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Feasibility Study of Using Cement Kiln Dust for COD Reduction in the Treatment of Municipal wastewater

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Abstract

Municipal wastewater contains both organic and inorganic pollutants. These pollutants can be removed by chemical coagulation. The present study investigates the feasibility of utilization of cement kiln dust as a coagulant for municipal wastewater and discusses the optimum dose to obtain maximum removal efficiencies of COD.Cement kiln dust (CKD) is useless byproduct from the cement industry and has a significant resource value for using lime as a substitute.The effect of different dosages of cement kiln dust ranging from (0.5-3.0) gm/l has been discussed on bench-scale tests. The result shows the feasibility of using kiln dust with optimum dose of 2 gm/L as a good coagulant for municipal wastewater.

Keywords: — *Municipal wastewater; CementKilnDust (CKD); pH; Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD)*

1. Introduction

Waste materials can be broadly classified in to two categories such as industrial wastes and domestic wastes. Cement kiln dust (CKD),fly ash, rice husk, demolished materials, waste tiles etc. are some industrial wastes and waste glass, incinerator residue, scrap rubber etc. are domestic wastes. Waste material recycling in to useful products has become a main solution to waste disposal problems. The main ingredient in cement is limestone which, along with a silica source, alumina source, and iron source is crushed and then introduced into a kiln, where it is heated at 15000C.From this process about 10 to 60% of CKD is generated as a by-product and 65% of cement is produced. Cement kiln dust (CKD) is useless byproduct from the cement industry.APCDs such as Electrostatic Precipitator and Bag Filter were used to reduce gases emission. Even after providing APCDs some CKD is left which is disposed off on to the land. This may cause problems since no complete removal of waste is possible.

The demands for water have suddenly increased due to technological advancement, population growth, and urbanization, which put great stress on the natural water cycle. Thus reuse of wastewater has become essential now a day. Planned reuse has gained importance in recent periods so that proper management of wastewater treatment is possible. The potential wastewater has to serve as a viable alternative source of water, in future.

Cement kiln dust (CKD) can be used in municipal wastewater treatment as a coagulant due to high CaO content which is reacted with the wastewater effluent to form large flocs.

Many chemicals in various forms are used in wastewater treatment. For all practical purposes, applications for chemicals in treatment of domestic wastewater fall into five categories:

i. Coagulation and flocculation
ii. Precipitation dissolved substances.
iii. pH adjustment.
iv. Nutrient addition to biological systems, and
v. Conditioning of wastewater sludge for digestion or filtration.

2. Materials and Methods:

Cement kiln dust is created in the kiln during the production of cement clinker. The dust is a particulate mixture of partially calcined and unreacted raw feed such as clinker dust and ash, enriched with alkali sulphates, halides and other volatiles. These particulates are captured by the exhaust gases and collected in Air Pollution Control Devices (APCD) such as cyclones, bag houses and electrostatic precipitators. Due to several factors the chemical and physical properties of CKD differ. Hence considerable change in plant operations with respect to raw feed, type of operation, dust collection facility, and type of fuel used etc has to be carried out. This results in varying use of the terms typical or average for CKD when compared with different plants. There are several types of cement kilns, which can be defined in a number of ways. Wet process kilns are fed raw materials in a slurry form, and dry process kilns are fed raw materials in granular form.CKD is composed of free limes which are coarser particles and sulphates and alkalis which are finer particles.

$$CKD = Coarser\ Particles(Free\ Lime) + Fine\ Particles(Sulphates\ \&\ Alkalis)$$

Coagulation technique is more suitable for wastewater treatment. Thus the paper investigates the CKD as a coagulant in treatment of municipal wastewater.
Standard bench-scale (jar test) apparatus was used to investigate the coagulation and sedimentation of CKD of doses 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 gm/l each.
Flash mixer was started at 300 rpm for one minute during which the CKD has been added at concentrations of 0.5, 1.0, 2.0, 2.5, and 3.0 gm CKD /l. Following the flash mixing a flocculation for 10 minutes was carried with gentle stirring at 10 rpm, after which sedimentation for 20 minutes is carried out, then the samples have been drawn and analysed for the parameters such as pH, COD, BOD and color.
All physical and chemical parameters were performed in accordance with the "Standard Methods for the examination of water and wastewater."

3. Results and Discussion:

A Cement Kiln Dust sample collected from J.K. Cement Company was analysed by x-ray diffractmeter and DTA analysis.
The following table shows chemical composition of cement kiln dust (CKD):
Table 1: Chemical composition of cement kiln dust (CKD)

Oxides	SiO_2	Al_2O_3	CaO	MgO	P^H	$CaCO_3$
%by weight	10.69	23.22	50.80	13.13	12.60	25.20

Three wastewater samples i.e. from Inlet, Aeration and Outlet were collected from Karad city STP and were analyzed for pH, COD, BOD and color. The results of wastewater analysis are shown in Table 2.

Table 2: Typical analysis of wastewater samples

Characteristics	**Wastewater Samples**		
	Inlet	**Aeration**	**Outlet**
pH	6.95	6.98	7.02
COD mg/l	472	196	166
BOD_3 at 27^0C mg/l	208	72	63
Color Hazen	116	128	81

The variation in COD after addition of different concentrations of 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0gm cement kiln dust /l of inlet, aeration and outlet wastewater samples are shown in Table 3 and figure 1, figure 2, figure 3.

Table 3: Results of COD after addition of different concentrations of 0.5, 1.0, 1.5, 2.0, 2.5 and 3.0gm cement kiln dust /l of inlet, aeration and outlet wastewater samples in the month of March,2015:

Cement Dose(gm/l)	**Inlet Wastewater Sample**	**Aeration Wastewater Sample**	**Outlet Wastewater Sample**
0.5	470	191	430
1.0	433	102.3	453
1.5	259	208	192
2.0	310	257	185
2.5	240	249	286
3.0	240	113	96

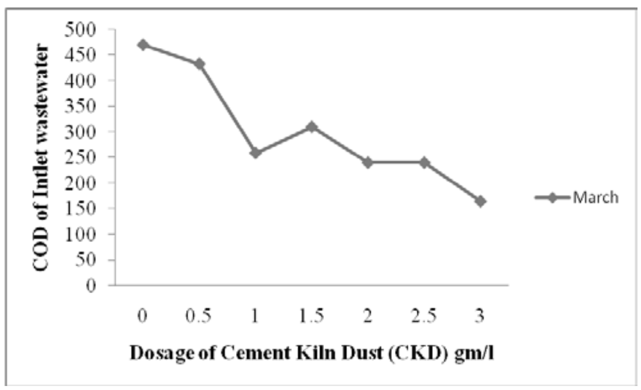

Figure 1: Variation in COD of inlet wastewater

From Figure 1 we can see that in inlet wastewater COD is decreasing from 1.0 to 2.5 gm/l addition of CKD dosages, but it increases slightly for 1.5gm/l CKD dosage and suddenly after dosing 1.5gm/l the COD value go is decreased and also for 3.0gm/l CKD dosage the COD is less. So we can say that at addition of CKD dosage decreases COD of wastewater. Thus optimum dosage of CKD in reduction of COD is approximately at 1.0 gm/l, 2.0 gm/l, 2.5 gm/l and 3.0 gm/l.Keeping in view the typical concentration of COD the optimum dosage of CKD for inlet wastewater will be 1.5gm/l of CKD addition.

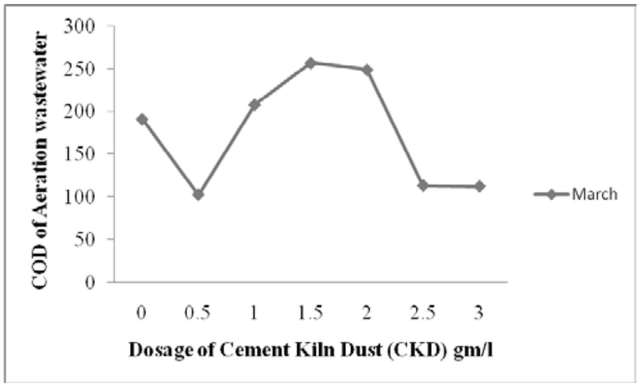

Figure 2: Variation in COD of aeration wastewater

From Figure 2 we can see that in aeration wastewater COD is decreasing for 0.5 gm/l addition of CKD dosages, but it increases from 1.0 to 2.0 gm/l and suddenly after dosing 2.5 and 3.0 gm/l the COD value go on decreasing. So we can say that at addition of CKD dosage decreases COD of aeration wastewater. Thus optimum dosage of CKD in reduction of COD is approximately at 2.5 gm/l and 3.0 gm/l.Keeping in view the typical concentration of COD the optimum dosage of CKD for aeration wastewater will be 2.0 gm/l of CKD addition.

From Figure 3 we can see that in outlet wastewater COD is increasing for 0.5 to 1.0 gm/l addition of CKD dosages, but it decreases from 1.5 to 3.0 gm/l so we can say that at addition of CKD dosage decreases COD of outlet wastewater. Thus optimum dosage of CKD in reduction of COD is approximately at 1.5 gm/l, 2.0 gm/l, 2.5 gm/l and 3.0 gm/l.Keeping in view the typical concentration of COD the optimum dosage of CKD for outlet wastewater will be 1.0 gm/l of CKD addition.

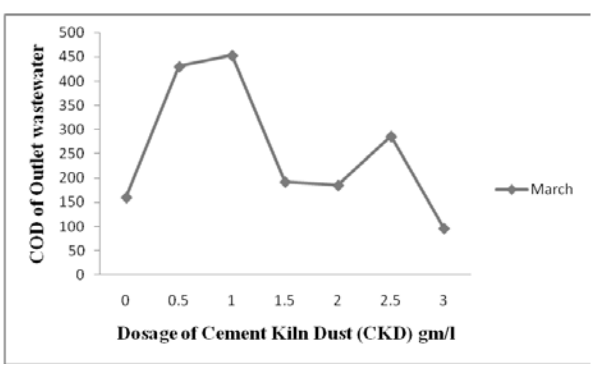

Figure 3: Variation in COD of outlet wastewater

4. Conclusion:

1. Cement kiln dust with dose from 1.0, 1.5, 2.0 and 3.0gm/l is able to reduce about 80% to 90% of COD and BOD for municipal waste water.
2. pH of inlet, aeration and outlet wastewater increases with increasing cement kiln dust(CKD) .
3. The optimum dose which satisfies high removal efficiencies for COD are ranging from 1.0 gm/l to 2.0 gm/l of CKD dosages. In month of March for inlet wastewater COD before addition of CKD was 470 mg/l and after addition of CKD at 1.0gm/l was 259 mg/l,1.5 gm/l was 310 mg/l and at 2.0 gm/l it was 240 mg/l, for aeration wastewater COD before addition of CKD was 191 mg/l and after addition of CKD at 1.0gm/l was 208 mg/l, 1.5 gm/l was 257 mg/l and at 2.0 gm/l it was 249 mg/l and for outlet wastewater COD before addition of CKD was 160 mg/l and after addition of CKD at 1.0 gm/l was 453 mg/l,1.5 gm/l was 192 mg/l and at 2.0 gm/l it was 185 mg/l.
4. The typical concentration of COD for municipal wastewater is 100 mg/l to 400 mg/l.In this project we can see that COD concentrations are already in permissible limits, but after addition of CKD it reduces below permissible limit. But the main aim of the study is to observe the study of reduction in COD using CKD as a coagulant, which is satisfied.

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