

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).

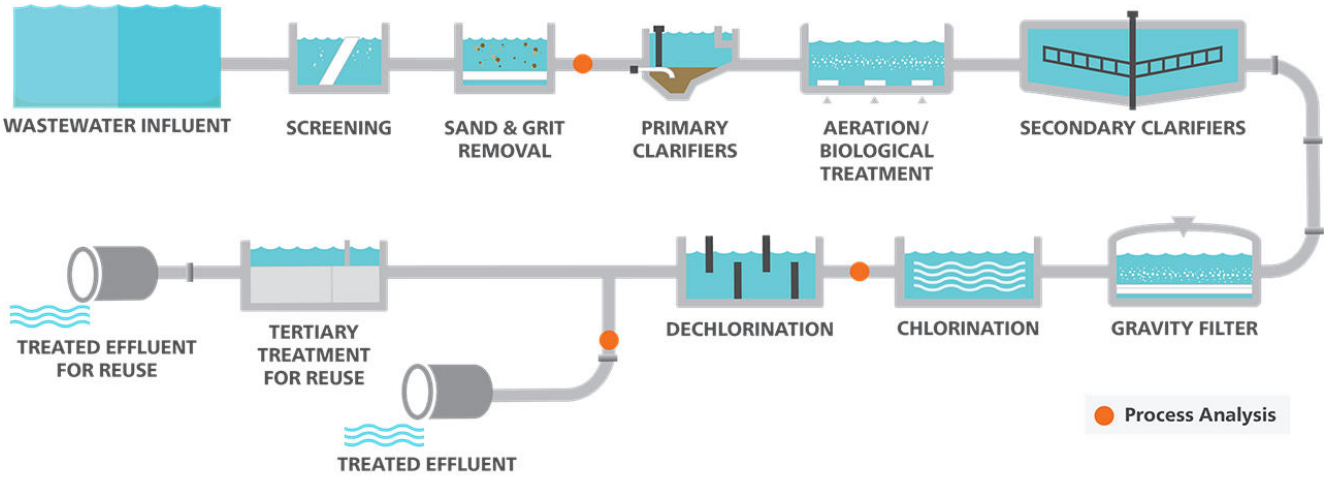

Figure 1. Process analyzer locations in the wastewater treatment process for phosphorus.

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.

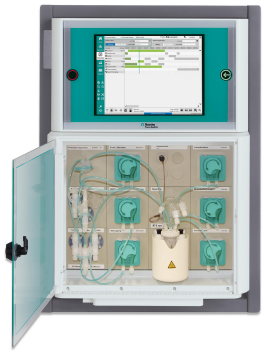

Figure 2. The 2035 TP Process Analyzer from Metrohm Process Analytics.

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 - Photometric

The 2035 Process Analyzer for Photometric Measurements includes a compact photometer module which is stable over a large concentration range, and is thermostated with stirrer capabilities. This analyzer is offered with two options: a cuvette system or a fiber optic dipping probe. The cuvette system is compact in order to reduce reagent consumption, yet it offers a long optical path length for high sensitivity. The fiber optic immersion probe broadens our application range substantially by making the accurate measurement of high concentration samples simpler through the use of internal sample dilution steps and a smaller light path than the cuvette system.

Photometric analysis is a common, widely-used technique which can determine ions such as ammonia, manganese, and iron in drinking water or even calcium and magnesium in brine solutions. Undesired sample matrix effects such as sample color or turbidity can be removed with differential measurements, taken before and after the addition of a color reagent.