



## Phosphate

### Phosphate Measurements

Phosphorus compounds – in particular ortho-phosphate  $\text{PO}_4^{3-}$  – are considered to be the limiting nutrients in most stagnant and flowing waters. An increase in their concentration caused by higher input (wastewater, avulsion etc.) results directly in increasing eutrophication of the water with known effects such as increased growth of algae, oxygen depletion as far as anoxia in the deeper regions, etc.

#### Measuring Methods

##### Molybdenum blue method

In an acidic medium, ortho-phosphates bond with ammonium molybdate to form molybdenic phosphoric acid. With the aid of a reducing agent this forms phosphorus molybdenum blue compound. Photometrical measurement of dye intensity can be performed at 880 nm.

##### Vanadate/molybdate method (yellow method)

In acids, ortho-phosphate ions react with ammonium molybdate and ammonium vanadate to form yellow ammonium phosphoric vanadomolybdate. This can be photometrically analyzed at 380 nm.

#### Phosphorus Compounds in Water

Phosphorus occurs in 3 compounds in natural waters:

- inorganic, dissolved ortho-phosphate
- dissolved organic phosphorus compounds
- particulate phosphorus (bound in biomass or attached to particles),

which add up to the total of phosphorus content  $P_{\text{Total}}$ , an important parameter in monitoring wastewater treatment plant effluents.

### Measuring Methods and Digestion

There are two methods available for determining phosphate or phosphorus concentrations:

- Molybdenum blue method
- Vanadate/molybdate method (yellow method)

Both techniques are based on the measurement of ortho-phosphate. Digestion of both dissolved organic as well as particulate phosphorus compounds is therefore mandatory for determining the total P content. In addition, an unfiltered sample must be acquired in order to include all solid matters in the digestion process.

Digestion is usually performed by heating the sample with peroxodisulfate and sulfuric acid.

### Elimination of Phosphates in Wastewater

To meet the required limits of P concentration in the effluent, the modern wastewater treatment facility has two methods available:

- Biological elimination of phosphates "Bio-P": incorporation of phosphate in microbial biomass (usually in combination with a preliminary anaerobic stage to stimulate luxury consumption of phosphate and intracellular storage as polyphosphate)
- Chemical-physical elimination of phosphates: Chemical precipitation of ortho-phosphates using metallic salts (usually  $Fe^{3+}$  or  $Al^{3+}$ ). The use of ortho-phosphate analyzers for effective control and regulation of precipitations results in considerable savings.

### Regulation according to P Concentration

With a continuous monitor  $PO_4$  analyzer, the operator of water treatment plants can realize significant cost savings.

*(cf. Application Report PO4 1609 2003 01e)*



## TresCon® OP 210

- Yellow method
- Continuous background compensation
- Continuous/Discontinuous operation selectable

### On-line orthophosphate measurement

- Control or feedback control of chemical phosphate precipitation, e.g. precipitating agent addition with simultaneous precipitation
- Monitoring biological phosphate elimination
- Measuring the phosphate pollution in natural waters
- Monitoring the phosphate concentration in the drinking water



### Measuring Principle

The PO<sub>4</sub> module uses the vanadate/molybdate method (yellow method) for determining the orthophosphate content. A reagent reacts with phosphate in the sample to color the sample solution yellow. The intensity of this color is recorded photometrically and evaluated as a measure of the phosphate content.

### Technical Data OP 210


<b>Measuring Ranges</b>	PO <sub>4</sub> -P	PO <sub>4</sub>
Measuring range 1:	0.05 - 3.00 mg/l; 1.5 - 100 µmol/l	0.15 - 9.00 mg/l; 1.5 - 100 µmol/l
Measuring range 2:	0.1 - 10.0 mg/l; 3 - 320 µmol/l	0.3 - 30.0 mg/l; 3 - 320 µmol/l
Measuring range 3:	0.1 - 25.0 mg/l; 3 - 800 µmol/l	0.3 - 80.0 mg/l; 3 - 800 µmol/l
<b>Resolution (Display)</b>	Measuring range 1: 0.01 mg/l or µmol/l	
	Measuring range 2: 0.1 mg/l or µmol/l	
	Measuring range 3: 0.1 mg/l or µmol/l	
<b>Accuracy</b>	±2% of the measured value ±0.01 mg/l PO <sub>4</sub> -P (Measuring range 1) ±2% of the measured value ±0.1 mg/l PO <sub>4</sub> -P (Measuring range 2 and 3)	
<b>Coefficient of Variation for Method</b>	2% (for all measuring ranges)	
<b>Response Time</b>	<4 min to measured value (after alteration in concentration at module input)	
<b>Measuring Interval</b>	Quasi-continuous measurement, 5, 10, 15, 20, 25 or 30 min settings	
<b>Calibration</b>	Automatic 2-point calibration (time and interval selectable)	
<b>Background Correction</b>	Continuous background compensation based on new WTW algorithm	
<b>Sample Input</b>	Approx. 0.06 l/h, solid content < 50 mg/l (e.g. sewage treatment plant effluent)	
<b>Consumption</b>	Reagent, 10 l: 60/155/310/465 days with cont./10/20/30 min measuring intervals Standard B 1.5 l: 90 days with 24 h calibration interval Cleaning solution, 1.5 l: 45 days with 24 h cleaning interval	
<b>Maintenance Interval</b>	Every 6 months	
<b>Guaranty</b>	2 years for defects of quality	

### Ordering Information

Separate TresCon® analyzer module for Orthophosphate for extension of an existing TresCon® system (requires 1 measuring place)		<b>Order. No.</b>
OP 210/ MB 1	Module for Orthophosphate: Measuring range 1	820 004
OP 210/ MB 2	Module for Orthophosphate: Measuring range 2	820 005
OP 210/ MB 3	Module for Orthophosphate: Measuring range 3	820 006
TresCon®-basic instrument with analysis module OP 210 for ortho-phosphate (wall mounting, space for 2 further modules)		<b>Order. No.</b>
TresCon® P 211/MB1	Orthophosphate, Measuring range 1	8A-40030
TresCon® P 211/MB2	Orthophosphate, Measuring range 2	8A-50030
TresCon® P 211/MB3	Orthophosphate, Measuring range 3	8A-60030
TresCon® Uno single parameter system ortho-phosphate with analysis module OP 210		<b>Order. No.</b>
TCU/P211-MB1	TresCon® Uno for Orthophosphate: Measuring range 1	820 104
TCU/P211-MB2	TresCon® Uno for Orthophosphate: Measuring range 2	820 105
TCU/P211-MB3	TresCon® Uno for Orthophosphate: Measuring range 3	820 106



Accessories and Consumables see brochure "Product Details"

 **TresCon® OP 510**

- 2-point calibration – high degree of accuracy
- Automatic Monitoring
- “Blue” method



**On-line P<sub>Total</sub> measurement**

- Monitoring the effluent from wastewater treatment plant for P<sub>Total</sub>
- Monitoring phosphorus pollution in natural waters

**Measuring Principle**

The P<sub>Total</sub> module consists of two units: in the first unit (digestion unit) the sample undergoes a chemical-thermal digestion; in the second unit the total phosphorus content is determined.

During the digestion all the phosphorus compounds contained in the sample are converted to orthophosphate; this can be determined photometrically. The phosphorus compounds are oxidized by peroxodisulfate under acidic conditions.

This process is accelerated by overpressure and an increased temperature so that very short digestion times are achieved.

The subsequent analysis is by the molybdenum blue method. The sample is mixed with a molybdate reagent which reacts with phosphate via an intermediate chemical step to form a blue coloration. The intensity of this coloration is a measure of the original concentration of the phosphate ions. It is measured photometrically and evaluated.

Technical Data OP 510	
Measuring Ranges	P <sub>Total</sub> : 0.01 ... 3.00/6.00*; 0.3 ... 100/200*
Resolution (Display)	Range: 0.01 ... 3.00 mg/l : 0.01 mg/l 0.30 ... 100 µmol/l : 0.1 µmol/l
Accuracy	±3% of the measured value ±0.05 mg/l P <sub>Total</sub>
Measuring Principle	Photometric reference beam method after digestion
Measuring Method	Molybdenum blue methode
Coefficient of Variation for Method	1.5%
Measuring Interval	10, 15, 20, 25, 30 or 60 min can be set (DIN EN measurement with 30 min digestion at approx. 248 °F/120 °C)
Calibration	Fully automatic 2-point calibration
Consumption	Reagents A, B, C, D: 10/15/20/30/60 days with 10/15/20/30/60 min measuring intervals Standard, 1.5 l: 70 days with 24 h calibration interval Cleaning solution, 1.5 l: 60 days with 24 h cleaning interval
Maintenance Interval	Every 3 months
Guaranty	2 years for defects of quality

Ordering Information		Order. No.
OP 510	Separate TresCon® analyzer module for total phosphorus for extension of an existing TresCon® system (requires 2 TresCon® measuring places)	820 011
TresCon® P 511	TresCon®-basic instrument with analysis module OP 510 for total phosphorus (wall mounting, space for 1 further module)	8A-8X030



*Accessories and Consumables see brochure “Product Details”  
Homogenizer available on demand (see brochure “Product Details”)  
\* by continuous sample dilution in a 1:1 ratio*

Parameter section

Dissolved Oxygen

pH/ORP

Conductivity

Turbidity/Suspended Solids

Nitrogen

Phosphate

Carbon: COD/TOC/DOC/BOD/SAC