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Degradation of Fish Processing Industry Wastewater in Hydro-cavitation Reactor

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Abstract

In this work wastewater released from fish processing industry has been processed for the degradation. Degradation of this wastewater has been effectively carried out for the reduction in BOD, COD, TOC, Color and Odor. Hydro-cavitation reactor system was used for this process. This reactor system proved of its best and given satisfactory results.

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*Keywords:*Hydro-cavitation, FPIW,Bio-degradability, BOD, COD,TOC

1. Introduction

Wastewaters of fish processing industries are the big sources of coastal environmental pollution. The discharge of fish processing industries will constitute biohazard to human being and other living organisms in the ecology [1]. These fish industries having many processing plants and are located to population areas. Different types of products are produced from fish in fish processing plants. Fish processing operations generates wastewater containing different contaminants in soluble, colloidal, and particulate forms. The intensity of the contamination depends on the specific operations like washing, filleting, cutting, cleaning and thawing [2]. Hence this fish processing method increases the organic matter in outlet water. Organic matter present in wastewater increases the Biochemical oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Organic Carbon (TOC).

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A new technology has been emerged to deals with wastewater coming from various industries. This technology is called as Hydro-cavitation reactor [3]. In this reactor cavities are formed by passing the liquid throw congested areas. This area can produce by using orifice plate or venturi. When a liquid passed through this orifice or venturi at higher pressure cavities are formed in downward side. Cavitation is nothing but generation, expansion and collapsing of cavities in very small time intervals as micro to milliseconds, which will release large magnitudes of energy over a region but at different locations in the system [4]. Generation of cavities is occurred when the pressure of liquid falls below the vapor pressure of that liquid. This collapsing act generates transient temperature in the range of 8000K -10,000 K and pressures of 800 atm -1000 atm. Due to this phenomena OH• and H• radicals will formed, which act as a oxidant for the degradation of pollutant present in the wastewater. This collapsing cavities produce shockwave which will degrade of organic matter [5].

In the present work hydro-cavitation reactor was examined for the degradation of Fish processing industry wastewater (FPIW). This was evaluated for BOD, COD, TOC, BI, Color and Odor. These parameters were analyzed as per standard procedure.

2. Experimental Method

2.1 Experimental Set-up

Hydro-cavitation reactor is shown in Fig. 1. Containing storage tank (10 L), control valves (V1–V3), the cavity generating system, suction-discharge pipe and bypass line. All the pipe assembly is of 25 mm diameter size. To control the flow of liquid through main tube of desired pressure bypass is used. Orifice plate was adopted for the generation of cavities. Central hole of 2 mm diameter was made in orifice plate which acts as a cavity generating system.

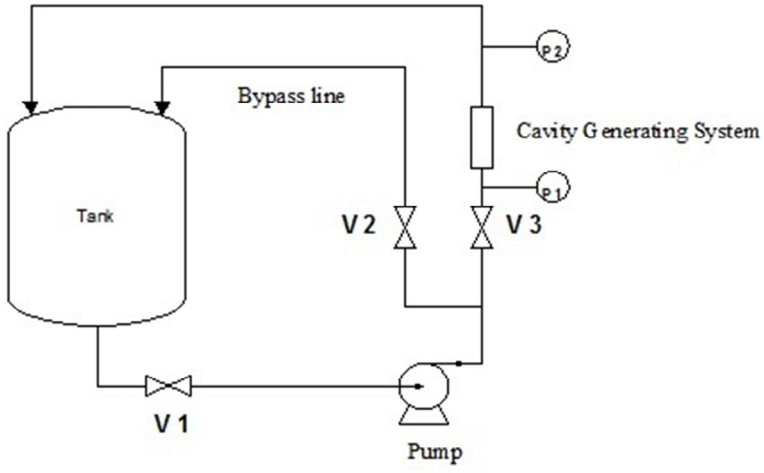

Fig. 1. Hydro-cavitation reactor setup for FPIW

2.2 Material

2.2.1. Fish Processing Industry Wastewater (FPIW)

Fish Processing Industry Wastewater was collected from local fish industry of Ratnagiri, Maharashtra (INDIA). FPIW is produced during various operations like preparation, product processing, inspection and trimming. The characteristics of FPIW sample are placed in Table 1.

Table 1: Characteristics of Fish Processing Industry Wastewater (FPIW)

Parameters	Values
BOD (mg/L)	1810
COD (mg/L)	22109
TOC (mg/L)	910
pH	6.12
Color	Reddish Black
BI (BOD:COD)	0.81

2.2.3. Analytical Techniques

Standard methods are used to determine the organic content of the FPIW. Methods are biochemical oxygen demand (BOD) and chemical oxygen demand (COD) [6]. Another method for calculating the organic value is the total organic carbon (TOC) method, in which combustion of organic content to carbon dioxide and water in a TOC analyzer [6]. The detection of color is done by UV–Visible Spectrophotometer and for odor detection Olfactometer is used.

2.2.4 Bio-degradability

Bio-degradability index (BI) is defined as the ratio of BOD and COD. Bio-degradability indexes (BI) determine the sustainability and suitability of FPIW for further treatment [7]. Bio-degradability index (BI) was calculated after the treatment of hydrodynamic cavitation.

3. Result and Discussion

3.1 Inlet pressure effect on degradation

The effect of inlet pressure from 4 bar to 9 bar was successfully carried out for the degradation of COD, TOC and BOD. After specified time interval samples were analyzed for COD, TOC and BOD. All results are shown in Table 2. The results indicate that effective reduction in COD, TOC and BOD occurs up to 80 min. Later reduction is constant up to 120 min. For 80 min of cavitation time percentage reduction in COD and TOC is 45.12 and 32.01. Similarly value of BOD is reduced from 18110 mg/l to 3761 mg/l for 4 bar inlet pressure. On increasing inlet pressure from 4 bar to 9 bar equivalent reduction is observed in COD, TOC and BOD. Hence 9 bar inlet pressure will increased the power consumption. Hence 80 min cavitation time and 4 bar inlet pressure can be considered optimum condition for the degradation of fish processing industry wastewater (FPIW).

Table 2: Effect of hydro-cavitation on Fish Processing Industry wastewater (FPIW)

Inlet Pressure (bar)	Time (min)	COD (mg/L)	COD Removal (%)	TOC (mg/L)	TOC Removal (%)	BOD (mg/L)	BI (BOD:COD ratio)
4	0	22109	0	910	0	18110	0.81
	40	14366	35.02	635	30.17	6033	0.42
	80	12133	45.12	618	32.01	3761	0.31
	120	11861	46.35	612	32.71	3795	0.32
9	0	22109	0	910	0	18110	0.81
	40	14127	36.10	624	31.35	5509	0.39
	80	11870	46.31	616	32.21	3561	0.30
	120	11773	46.75	616	32.24	3414	0.29

COD/TOC Removal(%)=(X-D)/X.100, where X= initial COD/TOC(mg/L), D=Final COD/TOC(mg/L)

3.2 Cavitation effect

3.2.1 Color and Odor Reduction

Color detection was carried out using UV-Visible spectrophotometer. The method is given by Naik et.al [8]. Blood is released from various operations of fish processing. Blood gives reddish black color to wastewater. Hence this was important to reduce color of FPIW. In hydro-cavitation reactor process color has been significantly reduced [9]. Color reduction is parallel process to organic degradation. Color has been reduced up to 51% on 80 min cavitation time, later it was constant.

Odor is the main problems associated with the FPIW. Odor is generated due to organic matter present in wastewater. Oflactomter was used for the detection of odor. In hydro-cavitation organic matter was degraded; this will leads in the reduction of odor effectively up to 76 % in 80 min. The experimental values of color and odor are shown in fig.2.

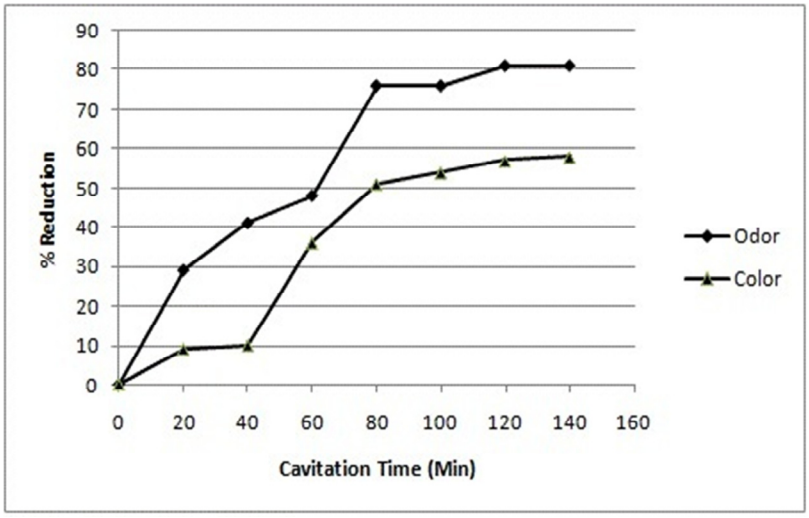

Fig. 2 Effect of Cavitation (Inlet Pressure of 4 bar) on Color and Odor Reduction

2.2 Bio-degradability

Bio-degradability was measured in terms of Bio-degradability Index (BI) which is ratio of BOD to COD. Metcalf, I. Eddy[7] described BI $\geq$ 0.3and BI $\geq$ 0.4 desirable for aerobic and anaerobic treatment. In the present experimental work, initial BI was 0.81 and after treatment of Hydro-cavitation BI reduced to 0.31 in 80 min at 4 bar inlet pressure. Increased inlet pressure not given significant result as compared to 4 bar. Inlet pressure (4 bar) of pump proved optimum and desirable for reduction in BI from 0.81 to 0.31. Calculated values of is displayed in Table 2. Hence Hydro-cavitation reactor can be effectively used for the degradation of Fish Processing Industry wastewater (FPIW).

4. Conclusion

The Hydro-cavitation reactor system proved itself a best secondary treatment option for the degradation of wastewater released by fish processing industry. Its BOD, COD, TOC, Odor and Color have been reduced promisingly at 4 bar Inlet pressure. Hence 4 bar inlet pressure and 80 min exposure time degrade wastewater of Fish Processing Industry (FPIW) easily as compared to traditional methods.

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