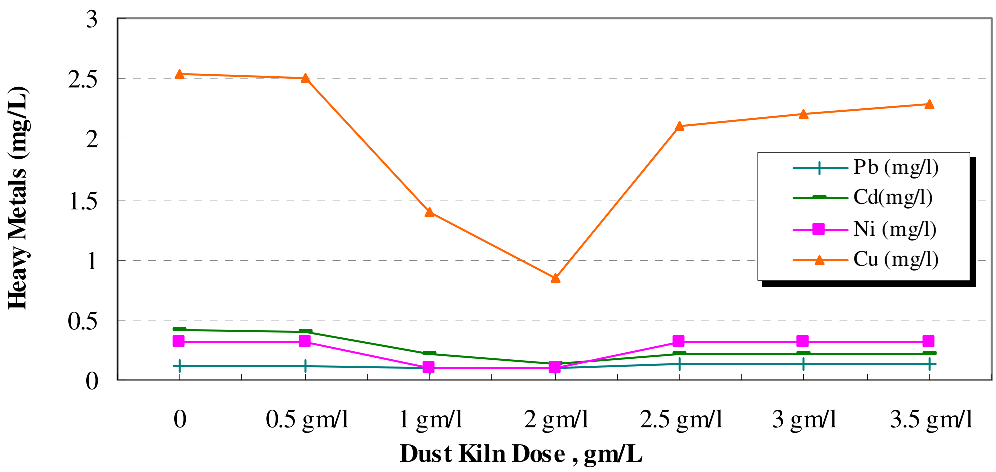

Figure 5 : Effect of Dust Kiln on Heavy Metals Elements Concentrations (Ni, Cu, Pb& Cd)

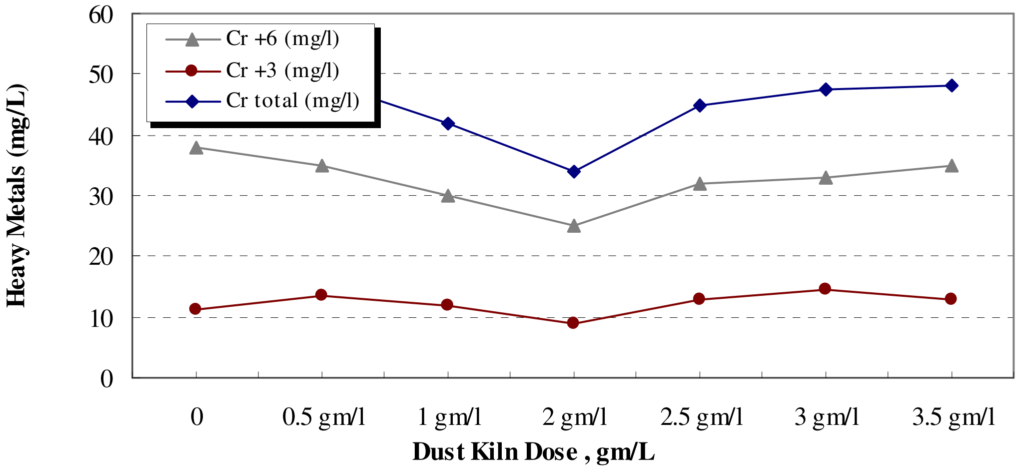

Figure 6 : Effect of Dust Kiln on Heavy Metals Elements Concentrations (Cr+6, Cr+3,Cr total)

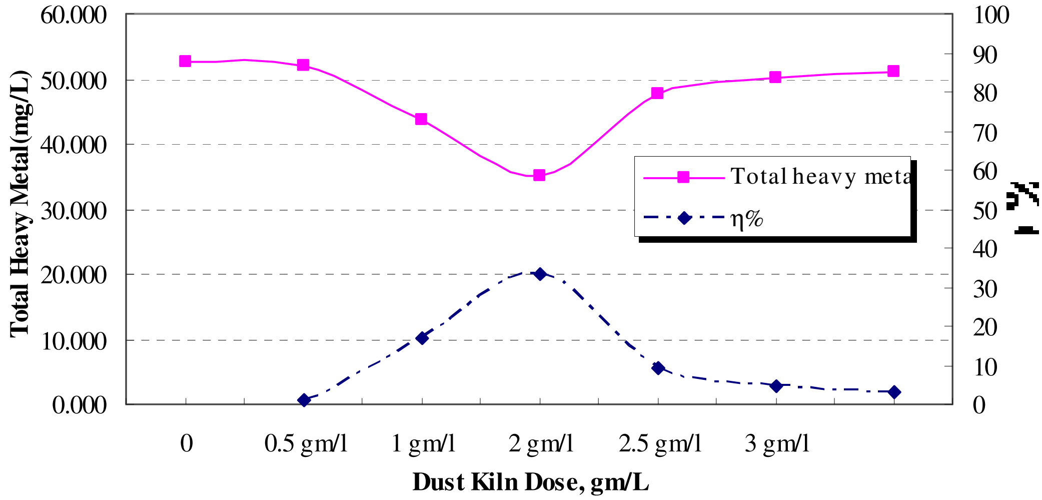

Figure 7 : Effect of Dust Kiln on Total Heavy Metals Concentrations