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Physicochemical properties of wastewater collected from different sewage sources

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Abstract

The physicochemical parameters of wastewater collected from 20 stations were investigated. These parameters were analyzed by standard methods. The color of the collected sewage water was pale yellow to black and was turbid in some selected stations. Unpleasant odor was noted in all selected stations. The pH of the wastewater varied from 6.3 to 7.3, while the water conductivity ranges from 650 to 2390 μScm^{-1}. The maximum total dissolved solid was 1,495 ppm, and the maximum biological oxygen demand was 569.5 mg/l. The chemical oxygen demand of the selected sites varied widely (507.1–602.9 mg/l), and the dissolved oxygen content varied from 0.01 to 0.242 mg/l. The nitrate content was found to be maximum in station 7 (18.5 ppm), and the sulfate content was found to be high in stations 1 and 2 (90 ppm). The sodium and potassium contents were maximum at station 5, and their concentrations were 260 and 60 ppm, respectively. The physicochemical parameters studied in this work were varied between the stations, and almost all parameters studied were higher compared with the permissible limit prescribed by the United States Environmental Protection Agency and World Health Organization.

Keywords: *Wastewater, sewage, Physicochemical, conductivity, Biological oxygen demand, Chemical oxygen demand*

1. Introduction

The pollutants from the wastewater are harmful to the public health and the environment, and they are toxic to the aquatic organisms as well. The wastewater treatment helps to remove contaminants from water to decrease pollutant load (1). Water pollution occurs through natural processes in certain cases, but most of the pollutions caused by human activities (2). The used water of a community is called wastewater or sewage. The sewage water is not treated before being discharged into waterways, which causes serious pollution in the particular environment (3).

There are three major categories of pollutants that cause pollution in water. The first category includes disease-causing agents such as viruses, protozoa, parasitic worms, and bacteria, which enter sewage systems and untreated waste. Because of the abundance of these microbes, wastewater acts as the common source of transmission for diseases such as dysentery, cholera, and typhoid. The second category of water pollutants includes oxygen-demanding waste, which includes the biodegradable matter such as plant residues and animal manure, which are added to the water naturally or by human beings. In natural process, this biological waste uses oxygen present in the sewage water and thereby results in oxygen depletion. Once all the oxygen has been depleted, bacteria are able to take control of the sewage, by making the water polluted. The third category of water pollutants includes water-soluble inorganic pollutants such as caustics, salts, acids, and toxic metals. Another kind of water pollutants includes ammonium salts, nitrates, phosphates, and so on. The pollutants such as nitrates and phosphates are the important nutrients, and these favor the growth of algae and thereby results in eutrophication (4-6).

Studies on the water quality were carried out by various researchers on various effluents. Earlier studies revealed that anthropogenic activities strongly affect the water quality. This was a result of cumulative effects not only from upstream development but also from inadequate wastewater treatment facilities (7). The water quality can be measured by analyzing the variations of total suspended solids, total phosphorous, chemical oxygen demand (COD), copper, iron, nickel, nitrogen, lead, zinc, and so on (8-10).

Wastewater is any water that has been adversely affected in quality by anthropogenic influences. It comprises liquid waste discharged by domestic residences, commercial properties, industries, and/or agriculture and can encompass a wide range of potential contaminants and concentrations (11). The contamination and quality of irrigation water are of the main concern especially in the regions with limited water resources (12). Characterization of wastewater and activated sludge has been used for control and optimization of existing processes and development of new processes. The most possible sources of water, soil, and plant pollutions are sewage sludge and residues of industries and intensive fertilization (13).

The importance of testing a waste characterization in this study is to identify the composition of the waste so actions can be taken to reduce the amount of trash discarded (14). The sewage water discharged from various domestic and industrial sources has been characterized by various researchers (11, 13). Urban environmental management is one of the important issues as the urbanization trend continues globally. The under-management of municipal wastewater in many southern urban areas is a major challenge. Management of wastewater in metropolitan cities is a very difficult task. The unsafe disposal of wastewater results in water pollution as well as terrestrial pollution. It causes various health problems, that is epidemics due to the processing of the contaminated water (15, 16). These wastewater eutrophicates the water bodies, causing the mortality of aquatic biological resources. Hence, the role of treatment plants is in the sustainable use of wastewater as they make the water usable for various purposes (17). The major objective of the present study was to characterize the wastewater discharged from different domestic sewage in Nagercoil town of Kanyakumari District in India. A study of this kind will improve our knowledge on the quality of wastewater being discarded into the environment due to various anthropogenic activities.

2. Materials and methods

The physicochemical parameters such as color, odor, pH, electrical conductivity (EC), total dissolved solids (TDSs), biological oxygen demand (BOD), COD, dissolved oxygen (DO), nitrate, sulfate, sodium, and potassium of the wastewater were tested in this study. The samples were collected from Nagercoil Town, Kanyakumari District, Tamilnadu, India, using clean BOD bottles. The collected samples were brought to the laboratory in an icebox. The DO was estimated by Wrinkler's method, and the pH was determined using a pH meter. Nitrate, sulfate, sodium, and potassium were estimated by standard methods of American Public Health Association (APHA) (18). The other parameters of the wastewater samples analyzed in triplicate by adapting standard procedures from the manual of APHA (19).

3. Results and discussion

The values of the physicochemical parameters observed in the present study may serve as an indicator of the fertility or pollution level of the study area. The experimental data on physicochemical properties of water samples collected from different municipal regions of Nagercoil are shown in Figures 1–10.

3.1 Color and odor of wastewater

The color of the wastewater typically depends on the different industrial processes. The measurement and removal of color are essential part as it is unfit for recycling without proper treatment. The wastewater collected during the study was colorless in stations 2, 3, 6, 9, 11, 14, 16, and 20, respectively. Moreover, the wastewater was pale yellow in color in stations 1, 4, 10, 12, 15, and 19. Blackish color was observed in stations 5, 13, and 17. However, the water was so turbid in stations 7, 8, and 18. The turbidity is caused by a wide variety of suspended materials that range in size from colloidal to coarse dispersion (20). In this study, unpleasant odor was noted in all stations.

3.2 pH

The pH of all 20 samples was measured immediately after its collection using a pH meter. The pH of the water sample collected from different stations was ranging from 6.3 to 7.3, and the result was shown in Figure 1. The pH of the water is known to influence the availability of micronutrients as well as trace metals (21). It is well known that the pH is an important parameter in evaluating the acid–base balance of water. A pH value of 7 is neutral; a pH less than 7 is acidic, and and a pH greater than 7 represents base saturation or alkaline. The principal component regulating ion pH in natural waters is the carbonate, which comprises CO_2, H_2CO_3, and HCO_3 (22).

3.3 Electrical conductivity

Water conductivity is mainly attributed to the dissolved ions liberated from the decomposed plant matter (23) and input of inorganic and organic wastes (24). EC values are noted to be different for various samples, ranging from 650 to 2,390 μScm^{-1}, and the result was shown in Figure 2. EC depends on the dissolved solids in the discharged water. The EC being the measure of dissolved solid in solution implies that station 5 had more dissolved solids than other sites. High EC values indicate the presence of high amount of dissolved inorganic substances in ionized form. The fluctuations in EC in any particular location depends on the fluctuation in TDSs and salinity (25).

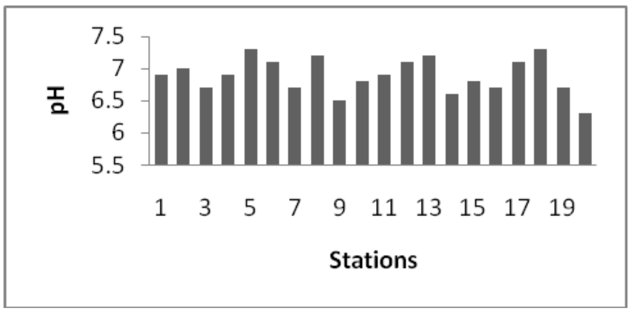

Fig. 1 Variation of pH at selected stations.

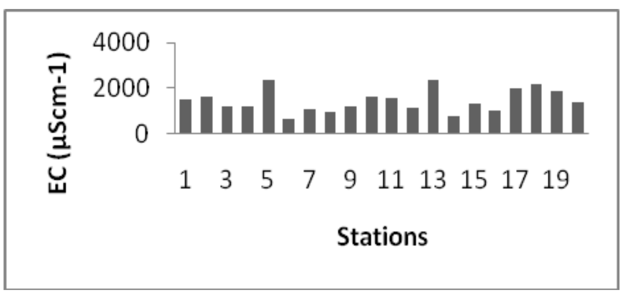

Fig. 2 Variation of electrical conductivity in sewage water in selected stations.

3.4 Total dissolved solids

The amount of TDSs in this study varies from 409.5 to 1505.7 ppm, and the result was shown in Figure 3. In water, TDSs are composed mainly of bicarbonates, chlorides, carbonates, phosphates, and nitrates of calcium, magnesium, sodium, and potassium; manganese; salt; and other particles (26). The higher values of TDS may be due to the discharge of waste from effluents from various small-scale industries in this town. Kataria et al. (27) reported that increase in the value of TDS indicated pollution by extraneous sources.

3.5 Biological oxygen demand

BOD showed the minimum value of 246.3 mg/l and the maximum value of 569.5 mg/l. The registered BOD value was high in the present study (Fig. 4). BOD increases due to biodegradation of organic materials that exerts oxygen tension in a water body (28). Increases in BOD can be due to heavy discharge of industrial wastewater effluent, animal and crop wastes, and domestic sewage. BOD value has been widely adopted as a measure of pollution in the particular environment. It is one of the most common measures of organic pollutant in water. It indicates the amount of organic matter present in water. Sources of BOD in aquatic environment include leaves and dead plants, woody debris, animals, animal manure, industrial effluents, wastewater treatment plants, feedlots, and food-processing plants and urban storm water runoff (29).

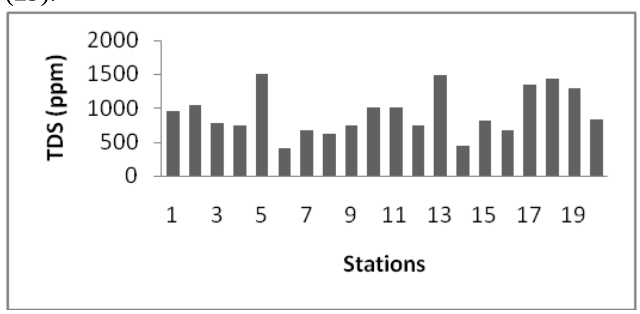

Fig. 3 Total dissolved solid content in selected location.

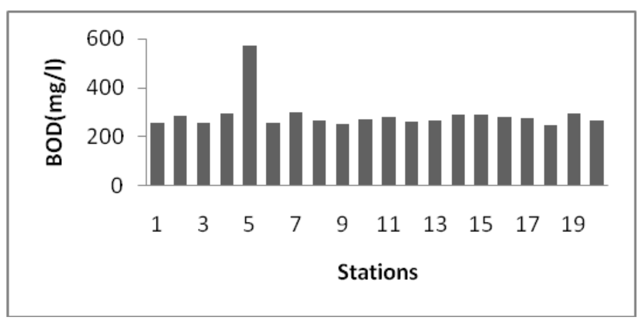

Fig. 4 Biological oxygen demand of wastewater from selected stations.

3.6 Chemical oxygen demand

COD showed the minimum value of 506.9 mg/l and the maximum value of 602.9 mg/l (Fig. 5). All organic compounds with few exceptions can be oxidized by the action of strong oxidizing agents under acidic condition. The COD determination is a measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. While determining COD, oxygen demand value is useful in specifying toxic condition and presence of biologically resistant substances. The COD and BOD values are a measure of the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. COD is also one of the most common measures of pollutant organic material in water. COD is similar in function to BOD, in which both measure the amount of organic compounds in water (29).

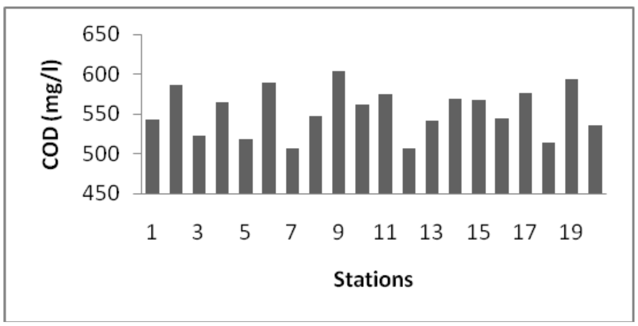

Fig. 5 Chemical oxygen demand of municipal wastewater.

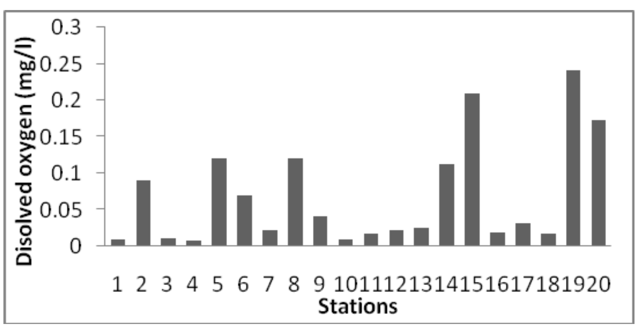

Fig. 6 Dissolved oxygen content in sewage water.

3.7 Dissolve oxygen

The DO content of the wastewater collected from different sources of sewage was shown in Figure 6. BOD directly influences the amount of DO in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the water. This means that less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low DO: aquatic organisms become stressed, suffocate, and die (29). The DO is a measure of the degree of pollution by organic matter, the destruction of organic substances, and the self-purification capacity of the water body.

3.8 Nitrate

The nitrate content of wastewater samples varies from 5 to 18.5 ppm, and the result was shown in Figure 7. Nitrate content is an important parameter to estimate organic pollution in a particular environment, and it represents the highest oxidized form of nitrogen. Nitrate is one of the very common contaminants in ground water and surface water. Nitrate occurs naturally in source water as a result of decaying plants. However, there are other manmade sources of nitrate that can increase its presence in source waters to dangerous levels. Agricultural sources of nitrates include livestock waste matter and chemical fertilizers. The presence of nitrates in the water samples is suggestive of some bacterial action and bacterial growth (30).

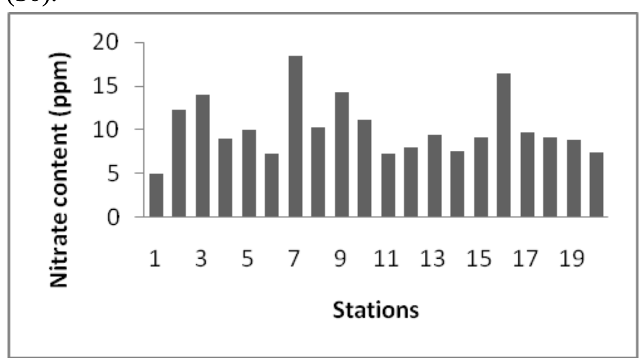

Fig. 7 Nitrate content of sewage water.

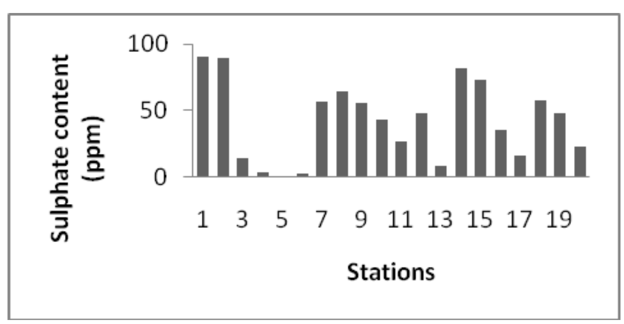

Fig. 8 Sulfate content of sewage water.

3.9 Sulfate

The sulfate content of wastewater varies from 1 to 90 ppm, and the result was shown in Figure 8. Sulfates are not considered toxic to plants or animals at normal concentrations. Sulfates are formed due to the decomposition of various sulfur-containing substances present in water bodies. The sulfate ions (SO_4^{-2}) occur naturally in most water supplies and hence are also present in wastewater. In human beings, small concentrations cause a temporary laxative effect (31). Sulfate occurs naturally in water as a result of leaching from gypsum and other common minerals (32).

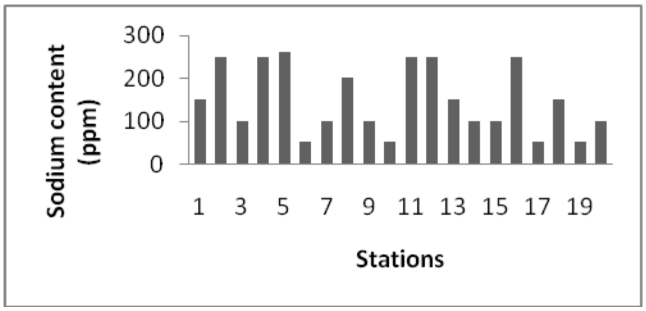

Fig. 9 Sodium content of sewage water.

3.10 Sodium

The sodium content of the sewage samples varies from 50 to 250 ppm (Fig. 9). Water containing more than 200 mg/l sodium should not be used for drinking by those on moderately restricted sodium diet. A maximum drinking water standard of 100 mg/l has been proposed for general public (26). The higher concentration of sodium in the groundwater causes toxemia in pregnant women and cardiovascular diseases (33).

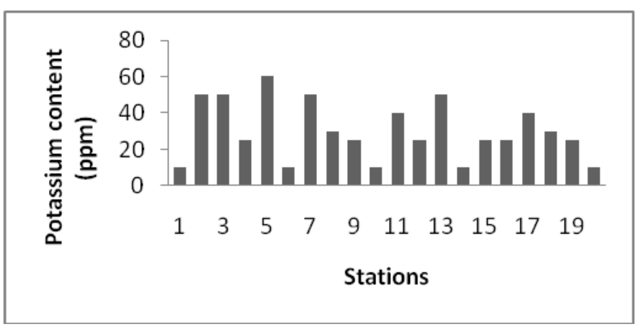

Fig. 10 Potassium content of sewage water.

3.11 Potassium

The potassium content of the sewage samples varies from 10 to 60 ppm (Fig. 10). The common sources of potassium are the silicate minerals such as microcline, orthoclase, and biotite (34). Potassium compounds are predominantly soluble and rarely precipitated. The major source of potassium in natural fresh water is weathering of rocks, but the quantities increase in the polluted water due to the disposal of wastewater. It has a similar chemistry like sodium and remains mostly in solution without undergoing any precipitation. Similarly, it is not very much significant from the health point of view but in large quantities may be laxative. The concentration of potassium in natural water is very low but high value being an indication of pollution by domestic waste (35).

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