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Study on the Spectral Response of Phosphates Nitrates and Suspended Sediments in Water

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Abstract: ***Phosphorus occurs naturally in rocks and other mineral deposits. During the natural process of weathering, the rocks gradually release the phosphorus as phosphate ions which are soluble in water. Nitrate is used mainly in inorganic fertilizers. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks.These solids include anything drifting or floating in the water, from sediment, silt and sand to plankton and algae. Total suspended solids are a significant factor in observing water clarity. The more solids present in the water, the less clear the water will be.The present research is to study the reflectance pattern of phosphate, nitrate and suspended sediments in visible region. Phosphate and nitrate samples of different concentrations are created and tested under laboratory conditions using handheld spectroradiometer.***

Keywords: phosphates, nitrates, suspended sediments, spectroradiometer, reflectance pattern

1. Introduction

Phosphorus occurs naturally in rocks and other mineral deposits. During the natural process of weathering, the rocks gradually release the phosphorus as phosphate ions which are soluble in water and the mineralize phosphate compounds breakdown.

Phosphates PO_{4-3} are formed from this element. Phosphates exist in three forms: orthophosphate, metaphosphate (or polyphosphate) and organically bound phosphate each compound contains phosphorous in a different chemical arrangement. These forms of phosphate occur in living and decaying plant and animal remains, as free ions or weakly chemically bounded in aqueous systems, chemically bonded to sediments and soils, or as mineralized compounds in soil, rocks, and sediments.

Phosphorus is one of the key elements necessary for the growth of plants and animals and in lake ecosystems it tends to be the growth-limiting nutrient. The presence of phosphorus is often scarce in the well-oxygenated lake waters and importantly, the low levels of phosphorus limit the production of freshwater systems. Phosphate is retained in the soil by a complex system of biological uptake, absorption, and mineralization. Phosphates are not toxic to people or animals unless they are present in very high levels. Digestive problems could occur from extremely high levels of phosphate.

Nitrate and nitrite are naturally occurring ions that are part of the nitrogen cycle. The nitrate ion (NO_3^-) is the stable form of combined nitrogen for oxygenated systems. Although chemically unreactive, it can be reduced by microbial action. The nitrite ion (NO_2^-) contains nitrogen in a relatively unstable oxidation state. Chemical and biological processes can further reduce nitrite to various compounds or oxidize it to nitrate

Nitrate is used mainly in inorganic fertilizers. It is also used as an oxidizing agent and in the production of explosives, and purified potassium nitrate is used for glass making. Sodium nitrite is used as a food preservative, especially in cured meats. Nitrate is sometimes also added to food to serve as a reservoir for nitrite. Nitrates occur naturally in plants, for which it is a key nutrient. Nitrate and nitrite are also formed endogenously in mammals, including humans. Nitrate is secreted in saliva and then converted to nitrite by oral microflora. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks.

The nitrate concentration in surface water is normally low (0–18 mg/l) but can reach high levels as a result of agricultural runoff, refuse dump runoff or contamination with human or animal wastes.The toxicity of nitrate to humans is mainly attributable to its reduction to nitrite. The major biological effect of nitrite in humans is its involvement in the oxidation of normal Hb to metHb, which is unable to transport oxygen to the tissues.

Total suspended solids (TSS) are particles that are larger than 2 microns found in the water column. Anything smaller than 2 microns is considered a dissolved solid. Most suspended solids are made up of inorganic materials, though bacteria and algae can also contribute to the total solids concentration.

These solids include anything drifting or floating in the water, from sediment, silt and sand to plankton and algae. Organic particles from decomposing materials can also contribute to the TSS concentration. Total suspended solids are a significant factor in observing water clarity. The more solids present in the water, the less clear the water will be.

Turbidity is an optical determination of water clarity. Turbid water will appear cloudy, murky, or otherwise colored, affecting the physical look of the water. Suspended solids and dissolved colored material reduce water clarity by creating an opaque, hazy or muddy appearance. Turbidity measurements are often used as an indicator of water quality based on clarity and estimated total suspended solids in water.

2. Sample Preparation

2.1 Phosphate

Sodium di-hydrogen phosphate monohydrate ($NaH_2PO_4.H_2O$) is used for the preparation of samples. According to IS 10500-2012 the amount of phosphates that can be released into the natural water bodies is 10mg/L. So the water containing phosphate content greater than 10mg/L can be considered as polluted. Spectroradiometer analysis is to be done to study the spectral response of water containing phosphate contents 5mg/L, 10mg/L and 20mg/L.

2.2 Nitrate

Sodium nitrate ($NaNO_3$) is used for the preparation of samples. Spectroradiometer analysis is to be done to study the spectral response of water containing nitrate contents of 5mg/L, 10mg/L and 20mg/L.

2.3 Suspended Sediments

According to IS 10500-2012 and EPA drinking water standards the permissible amount of suspended sediment concentration in water is 100mg/L. Humus is used for the preparation of samples. Samples with suspended sediment concentration 80mg/L, 90mg/L, 100mg/L, and 110mg/L can be prepared. Humus is mixed with water and allowed the settleable particles to settle down. The remaining water is collected and dried to get the suspended particles.

3. Results

3.1 Phosphates

The reflectance pattern of phosphate is shown in figure 8.1

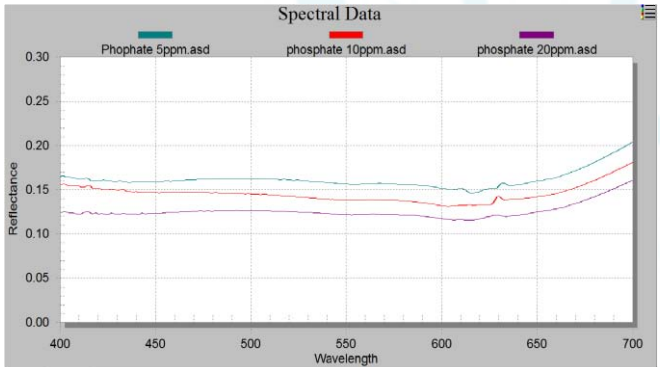

Figure 1: Reflectance pattern of Phosphate

The graph shows the reflectance pattern of phosphate in visible region of electromagnetic spectrum (400nm-700nm). The reflectance values decreases with increase in concentration of phosphates.

3.2 Nitrates

The reflectance pattern of Nitrate is shown in figure 2

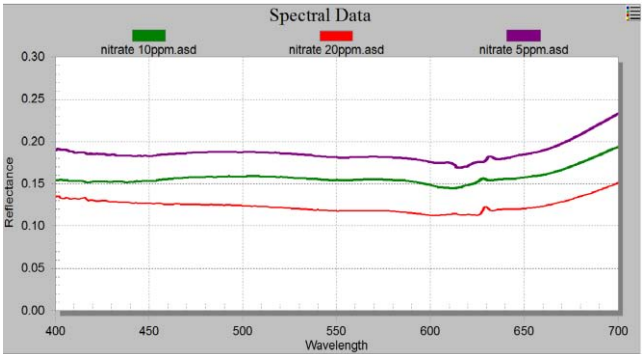

Figure 2: Reflectance pattern of nitrate

The graph shows the reflectance pattern of nitrate in different concentrations. The graph shows the reflectance pattern of nitrate in visible region of electromagnetic spectrum (400nm-700nm). The reflectance values decreases with increase in concentration of nitrate.

3.3 Suspended Sediments

The reflectance pattern is shown in figure 3

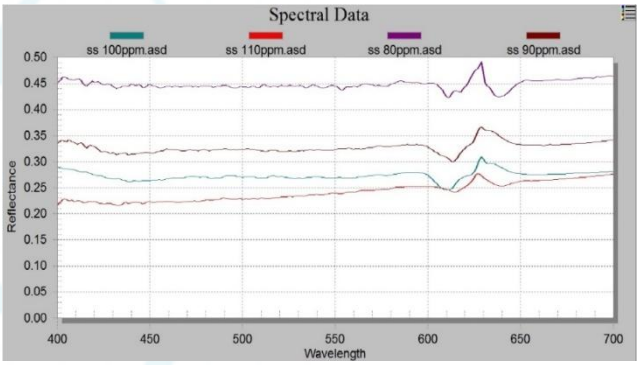

Figure 3: Reflectance pattern of Suspended sediments

From the graph it is evident that the reflectance value dereases as the concentration of suspended sediments increases. There is a peak in the reflectance pattern in the red region between 600nm and 650nm.

4. Discussions

The reflectance patterns for phosphates and nitrates were collected and studied and the results obtained are as follows:

- The phosphates and nitrates have similar reflectance pattern. The pattern is close to a straight line. Therefore, the phosphate and nitrate solutions, as they are true solutions, don't have a spectral signature of their own, ie, they are not optical water quality parameter.
- In the reflectance pattern of suspended sediments there is a peak in red region (between 600nm and 650nm). The peak is because suspended sediments relflects that wavelength morethan anyother wavelength. This gives red colour to the water having suspended sediments of humas. Thus suspended sediments have a signature reflectance poattern and therefore it is optical water quality parameter.
- For phosphates, nitrates and suspended sediments, as the concentration of parameter increases the reflectance value decreases. This is because of the the increased amount of

molecules absorbs more amount of electromagnetic energy thus decreasing the reflectance value.

5. Conclusion

Water quality is a general descriptor of water properties in terms of physical, chemical, thermal, and/or biological characteristics. For the estimation of waterquality parameters sepectroradiometer can be used. The reflectance values can be directly measured from the spectroradiometer more accurately thn satellite data. The data obtained can be used to develop a mathematical relationship between parameter and spectral reflectance. This model can be used for obting the concentration of a parameter at any point where reflectance values are known.

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