Available online at **www.joac.info**

ISSN: 2278-1862

Journal of Applicable Chemistry

2023, 12 (4): 329-344

(International Peer Reviewed Journal)

Physicochemical Analysis of Wastewater from Chemistry Laboratory of St.Joseph's College, Jakhama, Nagaland

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Accepted on 3rd July, 2023

ABSTRACT

Wastewater from laboratory is a type of wastewater containing certain contaminants as a result of using mixtures of chemicals by the students or researchers while carrying out their practical's in institutions. The discharge of this wastewater without proper treatment into the lands or through improper drainage systems can be hazardous to the environment as well as human health in the long run. The main objective of this study is to analyze the physicochemical parameters of a lab wastewater and see its impact on the environment. Four samples were collected from the chemistry laboratories of St. Joseph's College, Jakhama, Nagaland. After which the experiment was carried out from the chemistry laboratory of Kohima Science College, Jotsomaand during which the samples were labeled as Sample-1,2,3 and 4 respectively. In this study, the 15 Physico-chemical parameters that were considered and analyzed using Standard Analytical Method were pH, TDS, EC, ORP, Salinity, Total Hardness, Alkalinity, DO, Chloride, Iron, Sulfate, Phosphate, Nitrate, Sodium and Potassium, respectively. After the determination, the resulting values were compared with the limited values directed by BIS and WHO Standards for drinking water. Thus, after all the thorough analysis and comparison, the study revealed that some collected samples were very acidic and contain some parameters which were at a very high concentration hence needs a proper treatment before directly discharging onto the environment and it is suggested that institutions should be provided with proper drainage systems for cleaner and safer environment.

Graphical Abstract:

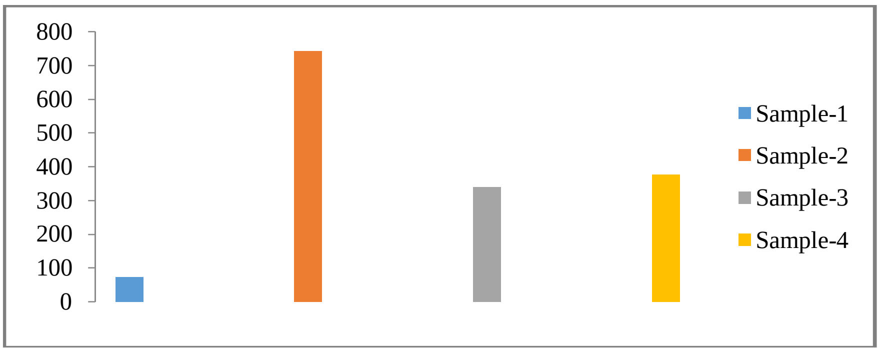

Chart showing ORP values of the four samples.

Keywords: Benzothiazole, Heterocycles, Aromatics, Antimicrobial, Biocidal.

INTRODUCTION

Laboratories assuredly offer a fathomless service to mankind and their contribution towards promoting various trades are well recognized. However, all these services can be declared as null and void if we look deeper into the potential hazardous effects it holds towards the environment and that is if the laboratory waste are irresponsibly disposed without any concern thoughts for the preservation of our environment.

Every kind of lab waste can affect the environment in one or the other way which includes' Laboratory wastewater'. Laboratory wastewater is any sort of wastewater that potentially contains mixtures of some harmful chemicals which are mostly created by the practical activities done in the lab by students or researchers. Most lab wastewater are hazardous that can actually have a consistent direct or indirect impact on the environment as once they are disposed through laboratory drainage, these liquid wastes from all these different outlets can find their ways into public wastewater systems which in turn can pose health hazards to certain water bodies. Laboratory wastewater can be hazardous to the quality of the soil as well if disposed without proper drainage and exposed for prolonged period of time which can indirectly have a negative impact on plants and animals due to the presence of various harmful chemicals and irritants in the wastewater. And considering how locals grow their crops in these soils, untreated wastewaters can eventually cause a breakdown of the healthy agricultural areas as well. In addition, wastewater containing concentrated acids, alkalis or other combustible reagents if disposed without neutralization can prove to be fatal to human health [**1**].

The random discharge of untreated or poorly treated wastewater effluents is no doubt the main source of water pollution. Several pollutants and their derivatives that are discharged into the environment are caused by organics, nutrients, and contaminants such as drugs residues, antibiotics, pesticides, heavy metals, etc and can be highly toxic to humans and aquatic environment [**2**]. Hence, water resources in India seem to be under severe stress due to all this over exploitation and pollution.

Sources of wastewater: With rapidly increasing population, urbanization, non-agricultural activities and economic development, a huge volume of wastewater can be generated. Particularly chemical wastewater which is most hazardous can be produced by the institutions, research laboratories, industries, mining sites, mineral processing sites, agricultural facilities, etc. It became an absolute necessity to know the sources of wastewater so one can effectively determine what actually passes through their wastewater ways and can implement those sewage treatment plants. Some of those sources are discussed below:

Urban Sources: This includes apartments, hotels, schools, restaurants, bars, resorts, places of worships, stadiums, hospitals, etc. wastewater from all these sources may include chemicals, bacteria, metallic impurities which gradually make the water toxic.

Natural Sources: This includes some natural events like flood, runoff water from gutters, water from pools, car garages, etc.

Agricultural Sources: As agricultural lands constantly require freshwater for irrigation, they can generate wastewater in large volume because of the use of certain chemicals such as pesticides, fertilizers, fungicides, insecticides, etc which gets mixed with the water [**3**].

Potential hazards of lab wastewater on environment: Through this research some chemicals that were found to be possibly present in lab wastewater and their adverse effects on the environment are given below:-

Phosphate: Although Phosphorus provides essential nutrients for all life, it is accompanied by certain environmental concerns such as mining of phosphorus from raw phosphate rocks can lead to land degradation, hazards towards water bodies, etc [4].

Sulfate: A chemical compound which can acidify surface water and soil, hence contribute to acid rain and fog leading to damaged ecosystems, forests and plants [5].

Iron: Iron can cause odored taste in drinking water wells and can participate in causing air pollution through mining of iron ore.

Nitrate: Nitrate pollution affects the environment by causing damage to our rivers, lakes, and coasts. Nitrate contaminated groundwater can indirectly affect the drinking waterways as well.

Sodium: Sodium in powdered form can be highly explosive in water and in fact can be a poison combined with various other elements. Its liquid form such as sodium hydroxide can possibly contaminate water sources [6].

Potassium: Potassium in excess can cause damage to germinating seeds, inhibits uptake of minerals and reduces the quality of crops [6].

Chloride: High amount of Chloride can be toxic to aquatic lives like fishes and other organisms and to aquatic vegetations as well. Chloride in excess can also cause corrosion of water pipes [7].

Their toxicity depends on the amount of exposure in terms of quantity and period of time. Emerging pollutants that are created by this wastewater have not gained scientific attention until recently and previous studies shows that most of these compound's present can be difficult to remove during sewage treatment. As a result, they can be mostly found in treated wastewater and aquatic environment. However, a study was done in Greece to analyse treated wastewater using simple method called RQ based approach through which they could evaluate the potential threat the emerging contaminants can hold. It was simply applied to micropollutants present in aquatic environment and this method could be used as a starting point for beginner organizations to monitor emerging contaminants. All this recent concerns have led to the establishment of certain interim aquatic guidelines and in addition European Union, United States Environmental Protection Agency(USEPA),WHO have developed a pollutant list, which comprises of contaminants that can have a major threat on the environment and human health [8].

Impact of lab wastewater on human health: Improper disposal of waste in any water systems can actually have an adverse impact on human health as well. Water contaminated with disease causing bacteria, viruses, protozoa, etc and toxic chemicals or other waste like plastics are definitely fatal to aquatic organisms when they consume such water, and as a result pollutants such as heavy metals like lead, cadmium, mercury, etc continues to remain in the body of these organisms and unfortunately, they reaches human body ultimately via food chain causing fatal to human lives in the long run. The WHO states that nearly 3.4 million people die each year from waterborne diseases (Ahsen Soomro 2019)

A study done in the U.S. evaluated on how the spreading of oil and gas wastewater on roads for dust suppression can have a potential human health impacts as it was indicated that these wastewater contains salt, radioactivity, organic micropollutants which can release certain carcinogens causing hazards to humans [9].

In addition, a case studied in India where datas were collected from six villages irrigated with wastewater and one control village where normal quality of water was used for irrigation and the analysis showed that higher rates of morbidity existed in the wastewater irrigated villages compared to the control village. Hence, exposure to wastewater and its activities places the villagers in higher risk of morbidity [10].

Considering all the above adverse effects wastewater can possibly hold on the environment and human health, it became an absolute necessity for researchers to come up with suitable ways for treating this wastewaters by means of removing certain toxic chemicals present in them. It is known that most of water supplied ends up as wastewater which makes its treatment very important.

Wastewater treatment is a process and technology that removes contaminants from it to ensure a better environment and public health. Likewise, treatment of laboratories wastewater became equally important as it does have certain contaminants that can possibly harm the environment as well as human health.

Current scenario of wastewater management system in India: In India, about 35% of its total population is covered with urban centres, where wastewater generation is estimated to be about 72,368 MLD (million litres per day) for the year 2020 to 2021.This estimation is almost quite double the rural areas counterpart. According to a report published by CPCB in the year 2021, India's current water treatment capacity is 27.3% and sewage treatment capacity is 18.6%. On the other hand, installed sewage treatment capacity is reported to be 31,841 MLD, however the operational capacity is 26,869 MLD which is much more lower than what is actually generated. As a result of this, only about 28% of the actual wastewater quantity is treated and the remaining 72% of it are all left untreated and disposed of in rivers, lakes or groundwater [11].

Although India's wastewater treatment capacity is high comparing to global average of around 20%, it is far from enough and in fact needs more swift measures and scaled up treatment capacity to avoid serious consequences that some areas are already facing. As we also read from one of the 2019 research report that most of the sewage treatment plants which were established under the Ganga Action Plan and Yamuna Action Plan are reportedly not working and out of 33000 million litres per day of waste generated, only 7000 MLD is collected and treated [11].

Current Scenario of Wastewater Management System in Nagaland: The severity of pollution in rivers of Nagaland varies from one region to another depending on the density of urban development, agricultural and industrial practices and the availability of wastewater treatment plants in those regions. The main sources of pollution are sewage/municipal drainage from Dimapur city through improper disposal of solid waste into drains and industrial effluents. Hence, on Jan14, 2023 Jacob Zhimomi minister of Public Health Engineer inaugurated the state's first ever sewage treatment plant "Pollution abatement of rivers Diphu and Dhansiri", at Shozukhu village. It was further mentioned that these two rivers were targeted in Nagaland as these had become highly polluted and the flow of sewage had to be stopped. This very project is currently monitored by National River Conservation Directorate under Department of Water Resources, River Development and Ganga Rejuvenation, Union Ministry of Jal Shakti [12].

Other waste management projects in Nagaland that are carried out under Swachh Bharat Mission are like open-defecation free(ODF) and ODF plus such as Grey Water Management, Plastic Waste Management, Faecal Sludge Management, Biodegradable Waste Management, etc [12].

It was last updated on 14th of Nov 2022 that a Wastewater Treatment Plant Project (ID: 605905) in Kohima district have begun and is still under development [13].

Step-Wise Treatment of Wastewater: Wastewater can be treated in several different ways by applying well suited methods and one of those treatment processes are briefly discussed below:

Step 1: Screening and pumping: The collected wastewater will pass through the screening equipment where some objects like plastics, rags, wood fragments and greases were removed. Then this removed material were pressed and disposed of in some landfill. The wastewater which was screened will then be pumped into the next step.

Step 2: Grit Removal: In this step, heavy and fine materials such as sand and gravel were removed from the wastewater and the materials will be disposed of in a landfill.

Step 3: Primary Settling: In this step, Clarifiers were used to pump off the settled materials at the bottom called the ‘primary sludge’ and the wastewater exits the tanks from the top. Here, greases were skimmed off the top and sent to the digesters along with the settled materials. In addition, chemicals were also added in this step to remove phosphorus

Step 4: Aeration/ Activated Sludge: Wastewater received most of its treatment in this step. Here, due to biological degradation, the pollutants are consumed by microorganisms and transformed into cell tissue, water, and nitrogen. Although, this activity is quite similar to those occurring at the bottom of lakes and rivers but in this case the degradation takes years to accomplish.
Step 5: Secondary Settling: Here, Secondary clarifiers (huge circular tanks) were used to separate the treated wastewater from the aeration tanks yielding an effluent, which is about 90% treated. The activated sludge is continuously pumped from the bottom of the clarifiers and are returned to the aeration tanks (step 4).

Step 6: Filtration: Those clarified effluents yielded from step 5 were then polished in this step by filtering through 10 micron polyester media.

Step 7: Disinfection: To ensure that the wastewater treated by all the above steps is free of bacteria, UV disinfection was used after the filtration step. This process kills remaining bacteria if any so it levels up to the discharge permits.

Step 8: Oxygen Uptake: The treated water which is now in a very stabilized high quality state, was aerated if necessary to bring the DO up to the permit level. Here, pollutants removal is maintained at 98% or greater [14, 15].

MATERIALS AND METHODS

Study Area:

Figure 1. Location of Nagaland on India map.

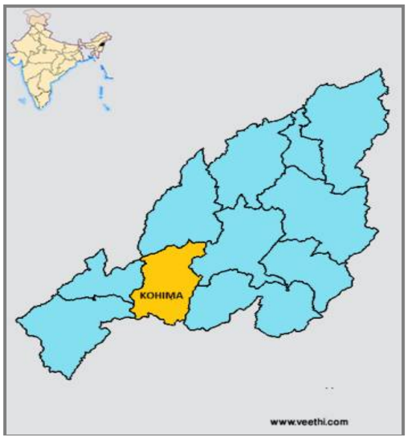

Figure 2. Location of Kohima on Nagaland map.

Figure 3. Location of Jakhama on Kohima map.

The research had been carried out in St. Joseph College, Jakhama district of Kohima, Nagaland. Jakhama is a Southern Angami Naga village located 18 km south of Kohima, the capital of Nagaland, also the second largest village in Southern Angami region located on the Kohima-Imphal highway. Jakhama village is located in the geographical coordinates of 25.5960^{o}N latitude and 94.1232^{o}E longitude. It hosts the St. Joseph's College, Jakhama [16, 17].

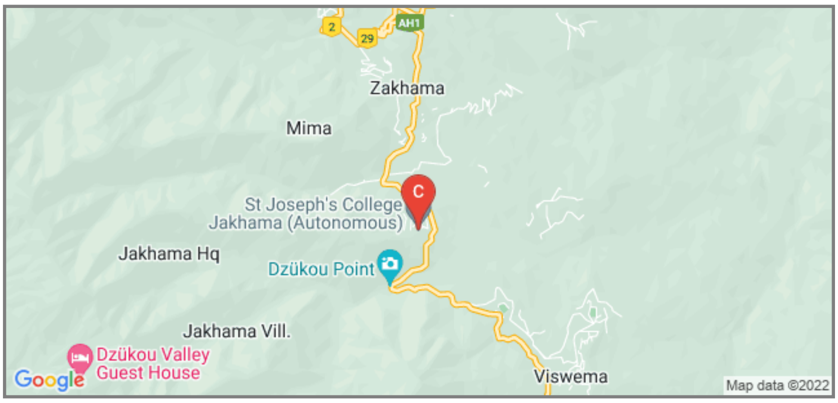

Figure 4. Location of St. Joseph's College, Jakhama.

Figure 5. Chemistry laboratories in St Joseph's College, Jakhama.

Methodology: In this study, the wastewater samples were collected from chemistry laboratory of St. Joseph College, Jakhama: Nagaland on 17th of February 2023. The wastewaters were collected in bottles of 1l capacity. the experiments were done in the college laboratory (Kohima science college, Jotsoma) starting from 20th of February 2023.

Figure 6. Samples collected in bottles.

Table 1. Method of determination of water quality parameters

Parameters	Method Of Determination
pH	pH meter EZ-9908
TDS	Microprocessor COND-TDS-SAL Meter
EC	Microprocessor COND-TDS-SAL Meter
Salinity	Microprocessor COND-TDS-SAL Meter
TH	EDTA - Titrimetry
ORP	ORP tester HI98201
DO	DO Winklers Method
Alkalinity	HCl - Titrimetry
Iron	Iris visible spectrophotometer 230 VAC (HI801-02)
Phosphate	Iris visible spectrophotometer 230 VAC (HI801-02)
Chloride	Argentometric Method
Potassium	Flame photometry
Sodium	Flame photometry
Nitrate	Iris visible spectrophotometer 230 VAC (HI801-02)
Sulfate	Iris visible spectrophotometer 230 VAC (HI801-02)

Data Analysis: After determination of the physiochemical parameters through the methods mentioned above, it was found out that for some wastewater samples, certain parameters couldn't be detected due to chemical interference. Hence, the resulting values of the 15 parameters for all the four collected samples are subjected in the categorized tables below:

Table 2. Resulting values for Physical parameters

Samples	Parameters					
	pH	TDS (mg L^{-1})	EC (µS cm^{-1})	ORP (mV)	SAL (mg L^{-1})	TH (mg L^{-1})
Sample-1	10.1	ND*	16.67	73	ND*	20
Sample-2	1.8	ND*	47.1	743	ND*	ND
Sample-3	6.6	466	718	340	538	280
Sample-4	2.7	1575	2.42	377	1815	ND

***Here ND indicates that the values obtained are in Parts per trillion

Table 3. Resulting values for Chemical Parameters

Samples	Parameters		
	Alkalinity (mg L^{-1})	DO mg L^{-1})	Chloride (mg L^{-1})
Sample-1	ND	135.5	ND
Sample-2	ND	47.1	ND
Sample-3	65	2.5	78.88
Sample-4	ND	3.1	ND

Table 4. Resulting values for Nutrient and Heavy Metal Parameters

Samples	Parameters					
	Iron (mg L^{-1})	Sulfate (mg L^{-1})	Phosphate (mg L^{-1})	Nitrate (mg L^{-1})	Sodium (mg L^{-1})	Potassium (mg L^{-1})
Sample-1	ND	40	ND	66.2	ND	ND
Sample-2	ND	100	ND	133	ND	76.03
Sample-3	ND	50	ND	3.4	1.04	2.23
Sample-4	ND	50	0.8	0.5	0.11	4.58

RESULTS AND DISCUSSION

Physical Parameters

pH: Determining the pH of wastewater is essential for its treatment such as removal of organic compounds and heavy metals [18]. In this study, it was found out that Sample-2 was the most acidic with a very low pH of 1.8 followed by Sample-4 with pH of 2.7 and Sample-1 most alkaline with pH of 10.1. The variation occurred in the pH values due to change in values of CO_2, carbonates, and bicarbonates in water [19]. According to WHO and BIS guidelines, the accepted pH range for drinking water is 6.5 to 8.5 and considering this, the study revealed that Sample 2 and 4 had a very low pH value which is extremely acidic. Low pH can indicate the presence of heavy metals resulting in the release of metal cations in water.

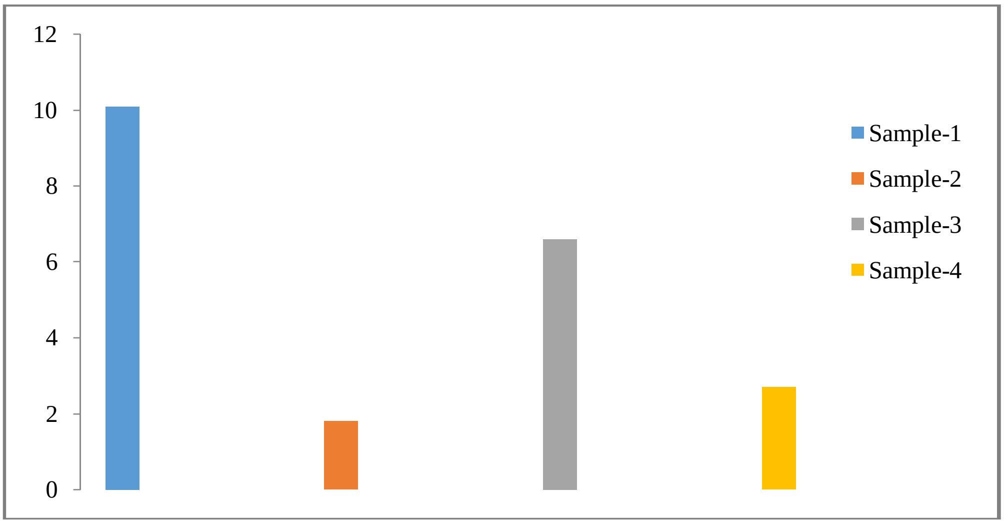

Figure 7. Chart showing pH levels of the four samples.

Total Dissolved Solids (TDS): Total Dissolved Solid is a measure of all dissolved substances in water (inorganic salts, organic matter and other dissolved materials) [20]. After the analysis, it was revealed that Sample-4 had the highest value of TDS (1575 mg L^{-1}) followed by Sample-3 (466 mg L^{-1}) and Sample-1 the lowest having TDS value of 10.86 mg L^{-1} respectively. According to WHO and BIS guidelines for drinking water, the accepted TDS value shouldn't exceed 500. Hence, the study revealed that Sample-4 exceeded this limit.

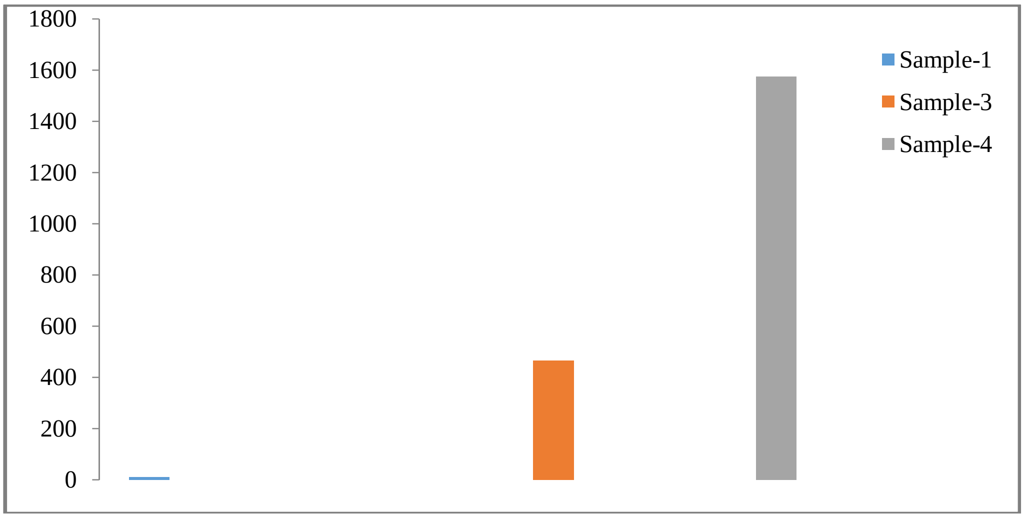

Figure 8. Chart showing TDS concentration.

Electrical Conductivity (EC): EC is the measure of a solution's ability to conduct current. Inorganic ions have major influence on the conductivity of water. EC is directly proportional to the TDS concentration and hence, high EC value in wastewater indicates high TDS concentration [18]. After the analysis, it was found out that Sample-3 had the highest concentration with EC value of 718µS/cm. However, the accepted EC value by WHO for drinking water is 2500 and therefore we can say that this samples had considerably low concentration of EC for a wastewater. In cases where high concentration of EC is found, its discharge into the surrounding watershed can bring water imbalance for aquatic organisms and can also decrease DO concentration.

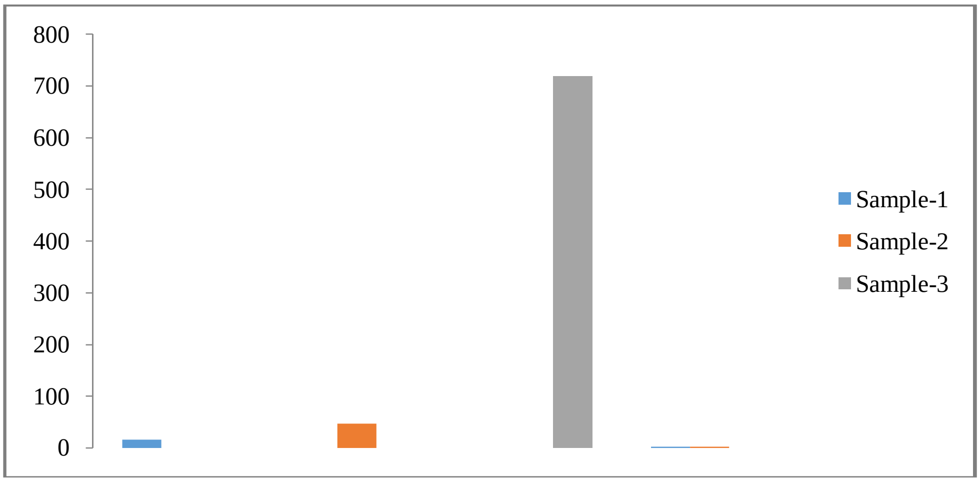

Figure 9. Chart showing the different concentrations of EC.

ORP (Oxidation Reduction Potential): ORP can also be simply understood as a fighting battle against oxidizers and reducers. ORP classifies substances as oxidizing or reducing agents and is measured in mV. High ORP indicates large amount of oxygen (or oxidizing agent) in the water and it decreases the pH levels. Low ORP indicates a reducing agent [21]. The analysis revealed that among the four collected samples, Sample-2 had the highest ORP value of 743mV and Sample-1 the lowest with ORP value of 73mV respectively. According to WHO and BIS guideline, the accepted ORP value is 650 and therefore it was seen that Sample-2 exceeded this limit and hence it can be concluded that large amount of oxidizers were used in Sample-2.

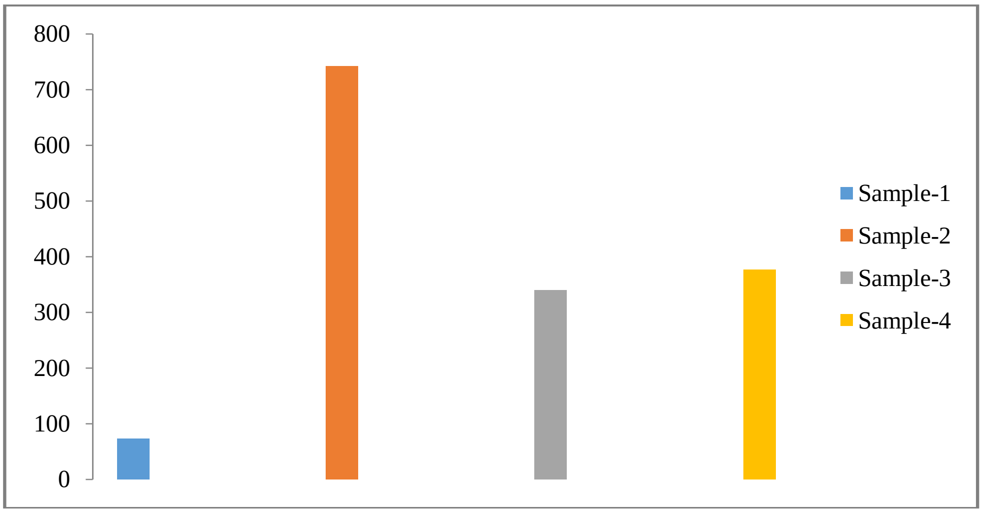

Figure10. Chart showing ORP values of the four samples.

Salinity (SAL): Salinity is the dissolved salt content of water bodies. It can contribute to conductivity and helps determine physical characteristics of water such as density and heat capacity (according to a report by the EPA in US) [22]. Saline wastewaters could be mostly generated by industries including chemicals, drugs, agricultural and aquacultural industries [23]. Excess salinity can occur in areas where evaporation is high. Salinity is an important parameter for wastewater treatment as discharge or high salinity wastewater may cause environmental pollution and damage the aquatic, terrestrial, and wetland ecosystems [24]. Through this analysis, it was found out that Sample-4 had excess salinity having value of 1815 mg L^{-1} while Sample-2 the lowest having a value of 0.000035 mg L^{-1} respectively.

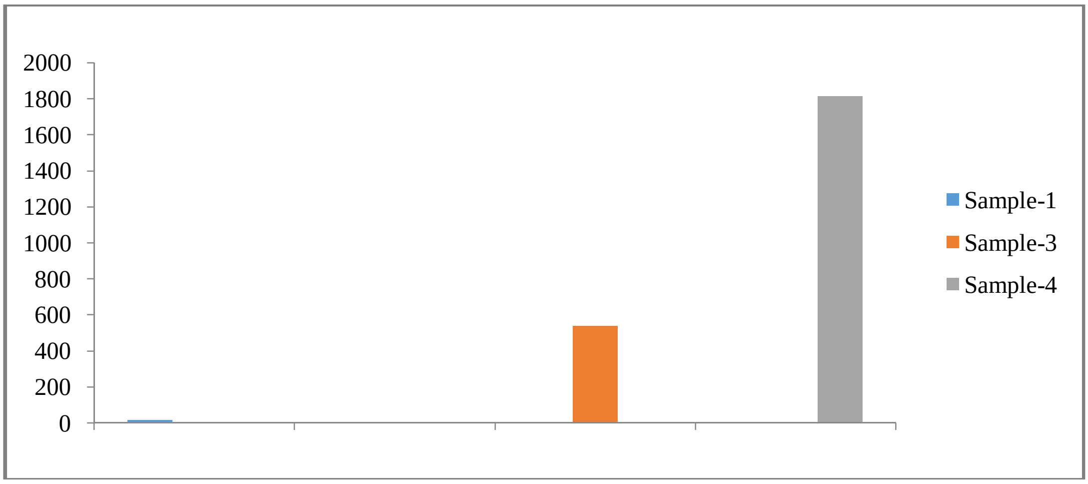

Figure11. Chart showing Salinity level of the three samples.

Total Hardness (TH): Total Hardness is referred to the combination of the two forms of hardness i.e. temporary (carbonate) hardness and permanent (non- carbonate) hardness [25]. During the analysis, TH for Sample-1 and 3 could not be detected due to chemical interference and hence they are recorded as ND under the data analysis. On the other hand, TH values for Sample-2 and 4 were found to be 20 mg L^{-1} and 280 mg L^{-1} i.e. after calculating using the given formula and the readings recorded from the experiment. According to WHO and BIS, the accepted value for TH is 300 and hence through this study, it was revealed that TH for this samples may be present in less concentration only which can be due to absence or very low concentration of Magnesium and Calcium carbonates/sulphates.

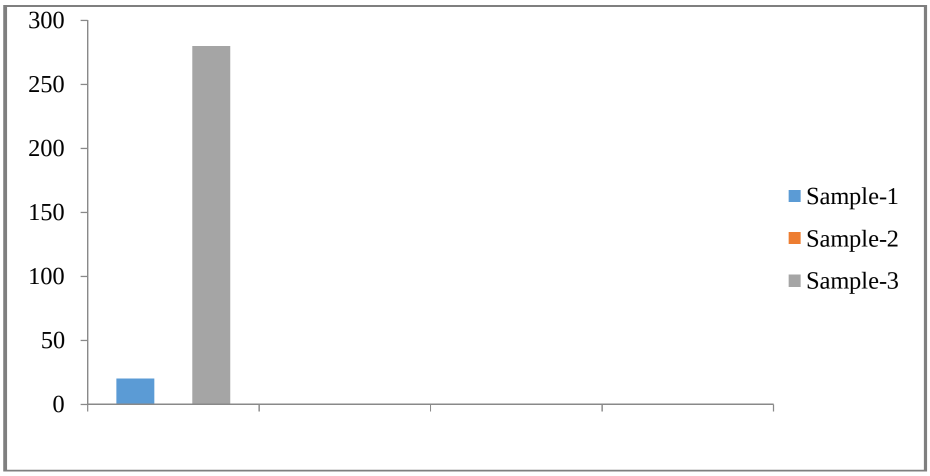

Figure12. Chart showing the TH levels for the two samples.

Chemical Parameters

Alkalinity: Alkalinity is the capacity to neutralize acids and it can result mainly from the salts of weak acids [26]. Presence of organic acids can also increase alkalinity. Alkaline waters are unpalatable and can cause gastrointestinal discomfort. In this study, alkalinity was less detected in the collected samples as most of it was towards acidic character. Hence, it was recorded as ND due to chemical interference under the data analysis. However, one alkalinity value of 65 mg L^{-1} was observed for Sample-3 which is quite less considering the accepted value given by BIS which is 200 mg L^{-1}. A low alkalinity range is between 50 mg L^{-1} to 100 mg L^{-1} for domestic wastewater and for industrial wastewater, the alkalinity levels are much higher. Low alkalinity causes corrosion of pipes and increases the chances of releasing many heavy [19]. High levels of alkalinity if detected can cause problems such as large amounts of scale and sludge, overheating of heat exchangers, and pipeline clogs. In most of these cases, high alkalinity is the problem rather than low alkalinity [27]. While in this study, the collected samples seemed to have high acidity and low alkalinity.

Dissolved Oxygen (DO): Dissolved Oxygen is essential for the survival of aquatic life and serves as an important indicator of ecosystem condition. DO levels in water partly depends on the chemical, physical and biochemical activities occurring in water. It's level can be influenced by pH i.e. any changes to pH value of water can affect how much DO the water can hold and transport (Meryl Kremer 2018) [28]. In this study, it was observed that among the four samples, Sample-1 had the highest DO level of 135.5 mg L^{-1} followed by Sample-2 with a value of 47.1 mg L^{-1} and Sample-3 the lowest with a value of 2.5 mg L^{-1} respectively. Hence, considering the accepted DO values by BIS which is 3.0, Sample-1 and 2 exceeded this limit.

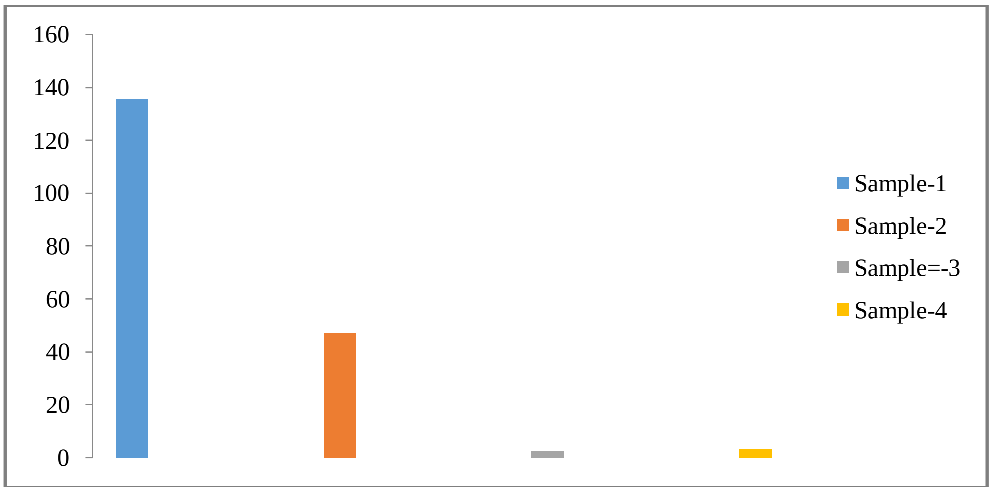

Figure 13. Chart showing the DO levels of the four samples.

Chloride (Cl): For safety reasons, chloride in wastewater should not exceed 250 mg L^{-1} as directed by BIS and WHO Standard [18]. In this study however, not much of chloride levels were detected for most of the wastewater samples due to chemical interference and hence were recorded as ND under the data analysis. However, chloride was detected in one of the sample i.e. Sample-3 and after calculating by using the given formula, the value was found out to be 78.88 mg L^{-1} respectively. Therefore, considering WHO accepted value it can be said that this samples had low levels of chloride.

Nutrient and Heavy metal Parameters

Iron (Fe): High concentration of Iron ions in water can cause odour and discolouration due to their precipitation [29]. Hence, it is necessary to analyse the concentration of iron ions before discharging into natural water bodies. Although the accepted values for Iron directed by WHO and BIS ranges between 0.2 to 1.0, however, during this experiment, presence of Iron could not be detected for the wastewater samples collected. Hence, it may be due to chemical interferences or must be present in very minute traces or even absent.

Sulfate: MN Dept. of Health reported in the year 2022 reported that high levels of sulphate can give water a bitter or medicinal taste and can have laxative effects. In this study, it was observed that Sample-2 had the highest level of sulfate i.e.100 mg L^{-1}, both Sample-3 and 4 had the same value (i.e.50 mg L^{-1}) and Sample-1 the lowest having a value of 40mg L^{-1} respectively. The accepted sulfate value as directed by BIS and WHO is 200 and hence through this study, it was revealed that these samples had somehow low to average level of sulfate.

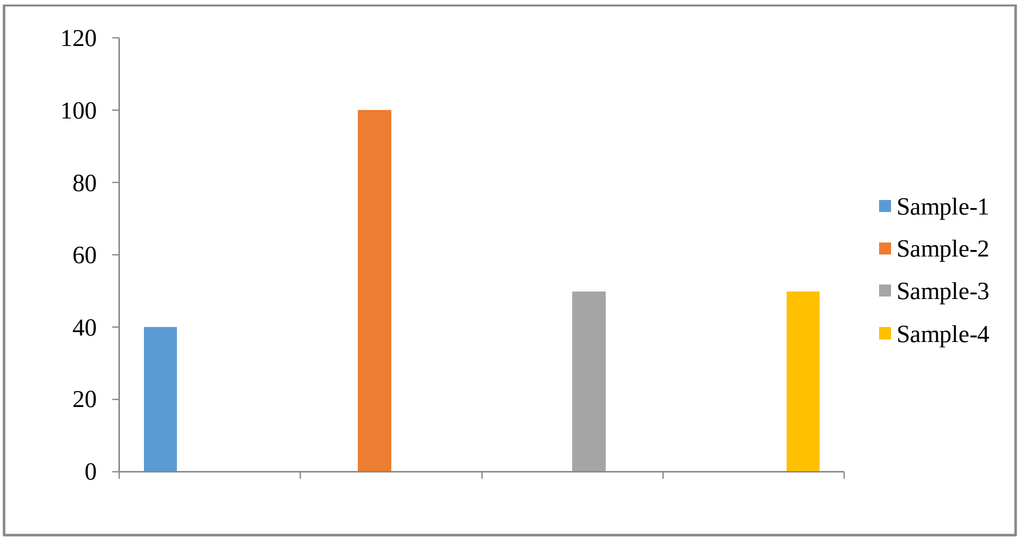

Figure14. Chart showing the sulfate levels of the four samples.

Phosphate: Phosphate also referred to as orthophosphate can be present in inorganic or organic compounds. Phosphate can be abundant in most wastewaters and should be removed before being discharged. When large quantities of phosphate reach waterways, algae species take up the nutrient and bloom and these algae blooms can strip waters of Dissolved Oxygen (DO) and suffocate fish, aquatic animals, and plant species. Some algae species releases toxins that are harmful to animals and humans (Sarah Jones 2020) **[30]**. However, in this study, phosphate level was detected only in one sample among the four samples i.e. Sample-4 with the value of 0.8 mg L^{-1} which actually exceeded the limit directed by the WHO standards i.e. 0.1. For the other three samples, the undetected values may be because of chemical interference.

Nitrate: Nitrates are the end product of the aerobic decomposition of organic nitrogenous matter and they are effective nutrient sources for algae [**18**]. In this study, it was observed that among the four samples, Sample-2 had the highest value of 133 mg L^{-1} followed by Sample-1 which is 66.2 mg L^{-1} and Sample-4 the lowest having a value of 0.5 mg L^{-1} respectively.

Sodium: David J. Halliwell *et al*., (2001) reported the effects of wastewater with sodium content on soil properties, particularly with respect to irrigation systems [**31**]. The impact of sodium may be detrimental to the environment because the uptake of phosphorus by algae was reportedly enhanced by sodium [**32**]. In this study, values for first two samples could not be detected either due to chemical interference or their concentration were out of range (maximum=100). On the other hand, the values for Sample-3 and Sample-4 were found to be 1.04 mg L^{-1} and 0.11 mg L^{-1} respectively.

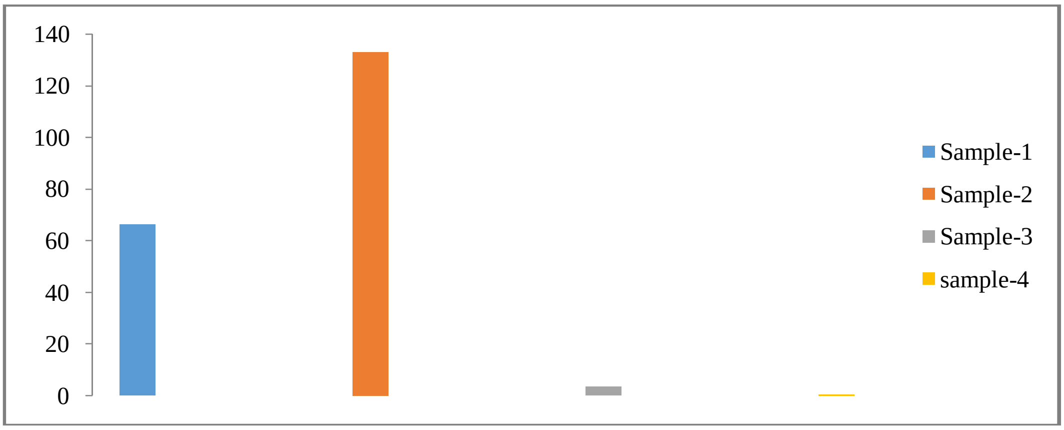

Figure15. Chart showing Nitrate values for the four samples.

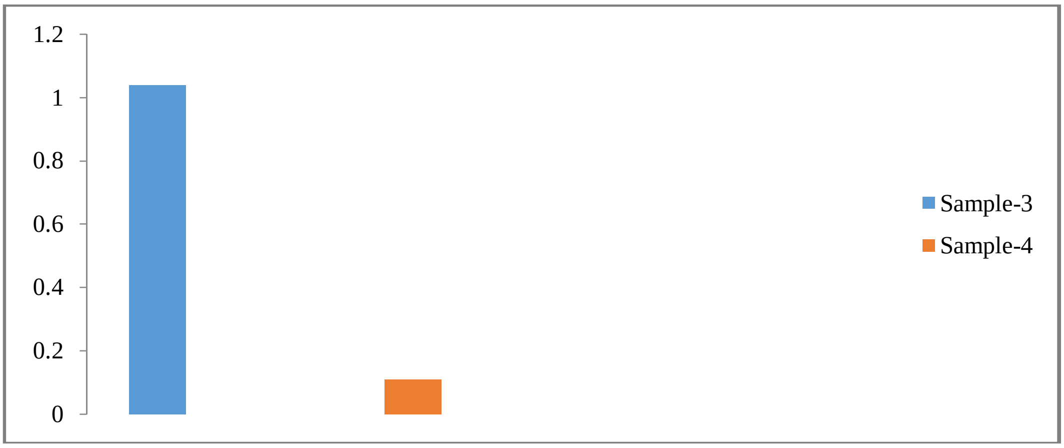

Figure 16. Chart showing the Sodium concentration in the two samples.

Potassium: It was reported from Ohio Watershed Network that the most common source of potassium in drinking water were that of water softeners using potassium chloride. This Potassium levels in drinking water can be very high and may significantly increase an individual's intake of potassium that could cause hyperkalemia in susceptible individuals [34]. In this study, potassium level for Sample-1 could not be detected due to chemical interference or very high concentration. However, the values for the other three samples were certainly detected with Sample-2 having 76.03 mg L^{-1} which was the highest, Sample-3 having 2.23 mg L^{-1} and Sample-4 with 4.58 mg L^{-1} respectively.

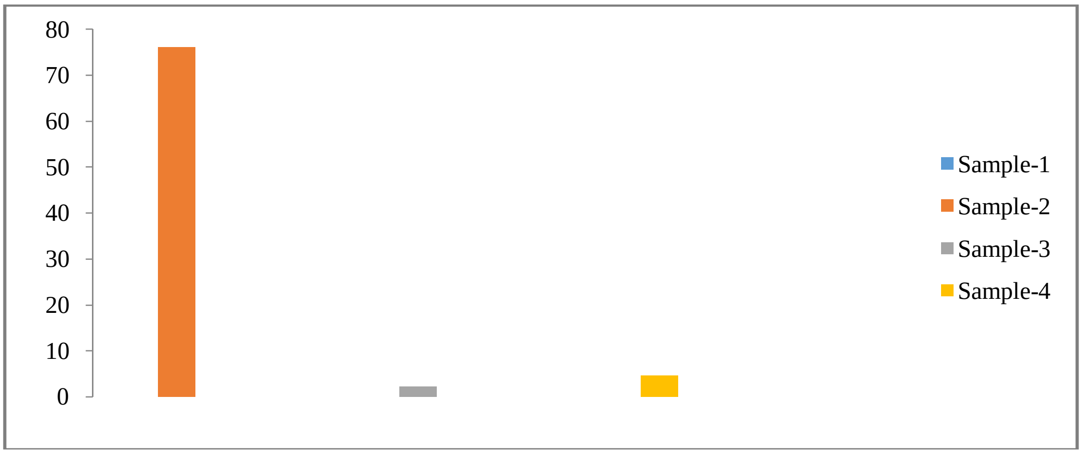

Figure 17. Chart showing the potassium concentration for the three samples.

APPLICATION

Write the application of work

CONCLUSION

. Upon all the thorough analysis and observation and considering the limits directed by the BIS and WHO Standards, this study revealed that under the physical parameters, very high acidity was detected in sample-3 and 4, high TDS in sample-4, very low to average EC values in all the four samples, high ORP in sample-2, high Salinity in sample-4 and TH was difficult to detect due to chemical interference. Under chemical parameters, it was found out that very high DO values were observed for two samples however alkalinity and chloride levels were hard to detect during this experiment. It was also observed that heavy metal like Iron could not be detected either due to chemical interference or may be absent although it would be rare for any wastewater do not have any heavy metals. Lastly, under the Nutrient parameters, it was observed that average levels of sulphate were found in all the four samples while high concentration of nitrate in two samples, high Potassium level in sample-2 were observed. On the other hand, difficulty was faced during the detection of phosphate and could be detected only in sample-4 and sodium only in sample-3 and 4 respectively.

Although this research was done in only one of the Colleges in Kohima district (St. Joseph's College, Jakhama), after the necessary observations, it can be concluded that laboratories in most of the institutions comprising of practical classes can contribute to certain amount of lab wastewater as by the continuous use of chemicals during their experiment which can have contaminants that can prove to be a hazard in the long run. As the students throw the chemicals through the sink and it can either find a way to general water resources through improper drainage system or dry out on the lands which can directly or indirectly have a hazardous impact on both the environment and human health, it is suggested that proper drainage system should be provided for all the institutions that have chemistry laboratories or having those other departments that uses certain chemicals during their experiment. In addition, overview of wastewater management system in Kohima district is still under development yet production of wastewater continues from many sources which is alarming and hence the district is in need of proper treatment plants to tackle with all these issues concerning the discharge of wastewater without treatment. The state governors of Nagaland also definitely need to step up and come up with more treatment plants as it has been reported that the state have only one treatment plant which was also recently activated in Dimapur district. Hence, with all this sewage production from different areas like institutions contributing to water pollution, it is suggested that all the authorities of different science institutions must take under consideration of the hazards chemical laboratories can bring to the environment and incorporate safety measures as well as proper drainage system should be provided that can have a control of where the lab wastewater are flowing to and making sure it is not directly discharged unto the environment without any concern for the negative impact it holds for the environment in the long run.

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