

Nutrient Management with WTW Alyza IQ

“Why is Nutrient Removal essential for WWTP?”

Introduction

From the early stages, wastewater treatment plants (WWTP) were developed for removal of organic matter (Tchobanoglous, G. et al, 2002), However starting in mid-20th century, eutrophication became apparent in lakes and rivers (Rodhe, W., 1969), this resulted from the discharge of phosphorus and nitrogen created during the advanced treatment developed in WWTP.

Eutrophication, comes from the Greek word eutrophos, meaning “well-nourished”, and is caused by excessive concentrations of nutrients, most notably Phosphorus (P) and nitrogen (N) (Rodhe, W., 1969), resulting in algal blooms dissolved oxygen depletion, and aquatic organisms’ fatality. Moreover, through food chains accumulation, human health is often harmfully affected by the toxic substances’ release during eutrophication (Fewtrell, L., 2004). As shown in Fig. 1 shown, algal blooms in South Korea serious affects the Nakdong and the Han Rivers, which supply water to more than 10 million people (Park, S.B., 2012).



Fig. 1, An algal bloom spreads across South Korea’s Nakdong River (Park, S.B., 2012).

Therefore, effective removal of phosphate and ammonium before wastewater discharge has long been a crucial step. To avoid eutrophication, most countries implement effluent standards for discharge of P and N. Effluent limits for P and N for various countries are listed in the following table.

Table 1: WWTP Effluent Discharge Limits for P & N in Various Countries

Country	T-P (mg/L)	T-N (mg/L)
US	0.07	1.5~3
EU	1~2	10~15
China	0.5~3	15~20
Australia	2	10~20
South Korea	0.2~0.5	20
Japan	8/per day	60/per day
India	5	100
Singapore	2~5 (PO ₄)	20 (NO ₃)
Vietnam	4~10	15~50

*The above data is summarized from internet sources.

WWTPs play a crucial role in safeguarding the environment by removing pollutants such as P and N from wastewater streams. The following figure is a stimulus P and N removal process.

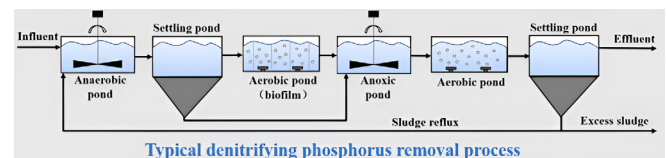


Fig 2, Stimulus Phosphorus and Nitrogen removal process (Dai, HL et al 2022)

Main Technologies on P & N Removal

Several methods and technologies are employed in WWTPs for P and N removal, including biological, chemical, and physical processes.

Biological Processes: Biological nutrient removal (BNR) processes, such as enhanced biological phosphorus removal (EBPR) and nitrification-denitrification, utilize microbial communities to metabolize phosphates and convert nitrogen compounds into harmless gases. EBPR relies on phosphorus-accumulating organisms (PAOs) to release phosphates under anaerobic conditions, followed by over-uptake phosphate in aerobic conditions for removal.

Nitrification involves the oxidation of ammonium to nitrite and nitrate by nitrifying bacteria, while denitrification converts nitrate to nitrogen gas under anoxic conditions.

Chemical Processes: Chemical precipitation, such as the use of metal salts like alum or ferric chloride, facilitates phosphate removal through the formation of insoluble precipitates. Similarly, nitrogen removal can be achieved through chemical processes like ammonia stripping or ion exchange.

Physical Processes: Membrane filtration techniques, including reverse osmosis and ultrafiltration are effective in removing phosphates and nitrogen compounds by physically separating them from the wastewater stream.

Table 2: Summary of Phosphorus and Nitrogen Removal Techniques

Technique	Advantages	Disadvantages
Biological Processes	Low cost	Tricky operation
Chemical Processes	Efficient	High cost for chemicals
Physical Processes	Efficient	High cost for membrane

To efficiently remove P and N, the above 3 processes are always combined together. For example, chemical precipitation will be used in the biological process to achieve a better removal rate. However, this step will increase the operation cost of the WWTP, therefore an online analyzer to real-time monitor the P and N concentrations is very important. There are a large number of analyzers in the market and these are crucial for monitoring and controlling P and N levels in water, wastewater, and various industrial processes. However, still there are many challenges to consider:

- 1. Accuracy & Sensitivity:** Especially low levels of phosphate ions in water.
- 2. Speed & Response Time:** Rapid detection and response time are essential, particularly in applications where real-time monitoring and control are necessary to conserve dosing material costs and energy consumption
- 3. Ease of Use and Maintenance:** User-friendly interfaces and intuitive operation are essential features for ensuring that operators can easily configure, calibrate, and maintain the analyzer.

4. Cost-effectiveness: Consumable reagents are often expensive and need special care for disposal after measurements.

Unique Features of the Alyza IQ

To overcome such obstacles, Xylem Analytics under the WTW brand developed a revolutionary phosphate and ammonium analyzer, the Alyza IQ to help customers to more efficiently monitor phosphate and ammonium.



Fig 3: Alyza IQ PO₄ inner structure photo

WTW invented the MultiPort Valve technology and ChemBags to overcome these specific challenges and these innovative features are unique to the Alyza IQ.

- **High Accuracy and Sensitivity**
Accuracy is up to $\pm 2\%$ or 20 ppt.
- **High Response Speed**
Only requires up to 5 minutes for each measurement
- **Ease use and Simply service**
Requires just 10 minutes of regular maintenance every 3 months
- **Minimal Reagent Consumption**
5 μL consumed per measurement, which is less than 1 ml per day at 10 minutes intervals
- **2 Channels**
2 spots can be monitored at the same time

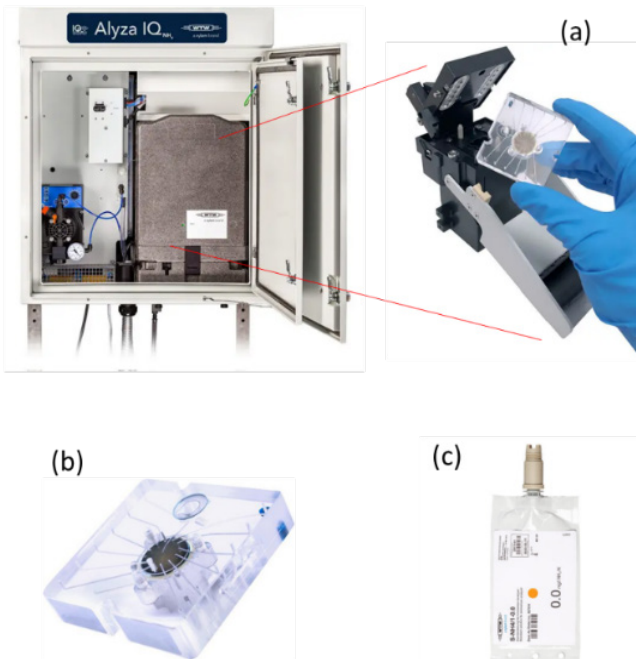


Fig 4, Alyza IQ Measuring units. (a) Measuring unit (b) MultiPort valve (c) ChemBags (reagents, standards, cleaning solution)

Successful Implementation In South Korea

Background

A number of hydraulic structures have been installed along the Yeongsan River, including an estuary dam and two weirs (Seungchon and Juksan). While these structures aid in regional water security and useful to reduce flooding, they also reduce water flow in the summer, thereby contributing to the occurrence of algal blooms. Apart from low flow-rates, high phosphate discharges are also a main reason for algal blooms. Hence strict regulation of effluent phosphate limits to 0.3 ppm by the government as compared to previous 2 ppm (Park, S.B., 2012) limits.

The Gwangju wastewater treatment plant is playing a key role for the management of phosphates discharged to the Yeongsan river, one of biggest rivers in South Korea.

The Problem

Previous generations of phosphate analyzers are unable to respond quickly, nearly one hour is required per measurement. Additionally, the operators of WWTPs would like to save costs for monitoring, a significant amount of reagents are consumed each year and waste disposal requires additional costs due to special handling.

The Solution

The Xylem WTW Alyza IQ was introduced in Gwangju WWTP and resulted in excellent performance. The phosphate concentration from the effluent is well monitored, and the reagent cost has been saved by 34%.

Table 3, Phosphate Monitoring Results by Using Alyza IQ

Project	Before Alyza IQ	After Alyza IQ
Measurement interval	1 hour	10 minutes
Reagent Usage	6 L per year	0.4 L per year
Reagent Cost	6,830,000 KRW	4,510,000 KRW

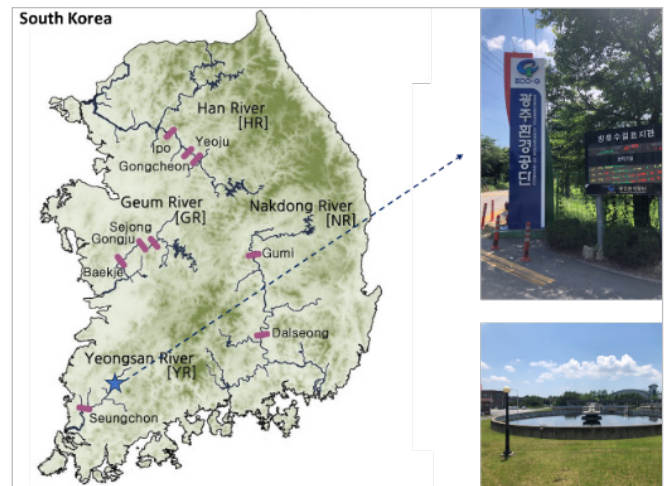


Fig. 5: Location of the Gwangju WWTP and analyzer setup



Fig. 6: The WTW Alyza IQ PO4 installed at the Gwangju WWTP

Successful Example In Watertown, USA

Background

The Watertown wastewater treatment plant has a capacity of 100,000 PE with an average flow of 12.0 M L/d. Phosphorous measurements are a critical necessity so as to meet the total Phosphorus effluent limit less than 1 mg P/L, that based on the Watertown City Rock River Total Maximum Daily Load (TMDL) allocations (Applied Technologies, 2022).

The Problem

When phosphate concentrations are higher, the operator is required to dose with a chemical precipitant (Ferric) manually based on grab samples. This is not efficient and is often inaccurate.

The Solution

The Xylem WTW IQ Sensor Net and Alyza IQ was introduced at the Watertown WWTP and implemented with an automatically dosing mechanism triggered by accurate phosphate monitoring data. Ferric dosing costs dropped from \$100K per year to \$60 per year, a 40% cost savings.



Fig. 7, A photo of Watertown WWTP

Summary

The Xylem brand WTW Alyza IQ is an efficient phosphate and ammonium analyser, which can help customers to manage P and N discharges, and importantly helps to save usage of dosing chemicals, resulting in cost savings.

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