Impact assessment of Dhampur sugar mill effluent on water quality of Bijnor district (U.P.)

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Abstract: Industrial effluents are the major source of water pollution, which disturb the life cycle of the living thing on Earth**.** Among the factors polluting the groundwater and surface water, sugar mills certainly have a larger share in form of their discharge of the wastewater as effluent. In this aspect the present study was carried out for the pollutants concentrations in the Dhampur sugar mill effluent. Every industry should adopt the Zero Liquid Discharge (ZLD) in their industry premises to avoid discharge of effluent without treatment. Groundwater & surface water samples were analysed for various parameters like pH, EC, TDS, TSS, BOD, COD, DO & NO_3 during the period of operation of sugar mill. The results revealed that there were variations in some parameters. The high values of DO (7.2 mg/Lit.), Nitrate (49 mg/Lit.) were found in the samples. The investigation suggests that water quality management, an important issue for the sustenance of human civilization must become a major priority.
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Introduction

Water is one of the most important precious resources found on the earth. It is an essential requirement not only for life sustenance but for the economic & industrial development also. In the last few decades, the tremendous increase in demand for the freshwater has been matter of great concern(Matta, *et al*., 2014; Matta and Kumar, 2015; Matta, Gagan, 2015a; Matta, *et al*., 2015a; Matta, Gagan, 2015b; Matta, *et al*., 2015b). The release of treated & untreated industrial effluents into various surface water bodies has not only affected the water quality but also polluted the groundwater due to percolation of water soluble pollutants (Mycin, R.T., 2014; Matta, *et al*., 2015c; Matta, *et al*., 2015d; Matta, *et al*., 2016; Matta and Gjyli, 2016).

We know that pollution is a *human problem* because it is a relatively recent development in the planet's history: before the 19th century Industrial Revolution, people lived more in harmony with their immediate environment. As industrialization has spread around the globe, so the problem of pollution has spread with it (Khanna and Matta, 2009; Khanna, *et al*., 2009; Singh, *et al*., 2010; Matta, *et al*., 2011; Tewari, *et al*., 2010; Khanna, *et al*., 2010). When Earth's population was much smaller, no one believed pollution would ever present a serious problem. It was once popularly believed that the oceans were far too big to pollute (Prachi, *et al*., 2011; Singh, *et al*., 2011; Khanna, *et al*., 2011a; Bhadauriya, *et al*., 2011; Khanna, *et al*., 2011b; Khanna, *et al*., 2012a; Khanna, *et al*., 2012b; Khanna, *et al*., 2012c). Today, with around 7 billion people on the planet, it has become apparent that there are limits. Pollution is one of the signs that humans have exceeded those limits. (Matta, Gagan, 2010; Cherian and Matta, 2010; Arora, *et al*., 2014; Matta, Gagan, 2014a; Matta, Gagan, 2014b).

India is the biggest producer of sugar on the planet with 550 sugar mills which produces 1305 million metric tonnes sugar per year (Saini, S. and Pant, S., 2014). Sugar industry is a standout amongst the most imperative agro-based commercial ventures in India & is in charge of making critical effect on provincial economy specifically & nation's economy as well. Sugar commercial enterprises rank second among agro-based business in India. Sugar industry is seasonal in nature & operates just for 120 to 200 days in a year for the most part from mid November to mid April (Deepthi, T. and Prabhakharan, J., 2016).

The Dhampur Sugar Mill (DSM) is located at Dhampur tehsil of Bijnore district in Uttar Pradesh. It is a private sugar factory which started in 1933; it is one of the largest producers of refined sugar in the country. DSM has initial capacity of 44,500 metric tonnes of sugarcane crushing per day (TCD), presently it makes 4200 metric tonnes of sugar per day.

India is agriculture based country & major use of water resources is for irrigation purposes. Sugar industry consumes substantial volume of water in different processing units, increase in sugar industrialization along with high rate of urbanization

& subsequent increase in population has led to the environmental degradation of the water resources (Kumar, S.D. and Srikantaswamy, S., 2015). There are two categories of sugar manufacturing process in India viz. (i) Carbonation process (ii) Sulphitation process for the production of white sugar. The present sugar industries have following operations:-

(i) Milling
(ii) Classification
(iii) Evaporation
(iv) Crystallization
(v) Centrifugation

During the production of sugarcane huge amount of water is discharged as wastewater to the surroundings with partially or without treatment, this wastewater is generally released into nearby water sources such as rivers, ponds or stream which produces obnoxious odour & unpleasant colour (Bandugula et al., 2014).

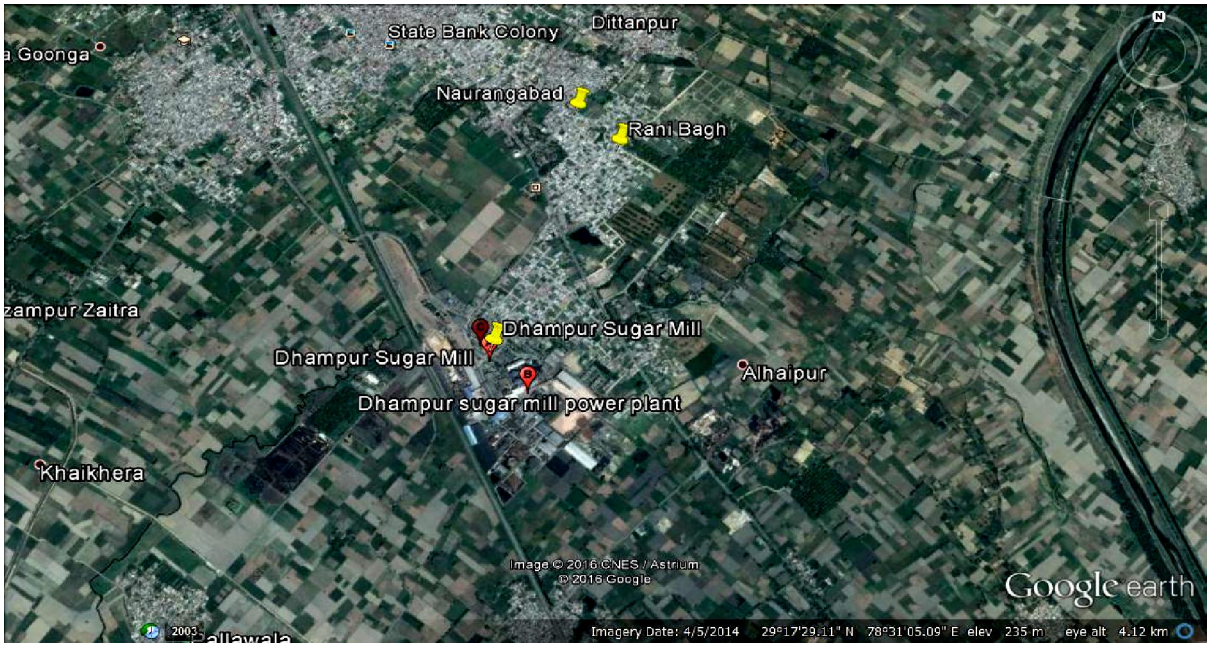

Fig. 1. Map showing all three study area.

Methodology

Water samples were collected from hand pumps close to the stream & progressively away from it. Thus six sampling sites were selected in the study area, three each for groundwater & surface water. Samples were collected at the operational period of DSM in precleaned polyethene bottles of one litre capacity; care was taken to collect samples. The Ph, EC & Temperature were measured in the field while analysis was carried out in the laboratory by using standardized protocol of APHA (2012).

Result & Discussion

Colour

As per the present study, the colour of effluent was dark brownish at all the three sampling sites i.e. DSM, Ranibagh colony, State Bank colony & Naurngabad.

Temperature

Temperature plays an important role in certain chemical and biological reactions taking place in water which affects organism's metabolic activity. It depends upon season, time sampling etc. The temperatures recorded were between 16-18°C. The temperature of the discharge at DSM outlet was recorded 26°C.

pH

In the present study, pH values of groundwater and surface water are 6.9 and 8.5 respectively. According to BIS standards pH of the effluents should be in the range of 6.5 to 9.0.

Dissolved Oxygen

The analysis of Dissolved Oxygen (DO) is one of the very important factors in water pollution and waste water control. Aquatic ecosystem totally depends on DO only. It affects the metabolic activities of microorganism. According to the BIS standards, the DO of effluent should be within the range 4 to 6 mg/lit. In the present study, DO of the surface water sample of DSM was recorded 6.9 to 7.2 g/lit respectively which is higher than the BIS Indian standard values.

BOD

Biochemical Oxygen Demand (BOD) is defined as amount of oxygen required by microorganism while stabilizing biological decomposable organic matter in water under aerobic conditions. The BOD is a very slow process in oxidation; organic pollutants are oxidized by microorganisms into carbon dioxide, water using dissolved Oxygen. In the present study, the BOD of all the three surface water samples exceeded the BIS Indian standard value i.e. 50 mg/l.

COD

The chemical Oxygen demand test describes the amount of oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The COD is a test which is used to measure the amount or quantity of pollution which has been released by domestic and industrial waste. COD is useful to determine the exact toxic condition and presence of biological matters. In the present study, the COD of both groundwater & surface water samples did not exceeded the BIS standard (250 mg/L).

TDS

The total dissolved solids concentration in the effluent represent the colloidal form and dissolved spectres. The rate of collision aggregated process is also influenced by pH of this effluent. In the rainy season less concentration of total dissolved solids are obtained due to dilution of waste effluent with rain water. In the present study, the total solids in both groundwater & surface water were within the prescribed limits of BIS Indian Standards (500 mg/L). On the basis of TDS, salinisation of groundwater is defined by Mehta et al., 2000.

TSS

Suspended solids are the cause of suspended particle inside the water body influencing turbidity. According to the present study, the suspended solids of groundwater & surface water samples were well within BIS standards (500 mg/L).

Nitrate

The nitrate concentrations vary between 25 to 49 mg/l. The high level of nitrate is observed at the Ranibagh, State Bank colony & Naurangabad site. Thus, nitrate pollution in the area is the combined effect of agricultural activity & the mixing of sugar mill effluent. It is observed that all nitrate samples from the study area have exceeded the permissible limit of nitrate prescribed by drinking water standard (Deshmukh, K.K., 2014). Thus, the groundwater resources contaminated with high levels of nitrate prove to be environmental hazards (Hill A.R., 1982, Pawar N.J. and Shaikh I.J., 1995, Datta P.S., Deb D.L. and Tyagi S.K., 1997).

Table 1. Physico–chemical Analysis of groundwater

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
Ph	7.85	7.5	7.01	7.4
Temperature	16.2	17.1	17.9	16.7
TS	220	235	215	228
TDS	79	86	89	87
TSS	150	156	140	146
BOD	2.4	2.8	2.6	2.5
COD	7.70	7.9	8.0	7.8
DO	6.9	6.79	6.80	6.81
NO_3^-	25.3	26.4	28.9	27.2

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Table 2. Physico–chemical Analysis of groundwater

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
pH	7.42	7.35	7.46	7.31
Temperature	18.9	17.2	18.5	19.0
TS	485	490	497	499
TDS	300	309	306	295
TSS	185	181	191	204
BOD	2.01	2.3	2.8	2.7
COD	7.1	6.5	8.3	8.6
DO	3.45	3.49	3.41	3.44
Nitrates	48	48	47	49

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Table 3. Physico–chemical Analysis of groundwater

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
pH	7.37	7.41	7.33	7.49
Temperature	17.6	17.9	18.4	18.9
TS	489	491	496	497
TDS	302	298	305	296
TSS	187	193	191	201
BOD	2.5	2.3	2.9	2.7
COD	0.73	0.69	0.84	0.79
DO	3.46	3.48	3.44	3.42
Nitrates	47	45	46	44

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Table: 4 Physico–chemical Analysis of surface water

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
pH	7.92	7.71	8.43	8.1
Temperature	23.8	24.6	25.5	25.6
TS	240	210	231	218
TDS	76	74	84	77
TSS	149	144	159	155
BOD	5.01	4.8	5.6	5.1
COD	8.06	8.2	8.7	8.3
DO	6.2	7.2	6.81	6.3
NO_3^-	27.8	26.8	29.0	28

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Table: 5 Physico–chemical Analysis of surface water

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
pH	7.45	7.49	7.52	7.42
Temperature	17.6	17.4	17.8	18.1
TS	500	499	485	480
TDS	300	306	310	311
TSS	200	193	175	169
BOD	16.2	15.1	18.2	13.7
COD	8.35	8.95	9.21	9.68
DO	3.40	3.41	3.38	3.37
Nitrates	44	43	45	41

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Table: 6 Physico–chemical Analysis of surface water

Sites / Parameters	Dhampur Sugar Mill	Naurangabad	State-Bank colony	Ranibagh colony
pH	7.41	7.46	7.44	7.48
Temperature	17.7	17.9	18.1	18.5
TS	491	488	495	496
TDS	302	304	312	308
TSS	189	184	183	188
BOD	17.2	18.1	20.4	19.8
COD	9.65	9.32	9.85	8.64
DO	3.41	3.42	3.39	3.40
Nitrates	42	43	45	43

(N.B.: All concentrations are reported in mg/l except pH and EC (µ/cm)

Conclusion

On the basis of chemical analysis of groundwater & surface water samples, it is possible to study the effect of sugar mill effluent as a source of pollution of groundwater & surface water in the area. Sugar industries in India are mainly located in the rural parts. The study reveals that the sugar industries through their continued operation, without taking the environmental precaution may cause serious health problems to the rural population residing in the proximity. Parameters like DO, BOD, Nitrate & colour have exceeded the prescribed limit particularly from the sugar effluent area. Majority of samples from sugar factory area have exceeded the permissible limit of nitrate. It is clear that the surrounding area groundwater becomes polluted due to sugar industry effluent. Hence it is not suitable for human consumption without prior treatment. Treatment to effluent releasing from sugar factory is essential to meet the required standards established by Indian standards.

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