

## Original Article



# Physico-Chemical Analysis of Wastewater Samples Collected from the Chemistry Laboratory at Kohima Science College, Jotsoma and Model Christian College Kohima

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### Abstract:

Wastewater especially from the chemistry laboratory contains several toxic chemicals that are harmful to the environment, although the quantity of wastewater produced by the laboratory is relatively small, it in some way has an impact on the environment. This study is aimed at analyzing the physicochemical parameters of wastewater collected from the chemical laboratories in Kohima Science College Jotsoma and Model Christian College Kohima using standard analytical procedures. The samples collected were analyzed for various physicochemical parameters like pH, Electrical Conductivity (EC), Salinity, Total Dissolved Solids (TDS), Oxidation-Reduction Potential (ORP), Iron, Sulfate, Phosphate, Nitrate, Dissolved Oxygen (DO), Potassium, Sodium, Total Hardness (TH), Alkalinity, Chloride and Calcium for which the results were compared with the standard prescribed by the BIS and WHO for drinking water. The results obtained from the physicochemical analysis of water samples shows that some parameters are found to be within the permissible limit while a few parameters were found to be beyond the permissible limit of BIS and WHO standards. Thus, it can be concluded that the values of the parameters vary depending on the water samples collected.

**Keywords:** DO, EC, Laboratory wastewater, pH, TDS

### Introduction

Water covers 71% of the earth's surface and it makes up about 65% of our bodies. Water is an indispensable natural resource essential for the existence of man and the ecological system. The water used daily in our life is taken from the lakes, rivers, and groundwater. After utilizing the clean water, the contaminated water returns back to these locations. This used water is what we called "wastewater" <sup>[1]</sup>. Hence in simple words, wastewater can be defined as the water generated after the use of freshwater, raw water, drinking water, or saline water in a variety of processes and applications, which may include stormwater,

surface runoff, and domestic, agricultural, commercial, industrial, and research activities <sup>[2]</sup>. The composition of wastewater is 99.9% water and the remaining 0.1% are other materials like organic matter, microorganisms, and inorganic compounds, which even though make up only a small portion of wastewater, are present in large enough quantity to endanger public health and the environment <sup>[3]</sup>.

The wastewater especially from the laboratories of various science institution and research facilities, even though they make up less than 1% of the total waste generated, it is often acidic and laden

with heavy metals and thus are the major producer of the diverse hazardous waste stream, and their direct disposal can lead to catastrophic environmental concerns. Laboratory wastewater most particularly waste from the chemistry lab involves several toxic and hazardous chemicals such as sulfuric acid, hydrochloric acid, nitric acid, alkalis, and other chemicals. These chemicals when it comes out with wastewater not only degrades the underground water quality but also degrade the soil quality exceptionally [4,5]

Wastewater if disposed directly to the environment before being treated leads to serious pollution. It is been known that more than 80% of the world's wastewater flows back into the environment without being treated [6]. The most direct impact of wastewater on the environment can be its contribution towards the destruction of natural habitats and its pollution, exposing the species that live in them to dangerous chemicals

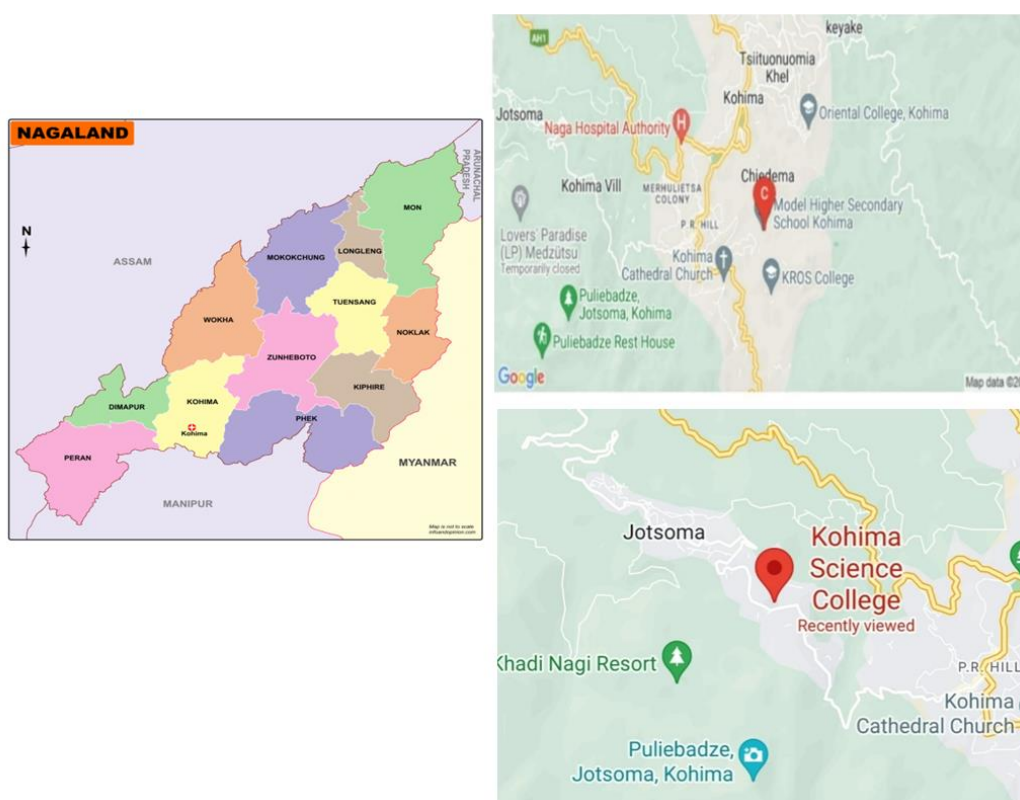
that would usually not be present in the normal run of things. Another damaging impact of wastewater is its effects on waterways which are often the most vulnerable. The presence of toxic chemicals in wastewater also disrupts the aquatic habitats by depleting the dissolved oxygen essential for marine life to survive [7].

**Objective of the study:** The objective of this study was to analyze the physicochemical parameters of wastewater collected from the chemical laboratories at Kohima Science College, Jotsoma, and Model Christian College, Kohima, the samples collected were compared with the standard prescribed by the WHO and BIS for drinking water and to estimate its toxicity.

**Study Area:** The wastewater samples for the study were collected from the chemical laboratory of two institutes in Nagaland state of India namely Kohima Science College, Jotsoma, and Model Christian College, Kohima.

**Table 1: Geographical Coordinates of Study Area.**

Location	Elevation	Latitude	Longitude
Kohima Science College, Jotsoma (KSCJ)	1474 meters above sea level.	25.665326	94.076294
Model Christian College, Kohima (MCC)	1444 meters above sea level.	25.658596	94.105331



**Figure 1: Map showing the study area.**

## Methodology:

### Sampling method

In this study, the samples were collected from the laboratory of the chemistry department of Kohima Science College, Jotsoma, and Model Christian College, Kohima. All the samples were collected in clean 1 L plastic bottles and were labelled as A,

B, and C where sample A and B were from Kohima Science College and sample C was from Model Christian College, Kohima. The samples were immediately transported to the laboratory and stored for further analysis.

The following parameters were considered:

**Table 2: Method of determination of water quality parameters.**

Parameters	Method of determination
pH	pH meter EZ-9908
ORP	ORP tester HI98201
EC	Microprocessor COND-TDS-SAL Meter
TDS	Microprocessor COND-TDS-SAL Meter
Salinity	Microprocessor COND-TDS-SAL Meter
TH	EDTA-Titrimetry
Alkalinity	HCL-Titrimetry
Calcium	EDTA-Titrimetry
Chloride	Argentometry
DO	DO Winkler's Method
Iron	Iris visible spectrophotometer 230 VAC
Sulfate	Iris visible spectrophotometer 230 VAC
Phosphate	Iris visible spectrophotometer 230 VAC
Nitrate	Iris visible spectrophotometer 230 VAC
Sodium	Flame photometry
Potassium	Flame photometry

### Result

**Table 3: Obtained values of the 16 parameters that were determined for 3 samples.**

Method	SAMPLE		
	A(KSCJ)	B(KSCJ)	C(MCC)
pH	2.1	7.0	2.2
ORP(mV)	554	262	645
EC( $\mu$ S/cm)	11	726	5860
TDS(ppm)	7.14	471	3.80
Salinity(ppm)	8.23	544	4.34
TH(mg/L)	ND	46	34
Alkalinity(mg/L)	ND	7	ND
Calcium(mg/L)	76.152	ND	ND
Chloride(mg/L)	ND	54.62	40.34
DO	2.6	3.5	21.5
Iron(mg/L)	1	ND	ND
Sulfate(mg/L)	150	15	190
Phosphate(mg/L)	ND	1.3	0.1
Nitrate(mg/L)	133	ND	133
Sodium(mg/L)	44	8.08	59.50
Potassium(mg/L)	40.67	11.31	19.88

ND= Not detected

(The result obtained after analysis were compared with the standard limit recommended by the BIS (IS 10500:2012) and WHO (2012).

### Discussions

**pH:** pH (potential hydrogen) is referred to as the concentration of hydrogen ions in water. In wastewater, determination of pH has proven essential as it helps to remove organic compounds and heavy metals during its treatment<sup>[8]</sup>. The acceptable range for pH according to the BIS and WHO standard for drinking water is 6.5-8.5. In this study, the pH value of sample B was found to be 7 which is within the limit set by BIS and WHO, while the pH value for two samples A and C were found to be 2.1 and 2.2 which were lower than the limit set by BIS and WHO standard thus making it acidic in nature, the reason for low pH value may be due to the presence of heavy metals resulting in the release of metal cation.

**ORP:** Oxidation-Reduction Potential (ORP) indicates how oxidizing or reducing a liquid is and can be measured in millivolts (mV) by an ORP meter. It is useful in testing a wide range of water systems including wastewater treatment systems, municipal tap water and groundwater<sup>[9]</sup>. In the present study the ORP values for all three samples i.e. sample A (554 mV), sample B (262 mV) and for sample C (645 mV) which on comparison with the BIS (650 mV) and WHO (650 mV) standard for drinking water were found to be within the permissible limit. Low ORP reading is an indication of the presence of a reducing agent, while a high ORP reading is an indication of the presence of an oxidizing agent<sup>[9]</sup>.

**Electrical Conductivity (EC):** Electric Conductivity (EC) refers to the ability of water to conduct electric current and is greatly dependent on the ion concentration within the water, which comes from inorganic materials like chlorides, carbonate compounds, sulfides and from dissolved solids. For instance, water containing ions such as calcium, magnesium, sodium, and chloride will have a higher EC compared to treated water<sup>[10]</sup>. In this study the value of EC for sample A was found to be 11  $\mu\text{s}/\text{cm}$ , sample B was found to be 726  $\mu\text{s}/\text{cm}$ , and sample C was found to be 5860  $\mu\text{s}/\text{cm}$ . The higher the conductivity, the more impurities in water. It is to be noted that even a small amount of contaminant in wastewater is enough to change the EC<sup>[10]</sup>.

**Total Dissolved Solids (TDS):** Total Dissolved Solids (TDS) is one of the simplest ways to determine water quality. The principal constituent of TDS is however bicarbonates, magnesium, calcium, potassium, sodium, chlorides, sulfate and nitrate anions whose presence in water can increase the TDS level<sup>[11]</sup>. A high level of TDS in water can lead to several health problems. According to BIS standards, the upper limit of TDS levels in drinking water is 500 ppm, however, the TDS level recommended by WHO for drinking water is 300 ppm. In this study, the concentration of TDS was found to be 7.14 ppm for sample A, 471 ppm for sample B and 3.80 ppm for sample C.

**Salinity:** Salinity is simply the measure of the amount of dissolved salts in water, the salts are mostly compounds like sodium, chloride, sulfate, potassium, magnesium, nitrate, and sodium bicarbonate which dissolve into ions<sup>[12]</sup>. Salinity can affect the dissolved oxygen levels in the water. Salinity increases as the solubility of dissolved oxygen in water decreases. In this study it was observed that the salinity value for sample A was found to be 8.23 ppm, for sample "B" it was found to be 544 ppm, and for sample C it was found to be 4.34 ppm.

**Alkalinity:** Alkalinity is a measure of the water's ability to neutralize acids or its ability to resist a change in pH, maintaining a fairly stable pH. Water with a higher level of calcium carbonate ( $\text{CaCO}_3$ ) has high level of alkalinity which decreases the water's acidity. Water with pH of 10+ is considered very alkaline while a pH of 8 to 10 is considered to be mildly alkaline. A pH of 7 is neutral and anything below 7 is considered acidic<sup>[13]</sup>. In this study, it was observed that for sample B having a pH value of 7, the alkalinity value was found to be 7, however for sample A and B having a pH value of 2.1 and 2.2. The alkalinity value of these samples was not detected due to chemical interference.

**Total Hardness (TH):** Total hardness (TH) is the property of water that prevents the formation of later with soap, which may be due to the presence of magnesium and calcium concentration. The combination of temporary hardness (carbonate) and permanent hardness (noncarbonate) can be

described as total hardness, which is contained in all forms of water including wastewater. Temporary hardness is associated with anions like bicarbonate, carbonate, and hydroxide, which can be removed by just boiling the water, however, permanent hardness is associated with noncarbonate anions like sulfate, chloride, and nitrate, which is difficult to remove<sup>[14]</sup>. In the present study the TH of sample A was not found due to chemical interference but the total hardness of sample B was found to be 46 mg/L and sample C was found to be 34 mg/L, which according to the general guidelines can be classified as soft water which may be corrosive in nature.

**Calcium:** Calcium is usually one of the most important contributors to water hardness and may negatively influence the toxicity of other compounds. It also functions as a pH stabilizer and alters the taste of water if present in excess<sup>[15]</sup>. In the present study the value of calcium for sample A was found to be 76.152 mg/L which is within the permissible limit of BIS and WHO (200 mg/L). However, the values for samples B and C were not found, the reason may be due to chemical interference which led to the failure to titrate beyond the equivalent point making determining the point at which the two solutes completely reacted impossible.

**Dissolved Oxygen (DO):** Dissolved Oxygen (DO) is a measure of the degree of pollution by organic matter, the destruction of organic substances as well as self-purification capacity of the water body<sup>[16]</sup>. When dissolved oxygen becomes too low, fish and other aquatic organism, cannot survive. No oxygen levels (anoxia) or low levels of oxygen (hypoxia) can occur when excess organic materials, such as algal blooms, are decomposed by microorganisms<sup>[17]</sup>. In the present study the dissolved oxygen levels for sample A was found to be 2.6 mg/L, for sample B it was found to be 3.5 mg/L both of which are within the permissible limit of BIS and WHO standard for drinking water. While for sample C the dissolved oxygen levels were found to be 21.5 mg/L, which is above the desirable limit of BIS and WHO standard. This high level of dissolved oxygen may be the reason for higher air saturation levels.

**Chloride (Cl):** Chloride as chloride (Cl) ions is one of the major inorganic anions in wastewater and water. In this study, it was revealed that the

concentration of chloride for samples B and C were found to be 54.62 mg/L and 40.34 mg/L respectively which is within the permissible limit of BIS (250 mg/L) and WHO (250 mg/L) standard for drinking water. However for sample A the concentration of chloride was not found which may again be due to chemical interference. In natural water, the chloride can impart a salty taste, which at a concentration above 250 mg/L is very apparent. It can also cause corrosion of appliances, metal piping, fixtures, and heat-exchange units<sup>[18]</sup>.

**Iron(Fe):** Iron is a troublesome chemical in water supplies and is one of the most abundant resources. Iron in water generally takes one of two forms- insoluble ferric iron and soluble ferrous iron. In soluble ferrous iron, the iron dissolves evenly and the water remains clear until it is exposed to atmospheric conditions after which it becomes ferric iron. In insoluble ferric iron the iron turns the water cloudy and a reddish-brown substance begins to form when exposed to air or atmosphere<sup>[19]</sup>. In this study, the concentration of iron was found to be 1 mg/L for sample A which is higher than the permissible limit of 0.3 mg/L for BIS and 0.1 mg/L for WHO standard for drinking water, while for samples B and C iron was not detected. In drinking water, it develops an unpleasant metallic taste<sup>[19]</sup>.

**Sulfate(SO<sub>4</sub>)<sup>2-</sup>:** Sulfate (SO<sub>4</sub>)<sup>2-</sup> is one of the major dissolved components of rain. In drinking water high concentrations of sulfate can have a laxative effect when combined with magnesium and calcium, the two most common constituents of hardness<sup>[20]</sup>. In high concentrations, sulfate is a threat to the livestock and natural environment, and is therefore subject to regulations. If the concentration of sulfate exceeds 250 ppm it gives a bitter taste or medicinal taste to water making it unpleasant to drink the water, and may also be highly corrosive. Thus, in many wastewater flows sulfate levels needs to be carefully monitored and moderated<sup>[21]</sup>. In this study the value of sulfate was found to be greater than 100 ppm for samples A and C and was found to be less than 20 ppm for sample B.

**Phosphate [PO<sub>4</sub>]<sup>3-</sup>:** Phosphate [PO<sub>4</sub>]<sup>3-</sup> is an anion derived from phosphoric acid (H<sub>3</sub>PO<sub>4</sub>). Phosphate can be present in organic and inorganic forms and can also be referred to as orthophosphate<sup>[22]</sup>. As

the algae proliferate, they eventually die and consume dissolved oxygen in the water that aquatic animals like fish needs to survive [23]. Phosphate can be used as water treatment chemicalsto maintain water quality in the distribution system (inhibit corrosion, reduce lead and copper levels) and also to solve specific water quality problems resulting from inorganic contaminants (calcium, iron, etc.,) [24]. A higher level of phosphate is indicative of eutrophication and pollution. Here the phosphate value for sample B was found to be 1.3 mg/L which is slightly higher than the permissible limit of WHO (0.1 mg/L), for sample C it was found to be 0.1 mg/L which is within the permissible limit of WHO standard, however for sample A phosphate was not detected.

**Nitrate( $\text{NO}_3^-$ ):** Nitrate ( $\text{NO}_3^-$ ) content is an important parameter to estimate organic pollution in a particular environment [25], it is a compound of nitrogen and oxygen found in nature, occurring in both surface water and groundwater from the natural decaying process of biological matter, however many anthropogenic sources may also contribute to nitrate levels in the environment. Nitrate among all nitrogen-containing compounds, is the most common form in water. Excess nitrate in water/wastewater can lead to environmental problems like eutrophicationand contamination of groundwater. In addition, consumption of excess nitrate by humans has been linked to cancer and a blood condition called methemoglobinemia. As a result, monitoring nitrate levels has proven critical for both environmental and health reasons [26].

Here the nitrate value for samples A and C was found to be 133 mg/L, which is much higher than the limit of 45 mg/L BIS standard, while for sample "B" nitrate was not detected.

**Sodium(Na):** Sodium (Na) is one of the element which forms the mineral sodium chloride, commonly referred to as salt. Sodium is a highly soluble chemical and is often found in groundwater. For the general public, a maximum drinking water standard of 100 mg/L has been proposed [27]. High concentration of sodium in drinking water is a more serious concern if you have a medical condition such as high blood pressure, or certain kidney, heart or liver diseases. Sodium can also have a serious negative effect on aquatic ecosystems. The result of the study revealed that the sodium value for sample A was

found to be 44 mg/L, for sample B it was found to be 8.08 mg/L, and for sample C it was found to be 59.50 mg/L.

**Potassium(K):** Potassium (K) is an alkaline metal closely related to sodium. Silicate minerals such as orthoclase, biotite, and microcline are common sources of potassium [28]. In natural freshwater the major source of potassium is weathering of rocks, but the potassium quantity increases in polluted water due to the disposal of wastewater. From a health point of view, potassium is not much of a significance but in large quantities, it may be laxative. The potassium concentrationis very low in natural water but a high value can be an indication of pollution caused by domestic waste [29]. The result of the study revealed that the potassium value for sample A was found to be 40.67 mg/L, for sample B it was found to be 11.31 mg/L, and for sample C it was found to be 19.88 mg/L.

### Conclusions

After the analysis of physicochemical parameters of wastewater samples collected from different chemical laboratories, the following result has been observed. The pH value for sample B (pH-7) was found to be within the set limit, while samples A and C were found to be acidic with a pH value of 2.1 and 2.2 respectively. The ORP values for all three samples were found within the set limit (554 mv, 262 mv, and 645 mv respectively). While the EC value for samples C (5860  $\mu\text{s}/\text{cm}$ ) was found to be high compared to sample A (11 $\mu\text{s}/\text{cm}$ ) and C (726 $\mu\text{s}/\text{cm}$ ). The TDS value was found to be 7.14 ppm, 471 ppm, and 3.80 ppm for the three (A, B and C) samples which were within the permissible limit of BIS and WHO. For salinity, the values were found to be 8.23 ppm, 544 ppm, and 4.34 ppm for sample A, B and C respectively. In this study, iron was detected only in sample A which was found to be 1 mg/L, while for samples B and C iron was not detected. Likewise, nitrate was detected only for samples A and C which was found to be 133 mg/L for both samples, while for sample B it was not detected and for sulfate, the value was found to be greater than 100 ppm in both samples A and C, but for sample B it was found to be less than 20 ppm. The DO for the samples was found to be 2.6 mg/L, 3.5 mg/L, and 21.5 mg/L respectively. The potassium and sodium were also analyzed for

which the concentration of potassium was found to be 40.67, 11.31, and 19.88 mg/L and the concentration of sodium was found to be 44mg/L, 8.08mg/L, and 59.50 mg/L respectively.

The alkalinity, chloride, TH, and calcium value for some of the samples were not found, the reason may be due to the high level of chemical interference, as the samples collected from the chemical laboratories of various institute was extremely colored with a high concentration of several others chemicals, which led to the failure to determine the values of this parameters.

Thus, it can be concluded that the value of the parameter varies depending on the quality of the samples. While some are within the tolerance limit of BIS and WHO standards few other parameters are found to be higher than the permissible limit set by WHO and BIS.

### Conflict of Interest

The authors declare no conflict of interest.

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