A Study on Characterization & Treatment of Laundry Effluent

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Abstract

It is a substantial fact that specific disposal standard for laundry effluent have not been prescribed by Gujarat pollution Control Board (GPCB). Laundry waste uses soap, soda, detergents and other chemicals for removal of stains, oil, grease and dirt from the soil clothing. The laundry waste is originated in the residential zone on account of manual cleaning, cleaning by domestic washing machines as well as large amount of effluents are generated by commercial washing including dry-cleaning. An attempt has been made in the present investigation to generalize the characteristics of laundry effluent generated by various sources in Vadodara (Gujarat). It has been found during the laboratory studies, that SS, BOD and COD of laundry waste are high. Treatability studies were carried out in the environmental engineering laboratory of B.V.M. Engineering College, V.V.Nagar for removal of these contaminants. The coagulation-flocculation followed by dual media filtration was found to be most suitable sequence of the treatment.
Keywords: Laundry effluent, soil clothing, coagulation-flocculation, dual media filtration

I. INTRODUCTION

Laundry industry is a service industry, In other words, laundry industry is not a manufacturing industry. [1] The State Pollution Control Board has, therefore, not framed standards for specific contaminant levels for the disposal of Laundry waste. No laundry industry in India needs to seek consent under existing environmental legislation.

Laundry waste originates from the use of soap, soda and detergents in removing grease, dirt and starch from soiled clothing. [1] The technology of washing include white- work washing, bleaching, blueing, and starching processes under normal circumstances. Specialized processes are used for woollen, silk and such other fabrics. Depending upon the type of the stain, various chemicals are used for removal of the stains.

So for as, dry cleaning is concerned, it is one of the important methods of cleansing of the textile in an organic solvent. The solvent used as dry cleansing fluids dissolve the stain of an oily nature, which would be more difficulty to remove with water.[2] In other words, dry cleaning actually facilitate subsequent tracing of many type of garments that are excellently difficult and tedious to press after they have been wasted in water. The dry cleaning detergents, fluids and solvents normally find the way in the wastewater. Thus, it is not only the soap and detergent but also various dry-cleaning fluids, solvent, dry cleaning detergents, stain-removing chemicals find way into the wastewater.

Petroethylene known as ‘pere’ is used in dry cleaning plants, while the use of kerosene is used for remaining 18% the kerosene type Stoddard solvent are commonly used by the laundry industry. [1] Normally, the solvent is reclaimed. However some part of it definitely becomes a part of wastewater. It is as such difficult to characterize the waste because washing technology is not the same. The application of the technique depends upon various factors like the type of the fabric, the amount of soiling, type of stain, the stain removal chemical used, the use of solvent for dry-cleaning

II. LITERATURE OVERVIEW

In India, normally commercial washing machines are used by laundry industry. However, almost all houses use domestic washing machines. The quality of the wastewater from the commercial laundry Industry and the domestic washing machine are obviously different and therefore it would be most difficult to generalize the wastewater characteristics emanated from the washing technology. Thus laundry waste originates from commercial and domestic sources are of different character.

The commercial laundries contains Fats, oils and greases (FOG) as well as total suspended solids (TSS), which are the major impurities of concern. These impurities are derived from the soils, which are removed from clothing as well as from the chemicals, which are used.

Undissolved or insoluble matter, floating or suspended in water, imparts a cloudy appearance (turbidity) to it, and is referred to as total suspended solids or TSS. Aside from its unpleasing aesthetic appearance, the main concern with high TSS levels is in its ability to harbour harmful bacteria, such as coliforms. These microorganisms are harmful and can be fatal when ingested. They can readily attach themselves and hide on suspended solids, and are not readily disinfected

The general characteristics of laundry waste can be summarized as under:

- It is strongly alkaline in nature
- BOD is less than 1000 mg/L
- COD is 1000-1500 mg/L

Dry-cleaning waste also contain some amount of oil and grease

- It also contains solids
- It may or may not be coloured
- It contains large quantity of soap soda ash and dirt

The character of laundry waste vary from sample to sample and depends on the type of source whether it is commercial or domestic laundry waste including type of chemicals used.

Fifty years ago, it seemed not objectionable to discharge untreated wastewater from industrial processes into rivers and lakes. Many believed that our supply of fresh water was unlimited and that it could somehow handle the waste. We also weren't as concerned with the long-term consequences of pollution, neither did we have the available technology to remedy the situation.

FOG and other organic chemicals are digested, to produce carbon dioxide and water, by sewage bacteria, which feed upon them. In this process, these bacteria consume and deplete the dissolved oxygen in the water. If untreated wastewater were to be discharged directly into rivers and streams, it would also deplete the dissolved oxygen and put marine and plant life into risk.

A measure of organic water quality contamination is its Biological Oxygen Demand or BOD5. This is a measure of the amount of oxygen wastewater consumes over 5 days, at 20oC during the biological break down of organic contaminants, including FOG. The higher the BOD5 level, the more organic contaminants are present in the water.

Most municipalities in countries other than India have set limits of 100-150 ppm for FOG (from vegetable or animal sources), 350 ppm for TSS and 300 ppm for BOD5. Commercial laundries, which exceed these limits, can have surcharges applied to their water bill; in proportional to the limits exceeded. For laundries using large volumes of water, this surcharge can be significant, ranging from hundreds to thousands of dollars per month, and so there is a strong economical motivation for abiding by the municipal by-laws and treating the laundry waste.

Virtually every municipality today, has adopted similar by-laws, specifying what can and cannot be discharged into sanitary sewers and the permissible levels of each contaminant. Pressure from the municipalities and escalating sewer surcharges, which are applied when contaminant levels exceed the by-law maximums, are now making it attractive for commercial laundries to provide their own effective pre-treatment program prior to discharging their wastewater. In India this concept is picking up rapidly. Wastewater treatment is essential before effluent being discharged.

Physically, wastewater is usually characterized by a grey colour, musty odour, a solids content of about 0.1%, and 99.9% water content. The solids can be suspended (about 30%) as well as dissolved (about 70%). Chemical and biological processes can precipitate dissolved solids. From a physical point of view the suspended solids can lead to the development of sludge deposits and anaerobic conditions when discharged into the receiving environment. [3]

Chemically, wastewater is composed of organic and inorganic compounds as well as various gases. Organic components may consist of greases, surfactants, oils, pesticides, phenols, etc. Inorganic components may consist of pH, sulphur, chlorides, alkalinity, toxic compounds, etc. In domestic wastewater, the organic and inorganic portion is approximately 50% respectively. However, since wastewater contains a higher portion of dissolved solids than suspended, about 85 to 90% of the total inorganic component is dissolved and about 55 to 60% of the total organic component is dissolved. Laundry wastes originate from the domestic and commercial washing machines are vary in their characteristics depend on type of chemicals to be used. [3]

Wastewater is the flow of used water from a community. The characteristics of the wastewater discharges will vary from location to location depending upon the source either it is domestic or commercial. Domestic wastewater includes typical wastes from the kitchen, bathroom, and laundry, as well as any other wastes that people may accidentally or intentionally pour down the drain. Sanitary wastewater consists of domestic wastewater as well as those discharged from commercial, institutional, and similar facilities. In general, the volume of sanitary wastewater generated is about 400 L/C/d. However, the range of flow usually varies from a minimum of about 20% to a maximum of about 400% of the average dry weather flow for small communities and about 200% for larger communities. Industrial wastes will be as varied as the industries that generate the wastes. [3]

III. THE BASIC OBJECTIVE OF PRESENT INVESTIGATION

An attempt is proposed to be made in the present investigation to study the origin, characteristics and the most effective and economical treatment methodology for treatment of laundry waste of Baroda. The basic objective of the present investigation is to disseminate the impact of discharge of laundry waste without treatment to the environment. It is essential that Gujarat Pollution Control Board (GPCB) take the necessary steps to segregate domestic waste from the sanitary waste. The laundry waste should be separately treated before it is permitted to discharge into the sewer.

The various treatment methodologies available for treatment of laundry waste include flocculation for removal of colloids and fat, oil and grease, trickling filter or bio aeration for removal of oxygen depleting substances. Flocculation followed by filtration or adsorption is also found to be a proven technology for laundry waste treatment.

The prime objective of the present investigation is to address the significant parameters of the laundry wastewater emanated from domestic washing machine, commercial washing machine and various dhobi-ghats of the city. Based on the analysis of laundry wastewater, most optimal sequence of the treatment of laundry waste can be determined. Thus present investigation broadly deals with two important aspects of laundry wastewater.

Characterization studies, which essentially include sampling and analysis of the effluent

Treatability studies which essentially includes determination of amenability of altering the characteristics of laundry wastewater by various technological options

IV. SCOPE OF WORK

The present study therefore encompasses following steps:

Collection of grab samples from different dhobi ghats, commercial washing machines and domestic washing machines, including preservation in a most scientific manner

Determination of various parameters present in the laundry wastewater, so that the treatment options for the treatability can be planned

Developing of various treatment options available for laundry wastewater by making a literature overview

Preparation of bench scale apparatus for jar test, aerobic treatment, filtration and other such studies

Suggestion of the best, effective and economical treatment methodologies based on the treatability studies

V. MATERIALS AND METHODS

The present investigation involves sampling, analysis and treatment of the waste generated from domestic washing machine and commercial washing machine. The major part of the effluent is also emanated from various dhobi-ghats of the city. For the present study, grab samples were collected from different four locations of dhobi-ghats, domestic washing machine and commercial washing machine however in the present paper the effluent emanated from dhobigat Fatehganj has been focused. The details of the location, time, etc. for various dhobi Ghats is given under sampling program, as shown in Table 1.

Table – 1
Sampling program: Various dhobi-ghats

Type of Collection of sample	Time	Location of dhobighat
Grab	12:00 AM	A (Fatehgunj)
Grab	11:00 AM	B (Anandnagar)
Grab	11:35 AM	C (Nizampura)
Grab	10:00 AM	D (Sama)

The samples were brought to the environmental laboratory of B.V.M. Engineering College of V.V. Nagar. All the samples were analysed in the environmental engineering laboratory. The result of the analysis has been reported in Table 2. The analysis was carried out in accordance with standard method, 28th Edition. However, pH and temperature were measured on the spot to avoid any change, which may occur in bringing the samples from the sampling port to the environmental engineering laboratory. However the other parameters like COD, BOD, TDS and TSS have been measure in the laboratory. 2 ml H2SO4 was added as preservative so that the integrity of the various characteristics of the effluent is not change.

The treatability study was also carried out in environmental engineering laboratory B.V.M. The major part of experiment included the jar test using alum as well as ferrous salts of different concentration. The results of the jar test has been recorded in Tables.

Subsequent to the characterization studies treatability studies were carried out using the following apparatus.

Jar test using coagulants - 6-blade laboratory stirrer as well as 6 beakers.

Filtration followed by sand and powder activated carbon-The supernatant was then taken for filtration by dual media visibly sand and Powder Activated Carbon. For 28 to 30 hrs. The apparatus for carrying out filtration studies is shown in Figure 4.1.

The burette was field with sand and Powder Activated Carbon in 1.5:1 proportion. The supernatant was passed from the top of the burette. The process of filtrate of was found to be very slow. The results have been reported in Tables.

A. Aerobic Biological Waste Treatment

In another set of set of experimentation. The supernatant was aerated for a period of 48hrs. The observations were made at the interval of 8hrs. The interval results have been reported in Tables. Aerobic biological waste treatment studied was carried out in a batch reactor as shown in Figure 4.2.

The supernatant from the flocculator was used for studying the impact of aerobic treatment. The effluent of laundry wastewater was fed in a feed bottle employing an air pressure flow system. The mixed liquor of aeration chamber was aerated by compressed air that is by using porous diffuser as shown in Figure 4.2.

The porous diffuser used for the purpose was aquarium aerator. It is possible that the aquarium aerator may become chocked at high MLSS levels, however studies was carried out as batch reactor for a period of 72 hours only. The initial BOD and COD and the subsequent BOD and COD were measured and have been reported in Tables.

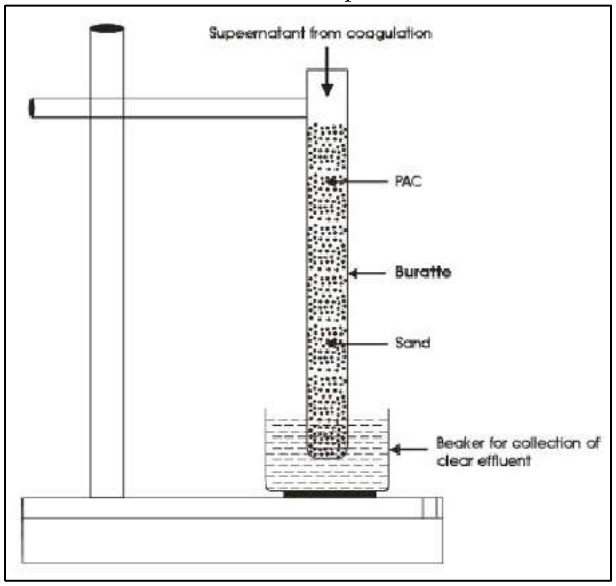

Fig 4.1 Filtration followed by Powder Activated Carbon

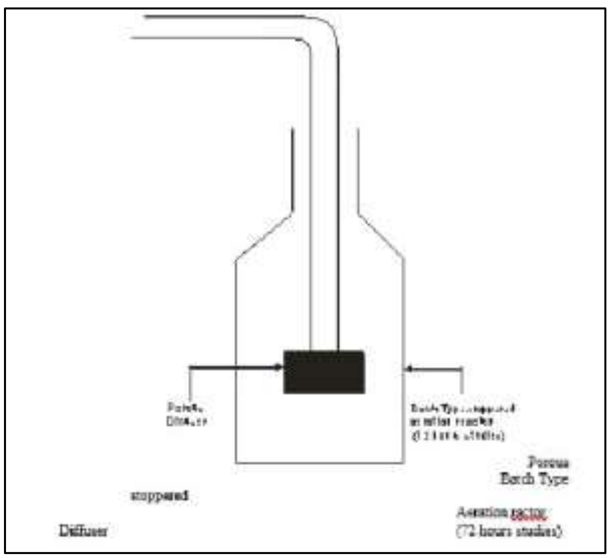

Fig. 4.2: Batch scale Aerobic Reactor for lab studies on Laundry waste effluent 9

VI. RESULTS AND DISCUSSION

A. *Characterization Studies*

Waste water characterization studies of various dhobi Ghats

The range of the characteristics of dhobi-ghats sample is shown in Table 3. From the Table 3, it is crystal clear that the BOD, COD and SS are in higher range than the general limits prescribed by IS 2490-1981.

Table – 3
The range of the Characteristics of various Dhobi ghat samples

Sr. No.	*Parameters*	*Characteristics of sample*
1.	*Temperature °C*	*30-34*
2.	*pH*	*7.88-10.32*
3.	*COD*	*376-910*
4.	*BOD*	*230-625*
5.	*SS*	*445-1550*
6.	*TDS*	*640-1455*
7.	*Oil and Grease*	*3-6*

B. Treatability Studies

1) Treatment of effluent from various dhobi-ghats

It is obvious from the characterization studies, the first step is to remove the solids. The range of the SS is 445mg/L to 1550mg/L. The coagulants alum and ferrous sulphate were used. The effluent was treated with 2%, 5% and 10% alum solution. Similarly, the effluent was also treated with 2%, 5% and 10% ferrous sulphate solution. The percentage reduction of SS is found to be maximum when the wastewater is treated with 5% and 5ml alum solution. The supernatant from the jar test was given treatment of filtration. Aeration studies on the supernatant were also carried out to study the effectiveness of it. It can be observed that the % reduction is only 14.

2) Treatment of the effluent from dhobi-ghat A i.e. Fatehganj.

The results of the treatment with the coagulants have been reported in Table 4 to Table 9. The percentage reduction of SS is found to be 48.98 during coagulation studies. The reduction in COD and BOD incidentally during the coagulation and flocculation studies with the optimum concentration of alum solution was found to be 39.77 and 35.18 respectively. The results of the filtration studies have been reported in Table 10. It is extremely clear from the Table 10 that the percentage reduction of SS by filtration experimentation is 68.28.i.e. the 227mg/L was reduced to 72 mg/L (which is within the limits). Both COD and BOD were found to be within the limits during filtration experimentation i.e. the results observed was found to be 71.68% and 74.65% respectively. Even the aeration yielded good results as can be seen from Table 11. The COD and BOD have been reduced by aeration 25% and 29% respectively.

Only analysis of sample collected at A is produced though the sample were collected and analysed for 4 different locations.

Analysis of collected samples from dhobi Ghat A

Table – 4
Results of jar test (2 percent solution)

Sr. No.	Parameters	Initial Value	*Treatment With 2% Alum Solution*			
			5 mL Dose	*% Reduction*	*10 mL Dose*	*% Reduction*
1.	*pH*	*7.88*	*7.67*	*-*	*7.4*	*-*
2.	*COD*	*376*	*261*	*30.59*	*121*	*31.25*
3.	*BOD*	*225*	*163*	*27.55*	*77*	*27.73*
4.	*SS*	*445*	*234*	*47.45*	*231*	*48.08*

Table – 5
Results of jar test (5 percent solution)

Sr. No.	Parameters	Initial Value	*Treatment with 5% Alum solution*			
			5 mL dose	*% Reduction*	*10 mL dose*	*% Reduction*
1.	*pH*	*7.88*	*7.30*	*-*	*7.20*	*-*
2.	*COD*	*376*	*226*	*39.89*	*108*	*38.64*
3.	*BOD*	*225*	*146*	*35.11*	*72*	*33.33*
4.	*SS*	*445*	*227*	*48.98*	*229*	*48.53*

Table – 6
Results of jar test (10 percent solution)

Sr. No.	Parameters	Initial Value	*Treatment with 10% Alum solution*			
			5 mL dose	*% Reduction*	*10 mL dose*	*% Reduction*
1.	*pH*	*7.88*	*7.1*	*-*	*6.94*	*-*
2.	*COD*	*376*	*229*	*39.10*	*106*	*39.77*
3.	*BOD*	*225*	*148*	*34.22*	*70*	*35.18*
4.	*SS*	*445*	*229*	*48.54*	*227*	*48.98*

Table – 7
Results of jar test (2 percent Feso4.7H2O solution)

Sr. No.	Parameters	Initial Value	*Treatment with 2% $Feso_4.7H_2O$*			
			5 mL dose	*% Reduction*	*10 mL dose*	*% Reduction*
1.	*pH*	*7.88*	*7.70*	*-*	*7.47*	*-*
2.	*COD*	*376*	*273*	*27.39*	*124*	*29.55*
3.	*BOD*	*225*	*171*	*24.00*	*80*	*25.93*
4.	*SS*	*445*	*236*	*46.97*	*234*	*47.41*

Table – 8
Results of jar test (5 percent solution)

Sr. No.	Parameters	Initial Value	*Treatment with 5% $Feso_4.7H_2O$*			
			5 mL dose	*% Reduction*	*10 mL dose*	*% Reduction*
1.	*pH*	*7.88*	*7.40*	*-*	*7.27*	*-*
2.	*COD*	*376*	*243*	*35.37*	*110*	*37.50*
3.	*BOD*	*225*	*154*	*31.55*	*73*	*32.40*
4.	*SS*	*445*	*232*	*47.87*	*229*	*48.53*

Table – 9
Results of jar test (10 percent solution)

Sr. No.	Parameters	Initial Value	Treatment with 10% $Feso_4.7H_2O$			
			5 mL dose	% Reduction	10 mL dose	% Reduction
1.	pH	7.88	7.15	-	6.97	-
2.	COD	376	229	39.09	107	39.20
3.	BOD	225	150	33.33	71	34.25
4.	SS	445	230	48.31	228	48.76

All parameters are in mg/L except pH

Table – 10
Results of Filtration of supernatant of 5% and 5 mL alum solution

Sr No.	Parameters	Initial Value	Final Value	% Reduction
1.	pH	7.30	7.25	-
2.	COD	226	64	71.68
3.	BOD	146	37	74.65
4.	SS	227	72	68.28

Table – 11
Results of Aeration of supernatant of 5% and 5 mL Alum solution

Sr No.	Parameters	Initial Value	Final Value	% Reduction
1.	pH	7.30	7.22	-
2.	COD	226	170	24.77
3.	BOD	146	104	28.77
4.	SS	227	195	14.0

All parameters are in mg/L except pH

VII. CONCLUSIONS

1) The laundry waste can be treated to achieve the general limits as given by 2490-1981
2) The general range of the effluent characteristics considering Dhobi Ghat A is given in Table 1. The BOD, COD and SS are found to be high which signify the treatment of the laundry waste before it is discharged into the water bodies.
3) The treatment sequence for the effluent collected from various sources like dhobi Ghat include various concentration of Alum and Feso4.7H2O solution, followed by filtration and aeration.
4) Physicochemical process followed by filtration yields desired results.
5) The percentage reduction during the coagulation-flocculation for removal of SS is 68. Subsequent to it, the percentage removal of BOD and COD are found to be 75 and 72 by filtration.
6) 48 hrs. aeration after coagulation-flocculation did not yield desired limits. Prolonged aeration therefore may be required.

REFERENCES

[1] Nemerow Nelson Leonard, Dasgupta Avijit, "Industrial and Hazardous Waste Treatment", van Nostrand Reinhold, 1991
[2] Martin Albert R., Fulton George P.,"Dry cleaning tec hnology and theory".
[3] Schiff Nathan, "Laundry waste treatment", 2001
[4] Bhatia S.C.,"Perfumes, Soaps, Detergents and Cosmetics", Volume 1, CBS Publishers and Distributers, 2001
[5] Marget Cuthberrt Rankin," The scienc e of laundry work", Blackie and Son Limited.
[6] Earnest A.J., "Clothes Care "' Cox and Wyman Ltd., London, 1967
[7] Garg S.K., "Sewage Disposal and Air Pollution Engineering", Khanna Publishers, 1994
[8] Holden J.T., Vowler John V., Hardwood F. Courtney, "The Technology of Washing", British Launderers Research Association,1935
[9] Metcalf and Eddy, Inc.," Wastewater Engineering Treatment, disposal and reused, Tata Mc-Graw Hill International Editions, 2002
[10] Parasuram K.S., "Soaps and Detergents", Tata McGraw-Hill Publishing Company Limited,1995
[11] Peavy Howard S., Rowe Donald R., Tchobanoglous George, "Environmental Engineering", McGraw-Hill Book Company, 1985
[12] Rao M.N. and Dutta A.K., "Wastewater Treatment", 2nd Edition, Oxford and IBH Co. pvt, Ltd
[13] Prof K N Sheth, "Methods in Effluent Treatment" in Control and Monitoring Environmental Pollution organized by Department of Chemistry, Sardar Patel University, Vallabh Vidyanagar Gujarat under the auspices of Indian Society of Analytical Scientists Baroda Chapter on 24th October,2001