Treatment of Ink Wastewater From Cardboard Printing Industry

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Abstract- *This study has been specially carried out to treat the ink containing wastewater generating from an industry located in MIDC, Butibori, Nagpur (Maharashtra). The ink wastewater has been generated due to the cardboard printing processes. Generally, this type of influent is generating in large quantity because printing machines have to be washed time to time to avoid dryness on printing roller and to avoid generation of ink layer on rotating drum. The ink wastewater contains large amount of suspended particles due to which water seems dark blue and black. These particles were totally removed by using Aluminium Sulphate as a coagulant and the efficiency was observed in terms of pH, COD, BOD, TSS, TDS, Coagulation-Flocculation and colour. The optimum dose of coagulant shows rapid settlement of suspended particles and along with this, aeration and chlorination helps to remove colour and odoriferous compounds present after coagulation and flocculation process. The removal efficiency of above parameters from this influent was found to be under the permissible limits of industrial effluent standards of Maharashtra Pollution Control Board (MPCB).*

Keywords- Cardboard, Printing, Ink wastewater, Influent, Removal efficiency.

I. INTRODUCTION

The printing process industries generally use colors, dyes, pigment and solvents for preparation of ink for printing of advertisement, news, detailed of products etc, on cardboard sheets, papers and boxes. The printing inks are generally oil based with mixture of dyes, pigment and solvents. The paper related products like newspapers, cardboard sheets, magazines are to be printed in Flexo Printing Machines. These machines have rotating drum which apply ink on papers. These drums required timely washing to avoid formation of ink layer on it. The process generates huge amount of colored / ink wastewater which cannot be directly discharged without treatment due to highly toxic and colored. The cardboard boxes are extensively using for industrial and commercial goods and for domestic material packaging. The production of cardboard manufacturing and their products are rapidly increasing in industry which is located in MIDC, Butibori industrial area. The manufacturing process of cardboard in this industry is automatic and required large quantity of water for machines maintenance and for printing process. The ink wastewater generation from this industry has not continuous it generate only when then printing machines have to be washed due to colour change of printing ink, break down of machines and to avoid ink layer stick on rotating drum in printing machine. Generally this influent is thick and contains large quantity suspended and floating particles due to which it seems black colour. The colour of this influent is not a 'true colour'; it is type of apparent colour (temporary). The ink wastewater seems like colored due to large quantity of suspended and colloidal particles present in it. There were several researchers studied the coagulation and flocculation process on wastewater treatment such as: (Altaher, et. al., 2011) optimize the coagulation-flocculation process on wastewater from petroleum industry. Rincon, 2014 presented electro-coagulation as a method to treat bilge water, with focus on emulsion and heavy metal removal efficiency. Ramavandi 2014, calculated the coagulation potential of FCE obtain from P. ovats seeds for removal of turbidity. The processes like coagulation-flocculation are shows simple and cost efficient (Choi et al., 2001; Kacha et al., 2003; Kim et al., 2004; Metes et al., 2000; Zemaitaitiene et al., 2003). The Daud et. al. 2015 investigates the efficiency of coagulation-flocculation process for removing of colour, COD, Suspended solids (SS) and oil from biodiesel wastewater.

In this study, we are focused on to treat ink containing wastewater which is generated from cardboard printing process with respect to removal of colour, COD, BOD, S.S, T.D.S etc. by using Aluminium Sulphate / Alum with finding out optimum dosage of coagulant. The purpose of this work is to give cost efficient and reliable treatment method to the industry to treat ink influent and allow the treated effluent disposed on land without danger to surrounding area of industry and well-being of the plants.

II. MATERIALS

In this study the coagulation and flocculation method was adopted to treat ink wastewater generated from printing process of cardboards. The printing ink is a complex mixture of dyes, pigments, solvents and colour, and all these parameters were observed in ink wastewater generated from printing machines. The detailed analysis of this wastewater shows that the influent contained maximum coarser, colloidal and suspended particles present in it and due to this ink wastewater generally thick in nature. To treat this wastewater chemical process is adopted followed by coagulation and flocculation process. The Aluminium Sulphate $(Al_2SO_4)_3$ / Alum has been used as a coagulant. Alum has 1.0 pH and acidic in nature and generally used for removal of suspended particles present in wastewater. The chlorine (Cl) is also used to remove colour retained after coagulation-flocculation process. A pH of 7.4 also gives good chlorine disinfection.

III. METHODS

3.1 Collection of samples

In the present study, the representative samples were collected directly from ink wastewater collection tank for evaluation of parameters. The samples were collected in one liter of plastic container. The flow rate and pH was measured at site by pH paper. Then detailed analysis was done within 24 hrs in the laboratory. The samples were analyzed for the following parameters like pH, COD, BOD, TS and TDS. The influent generation rate from industry was found 5000 - 6000 liter per day.

3.2 Experimental tests

The pH of samples was determined by litmus paper at site and by digital pH meter in the laboratory. The values are nearly same at site and laboratory experiments. The pH of ink wastewater is 8.0 - 9.0. The suspended and dissolved solids are calculated by gravimetric method. The COD of sample is in between 2300 mg/l to 2800 mg/l and it is calculated by potassium dichromate reflux method. The BOD of sample is 200 mg/l to 350 mg/l and it is calculated by DO method in 3 days, 27°C. The jar test method is used for coagulation and flocculation process. The 10% Aluminium Sulphate solution has been prepared for coagulation flocculation process. The pH of solution is recorded as 1.0 and pH of sample is recorded as 8.5. The jar test consists of 4 beakers of 500 ml each. The 500ml of ink wastewater filled in all jars and then coagulant dose are added in jars, fig.no.2. The first jar has no any coagulant dose, second jar have 2ml dose, third jar have 4ml dose and forth jar have 6ml dose, table no.:1. The doses are added when agitator are rotating in jar with high velocity for proper mixing of coagulant dose. The agitator rotating at 50 rpm for 10 minutes and slow down up-to 10 rpm and then stopped. The particle separation from sample has been observed immediately after addition of coagulant in samples. When alum reacted with sample then charged particles from ink wastewater are converted into a large size floccs and get heavier. All these flocculated particles is settled down at bottom of jar. The flocculation rate is different in each jar. The beaker where high settlement of sludge is observed, the upper part of water is then take out in different jar and filtered through filter media to removed very fine particles. The optimum dose of Aluminium Sulphate gives better results in the coagulation and flocculation. The water from this process has light red in colour and odorous. To remove colour chlorination treatment has been given and dose was calculated at site. The odoriferous compound was removed by oxidation process. The efficiency of treated effluent has been calculated by pH, COD, BOD, SS and TDS. The removal percentage of all these parameters was greater than 65% and results are under the criteria of industrial standard effluent. To treat ink wastewater, it required standard operation procedure and it has been shown in fig. no. 1.

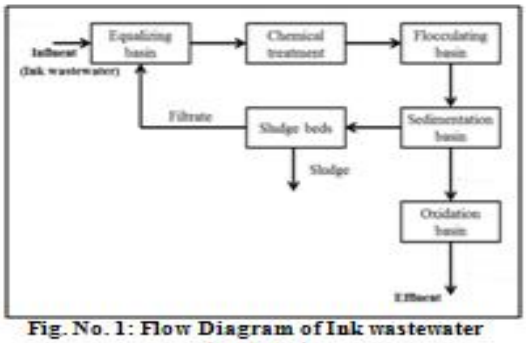

Fig. No. 1: Flow Diagram of Ink wastewater treatment

The treatment plant of ink wastewater requires equalization tank to store the excess influent and to balance the further working of treatment plant. The screening chamber is required before equalization tank to remove floating and coarser particles from influent. To maintain efficiency, batch operation is adopted for treatment. The influent is sump from equalization tank and transfer into flocculation tank in fixed volume with the help of pump. When the agitator is rotating add coagulant dose for proper mixing. After 30 minutes this water is transfer into sedimentation tank for settlement of sludge. After 45 minute of settlement the clear water from top part without disturbing settled sludge are transferred into oxidation tank. Then finally, withdraw the settled sludge via drain valve and allow for sun dry. The clear water from above process only required oxidation for 45 minutes and chlorination to remove present light colour. ref. fig. no.:1.

IV. RESULTS AND DISCUSSION

The Aluminium Sulphate $(Al2SO_4)_3$ / Alum has superior efficiency in removing turbidity. It is cheapest and suitable coagulant to treat such type of ink wastewater. The turbidity and all suspended particles were removed by coagulation-flocculation method. The dose of chemical is about 800 mg/l to 1000 mg/l.

From fig. no.:4 it is clearly observed that, the turbidity is decreases as coagulant dose increases until the optimum coagulant dose and after optimum dose turbidity increases as increased coagulant dose. Therefore, it is necessary to find out optimum dose of coagulant by jar test apparatus. The results obtained shows that best turbidity removal has been achieved at 800 mg/l, fig. no.:4. The concentration of chemical is an important factor that affects the efficiency of particle separation

Fig. No. 2: Ink wastewater before coagulation-flocculation on jar test

Fig. No. 3: Ink wastewater after coagulation-flocculation on jar test

Table No. 1: Doses of coagulant and sludge settlement

Sr. No.	Parameters	IS : 2490 (part I) - 1981 Standards for Industrial Wastewater	Ink wastewater influent	Treated ink wastewater effluent
1	pH	5.5 - 9.0	8.0 - 9.0	7.2 - 8.0
2	Colour	Colourless	Dark blue and black	Colourless
3	Odour	Odourless	Offensive	Not any specific smell
4	Chemical Oxygen Demand (COD)	Less than 250 mg/l	2620 mg/l	240 mg/l
5	Biological oxygen Demand (BOD)	Less than 30 mg/l	330 mg/l	30 mg/l
6	Suspended Solids (S.S)	Less than 200 mg/l	1180 mg/l	60 mg/l
7	Dissolved Solids	Less than 2100 mg/l	1700 mg/l	1570 mg/l

After the coagulation and flocculation result the effluent is being passed through activated carbon filter media to remove micro particles. This effluent requires oxidation to remove odoriferous compounds present in it and chlorination is also required for disinfection and removal of colour. The dose of chlorination is 1000 mg/l to 1200 mg/l. The final effluent was satisfy all the industrial effluent standard values which is given by IS: 2490 (part I) - 1981.

Table No. 2: Characteristics of ink wastewater before and after treatments

Beaker	Dose of coagulant (ml)	Settlement of sludge (ml)				
		10min	20min	30min	40min	50min
1	-	-	-	-	-	-
2	2ml	495	490	488	486	485
3	4ml	390	260	180	125	110
4	6ml	410	335	255	170	140

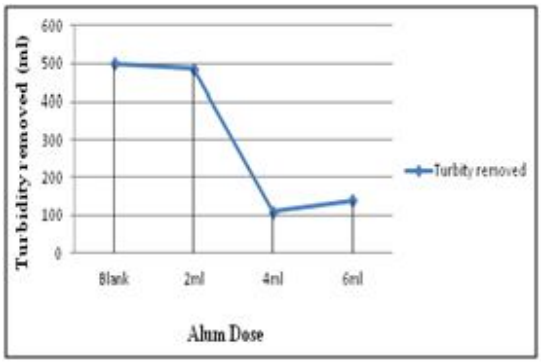

Fig. No. 4: Turbidity removal after coagulation-flocculation

Note: - The average values of ink wastewater samples are shown in table no.2

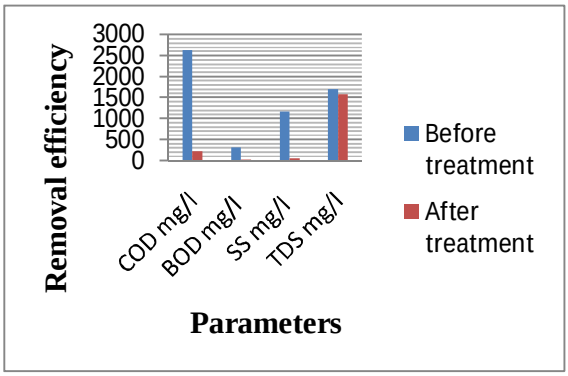

Fig. No. 5: Ink wastewater parameters before and after treatment

Figure No. 6: Ink wastewater

Figure No. 7: After coagulation

Figure No. 8: After chlorination

V. CONCLUSION

During the study, the ink wastewater samples were collected from cardboard printing industry. From the detailed analysis on ink wastewater, it is concluded that the colour of this influent has not a true colour (not permanent), it is apparent type. The dark blue and black colour seems due to more coarser and colloidal particles and these particles were coagulated by adding Aluminium Sulphate with calculated optimum dose into it. The ratio of BOD and COD is about 9.0 and it should not be biodegradable; therefore it is treated only by chemical process. The Aluminium Sulphate (Alum) is used as a coagulant for treatment and it gives better results with respect to coagulation and their sludge settlement. After coagulation process all suspended particles are removed fig. no.:7. The colour which is present even after coagulation was successfully removed by chlorination process fig. no.: 8. the dose of chlorination is about 1000 mg/l to 1200 mg/l is required. The suspended and coarser particles are removed by coagulation-flocculation process. The suggested treatment on ink wastewater reduced the COD and BOD up-to 85% to 90% and suspended solids is up-to 95% and it is under permissible limit of industrial effluent standards as per Indian standard for industrial effluent. The treated effluent was successfully reused in industry for all secondary purposes.

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