



Application Note AN-PAN-1009

Online analysis of ammonia, nitrate, and nitrite in wastewater

Water is the source and basis of all life. As a solvent and transporting agent, it carries not only vital minerals and nutrients, but also, increasingly, harmful pollutants which accumulate in aquatic or terrestrial organisms. Because of the associated health risks, the World Health Organization (WHO) has issued guideline values for about 200 substances found in water, including nitrogen compounds such as ammonia (NH_3), nitrate (NO_3^-), and nitrite (NO_2^-). Therefore, the treatment of wastewater is a

critical topic and compliance with the legal limits is very important to help safeguard the environment from these mobile pollutants. This Process Application Note deals with online measurements of ammonia, nitrite, and nitrate in wastewater treatment plants. These nitrogen compounds are analyzed simultaneously using a drift-free colorimetric measurement in a multi-parameter process analyzer from Metrohm Process Analytics.

INTRODUCTION

The importance of nutrient removal in the form of nitrogen and phosphorus in industrial and municipal wastewater has increased significantly over the past decade to minimize water pollution and avoid eutrophication of water bodies. Nitrogen is present in wastewater as mostly organic nitrogen, ammonium/ammonia, and nitrate. This wastewater must be properly treated to meet stringent effluent requirements imposed by legislation.

Biological nutrient removal (BNR) processes are put in place at modern wastewater treatment plants (WWTP) to treat and remove the nitrogen compounds, and these involve both nitrification and denitrification process steps. Nitrification

(**Reaction 1A**) takes place in the aeration basin (**Figure 1**) where ammonium is oxidized to nitrate via nitrite using oxygen and different species of nitrifiers (bacteria). During subsequent denitrification (**Reaction 1B**), the nitrate is further converted to nitrogen gas (N_2) using specialized heterotrophic bacteria in the absence of oxygen (i.e., anoxic zone). The N_2 formed is harmlessly released into the atmosphere. It is therefore very important to measure the ammonia, nitrate, and nitrite concentrations continuously throughout both process steps to ensure complete nitrogen oxidation and subsequent nitrogen gas conversion.

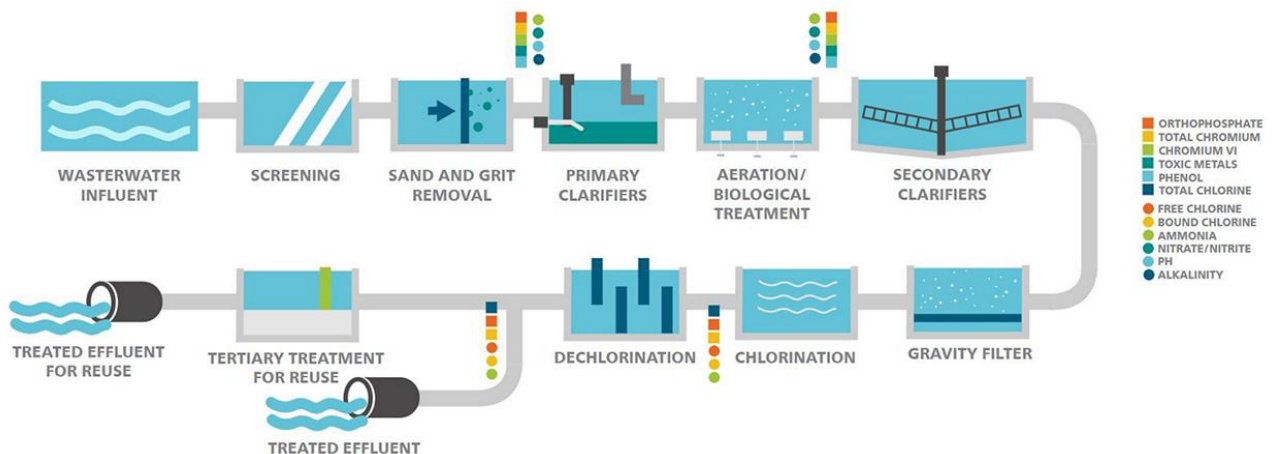
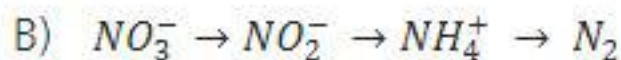
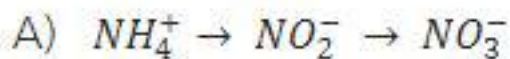


Figure 1. Illustrated diagram of process analyzer locations and measurement parameters in the wastewater treatment process.



Reaction 1. Overall reaction of biological nitrogen conversion in wastewater treatment plants. (A) Nitrification and (B) denitrification.

An increase in ammonia and nitrite levels in the effluent indicate that either an insufficient aeration step or a change in toxicity or pH is disturbing the nitrification process. On the other hand, an increase of nitrate in the effluent can indicate that the anoxic zone is not developing correctly or the Biochemical (or Biological) Oxygen Demand (BOD) food source in the effluent is lower than usual.

The ammonia and nitrate/nitrite content must be constantly monitored in wastewater effluent to ensure environmental compliance. Traditionally, these parameters can be measured by laboratory analysis. However, this methodology does not provide «real-time» results and requires constant maintenance and

human intervention to adapt to current operation conditions. Robust self-cleaning online process analyzers are the only reliable measurement solution for industrial, sewage, and municipal wastewater applications with high concentrations of solids and bacteria.

Metrohm Process Analytics offers a multi-parameter process analyzer solution for the simultaneous analysis of ammonia, nitrate, and nitrite over a wide concentration range covering all influent and effluent requirements—the **2060 TI Process Analyzer (Figure 2)**. This process analyzer can also monitor nitrogen compounds online, guaranteeing high nutrient treatment efficiency and low operating and energy costs.



Figure 2. 2060 TI Process Analyzer for wastewater treatment plants.

APPLICATION

NH_3 , NO_3^- , and NO_2^- can be analyzed simultaneously using a drift-free photometric measurement. The 2060 TI Process Analyzer is

able to measure a wide range of NO_2^- , NO_3^- , and $\text{NH}_3/\text{NH}_4^+$ concentrations, from $\mu\text{g/L}$ to mg/L (Table 1).

Table 1. WWTP measurement parameters and concentration ranges before and after treatment processes.

Parameters	Influent [mg/L]	Effluent [mg/L]
NH_3	0–6000	0–60
NO_3^-	140–1400	0–88
NO_2^-	160–320	0–16

REMARKS

Other parameters like Chemical Oxygen Demand (COD), free and total phosphate, total nitrogen, pH, heavy metals, chlorine, and more

can be measured online in wastewater streams using Metrohm process analyzers.

CONCLUSION

Ammonia, nitrite, and nitrate are important parameters to measure in wastewater treatment plants. For increased analysis frequency, the 2060 TI Process Analyzer from Metrohm Process

Analytics can prevent out-of-specification data of wastewater streams and help to guarantee compliance with governmental regulations.

RELATED APPLICATION NOTES

[AN-PAN-1039 Ortho- and total phosphate phosphorus analysis online according to EN ISO 6878](#)

[AN-PAN-1030 Monitoring of chromate in](#)

[wastewater streams](#)

[AN-PAN-1002 Free, total & WAD cyanide in gold leach slurry & wastewater](#)

OTHER RELATED DOCUMENTS

[8.000.5358 Environmental Testing Industry I - Online Analyzers for Municipal Wastewater Analysis](#)

[8.000.5359 Environmental Testing Industry II - Online Analyzers for Potable Water Processing](#)

BENEFITS FOR ONLINE PROCESS ANALYSIS

- Fully automated diagnostics – automatic alarms for when samples are out of specification parameters.
- **Guarantee compliance** with governmental regulations.
- **Avoid unnecessary costs** by measuring multiple parameters simultaneously in a process stream.



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CONFIGURATION



2060 Process Analyzer

2060 Process Analyzer 是一在湿化学分析,用于无数用。此程分析提供了一个新的模化概念,由一个称«主机»的中心平台成。

主机由部分成。上部包含触摸屏和工算机。下部含有柔性取部,其中放有用于分析的硬件。如果主取部容量不足以分析挑,那主机可以展多四个外的取部机,以保有足的空来最具挑性的用。附加机的配置方式使每个取部机可以与具有集成(非接触式)液位的合使用,以增加分析的正常行。

2060 Process Analyzer 提供不同的湿化学技:滴定法、舍滴定法、光度定、直接量和准添加入法。

足所有目要求(或足的所有需求),可提供品理系,以保分析解决方案可靠。我可以提供任何品理系,如冷却或加、和脱气、等。