Burnt Coal Treatment to an Industrial Wastewater Containing Dyes

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Abstract-Waste material of coal or burnt coal in the form of fly ash is continuously being accumulated up to the tune of millions of tons per annum. In present study burnt coal was collected from coal powered generation house, characterized, converted into adsorbent material and utilized against industrial dye waters. Efficiency of burnt coal was checked as an adsorbent using optimum dose of 4g/L, and reduction of COD (54%), color (76%), turbidity (72%) and TSS (98%) from dye wastewaters was observed. The adsorptive capacity of burnt coal was declined when adsorbent dose was increased

Keywords-Waste, Coal, Fly Ash, Dye, Optimum, Dose

I. INTRODUCTION

Textiles industries are main consumer of dyes. The related industries of dyes and textile are producing toxic material of 100 tons directly dumped annually into canals and estuaries [i]. The production worldwide and consumption reached over $7*10^5$ tons annually of 10000 types of dyes [ii, iii]. Therefore the huge quantities of water became contaminated. The activated carbon produced from Jatropha curcas husk used for removal of toxic, anionic dyes and heavy metal and organic matter from water. The Jatropha curcas husk is the biodiesel industry waste. [iv]. It has been reported that dye wastewater is rich in color, turbidity, pH, chemical oxygen demand (COD), biological oxygen demand (BOD), temperature, acids, transition metals, alkaline and toxic chemicals [v]. Dye production decides physico-chemical parameters of wastewater [vi]. Thus it creates lots of environmental pollution issues on its discharge [vii]. The examination of effluent, discharged from dyes manufacturing plant content high load of COD, BOD and aromatic hydrocarbon. It was rich in acidic dyes, and metal complexes. On the surface of effluent the suspended matters were also floating. It was noted that conventional methods were less effective to decontaminate the effluent completely. The unchecked drain of untreated contaminants could have damaging effect for human and animal life, spoil underground water and affect fertility of soils. Physico-chemical as well as biological process efficiency varies according to the temperament and complexity of industrial effluents. Adsorption process of activated carbons depends upon specific surface area, and pore size [viii]. Waste in the form of coal fly ash from coal based power plants during combustion of coal is collected from coal fuel boilers with the help of electrostatic precipitators, creating serious problems for environmental and its safe disposal [ix]. The coal fly ash production worldwide is about 600 million tones. Whereas studies suggest Pakistan possesses coal reserves of 3,362 millions tones and Lakhra coal reserves are 1328 million tones. In FBC power plant at Khanote, with ash generation up to 55680 m^3/hr [x-xi]. In case of sugarcane Pakistan produces estimated 48000 million tones per annum, from which 13,384 millions tones bagasse production and 0.5 millions tones of fly ash production was achieved in 2009 [xii]. Fly ash has good porous structure and adsorption capacity therefore increased use is observed for production of low cost fly ash for removal of aromatic compounds [xiii], transition metals [xiv] dyes [xv] and organic contaminants [xvi]. Present research was carried out study low cost fly ash treatment efficiency to reduce parameters such as; COD, turbidity, color, and TSS from effluents of industrial dyes.

II. MATERIALS AND METHODS

Adsorbents prepared from coal fly ash samples were examined for dyes effluent treatment for reduction of organic pollutants. Different types of coal ash samples were obtained from Lakhra Power Generation Company Limited, Jamshoro. However bagasse fly ash of sugarcane was obtained from Matiari Sugar Mills (Pvt) Limited, at Matiari.

TABLE I
MATERIAL COMPOSITION OF CFA, BBCA, CCA AND SBFA

Ash Type	LIO(%)	SiO_2(%)	Al_2O_3(%)	Fe_2O_3(%)	CaO(%)	MgO(%)	SO_3(%)
Coal Fly Ash	14.48	23.61	14.09	9.15	22.89	2.71	13.13
Bottom Coal Ash	6.65	3.37	16.41	24.95	10.77	0.61	6.25
Cinder Coal Ash	3.10	38.54	29	18.32	6.20	1.91	2.94[12]
Sugarcane Bagasse Fly Ash	13.45	74.69	3.60	4.9	2.56	0.69	0.11[17]

A. Preparation of Carbon (Activated) Adsorbent from Coal Ash

Coal and sugarcane bagasse fly ash samples were ground with disc pulverizer, (type 1025 W, MFC No.8375, Yoshida Seisakusho Co. Ltd Tokyo Japan) at 560 rpm. Grinded fly ash samples were sieved at 290 rpm speed on RO-Tap Type Sieve shaker (Japan).

B. SEM Analysis of Fly Ash Adsorbents

Surface morphology and porosity of raw and prepared adsorbent fly ash samples was carried out by scanning electron microscope (SEM) (JSM-6380, JEOL, Japan) in Mining Engineering Department Advanced Research Laboratory, Mehran University of Engineering and Technology, Jamshoro. Fly ash SEM at 5 kV used for surface morphology of raw and fly ash adsorbents (i, ii).

C. Analysis and Treatment of Dyes Effluent by Adsorption

Dye samples were collected from Jamshoro dyes manufacturing plant effluent discharge and were checked for water quality. Effluent samples were checked for COD using dichromate kit method COD vial (Merck Company, Germany), and spectrophotometer (DR-2000, Hach U.S. A) with COD program option 435 and 620 nm wavelength . Color, turbidity and TSS of dyes effluents observed via absorptiometric method at 455 nm, 450 nm and 810 nm wavelengths respectively.

III. RESULTS AND DISCUSSIONS

Sorption is specific and influenced by its physicochemical properties of fly ash samples such as; pore size, surface area and chemical composition whereas alumina, iron and silica oxides in fly ash work as stable coagulants in reducing contamination concentration Table I. However, sugarcane bagasse combined with fly ash showed more surface area and porosity than simple coal ash, resulting in more adsorption capacity for contamination removal but not with simple coal fly ash. It confirms that smaller particle size with more specific surface area, promotes adsorption. In present study effluent dyes 100mL sample when treated with prepared fly ashes for removal of effluent pollutants at dose variations, it was concluded that SBFA adsorbent showed reduction in effluent chemicals as COD, turbidity, TSS and color Table II. Adsorptive capacities at dosage of 2g/100mL was found to be the optimum dose required to carry out study, however increasing adsorbent dosage from 2g does not improve adsorption efficiency (ii).

TABLE II
FLY ASHES ADSORBENTS DOSAGE EFFECTS IN SORPTION OF INDUSTRIAL EFFLUENT POLLUTANTS

COD Adsorption%					Color Adsorption%				Turbidity Adsorption%				TSS Adsorption%			
Dose	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**
2g	44	37	34	39	48	46	44	39	68	88	48	41	24	89	87	65
4g	51	39	43	34	70	45	39	53	71	46	40	54	93	89	88	91
6g	48	48	40	37	59	48	48	46	63	51	48	49	87	81	89	91
8g	49	49	42	35	56	53	51	51	61	55	53	53	96	92	87	90

TABLE III
FLY ASH ADSORBENTS DOSAGE EFFECT ON THE ADSORPTIVE CAPACITY FOR INDUSTRIAL EFFLUENT POLLUTANTS REMOVAL

COD Adsorptive capacity (mg/g)					Color Adsorptive capacity(mg/g)				Turbidity Adsorptive capacity(mg/g)				TSS Adsorptive capacity(mg/g)			
Dose	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**	**SBFA**	**CFA**	**BCA**	**CCA**
2g	29	18	18	16	97	118	113	99	29	24	23	22	6	19	18	14
4g	17	11	9	12	66	59	52	68	15	13	12	15	9	11	9	10
6g	11	8	6	9	36	44	42	39	9	7	8	9	6	7	7	8
8g	9	6	4	6	26	37	33	31	5	7	6	7	3	5	5	4

The initial COD levels in effluent dyes were 1171 mg/L, when 100 mL sample treated at dose variations, the reductions in COD up to 54% at 4g dose of SBFA and 50% removal rate at adsorbent dose 8g of CFA was achieved. (39%) COD removal was observed with 2g BCA dose, CCA dose of 4g resulted in 44% COD removal was observed Fig.2 (b). Effect on pH not observed range was under NEQS.

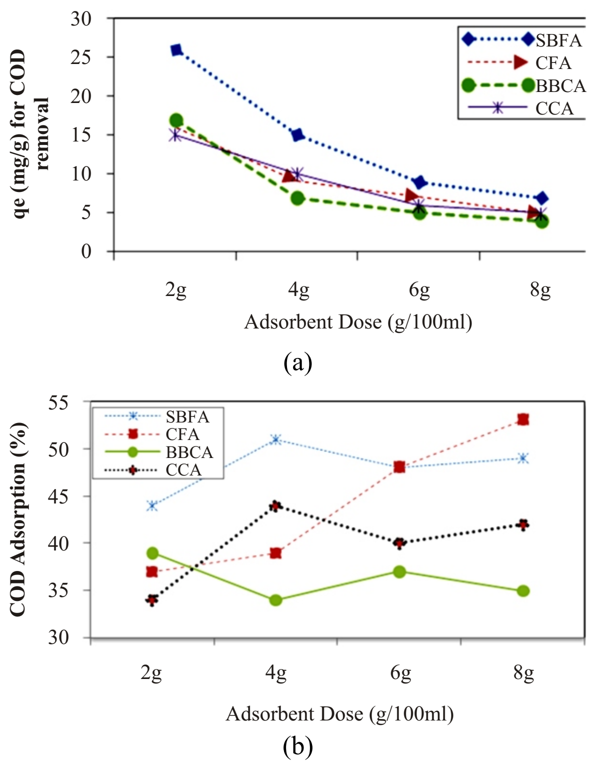

Fig. 1. Adsorptive capacity of fly ashes for dyes effluent COD removal at dose variations

Dyes effluent samples contained 1280 FTU level of turbidity when treated showed removal efficiencies of 71% for SBFA and 53% for CCA respectively observed with dosage of 4g each, whereas 55% CFA and 53% BCA at dosage of 8g showed removal in turbidity of wastewater

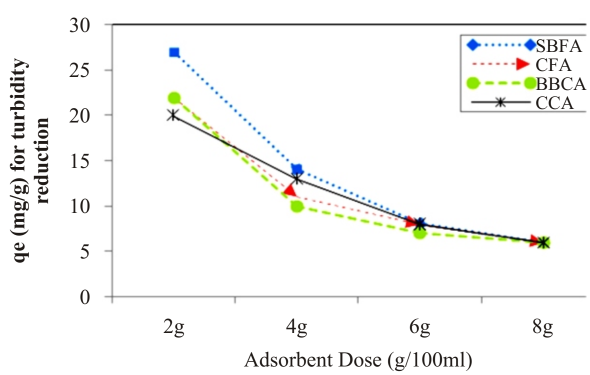

Fig. 2. Adsorptive capacity (mg/g) of fly ash adsorbents for dyes effluent turbidity reduction

Concentration of total suspended solids (TSS) in effluent dye samples stood at 349 mg/L. the wastewater solutions when subjected to 8g dosage and 30 minutes contact time, the removal efficiencies were 96%, 92%, 87% and 91% for SBFA, CFA, BCA and CCA respectively [Fig.2]. During present research work Langmuir and Freundlich isotherm models were examined and concluded that Freundlich model was suitable for effluent dyes adsorption by use of coal fly ash.

IV. Conclusion

Examination of individual and combined fly ashes regarding adsorption studies against effluent dyes resolved it to be effective reductant for COD, turbidity, color and TSS. Observation of reduction in COD (49%, 37%, 44% and 51%), turbidity (55%, 53%, 54% and 71%), color (53%, 51%, 53% and 70%) and total suspended solids (92%, 87%, 91% and 96%) using CFA, BCA, CCA and SBFA respectively.

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Nomenclature

COD: Chemical Oxygen demand

TDS: Total Dissolved Solids

TSS: Total Suspended Solids

CFA: Coal FlyAsh

SBFA: Sugarcane Bagasse FlyAsh

BBCA: Bottom Based Coal Ash

CCA: Cinder Cinder Coal Ash