DYE WASTEWATER TREATMENT BY HYDRODYNAMIC CAVITATION PROCESS

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ABSTRACT

In the present work, degradation of dye effluent has been investigated using hydrodynamic cavitation process .In this study, the effect of hydrodynamic cavitation was examined for the different time intervals from 0 to 120 mins. In hydrodynamic cavitation pump was used of 1 H.P capacity and reactor capacity was 50 litres. With hydrodynamic cavitation, maximum COD removal achieved was 64% in 120 mins.

***Key words**: Advanced oxidation process, COD removal, pesticide wastewater, Hydrodynamic cavitation.*

Introduction

Synthetic dyes are present in all spheres of our everyday life and its application is consistently growing. The dye pollutants from the textile industry are a most important of environmental pollution, these effluents are toxic and mostly non biodegradable. The industries involving production and application of dyes in the wastewater , causes the major threat to the surrounding eco systems due to health hazard caused by toxicity.Waste water from the textile industry containing dyes causes serious environmental problem due to their intense color and potential toxicity.

There are various types of dyes:

A) Acid Dyes
B) Natural Dyes
C) Basic (Cationic) Dyes
D) Synthetic Dyes
E) Direct (substantive) Dyes
F) Disperse Dyes
G) Sulfur Dyes
H)Pigment Dyes
I) Mordant Dyes
J) Reactive Dyes
K) Azo Dyes

Treatment technology

The cavitation is defined as the phenomena of formation, growth and collapse of micro-bubbles or cavities , where this process occurs in few milliseconds and releasing large magnitude of energy. In Hydrodynamic cavitation bubbles or cavities are formed due to pressure variation in the flowing liquid , by change in the flow area such as venturi , orifice plate etc. According to the Bernoulli principle , when the liquid passes through the venturi the

kinetic head increases at the expenses of the pressure head. If the throttling of the venturi/orifice is sufficient , the pressure at the throat is equal or falls below the vapour pressure of liquid and thus the vaporous cavities are formed.The collapse of the micro-bubbles/cavities generates localized 'hot spots' and due to this condition the temperature is around 10,000 K and the pressure is 1000 atm.During these condition the water molecules are dissociated into 'OH*' and 'H*' radicals. OH* radicals react with the organic pollutants and oxidize/mineralize them.

Factors affecting hydrodynamic cavitation:-

Cavitation number, Inlet pressure, Diameter of the constriction, Physicochemical properties of the liquid and the initial size of nuclei, Percentage of free area for the flow (**Chanda S K, 2008)** Hydrodynamic cavitation has great potential in water disinfection due to its capability to generate highly reactive free radicals and turbulence. The mechanism involved in disinfection of microorganisms by cavitation is thought to involve the following effects **(Gogate and Kabadi, 2009)**.

1. Mechanical effect: Associated with the generation of currents, shear stresses and turbulence due to liquid circulation.
2. Chemical effect: Generation of free hydroxyl radicals.
3. Heat effect: Hot spot generation due to high local pressure and temperature. It has been observed that in hydrodynamic cavitation, chemical and thermal effects play supporting roles to mechanical effects in microbial disinfection. **(Jyoti and Pandit, 2004)** applied ozone and hydrodynamic cavitation to bore well water and found this technique much more effective in water disinfection compared to other individual physical-chemical techniques including ozonation, hydrodynamic cavitation and acoustic cavitation. Cavitation can also be used as supplementary technique to a conventional biological oxidation process to increase substrate biodegradability or to reduce toxicity by degrading bio refractory materials **(Gogate and Kabadi, 2009)**. It can also be used with an anaerobic digestion process to improve the digestibility of the sludge by solubilising it.

EXPERIMENTAL PROCEDURE

For hydrodynamic cavitation, experiments were performed in reactor of capacity 50 liters in which effluent was lifted and circulate by the pump of capacity 1 H.P. for different intervals of time without use of any chemical. Sample was kept for quiescent condition for 2 hours for the settlement of the precipitate. All experiments were carried out in batch mode. Several set of experiments were carried out to check the optimum range of time.

FIG. 1 HYDRODYNAMIC CAVITATION REACTOR

RESULT AND DISCUSSION

TABLE 1:- RAW EFFLUENT CHARACTERISTICS

PARAMETERS	CONCENTRATION
pH	8
COD	8,800 mg/l
COLOUR	2,631 CU
TDS	1,59,658 mg/l
TSS	2,976 mg/l
TS	1,62,634 mg/l

The wastewater characteristics play a significant role on its treatment. Raw wastewater parameters were measured and listed in Table 1. These results indicate that this wastewater contains high load of organic and inorganic matter. Therefore, this wastewater can cause damage to the environment when discharged directly without proper treatment.

COD degradation after treatment

SR NO	TIME (min)	COD OF RAW SAMPLE (mg/l)	COD OF TREATED SAMPLE (mg/l)	PERCENTAGE OF COD REMOVAL (%)
1	0	8,800	8,800	0
2	15	8,800	8,213	6.67
3	30	8,800	8,017	8.89
4	45	8,800	5,060	42.5
5	60	8,800	4,576	48
6	75	8,800	4,253	51.67
7	90	8,800	3,520	60
8	105	8,800	3,312	62.36
9	120	8,800	3,105	64.71

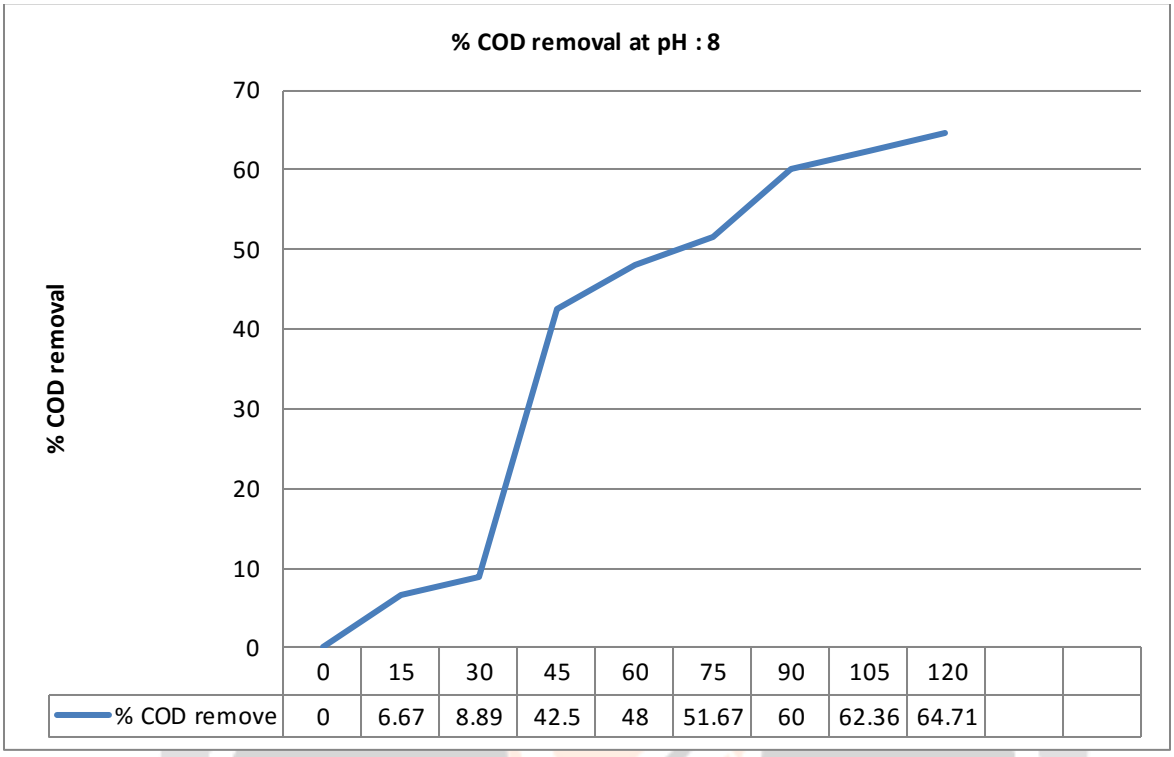

FIG. 2 % COD REMOVAL WITH HYDRODYNAMIC CAVITATION PROCESS

In this study, the effect of cavitation was examined for the different time intervals from 0 to 120 mins. In hydrodynamic cavitation pump was used of 1 H.P capacity and reactor was 50 liters. With hydrodynamic cavitation, maximum COD removal achieved was64.71 % in 120 mins as shown in Fig.

CONCLUSION

The degradation of wastewater from dye wastewater was investigated by the cavitation process. maximum efficiency of COD removal is achieved at 120 mins, 64.71% with hydrodynamic cavitation without any use of chemical. Cavitation is eco-friendly way to reduce the pollution load of wastewater. These processes differ from the other treatments processes because wastewater compounds are degraded rather than concentrated or transferred into a different phase and secondary waste materials are not generated. Sludge generation is very less compare to other processes.

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