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# PHYSICO–CHEMICAL ANALYSIS OF INDUSTRIAL EFFLUENTS AND THEIR IMPACT ON WATER AND SOIL AROUND PATNA

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***ABSTRACT***

*Numerous sorts of water contaminants, including pesticides, heavy metals, detergents, household wastes, and fertilisers, were produced as urbanisation and industrialisation advanced. The many sources dispersed these contaminants across the ecosystem.The physicochemical properties of water samples from a few ponds in and around Patna, Bihar, are examined in this study report.pH, electrical conductivity, calcium, phosphorus, total hardness, alkalinity, chloride, dissolved oxygen, temperature, free carbon dioxide, nitrate, and chloride were among the variables examined.The water parameters employed in the current experiment were obviously beyond the surface water contamination threshold, rendering them unusable for a number of applications. A modest attempt has been undertaken in this inquiry to determine how much the water quality has changed in relation to WHO water quality guidelines (WHO).*

***Key words:*** *Industrial waste, Physico-Chemical, Dissolved Oxygen (DO), Alkanity*

## 1. INTRODUCTION

All sorts of known life on earth depend on water, which covers 70.9% of the planet's surface.96.5% of the water on Earth is in the oceans, 1.7% is in the ground, and the remaining 1% is in other important bodies of water, includes the ice caps in Greenland and Antarctica, and 0.001% of it is in the atmosphere as vapour, precipitation and clouds (which are made up of both solid and liquid water droplets floating in the atmosphere).Fresh water makes up just 2.5% of the planet's total water, most of which is found in ice and groundwater.Freshwater makes up only 2.5% of the planet's total water supply, and the rest of it is found in ice and groundwater.Understanding the physicochemical characteristics of ponds, lakes, and reservoirs has not received much attention in India [1]. Ponds serve as both a vital water supply and a vital habitat for many different microorganisms.Due to a number of man-made activities, India is experiencing serious issues with biological oxygen demand, eutrophication, siltation, sedimentation, and a decline in the quality of the water, and shrinkage of ponds.Significant modifications to the physical and chemical composition of aquatic water bodies are brought on by anthropogenic nutrient enrichment [2]. The growth of weeds and algae is encouraged by an overabundance of

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nutrients, which causes eutrophication in the water bodies [3]. Ponds and rivers lose their economic, social, and recreational value as a result of nutrient enrichment [4]. The diverse water bodies' water quality deteriorates as a result of these circumstances. Due to the pond's water's numerous uses, the majority of cities and towns have sprung up around its bank. However, some ponds are regrettably being contaminated by the careless discharge of sewage and industrial pollutants [5]. Pond pollution is caused by a variety of pollutants or toxins, some of which are included in Table 1. These contaminants damage the biological purification system of ponds when they are released through sewage systems, which causes several pollution issues. The aquatic system's live biota has been severely impacted. The World Health Organization and the Bureau of Indian Standards have provided a list of the drinking water standards in Table 2. (BIS).

## 2. MATERIAL AND METHODS

### 2.1 Area of Study

The capital of Bihar and the administrative centre of the Patna district. Due to the natural water sources in Patna slowly dying off, the city's residents are projected to have a serious water crisis in the next decades. In several areas of the city, the groundwater level has decreased by 15 to 25 feet during the past 30 years, and it is projected to decrease further due to the disappearance of water bodies. Up until a few decades ago, the city was covered in several tiny ponds and ditches that were completely planted with aquatic vegetation, serving as vital water buffers.However, the bulk of surface water bodies have either been colonised by habitations or changed into landfills for household sewage, wastewater, and rubbish. The goal of the current study is to evaluate how three specific ponds in Patna, Bihar, have changed in terms of their physicochemical characteristics.

**Table 1:WHO and BIS drinking water standards from 1993.**

| S. No | Parameters | Units | BIS, 1998 | | WHO, 1993 | | Methods |
|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 | *9.2* | 6.5 | 8.5 | Electrometric |
| 2 | EC | (µS/cm) | - | - | - | - | Electrometric |
| 3 | TDS | mg/l | *500* | *1000* | 300 | 600 | Electrometric |
| 4 | TSS | mg/l | - | - | - | - | Electrometric |
| 5 | Total Hardness | mg/l | *300* | *600* | - | - | Titration *(EDTA method)* |
| 6 | Alkalinity | mg/l | *200* | *600* | - | - | Titration |
| 7 | Chloride | mg/l | *250* | *1000* | 200 | 600 | Titration |
| 8 | Dissolved Oxygen | mg/l | - | - | - | - | Winkler method |
| 9 | Free $CO_2$ | mg/l | - | - | - | - | Titration |
| 10 | Nitrate | mg/l | - | - | - | - | Titration |

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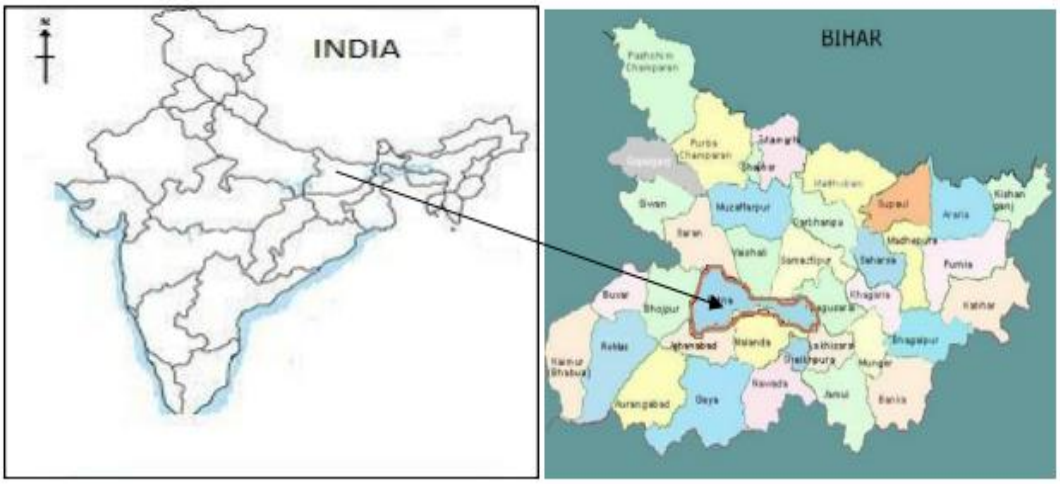


Fig. 1. Map of Study Area.

### 2.2 Collection of water samples

One-liter high-grade plastic bottles that had been washed three times in sample water before being filled with water were used to collect pond water samples.Between 10 and 11.30 am, water samples were taken from the pond's edges. At the sample sites after applying the appropriate preservatives, such as sulphuric acid, alkali iodide, and magnesium sulphate. A water testing facility received the gathered water samples and tested them for a number of physicochemical components. Three ponds in Patna were selected for the study: Adalatganj Pond, a Secretariat Pond (marked S2), and Phulwarisharif Pond are all ponds (denoted as A3).This publication does not include a broad description of the pond.

### 2.3 Methodology

For the water sample, [6] & [7]'s instructions were followed.The dissolved oxygen (DO) was set at a specified location, and samples of pond water were examined using the techniques described in [6] and [7].

## 3. RESULT AND DISCUSSION

Table 2 displays the findings of the physicochemical examination of numerous sampling sites.

### 3.1 pH

A pH value, or a negative decimal logarithm, is how scientists measure the hydrogen ion activity in a solution.Water gets moderately acidic when it comes into contact with air.This may be the consequence of water absorbing carbon dioxide from the atmosphere, slowly converting it into carbonic acid, and then dissociating it to release hydrogen ions:

$$CO_2+H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons HCO_3^- + H^+$$

The pH of water samples from sites P1, S2, and A3 pond ranged from a minimum of 7.4 to 8.08, 6.1 to 7.9, and 6.2 to 6.8, respectively. The research indicates that the water in pond A3 is relatively acidic, which may be brought on by plants decomposing

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and releasing CO2 as a result of biological oxidation, which lowers the pH, as well as stored organic materials. It is not recommended to use the water from these ponds.

**Table-2 parameters of different water samples**

| S.N. | Parameter | Phulwarisharif pond | Secretariat pond | Adalatganj pond |
|---|---|---|---|---|
| 1 | pH | 7.0-8.5 | 6.1-7.8 | 6.5-7.0 |
| 2 | EC | 345-435 | 90-160 | 145-175 |
| 3 | Calcium | 34-47 | 18-20 | 25-30 |
| 4 | Phosphate | 0.2-0.5 | 0.35-0.65 | 0.40-0.57 |
| 5 | Total Hardness | 180-230 | 135-145 | 155-190 |
| 6 | Alkanity | 75-105 | 60-115 | 55-85 |
| 7 | Chloride | 35-45 | 9-15 | 28-35 |
| 8 | Dissolved oxygen | 4-5 | 4.4-6.8 | 3.8-4.2 |
| 9 | Free $CO_2$ | 7.6-8.5 | 6.5-7.8 | 6.9-7.7 |
| 10 | Nitrate | 0.75-0.90 | 0.46-0.68 | 1.07.1.15 |

### 3.2 Electrical conductivity

The EC value of a solution serves as a measure of its electrical conductivity. It provides the quantity of dissolved electrolytes present and acts as a criterion for both dissolved and dissociated substances. For drinking water, 300 micromhos/cm of EC is acceptable [8]. Maximum EC were recorded at site P1, and minimal EC were noted at site S2. The sample sites P1 and A3, which are overflowing with household sewage and wastewater from several homes, had the highest levels of conductance in the pond water in the current research.

### 3.3 Calcium

The water is naturally composed of calcium.It is a white, silvery metal that is much softer than sodium metal yet much harder. Alkaline earth metals, of which calcium is a part, react violently with water. More or less all calcium compounds are water soluble. Coral reefs contain calcium as well. The average calcium content in rivers is 1-2 ppm, however in locations with abundant lime, this concentration can reach 100 ppm. The hardness of the water might be caused by calcium in the water.

### 3.4 Phosphate

Orthophosphate, metaphosphate (sometimes referred to as polyphosphate), and phosphate that is bound to an organic material are the three different forms of phosphate. Phosphorus is present in many different compounds' chemical formulae.Unless it is present in extremely high concentrations, phosphorus does not pose a harm to either humans or animals.Extremely high phosphorus levels may cause digestive issues.Phosphorus enters streams from a variety of sources, including animal and human waste, fertiliser runoff, bedrock that contains phosphorus, laundry and cleaning supplies, and industrial effluents.These phosphates exacerbate eutrophication when they are utilised extensively to feed aquatic plants.The natural ageing of a body of water, such as a lake or pond, is referred to as eutrophication.The increasing nutrient levels in the water body, which in turn encourage plant development, cause this

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process.The rate at which plants degrade can be accelerated. The pond or lake's bed fills up and gets shallower as silt enters the water and this dead plant matter builds up.Often, this process takes tens of thousands of years. Throughout the course of the examination, phosphotes were found at concentrations of 0.2 to 0.4 mg/l at P1, 0.34 to 0.67 mg/l at S2, and 0.41 to 0.75 mg/l at A3, respectively.The highest concentration of phosphate ever found at site A3. Contributing variables may include local washermen's washing of clothing, sewage discharges from homes, and street runoff (Dhobi).

### 3.5 Total Hardness

The amount of dissolved salts in the water determines the overall hardness in large part. Since readings above 180 mg/l are regarded to be very hard, river water might be categorised in this way. Additionally, deposits created by hard water choke pipes. The main components of these deposits, known as "scale," are calcium carbonate (CaCO3), magnesium hydroxide Mg(OH), and calcium sulphate (CaSO4).The formation/dissolution of calcium carbonate scales is described by the following equilibrium reaction:

$$CaCO_3 + CO_2 + H_2O \leftrightharpoons Ca^{2+} + 2HCO_3^-$$

Everywhere there is a problem with hard water, water softening is frequently employed to lessen any negative impacts.At P1, 130 to 145 mg/l at S2, and 160 to 198 mg/l at A3, overall hardness was observed to vary between 186 and 231 mg/l in the current investigation.The pond's constant consumption of massive amounts of sewage and soap from the neighbouring slum neighbourhoods is likely what causes the high hardness readings.

### 3.6 Alkalinity

Alkalinity imparts a sour and bitter flavor to water bodies. The internal organs of our bodies and the blood energy transfer systems benefit from high alkalinity. While a high acidity environment will promote the development of sickness within the body.Alkalinity values at P1, S2, and A3 in the current investigation varied from 70 to 110 mg/l, 65 to 120 mg/l, and 50 to 90 mg/l, respectively.The presence of carbonate in the water samples helps to explain the pond's intermediate range of alkalinity.

### 3.7 Chloride

One of the main anions in water is chloride (Cl), which is usually coupled with calcium, magnesium, or sodium.The chloride ion is produced when the halogen chlorine accepts an electron to transform into an anion (negatively charged ion), Cl.Chemical evidence of faecal pollution in groundwater or surface waters that is valuable and reliable, Both drinking water and sewage may include chloride, a non-reactive solute.Chloride is used by many water regulatory agencies across the world to measure the pollution levels in rivers and other sources of drinkable water. A high quantity of chloride in the blood is a sign of hyperchloremia, an electrolyte imbalance that affects human health. Chloride levels in adults should range from 97 to 107 mEq/L. In the current investigation, the sites with the highest and lowest chloride concentrations, respectively, were P1 (35–44 mg/l) and S2 (7–12 mg/l). This may be because local

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drains, local sewage, and local dumping of different waste goods are polluted, and vice versa. The chloride readings were discovered to be within acceptable limits.

### 3.8 Dissolved oxygen

For the sustaining of aquatic life, dissolved oxygen (DO) is a crucial water quality measure. Dissolved oxygen regulates the metabolic activities of communities of plants and animals and serves as a water quality indicator. Compared to other chemical characteristics, this one tells us more about the general health of water bodies. The oxygen that is dissolved in the water is essential for aquatic flora and wildlife.The majority of ponds, lakes, and streams constantly refill the water's oxygen content with oxygen from the air. When this happens, organisms deplete the dissolved oxygen in the water more quickly than it can be replenished by air. The creatures will suffocate if the oxygen is completely depleted. The present investigation's DO ranges are 4.0 to 5.0 mg/l at site P1, 4.4 to 6.7 mg/l at site S2, and 3.7 to 4.2 mg/l at site A3. According to reports, the amount of DO in the pond varies according to the surrounding temperature and water body depth. The lack of much turbulence in the water samples at site A3 may be responsible for the decline in DO.

### 3.9 Free $CO_2$

The carbon dioxide that almost all natural waters contain is obtained in a variety of ways. Carbon dioxide gas makes up 0.03 percent of the volume and 0.05 percent of the weight of the air. Some of this gas is absorbed by rain as it falls through the air. Additionally, carbon dioxide is a byproduct of combustion, released by geysers, hot springs, and volcanoes, as well as released by the breakdown of carbonate minerals. Free CO2 levels in the current research range from 6.8 to 7.4 mg/l at site A3, 6.2 to 7.7 mg/l at site S2, and 7.5 to 8.4 mg/l at site P1.In ponds, the amount of free CO2 varies depending on the depth, water temperature, and local rock composition.

### 3.10 Nitrate

A naturally occurring nitrogen and oxygen molecule called nitrate may be found in many of the foods we eat.Nitrate levels in the groundwater have been found to be low. Drinking water often only accounts for a small portion of our total nitrate intake.Newborns are at danger for health issues because excessive nitrate levels in drinking water can induce methemoglobinemia, sometimes referred to as "blue baby syndrome." The Safe Drinking Water Act mandates that the U.S. Environmental Protection Agency utilise 10 mg/L of nitrogen as a nationwide standard for public sources.The nitrate concentration of the pond was found to be fairly low according to the Safe Drinking Water Act.Local runoff or seepage from corporate, residential, and governmental operations and plant waste determine the

levels in pond water were at their peak in the winter and at their lowest in the summer.The high nitrate level might be the result of nitrogen-rich effluent or sewage infiltrating the pond water.

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## 4. CONCLUSION

The following conclusions were reached after examining the surface water samples collected from the selected sampling locations in Patna Town:According to the analysis, the chosen ponds in Patna include sizable volumes of home sewage, food items, street runoff, municipal garbage dumps, and night soil, some of which are poisonous and detrimental to people as well as aquatic plants and other living things.The overall hardness levels frequently exceeded the necessary threshold even in water samples taken from the A3 site.This outcome demonstrates the significant pollution load that the neighborhood's selected pond in Patna gets.The analytical findings show that pond water is inappropriate for home use and human consumption and that it can cause a number of waterborne illnesses, including botulism, jaundice, hepatitis A, dysentery, typhoid, cholera, and diarrhoea.The most frequent ways that individuals pollute the water are via bathing, washing, drinking, cooking, or eating contaminated food.It is essential to protect these ponds from the steadily increasing human demand in order to prevent the disruption of aquatic life.

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