Application of Hybrid Hydrodynamic Cavitation in Dye Intermediate Waste Water Treatment

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Abstract— Wastewater discharge from industrial units containing newer and refractory chemicals is a significant problem for conventional treatment plants. The release of this toxic wastewater into the natural environment is not only hazardous to aquatic life but also creates significant environmental concerns. Conventional wastewater treatment methods like adsorption on activated carbon, extraction, and chemical oxidation have limitations such as limited applicability. Hydrodynamic cavitation has emerged as promising technology for COD reduction as it does not require chemicals and sludge generation is also very less in this process. This process results in sudden drop and increase of pressure in a liquid, which creates cavities and bubbles followed by sudden and violent collapse. Hydrodynamic cavitation has application potential in wastewater treatment, but sometimes it is also difficult to obtain satisfactory treatment efficiency by using hydrodynamic cavitation alone. In these situations, the process could be supplemented by other advanced oxidation processes (AOPs) to generate more oxidizing agents. Hydrodynamic cavitation treatment removal efficiency enhanced by adding oxidizing agent like H_2O_2, $FeSO_4$, Chlorine etc. & it is also known as hybrid hydrodynamic cavitation. A study was undertaken for effect Hybrid hydrodynamic cavitation for degradation of pollutant from Dye intermediate waste water by & chlorine gas was used in hydrodynamic cavitation. Study shows that with the use of chlorine in hybrid hydrodynamic cavitation, 74.15 % removal in COD & 84.06% removal in colour from dye intermediate wastewater is observed.

Key words: Hybrid Hydrodynamic Cavitation, Waste Water Treatment

I. INTRODUCTION

Different physical, chemical and biological methods are presently available for the treatment of wastewater discharged from various industries. Waste Water discharge from the chemical industries contains recalcitrant substances which creates significant problem in conventional wastewater treatment plants. Other wastewater treatment methods like adsorption on activated carbon, extraction, and chemical oxidation have limitations such as limited applicability. Advance Oxidation Processes (AOPs) are effective treatment that can degrade complex bio-refractory molecules. In AOPs hydroxyl radical (•OH) are generated and it has higher oxidation potential. The hydroxyl radicals (•OH) oxidize organic pollutants present in wastewater. Various AOPs have been used by many researchers for the waste water treatment such as Fenton oxidation, cavitation, H_2O_2, electrochemical oxidation, photolysis, etc.

Cavitation can simply be defined as a physiochemical process employing oxidation mechanism coupled with physical breakage/thermal decomposition using cavitating device for degradation of chemical substances.

If the cavitation occurs by pressure variation in the flowing liquid due to the presence of throttling devices such as venturi, orifice etc., it is called as hydrodynamic cavitation.

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.

A combination of advanced Fenton process/Advance Oxidation Process and cavitation has been observed to intensify the degradation process by way of turbulence and generation of additional free radicals.

II. MATERIALS AND METHODS

A. *Waste Water Samples*

A wastewater samples were collected from the dye intermediate industry. The composition of wastewater then characterized to identify the pH, COD, Color. A wastewater generated from Dyes & Dyes intermediate processes are not having consistent quality. It differs due to change in raw material, raw material yield, various route of processes, chemical synthesis, stoichiometric balance, process control parameter etc.

Here Dye intermediate wastewater quality ranges observed from pH= 6.8-7.1, COD = 50,000-56,000, Color= 2900-3500 pt. co. scale.

B. *Experimental Set-up*

The experimental set-up is as shown in Fig. 1. The Hybrid hydrodynamic cavitation (HHC) unit consists of a Cavitation component, a Rotameter, Chlorine purging section, Tank of 150 liter capacity, Centrifugal pump.

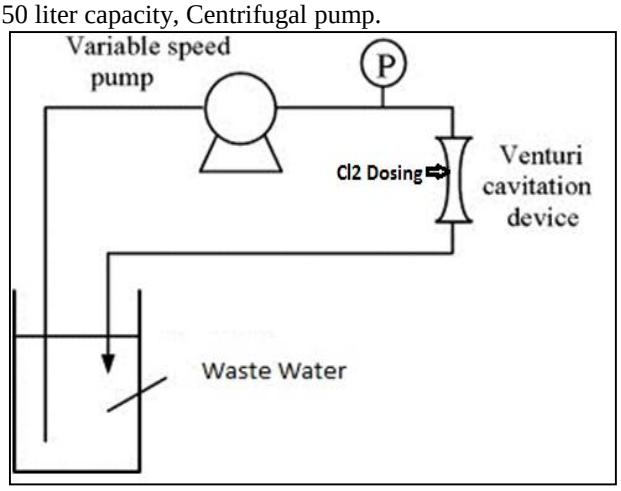


Fig.1

C. *Experimental procedure*

The experiments were carried out in a batch mode. Venturi used in Hydrodynamic cavitation to generate Cavitation. Dye intermediate wastewater sample is collected. Wastewater is transferred into container. Then Pump is put in operation. Waste water is pumping into contracting part i.e. ventury. Here at ventury section chlorine is added into wastewater. Chlorine dosage is controlled by rota meter. Chlorine gas is

dissolved in wastewater & reacts with it. Waste water is recovers pressure at downward section. Water flows downward & collected in container. Again pump is throwing water into circulation & passed to cavitating portion. Chlorine is reducing pH of wastewater hence alkaline material is added into wastewater manually to maintain pH range. Experiments were carried out to find out removal of Colour,COD from waste water & determine the effect of Chemical dosage, Cavitation time,.

III. Characteristic & Experiment

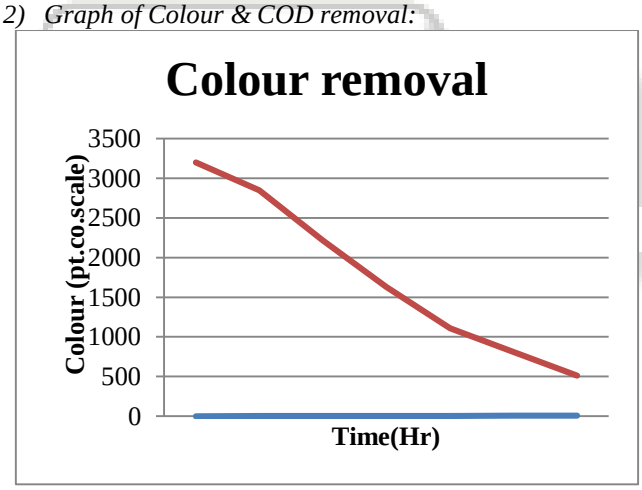
A Wastewater Sample was collected from dye intermediate industry. The Initial characteristics of waste water is pH = 68, COD = 54,200 mg/l, Color = 3200 pt.co. scale.
An experiment was carried out for with addition of Chlorine in hydrodynamic cavitation. Chlorine was consumption is observed 7.5 kg.

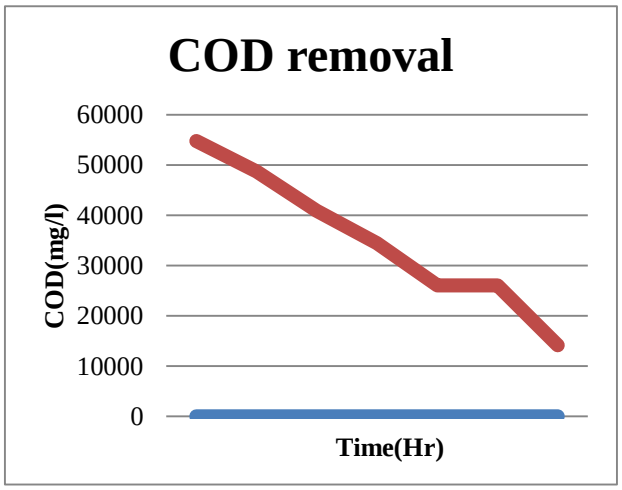
IV. Result Comparison & Discussion

A. Result:

1) Result of Experiment:
With the chlorine base Hybrid hydrodynamic cavitation treatment model final result observed is pH = 6.9, COD= 14165 mg/l & Color = 350 pt. co. scale result was attained.

2) Graph of Colour & COD removal:





B. Summary of result:

Above result shows that, It is clearly seen from the figure that operating time has significant effect on removal of pollutants. COD removal is 74.15% & Colour removal is 84.06% was attained experiment.

Cavitation number is considered as one of the major operating parameter for hybrid hydrodynamic cavitaion. Cavitation number is required to less than one foe effective cavity generation. Ideal range of cavitation number is 0.15-0.25. During the experiment Cavitation number found is 0.25 which is in ideal range,

V. Conclusion

Hydrodynamic cavitation with combination of chlorine has been investigated with an objective of effectiveness in removal of pollutants from dye intermediate wastewater.
This study shows the Hybrid hydrodynamic cavitation was found to be effective method for treatment of Dye intermediate wastewater.
The removal observed is 74.15% in COD reduction & 84.06 % Colour reduction was attained.
Hydrodynamic cavitation in combination with chlorine can act as advance oxidation process & this process considerable remove COD & Colour & other pollutants from dye intermediate wastewater. Chlorine gas enhances removal of pollutants from wastewater stream. Further experiment with modification will ensure the effectiveness of removal of COD from dye intermediate wastewater.
Hydrodynamic cavitation is energy efficient technology & cost effective technology for wastewater treatment.

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