Application Note AN-PAN-1039

Determination of ortho- and total phosphate phosphorus in water

Online analysis according to EN ISO 6878

Phosphorus removal is essential in wastewater treatment plants to ensure the environmental balance is not upset by discharged effluent. In the treatment facility, it is important to know the bioavailable orthophosphate phosphorus (o-PO_4-P) concentration in the influent stream either to feed bacteria or to calculate the amount of reagents needed for chemical treatment.

For environmental compliance monitoring purposes, treated effluent is monitored for total phosphate phosphorus (TP), i.e. the sum of all insoluble and dissolved phosphates present.

This Process Application Note describes the benefits and uses of the Metrohm 2035 TP Analyzer to monitor both o-PO_4-P and TP according to EN ISO 6878 (formerly DIN 38405-D11) around the clock.

INTRODUCTION

The abundance of phosphorus compounds in wastewater is problematic. Elemental phosphorus is highly reactive and thus binds easily to oxygen, forming phosphates (orthophosphates o-PO_4, polyphosphates, and organic phosphates). Phosphates in water sources can come from minerals, detergents, agricultural (fertilizer) runoff, and other anthropogenic influents. Environmental agencies have strict regulations regarding industrial phosphate emissions. Total phosphate phosphorus (TP) is a plant nutrient, which in high concentrations in surface waters can lead to eutrophication (overfertilization). For biological sewage and wastewater treatment, the bioavailable o-phosphate phosphorus (o-PO_4-P) is necessary for the bacteria to live, but this can be detrimental to rivers and lakes. An increase in these nutrients fosters growth which depletes dissolved oxygen and kills fish, or even introduces harmful toxins (algal blooms). Phosphorus removal is therefore essential in wastewater treatment plants to ensure the environmental balance is not harmed by discharged effluent (Figure 1).

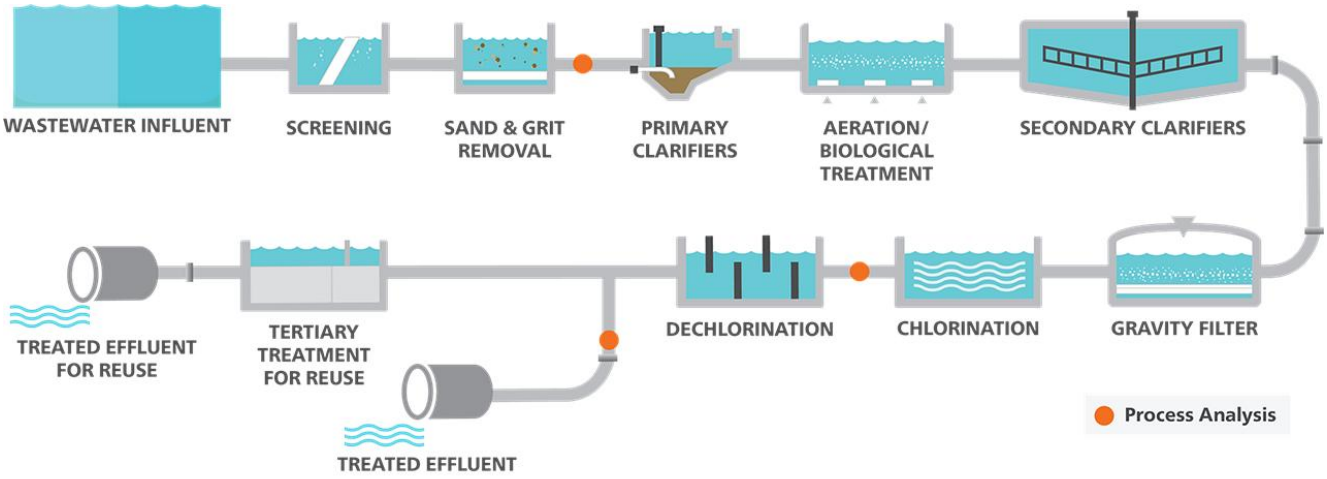

Figure 1. Process analyzer locations in the wastewater treatment process for phosphorus.

Most phosphorus in treated wastewater is bound into other filterable forms and removed as precipitated sludge. Chemical treatment with Ca, Al, and/or Fe for coagulation can be costly and slow, allowing biological treatment to rise in popularity over the last decade. In the treatment facility it is important to know the o-PO_4-P concentration in the influent stream either to feed the bacteria or to calculate the amount of reagents needed for chemical treatment. For environmental compliance monitoring purposes, treated effluent is monitored for TP—the sum of all insoluble and dissolved phosphates present. TP is not useful for identifying the origin of the phosphorus within a process, only for overall monitoring and wastewater compliance purposes.

The 2035 TP Analyzer from Metrohm Process

Analytics (Figure 2) can keep track of both o-PO_4-P and TP around the clock. With direct colorimetric applications, only o-PO4-P is measured in a sample. TP can be determined by digesting the sample with heat, an oxidizing agent, and acid before performing the photometric measurement on the freed o-PO_4-P. To monitor both o-PO_4-P and TP according to EN ISO 6878, a compact digestion cuvette photometer module is used. Multiple sample streams can be connected to the 2035 TP Analyzer, allowing complete control over the phosphorus treatment process. The analyzer can send alarms for peak concentrations, saving bacteria, or notifications if regulation limits are exceeded.

APPLICATION

The colorimetric determination of o-PO_4-P and TP is based on EN ISO 6878 (formerly DIN 38405-D11) using a compact digestion cuvette photometer module. Organic and inorganic phosphate compounds are oxidized, then ammonium molybdate and potassium antimonyl tartrate are added to form phosphomolybdic acid. The ascorbic acid reduction forms molybdenum blue which is measured at 875 nm.

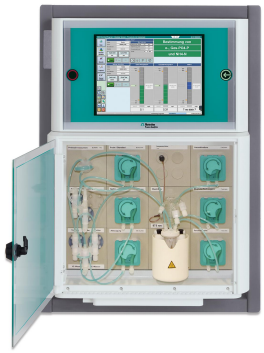

Figure 2. The 2035 TP Process Analyzer from Metrohm Process Analytics.

Table 1. Parameters for TP monitoring

TP category	Range	Detection limit
Low TP	0–150 µg/L PO_4-P	5 µg/L
Standard TP	0–5 mg/L PO_4-P	50 µg/L
High TP	0–100 mg/L PO_4-P	1 mg/L

FURTHER READING

Brochure: Environmental Testing Industry I - Online Analyzers for Municipal Wastewater Analysis

Phosphor species in process water

Wastewater treatment plants: Nitrogen removal simultaneous analysis of ammonia, nitrate and nitrite

BENEFITS FOR ONLINE ANALYSIS

- **Save money by reducing downtime**: analyzer sends alarms for out-of-specification values which inform the operator sooner
- **Process data available at your fingertips 24/7** means no waiting for slow, manual laboratory methods
- **Efficient chemical treatment** by constantly monitoring the influent streams

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CONFIGURATION

2035 Process Analyzer – Photométrie

Le 2035 Process Analyzer pour mesures photométriques comprend un module de photomètre compact, stable sur une large gamme de concentrations et thermorégulé avec capacités d'agitateur. Cet appareil d'analyse est proposé avec deux options : un système avec cuve ou une sonde d'immersion à fibre optique. Le système avec cuve est compact afin de réduire la consommation en réactifs tout en offrant un trajet optique de grande longueur afin d'obtenir une haute sensibilité. La sonde d'immersion à fibre optique élargit de manière substantielle notre gamme d'applications en simplifiant les prises de mesure précises d'échantillons à haute concentration par l'utilisation d'étapes internes de dilution des échantillons ainsi qu'un trajet optique plus court que le système avec cuve.

L'analyse photométrique est une technique commune largement appliquée, capable de déterminer des ions tels que l'ammoniac, le manganèse et le fer dans l'eau potable, voire meme le calcium et le magnésium dans des saumures. Les effets indésirables des matrices d'échantillons comme la couleur d'un échantillon ou sa turbidité peuvent etre éliminés par des mesures différentielles réalisées avant et après l'addition d'un réactif de coloration.