

Review

A Review of Recent Developments in Analytical Methods for Determination of Phosphorus from Environmental Samples

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Abstract: Phosphorus is essential to environmental systems because it affects both agricultural productivity and ecological balance. Since it contributes to eutrophication and pollution problems, its existence in a variety of environmental matrices, including soil, water, and air, necessitates precise and effective determination methods for monitoring and managing its levels. This review paper provides an extensive overview of the latest advancements in analytical techniques for measuring phosphorus in environmental samples. We investigate sophisticated spectroscopic, chromatographic, and electrochemical techniques in addition to conventional approaches like colorimetric analysis. Innovative techniques such as mass spectrometry (MS), X-ray fluorescence (XRF) spectrometry, and nuclear magnetic resonance (NMR) spectroscopy are also highlighted in this study, along with newly developed technologies such as biosensors, lab-on-a-chip devices, and nanotechnology-based techniques. Real-time and field-deployable monitoring technologies are also covered, with a focus on their advantages and usefulness. Among the techniques reviewed, XRF and colorimetry methods have proven to be the most reliable due to their precision, cost-effectiveness, and adaptability for different sample matrices. While emerging spectroscopic and electrochemical techniques offer promising alternatives, further validation and standardization are needed for routine environmental monitoring. Future research should focus on integrating automated and high-throughput techniques to enhance monitoring capabilities further.

Keywords: phosphorus; eutrophication; spectrophotometry; environmental samples; colorimetric methods



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1. Introduction

Phosphorus is an essential nutrient for both plant and animal life and is involved in several biological processes [1,2]. On the other hand, an abundance of phosphorus in the environment, mainly from wastewater effluents, industrial discharges, and agricultural runoff can cause serious ecological problems, including eutrophication in aquatic systems [2]. Although phosphorus is a necessary ingredient for biological systems, excessive phosphorus accumulation in environmental matrices, such as soil, water, and air, causes serious ecological risks [3]. Excess phosphorus causes eutrophication in aquatic systems, which results in algal blooms that reduce oxygen levels and disturb aquatic life. While phosphorus-containing aerosols contribute to particulate pollution in the atmosphere, phosphorus accumulation in soil can change microbial activity and decrease nutritional

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web jul 23 2018 introducing adverbs of frequency can help give them further expressive capabilities by allowing them to speak about how often they perform daily tasks write these adverbs of frequency on the board next to a list of the days of the week for example always monday tuesday wednesday thursday friday saturday sunday