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Wastewater characterization in urban areas: A case study of Aligarh city, U. P, India

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ABSTRACT

The rapid growth of the population, the technological and industrial boom has brought enormous problems and degradation of the environment. Effective collection and treatment of urban wastewater is a critical problem in developing countries like India. In the present study Aligarh city in U.P India has been taken where the development has taken place in an unplanned manner, resulting in its haphazard development. This has led to industries being located in densely populated areas. The drains all over Aligarh city carry industrial and domestic wastewater together giving it a uniqueness of its own. This has led to the overburden of the drainage system of the city leading to its collapse. The study was undertaken to analyse the wastewater quality of various lagoons and drains of the city during the year 2010. The wastewater quality varied to a great extent among various locations as the wastewater is of mixed quality. The study points the importance for a treatment plant before discharging wastewater and can also serve as the baseline data for its design.

Keywords: wastewater, lagoons, drains, Aligarh city.

INTRODUCTION

The continually increasing demand for water for beneficial purposes has forced man to assess and examine water reuse technologies more seriously than ever. Regardless of origin, industrial wastewater, after proper treatment, represents another ample and reusable water source. Water pollution has been a major cause of concern to scientists and engineers [12].

Water resource development has taken place all over the world. There is a tremendous amount of pressure in protecting the water resources available in the country. Protecting the surface water resources from wastewater pollution plays a vital role for the development. The disposal of wastewater into the surface water bodies leads to serious problems and affects the people in

health aspects. Especially in the urban areas, the pollution of domestic effluent discharges into the nearby surface water bodies created problems for the public. There are many ways of safe disposal of wastewater. But improper management of wastewater generation in the urban areas find its own way of getting into the surface water. Hence, the effluent discharge affects the surface water bodies. The water quality changes in the surface water bodies created many health problems to the public. Urban conglomerations are increasing at a very fast pace. Pivotal to the urbanization phenomenon are the associated problems of providing municipal services and water infrastructure, including the provision of both fresh water resources and sanitation services. Indian cities are no exception to the urbanization process and have tremendously expanded. The major cities are growing with a daily average addition of 1000 persons. As a result of this tremendous growth, service infrastructure is not able to keep up to provide the city a healthy environment. Ample supplies of clean unused water can no longer be taken for granted due to population growth, increasing urbanization and industrial water demands. Pollution of fresh water streams and ground water by industrial discharges result in depletion of existing water sources. Hence, it is increasingly becoming obvious that reuse of wastewater is a viable solution in many instances [10,11].

Study Area

The Aligarh city is spread over an area of 34 square kilometres. It is also an important centre of lock smithy. The town has a population of more than half a million, according to the 2001 census. The indiscriminate growth which is a hallmark of Aligarh has left its impressions on the environment. On account of its being an important centre of lock smithy, and other allied industrial functions like electroplating, casting, the town is besieged with rural migration. However, the town's infrastructure is such that it is unable to take on the extra load thereby resulting in a major breakdown of sanitary conditions.

Drainage System and Wastewater Generation

Sewer line has been laid approximately in 25% of the city area. Rest of the water is disposed by means of open drains. There is no sewage treatment plant in the city and all the sewage is being pumped by pumping stations to the sewage farm situated on Mathura road. During monsoon, Kaalideh situated on Agra road and Naveen colony situated on Kanpur road always face the problem of sewage flooding. Therefore, Master Plan 2021 has proposed a sewage farm and sewage treatment plant on Mathura road over 373.36 hectare [1].

Also the natural water reservoirs, ponds and lagoons have been identified in the master plan and their surrounding areas have been proposed to be developed from the entertainment point of view. Therefore for reservoirs, ponds and drains total 152.85 hectares has been preserved [9].

Sewage pumping stations have been established at Mathura road and Charra bus stand. Mathura pumping station comprises one pump of 120 Hp, two pumps of 110Hp and one pump of 50 Hp, which pumps most of the sewage coming from the city to the sewage farm for irrigation purpose. Charra bus stand pump station have two 40 Hp and two 20Hp pumps which pumps the sewage coming from civil lines and its neighbouring areas to the drains which goes to the sewage farm situated on Mathura road [5,6].

At Sarai Rehman (situated between G.T. road and Gular Road) direct pumping is taking place from the drains itself for discharging of the sewage. Gular road pumping station consists of 50 Hp and 40 Hp each. In the same manner G.T. Road pumping station consist of three 30 Hp and two 15 Hp pumps which pumps the sewage coming from a portion of civil lines, areas of Lal diggi, Malkhan Singh state Hospital and areas of Nai Basti to the open drain of Soot mill which

ultimately goes to sewage farm located on Mathura Road. It is clear that the sewage pumping station located on Mathura road handles the most of the sewage of Aligarh for its ultimate disposal [2, 3, 4].

Collection of samples and its description:

Wastewater quality of various lagoons and drains were analysed to identify the contaminated wastewater of the city. The samples of drain were collected from the inlet and discharge points and stored as per standard methods before analyzing the physical and chemical parameter. All the samples were tested for pH, Chlorides, Sulfates, BOD, COD, TS, TSS, TDS, Alkalinity and Total Hardness [7].

The entire chemicals used in the study are laboratory grade. The water used in the study was distinguished and later double distilled and stored securely to avoid contamination. All the analysis was conducted according to standard method. The study is carried out at the room temperature which varied from 20 – 25°C in winter time to 30 – 38 °C in summer time [8].

Sampling Locations



Locations names details:

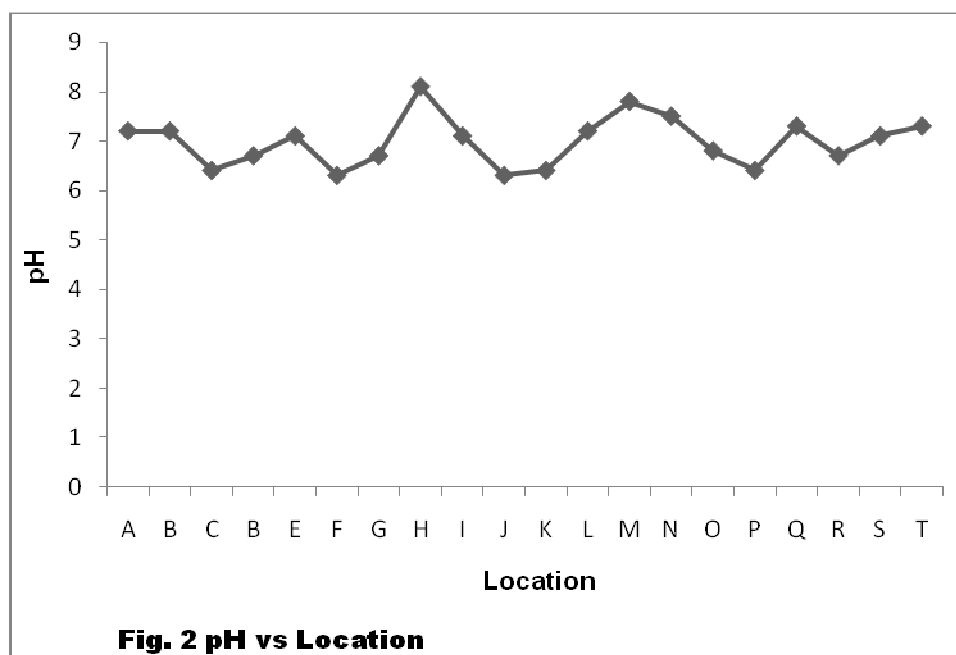
S.NO	Location Name	Location Designated
1.	CHAUTAAL INLET	(A)
2.	CHAUTAAL MAIN	(B)
3.	LOCO COLONY INLET	(C)
4.	LOCO COLONY MAIN	(D)
5.	GULAR ROAD INLET	(E)
6.	GULAR ROAD MAIN	(F)
7.	KAALIDEH	(G)
8.	CHANDANIYA	(H)

9.	LAAL DIGGI	(I)
10.	MATHURA PUMPING STATION	(J)
11.	GULAR ROAD PUMPPING STATION	(k)
12.	SHAHJAMAL PUMPING STATION	(L)
13.	ETAH PUMPING STATION	(M)
14.	ETAH BYE PASS FINAL	(N)
15.	SURENDRA NAGAR INLET	(O)
16.	SURENDRA NAGAR MAIN	(P)
17.	JAFRI DRAIN FINAL	(Q)
18.	ALIGARH DRAIN VIVEKANAND COLLEGE	(R)
19.	ALIGARH DRAIN FINAL	(S)
20.	ALIGARH DRAIN QILA ROAD	(T)

RESULTS AND DISCUSSIONS

The wastewater samples were analysed and results are represented in the form of graphs. The wastewater samples of lagoons has been also characterised with respect to inlet and outlet.

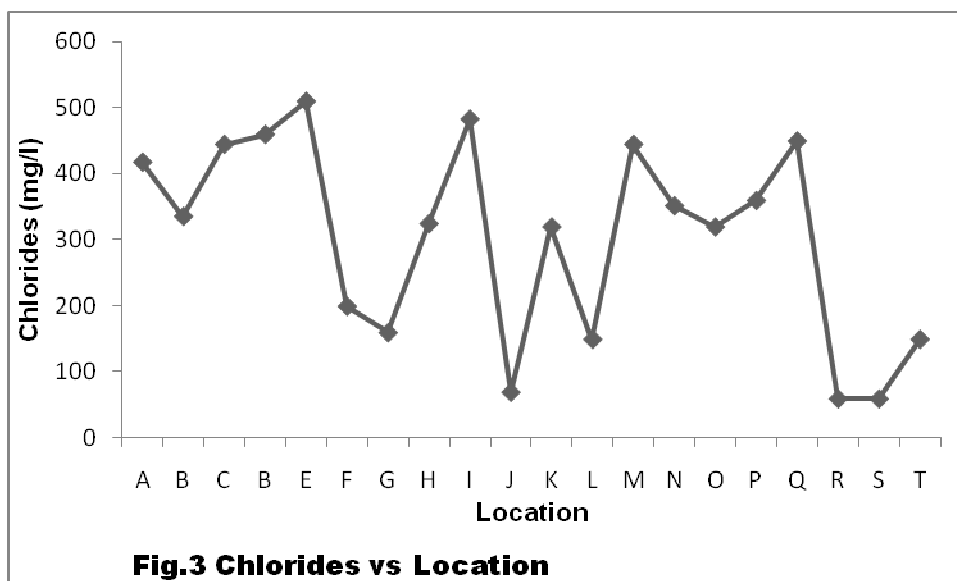
pH:



The above graph represents the pH value of the samples analysed of wastewater from various Lagoons and Drains. The pH lies between the standard ranges of 6.5-9 (CPCB). The maximum value is 8.1 of 'Chandaniya' Gandhi Eye Hospital and the minimum value is 6.3 of Mathura pumping station. The average is 6.98 i.e. 7 (approx.).

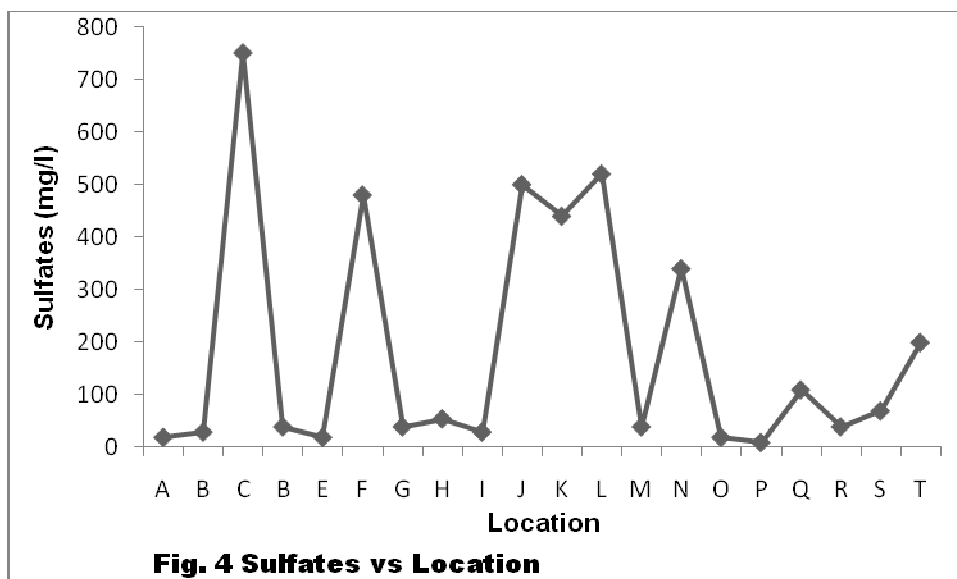
Chlorides

The Fig.3 represents the chlorides concentration of the samples of wastewater of different Lagoons and Ponds. It shows a great difference between the wastewater of city area and civil line area with respect to chlorides. The range of chloride concentration lies between 300-500mg/l as compared to city area where the concentration is below 300mg/l.



The maximum chloride concentration is 510mg/l of Gular road inlet and minimum is 60 mg/l of the Aligarh drain. The high concentration of Gular road inlet may be a result of point source contamination as the concentration of the lagoon itself is around 200 mg/l. The average concentration of all the Lagoons and drain is 312 mg/l. Chloride concentration are within the prescribed limit at all the locations.

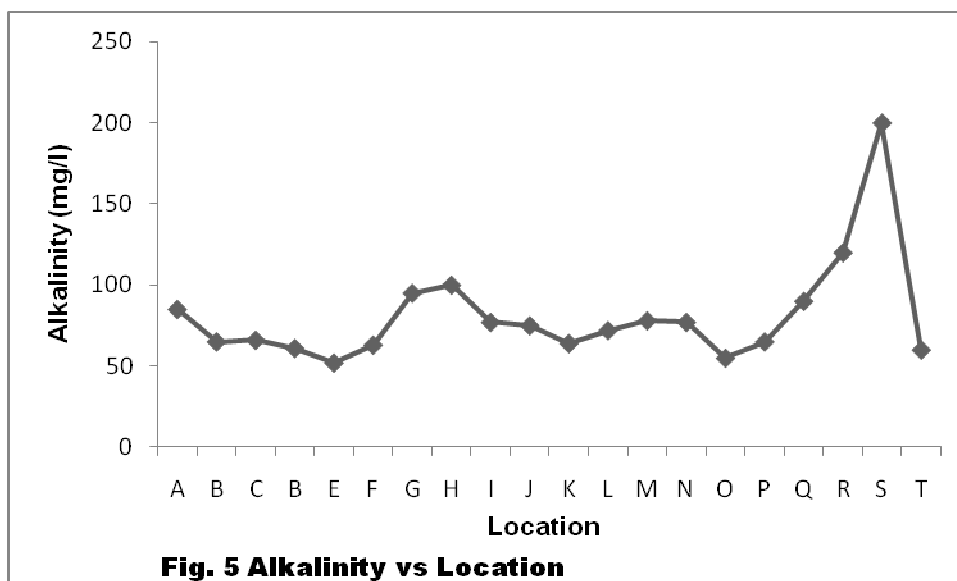
Sulfates



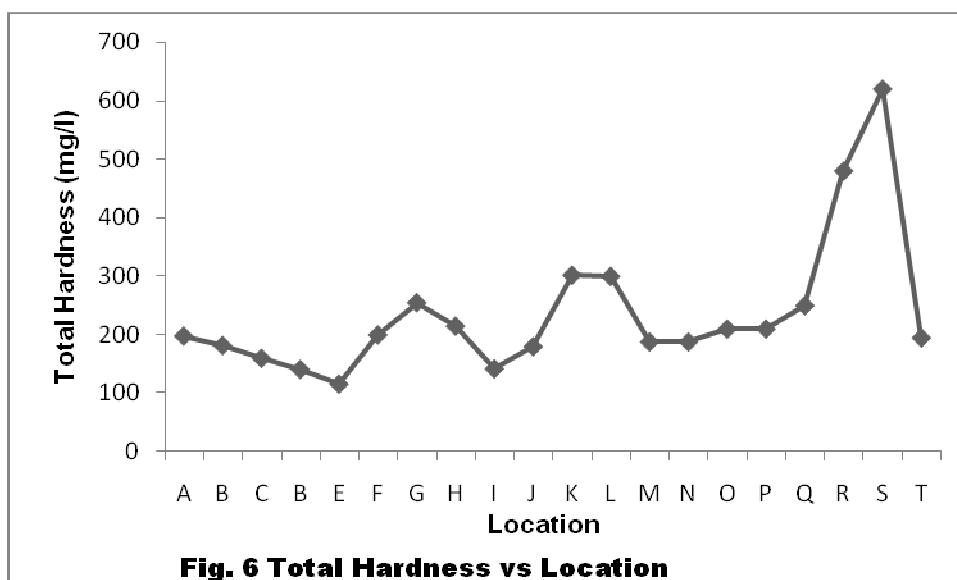
The graph represents the sulphates concentration of the samples of wastewater analysed from different lagoons and drains. The maximum concentration is 750 mg/l of Loco colony inlet the minimum being 10 mg/l of Surendra Nagar lagoon. The average concentration is 311 mg/l.

Alkalinity

The graph represents the alkalinity in terms of mg/l as CaCO₃. The maximum alkalinity is being represented by Aligarh drain final output i.e. 200 mg/l and minimum is 52 mg/l of Gular road inlet. The average value is 81mg/l.



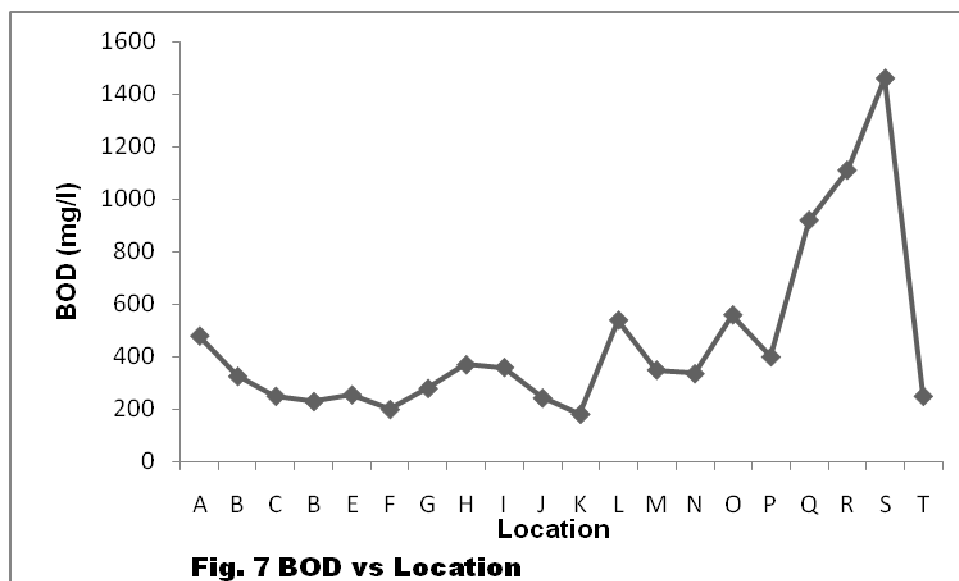
Total Hardness



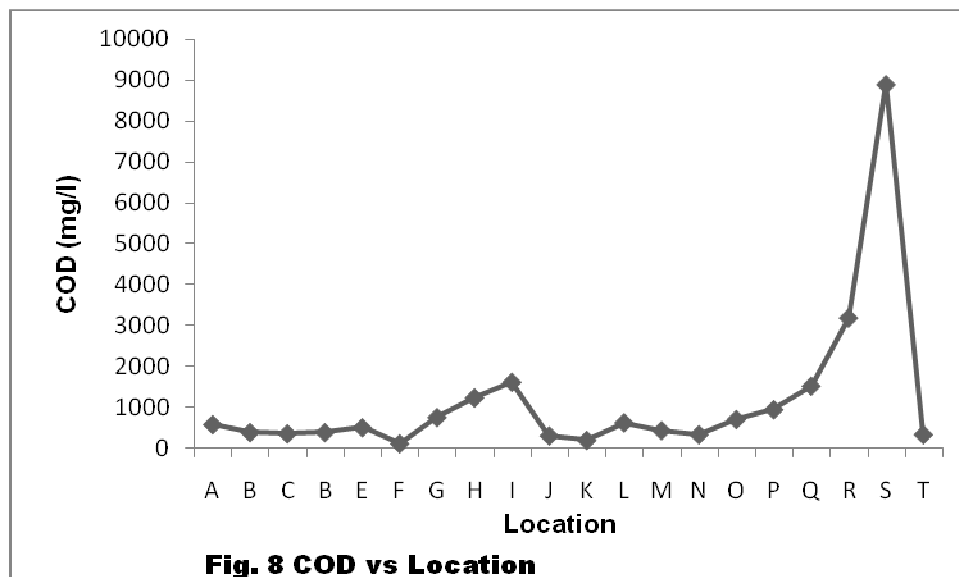
The graph represents the total hardness in terms of mg/l as CaCO_3 . The maximum being of Aligarh drain final output i.e. 620 mg/l and minimum being 141 mg/l of Loco Colony Main. Aligarh drain has such a high concentration as compared to the rest of the samples because it carries industrial wastewater. The average value is 236.6mg/l.

Biochemical Oxygen Demand (BOD)

The graph represents the BOD in mg/l. The maximum BOD is 1460 mg/l of Aligarh drain final output and minimum is 182 mg/l of Gular road pumping station. Aligarh drain is having such a high concentration due to discharge from slaughter house and meat processing industries whose discharge is carried by the drain. The average is 451 mg/l which is above the prescribed limit.



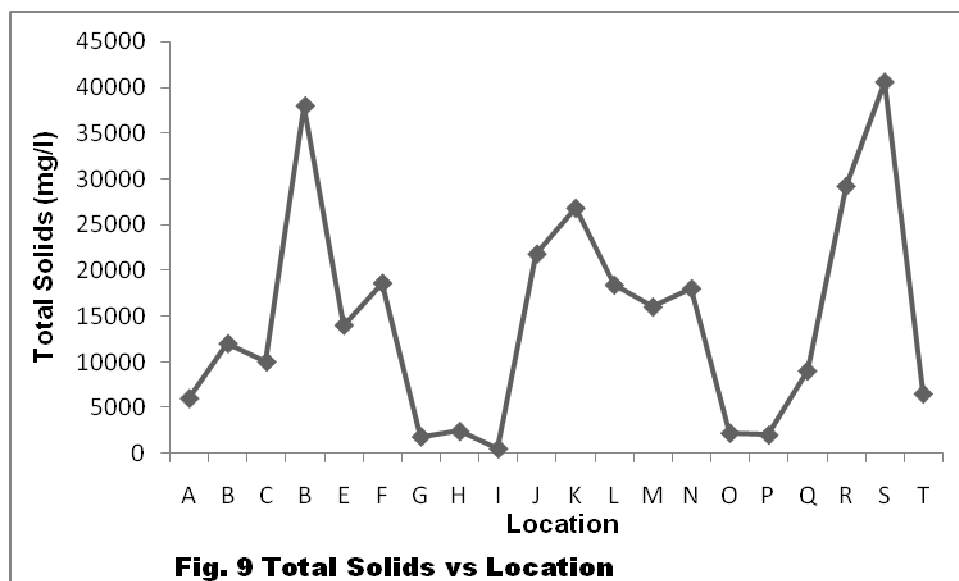
Chemical Oxygen Demand (COD)



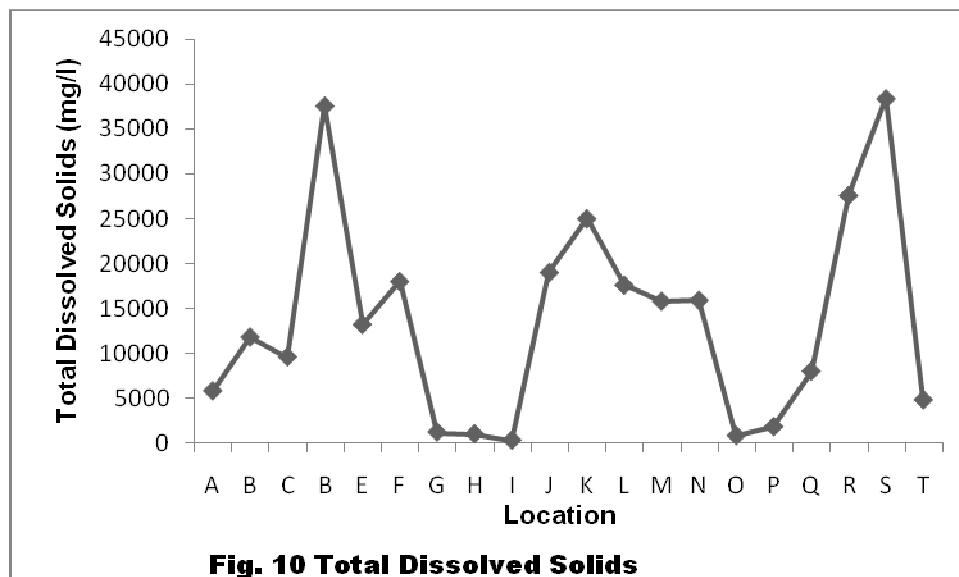
The graph represents the COD in terms of mg/l. The maximum being 9000 mg/l of Aligarh drain final output and the minimum is 210 mg/l of Gular Road pumping station. Aligarh drain is having such a high concentration as compared to the rest of the samples because of the discharge from the slaughter house. This can be concluded because Aligarh drain water sampled at Vivekanand College is also having high concentration but the sample of final output after the meat processing industry and slaughter house results in steep shoot up in the reading of the COD. The average COD is 1190 mg/l which is higher than the limit to discharge in to the sewer lines.

Total Solids

The Fig.9 shows the Total solid concentration of the samples of wastewater analysed. The maximum value is 40600 mg/l of Aligarh drain final and the minimum is 500 mg/l of Laal Diggi. The average value is 14690 mg/l.



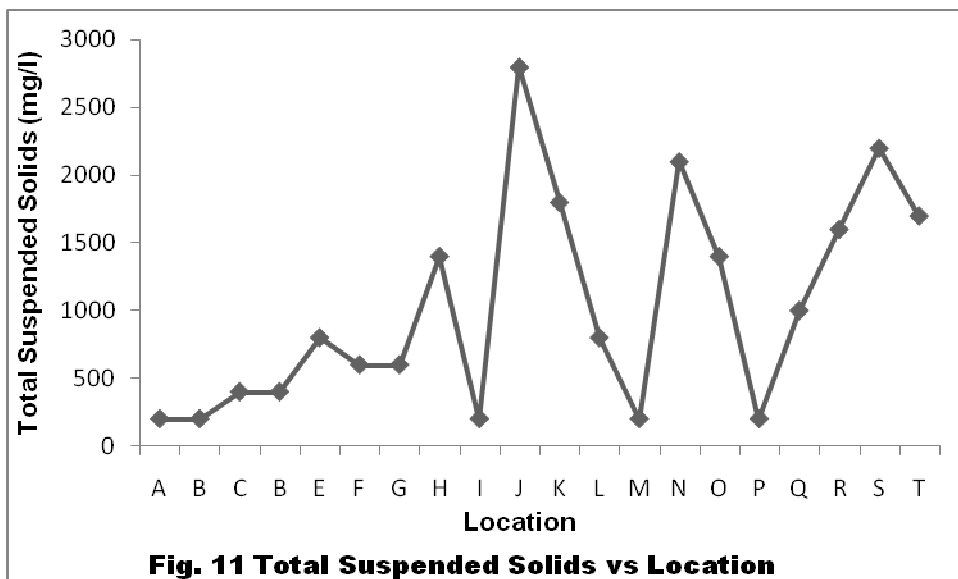
Total Dissolved Solids



The graph represents the total dissolved solids in mg/l. The maximum value is 38400 mg/l of Aligarh drain final output and the minimum is 300 mg/l of Laal Diggi. The average value is 13660 mg/l.

Total Suspended Solids

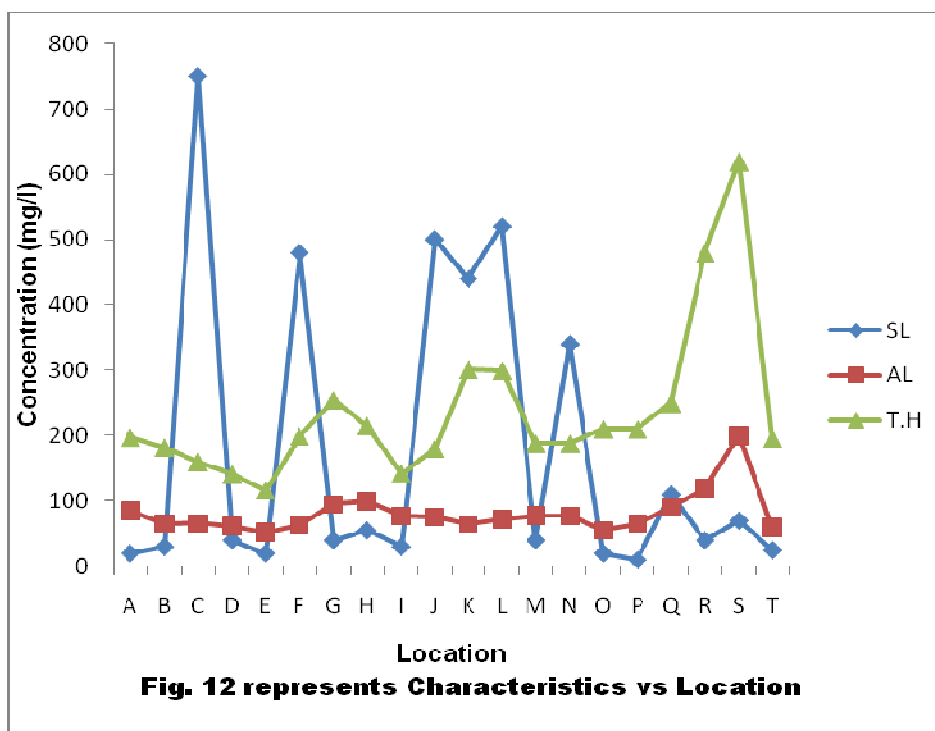
The graph represents the total suspended solids in terms of mg/l. The maximum is of 2800 mg/l of Mathura pumping station and the minimum is 200 mg/l. The Mathura pumping station is having such a high concentration of suspended solid as it collects water from most of the city part and on the of collection the organic matter decomposes resulting in suspended solids as compared to the Aligarh drain where total solids concentration and total dissolved solids concentration is high as the source of contamination is instant and organic matter doesn't gets time to decompose before reaching the site of sampling. The average value is 1030 mg/l.



Comparative graph of the wastewater characteristics:

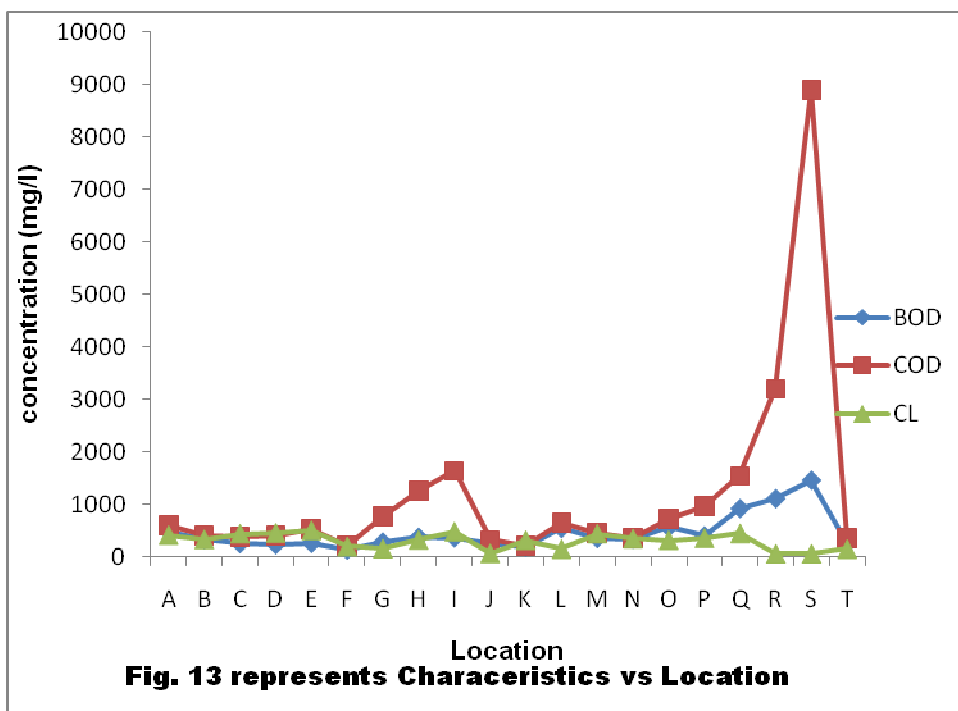
Sulfates, Alkalinity and Total Hardness:

Fig 12 shows the maximum concentration of sulphate at loco colony while alkalinity and total hardness are found maximum at Aligarh drain final.



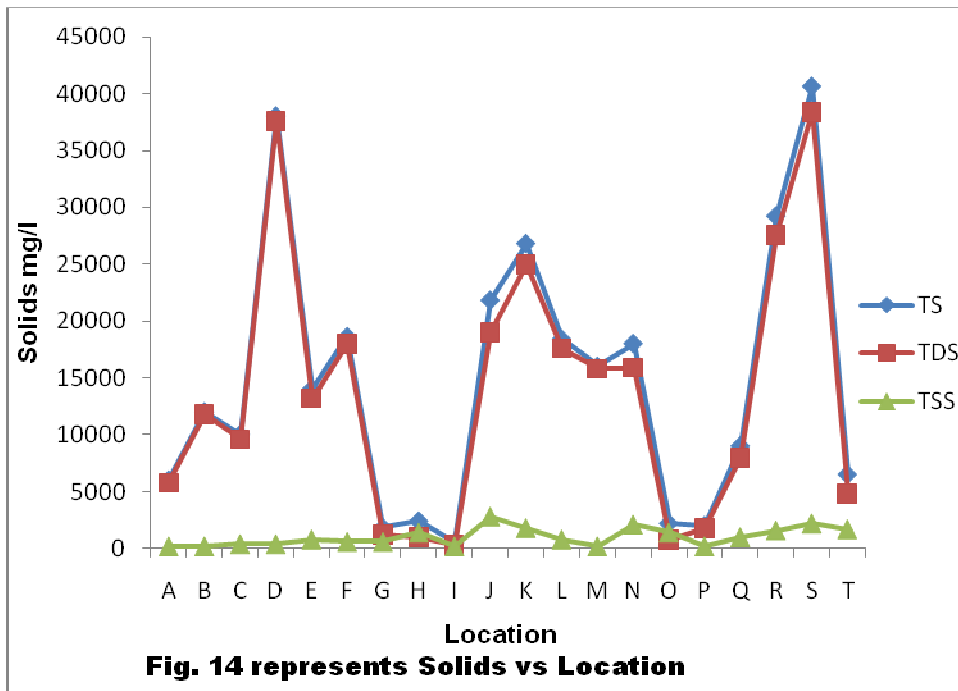
BOD, COD and Chlorides:

Fig. 13 represents the comparison of BOD, COD and chloride. The BOD and COD values are found maximum at Aligarh drain final. Also the graph shows at most of the location the values of BOD and COD are higher than the prescribed limit for discharge in the public sewers.



Total Solids, Total Dissolved Solids and Total Suspended Solids:

The Fig.14 represents the maximum concentration of total solid and total dissolved solid at Aligarh drain final out let. Also the pattern of total suspend solid indicates Aligarh final drain is highly polluted then the other locations.



OBSERVATION TABLE

S.NO.	LOCATION	pH	CL	SL	BOD	COD	TS	TDS	TSS	AL	T.H
1	Chautaal Inlet	7.2	418	20	480	595	6000	5800	200	85	198
2	Chautal main	7.2	336	30	326	400	12000	11800	200	65	182
3	Loco colony Inlet	6.4	445	750	250	370	10000	9600	400	66	160
4	Loco colony main	6.7	460	40	230	400	38000	37600	400	61	141
5	Gular road Inlet	7.1	510	20	256	520	14000	13200	800	52	116
6	Gular road main	6.3	200	480	128	200	18600	18000	600	63	200
8	Kaalideh, Gambhirpura	6.7	160	40	280	768	1800	1200	600	95	255
9	Chandaniya Gandhi Eye	8.1	325	55	370	1248	2400	1000	1400	100	215
10	Laal Diggi	7.1	483	30	360	1632	500	300	200	77	142
11	Mathur pupming station	6.3	70	500	243	320	21800	19000	2800	75	180
12	Gulra road pumping station	6.4	320	440	182	210	26800	25000	1800	64	302
13	Shahjamal pumping station	7.2	150	520	540	640	18400	17600	800	72	300
14	Etah chungi pumping station	7.8	445	40	350	450	16000	15800	200	78	188
15	Etah chungi final	7.5	352	340	336	350	18000	15900	2100	77	188
16	Surandra nagar Inlet	6.8	320	20	560	720	2200	800	1400	55	210
17	Surendra nagar main	6.4	360	10	400	960	2000	1800	200	65	210
18	Jafri drain final	7.3	450	110	920	1536	9000	8000	1000	90	250
19	Aligarh drain Vivekanand college	6.7	60	40	1110	3200	29200	27600	1600	120	480
20	Aligarh drain Final	7.1	60	70	1460	8900	40600	38400	2200	200	620

CONCLUSION

The following conclusions can be drawn from the present study:

1. The result shows the pH value of drains and lagoons are within permissible limit (6.5-9). However there is a slightly change at Gandhi eye hospital where it is highest due to discharge from hospital. At all locations the pH values are within permissible limit.
2. The chlorides concentration is high in Jafri drain i.e. 450 mg/l as compared to 110 mg/l in Aligarh drain. While the sulphates concentration is not having much difference i.e. 60 mg/l and 70 mg/l respectively. It can be concluded that the industrial wastewater is contributing in terms of chlorides while in terms of sulphates it is almost same.
3. The alkalinity and total hardness is slightly higher in Jafri drain than Aligarh drain i.e. 90 mg/l & 250 mg/l and 81 mg/l & 237 mg/l respectively. Overall industrial wastewater is not having any major influence on wastewater characteristics in terms of alkalinity and total hardness.
4. When the solids concentration is concerned it is very high in both Jafri drain i.e. 9000mg/l and Aligarh drain i.e. 40600 mg /l of total solids concentration as compared to the inlet at Aligarh drain behind Qila, Panjipur where the concentration is 6500 mg/l. It means that Aligarh domestically is contributing 40% more solids to the drain through Jafri drain and 525% (34100 mg/l) to Aligarh drain owing to the industries.
5. It was observed that the dissolved solids formed the main part of total solids concentration as compared to suspended solids. The average concentration is 1030 mg/l for total suspended solids and 13660 for total dissolved solids respectively. The value of dissolved solids is not showing much variance as compared to dissolved solids.
6. When the wastewater was analysed in terms of BOD and COD the Jafri drain was having the concentration as 920 mg/l and 1536 mg/l as compared to 1460 mg/l and 8900 mg/l of Aligarh drain. The Aligarh drain is having a high COD is due to the contribution from slaughter house and meat processing industry in comparison to Jafri drain. But, the BOD value is not having such a high difference. Reason for this fact is examined by studying the solids concentration with BOD and COD values. It is concluded that even the solids concentration is high, the value of BOD and COD is not as high as was anticipated, because of a pollutant which is degrading the organic waste in wastewater to neutral form and converting it into the solid precipitate resulting in the high solid concentration but without organic load, the main suspect responsible for it is the acid which is contributed from the small scale industries specially lock industry. BOD & COD values are higher than the prescribed limit at all the locations and should be treated before discharge in to public sewers.
7. One more parameter that may be affecting the biological parameter is detergents and surfactants as most of the drains and lagoons are virtual washing places of laundry resulting in the manipulation of the wastewater characteristic making it more difficult to analyse. So for more clearer picture about the characteristics of wastewater, it must also be analysed in terms of detergents and surfactants and also the sewage sludge analysis must be undertaken.

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