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Effect of Sugar mill on Physico-Chemical Characteristics of Groundwater of Surrounding Area

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Abstract

The present study was aimed to determine the impacts of sugar industry on ground water quality of area around the sugar industry. In villages, town and cities most of the population totally depend on the ground water for drinking purposes, domestic as well as for agriculture use, hence quality of ground water is extremely essential and must be analyzed. Ground water sample is compared with the prescribed standard of drinking water given by BIS. Ground water sampling is done in 10 different locations around sugar mill. Various physicochemical parameters is determined using standard method like colour, taste, odour, temperature, pH, Alkalinity, TDS, TSS, TS, DO, COD and BOD. Results of analysis indicated that some parameter like Alkalinity, TDS, COD and DO does not satisfy the BIS limits of drinking water.

Keywords: Sugar mill effluent, chemical oxygen demand, drinking water, BIS limits.

Introduction

Groundwater is the primary source of water for drinking, domestic, agricultural and industrial purposes in most of the countries. It is one of the foremost sources of water which complete the requirement of mankind in different sectors from last few decades. It plays an important role to enhance the economics of India and ensures food security[1]. Ground water is account 20% of the world resource of fresh water and used by industry, Farmers use for irrigation and village's people use for domestic purposes. Only about 1% of all of fresh water available in rivers, ponds and lakes, out of 0.03% water require for survival of many forms of animal and plant life on the earth surface. India accounts for 2.2% of the global land and 4% of the world water resources and 16% of the world population[2]. It is estimated that one third of the world's population use groundwater for drinking as well as for all domestic purpose. Water is a prime natural resource, a basic human need and a precious national asset[3]. Therefore, water quality and its management options need to be given greater attention in the developing countries.

In the last two decades, the rapid growth of industrialization and urbanization in developing country has created negative impact on the environment. The sugar industries are playing very important role in the economic growth of India. But the effluent released from the sugar industries produced a high degree of organic pollution load in both aquatic and terrestrial ecosystem. Sugar mill effluent produces intolerable odour and obnoxious colour when released into the water body as water body is mainly use for the disposal of liquid waste. Sugar mills play a major role in polluting the water bodies and land by discharging a large amount of wastewater as effluent[4]. The effluent comes from the various industries, sometime percolates through the sub soil and reaches the ground water table forming contaminated pool, which disturb the natural ground water quality by changing its chemical composition[5].

Presently, India has nearly 650 sugar mills that produce about 15 million tons of sugar and 13 million tons of molasses[6]. These mills discharge huge amount of effluent per day without any proper treatment during the crushing or working season. It has also been reported that sugar mill effluent contains a high magnitude of pollution load and causes adverse effects on soil and biological system[7]. Several chemicals are used in sugar industries during the manufacturing process mainly for coagulation of impurities and refining of the end products. All chemicals, one way or another, contribute towards increasing the organic pollution, dissolved solids and suspended material. Sugar industry effluent constitutes a number of physico-chemical elements of suspended and dissolved solids with the high amount of biological oxygen demand (BOD), chemical oxygen demand (COD), chlorides, sulphate, nitrates, calcium and magnesium.

It is estimated that over 80% of the wastewater generated across the world are not presently collected or treated[8]. Ground water pollution by various organic and inorganic substrates may alter the quality of that water, which may cause adverse health effects on humans. Effluents produced from sugar industries persuade water and soil pollution. India is one of the leading producers of sugar in the world and a large amount of waste is also produced by these industies[9]. The sugar industry generates about 1,000 L of wastewater for every ton of sugar cane crushed[10]. The wastewater effluents from the sugar industry are variable in both quantity and quality depending on the product produced. Various physico-chemical and biological treatment options are available for the treatment of wastewaters[11]. But still there is

discharge of large amount of untreated effluent from the industries.In present study we mainly consider the pollution caused by the sugar industry and its effect on ground water.

Material and Methods

Sampling location and Sampling procedure: Present study was conducted to analyse the effect of Sugar Industry on the ground water quality of nearby area of sugar industry. For study 'The Panipat Sugar Mill', present in Panipat City Haryana was selected. Ground water sample were collected in triplicate from tube wall or hand pump from 10 different locations cover 10 km area around the Sugar Mill. Sampling location along with their distance from sugar mill is shown in table 1. Plastic bottles of 2 litres capacity has been used to collect the water sample, before sampling flushing out of the hand-pumps was done for 10 minutes to evacuation of the stored water in the pipelines. All physico-chemical parameters were analyzed by standard method mentioned in APHA.

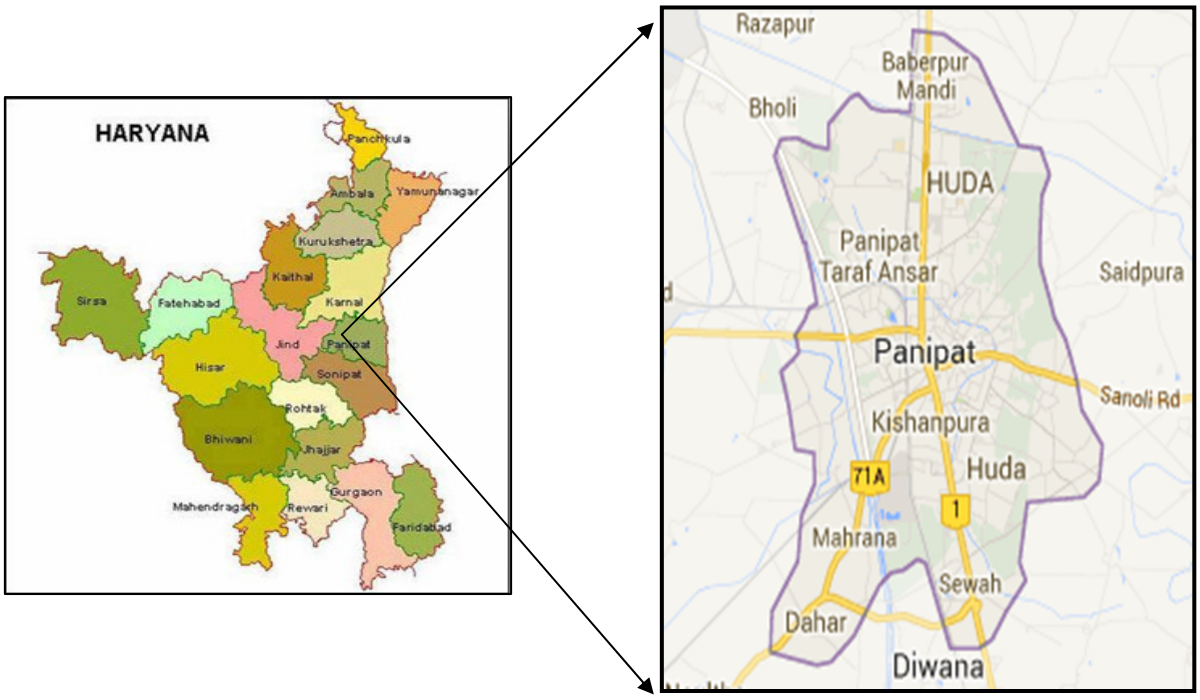
Results and Discussion

Physico-chemical analysis of ground water is shown in table-2 and 3 all parameter analyzed were compared with prescribed limit of BIS for drinking water.

Colour, taste and odour: In present investigation light pale yellow colour is appeared in sample of location W2, W7 and W10 (table- 2). Pale yellow colour appear in water may be because of the dissolve soil particles in the ground water. All other sample is colourless. It indicates that there is no oxidation in ground water samples and safe for drinking. The different colours of water such as brown, red, orange and yellow is usually caused by varying chemical oxidation states of the iron (rust) in iron pipes use in transportation of water. Taste is agreeable in all the ground water samples. Odour is unobjectionable and agreeable in the all ground water sample**.**

Table-1
Location of sampling points with their distance from sugar mill

Sample No/ID	Name of sampling area	Distance from Sugar Mill (km)
W 1	Sugar Mill Colony	<1
W 2	Ajaad Nagar	1
W 3	Shastri colony	2
W 4	Sanjay colony	3
W 5	Binjhol	4
W 6	Msharana	5
W 7	Dahar	6
W 8	Noltha	8
W 9	Babail	9
W 10	Nimbri	10



Map of study area

Table-2
Physico-chemical parameters of different water samples *(Mean ±SD)*

Sample No.	Colour	Taste	Odour	Temperature (ºC)	pH	Alkalinity (mg/l)
W1	Transparent	Agreeable	Unobjectionable	30±2.1	6.9±0.1	245±1.5
W2	Transparent	Agreeable	Unobjectionable	29±1.1	7.2±0.2	220±0.8
W3	Pale Yellow	Agreeable	Unobjectionable	29±0.5	7.2±0.1	383±0.5
W4	Transparent	Agreeable	Unobjectionable	28±0.02	7.05±0.1	248±0.04
W5	Pale Yellow	Agreeable	Unobjectionable	26±1.02	7.3±0.05	105±0.09
W6	Transparent	Agreeable	Unobjectionable	29±0.5	7.3±0.8	294±0.21
W7	Pale Yellow	Agreeable	Unobjectionable	33±0.1	7.2±0.1	356±0.8
W8	Pale Yellow	Agreeable	Unobjectionable	27±0.8	7.2±0.02	480±1.2
W9	Transparent	Agreeable	Unobjectionable	26±0.06	7.3±0.05	498±0.8
W10	Pale Yellow	Agreeable	Unobjectionable	30±0.5	7.1±0.09	330±0.5
BIS Limits	-	-	Unobjectionable	-	6-8.5	200

Table-3
Physico-chemical parameters of different water samples *(Mean ±SD)*

Sample No.	TDS (mg/l)	TSS (mg/l)	TS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)
W1	438±2.1	0	438±0.9	3.4±0.05	0	35±0.1
W2	602±1.5	0	602±1.1	3.6±1.2	0	23±0.5
W3	581±0.9	2.1±0.02	583±0.7	2.9±1.05	0	18±0.02
W4	450±0.6	0	450±0.3	3.9±.9	0	20±0.06
W5	151±0.04	1.8±0.03	152±0.2	4.9±1.02	0	16±1.03
W6	300±0.07	0	300±0.05	4.5±0.3	0	14±0.5
W7	331±0.05	0.8±0.2	331±0.04	3.5±0.9	0	12±0.4
W8	521±0.3	0	521±0.6	5.5±0.5	0	22.4±0.6
W9	490±1.2	0	490±0.2	4.9±0.4	0	0
W10	450±0.6	0	450±0.5	5.5±0.2	0	0
BIS Limits	500	5	-	4 to 6	0	10

Temperature: In this study the temperature of the ground water was ranged from 26 - 33^0 C, which is good for drinking and also good for aquatic life (table-2). Temperature of water is important parameter because it effects bio-chemical reactions in aquatic organisms and it also affects the DO of the water. An increase in water temperature leads to boost the chemical reactions in water, which reduces the solubility of gases, change the tastes and odours. Temperature is an important indicator of water quality. Tariq et al study on characteristics of industrial effluents and their possible impacts on quality of underground water and they have reported that the temperature of ground water samples was in range 32-33^0C[12]. Hariharn et al. also analysed the ground water samples and reported the temperature in range of 26-28^0C[13].

pH: In present investigation the pH values of the ground water sample are comes in range from (6.9 to 7.5). So the study indicates that the values obtained are within the permissible limit (table-2). pH of water in the range of 6.5 to 8.5 is not harmful to human and does not has direct effect on health pH indicates the level of pollution by acidic and alkaline waste in a water source. Acid-base reactions are very essential in ground water, because of their effect on pH and their ion chemistry in water. Deshmukh has analysed the ground water pH comes in range of 7.1-8.8 [14]. Similarly Agale et al analysed the ground water pH and reported that in range 7.1-8.5 [15].

Alkalinity: Alkalinity of ground water samples in present study is come in range of 105- 498 mg/l (table- 2). This indicates that water from all sampling location in the selected area is hard, according to BIS drinking water standards total alkalinity value 60 ppm or more indicates that water is hard. But up to 200 mg/l alkalinity can be safe for drinking. Only the alkalinity of ground water sample from W2 and W5 is within the prescribe limit of BIS. All other water sample exceeds the BIS limit. Alkalinity in most of ground water samples was high indicates the presence of Carbonate and bicarbonates ions. Sugar industry effluent discharge also contain large amount of carbonates ions which may be the reason behind the high alkalinity of ground water. Effect of alkalinity is that much low and much high values of alkalinity can cause nuisance problems. Alkalinity values less than 75 mg/l can change pH levels in water system and make the water corrosive. Corrosive water can then lead to potentially harmful metals dissolving from the plumbing into the drinking

water which may cause several health effects by increasing metal concentration in water. High alkalinities values, over 500 mg/l are in water are associated with high dissolved solids which can create scale build up on water pipeline systems, especially hot water pipeline systems. Scale build up in the pipeline system can increase power consumption and also increase the costs to heat the water. Chhaya et al analyse the physicochemical property of ground water in Pravara district Anmednagar Maharashtra note alkalinity comes in range 200-800 mg/l[16]. Our results are in accordance with other workers, they have also reported similar results for alkalinity of ground water 294-1498 mg/l [2] and 156-516 mg/l [17].

Total dissolved solid (TDS): In present investigation TDS of the sample is range from 151-602 mg/l. Maximum value of TDS in this study is at location W2 (602 mg/l), W3 (581 mg/l) and W8 (521 mg/l). These stations cross the BIS limit (500 mg/l) (table- 3). TDS of all other sample are within the limit. Sugar mill effluent is not only the reason behind the high TDS in ground water sample. TDS content of ground water samples may be due to vegetable decay, evaporation, disposed of effluent and chemical weathering of rocks which add calcium and carbonates in the water. The salinity behaviour of any water samples is generally characterized by its total dissolved solids content[17]. Panday and Tiwari analysed the TDS of ground water in Ghazipur city comes in range 145-245 mg/l[18]. Tariq et al analysed the TDS of ground water come in range 302-2799 mg/l[19].

Total suspended solids (TSS): In present study TSS of the water sample are come in range 0.8-2.1mg/l. TSS of all samples was within the limit (table- 3). The presence of TSS in underground water, however, even in a small amount does indicate the impact of Sugar Mill effluents in the close proximity. TSS affects the light penetration, influencing turbidity and transparency in water body, which may cause adverse effects on aquatic life. Nasrullah et al. analysed the ground water and note TSS comers in range 1.78-2.09 mg/l[20]. Olajumke et al analysed the TSS of ground water was 2.57 mg/l[21].

Total solids (TS): In the present study the range of total solids of ground water samples is from 152 to 602 mg/l (table- 3). The term solid refers to the matter that are either filterable or in filterable and remain as residue upon filter paper by drying at a defined temperature after drying. Different forms of solids (TDS, TSS and TS) are defined on the basis of method applied for their determination. High concentration of total solids during summer was probably due to low level of water, the direct relationship between rainfall and total solids was attributed to an increased load of soluble salts as results of surface runoff. In water total solids, total dissolved solids and total suspended solids are composed mainly of carbonates, bicarbonates, chlorides, sulphates, nitrates, Ca, Mg, Na, K, Mn and other organic matter silts which are present either in dissolve or in suspended form. Usharani et al. have analysed the TS of ground water was comes in range 593-725 mg/l[22].

Dissolve Oxygen (DO): In present study DO of ground water sample is range from 2.5 - 5.5 mg/l. DO of drinking water must be 4-5 mg/l according to the BIS limit. So sample from location W1, W2, W3 and W4 not satisfy the BIS limits (Table- 3). All other sample was within the limit. It is one of the most important parameter in water quality judgment. DO is very important for all physical and biological process going in water. The DO levels in waters depend on physical, chemical and biological activities of the water body. The analysis of DO is very important in water pollution controls as well as waste water control. Aquatic ecosystem is entirely depends on DO of water for a variety of biochemical changes. Dissolve oxygen of ground water is zero but when it comes in contact with air in environment oxygen present in air get dissolve in water.

Biological Oxygen Demand (BOD): BOD of all ground water samples was zero (table- 3). All the underground water samples were within the permissible limits. In general, the BOD of groundwater must be zero because organic matters are mostly filtered through subsurface strata and thus leaving no space for the development of microorganisms which are responsible for water borne diseases. But some time there is BOD in water which is due to industrial effluent might have contributed some organic pollutants sometime percolate through the sub soil and reaches the ground water table forming contaminated pool, which is potential threat of water contamination in future.

Chemical oxygen demand (COD): In present investigation COD of ground water samples range from 0 to 35mg/l. COD of drinking water should not exceed 10mg/l (table-3). If COD exceed 10mg/lit then it is unfit for drinking. The COD is used to measure pollution load in terms of quantity of oxygen required for oxidation of organic matter to produce carbon dioxide and water. Water with high COD indicates that there is presence of organic waste and oxygen is required for the oxidation of these wastes so all oxygen is used for the oxidation of organic waste and that are why there is inadequate oxygen available in water sample. Presence of low oxygen in the water reduced the ability to sustain aquatic life. Pawar et al. analysed the COD of ground water comes in range 5.05-22.74 mg/l[23]. Other researchers also analysed the ground water and they reported that COD was ranged from 25-95 mg/l[24].

Conclusion

The results of physicochemical analysis of ground water around selected sugar industry indicates that some parameter like Alkalinity, TDS, COD of ground water exceed the permissible limit given by BIS Limit of drinking water. High level of Alkalinity, COD, TDS and low level of DO make the ground water unfit for drinking purposes for living organisms including human. This water can be used for irrigation purpose directly but before use as drinking it must be purified in term of removal

of High TDS, COD, alkalinity and addition of sufficient amount of oxygen must be done by aeration.

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