

## “Wise” Control of Wastewater Systems: WDC

### Introduction

This application note introduces the innovative device WDC (Wise Device Control), for the wise control of the processes.

It is an intelligent solution that can perceive and interact with the environment. For example, WDC can control the lots for the continuous optimization of nitrogen removal processes.

It presents measurement devices with non-deterministic multi-functionality and maintenance strategies.

In this application note it will introduce the application of WDC to N-C removal process. WDC works to control the process of wastewater treatment from essential parameters on the analysis of the flow of water in a basin. Under the load of ammonium (NH<sub>4</sub>), WDC has been working for process controller Nitrification - Denitrification, and monitors the sequence of the two processes.

### Why?

Nitrogen is the nutrient for microorganisms that allow the natural purification of water, so it is an essential component in the process of biological removal.

Nitrification in the nitrogen cycle is an important process because it allows the oxidation of ammonia from the decomposition of nitrate in biological organisms. The process of nitrification has been recognized as a fundamental method in agriculture and in environmental protection (removal of ammonia by water). The nitrogen conversion processes are essential for most wastewater treatment plants.

Nitrification generally occurs by the action of autotrophic microorganisms that oxidize ammonia to nitrate. This is a strictly aerobic oxidation process carried out by nitrifying bacteria (Nitrosomonas and Nitrobacter) in the soil and water.

On the other hand, denitrification is a process of anaerobic reduction of nitrate to nitrogen gas and is carried out by heterotrophic denitrifying bacteria of genus Pseudomonas in the process of denitrification.

The leading factors for a “wise” control of a WWTP systems are:

- Actual local “And/Or” loop automation (like about DO) only;

- Lack of sustainable on-line sensors (from a technical and economical point of view);

- WWTP process complexity and relate interdisciplinary skill required;

- Low economy of small WWTPs doesn't allows large approach to process automation.

In this case the benefits/challenges are:

- Easy costumed installation, configuration and handling of Wise Process Controllers;

- More robust on-line control and Long Life Cycle technological application;

- Outflow discharges that doesn't exceed the permitted legal limit (continually);

- Minimal Staffing;

- Minimal operational costs.

### Features

A Process Control Device may be defined “WISE” (WDC<sup>®</sup> – Wise Decision Control Device) when the same:

- has a Not-Deterministic Multi-functionality;
- is Based on Software Expert Incremental Knowledge (Artificial Intelligence);
- has a Knowledge Base embedded into Low-Cost and Smart Hardware/Software Technology (f.e.: Microchip, Wireless Comm., etc.);
- allows an Evolutive/Adaptive approach toward its Knowledge Base Upgrading;
- is Compatible/Sustainable too from the “Cost/Performance” Rate point of view.

A Not-Deterministic Approach, in Process Monitoring & Control, means to compute with the embedded knowledge contents in data (by Knowledge Modeling) and not only with the numbers they self represent.

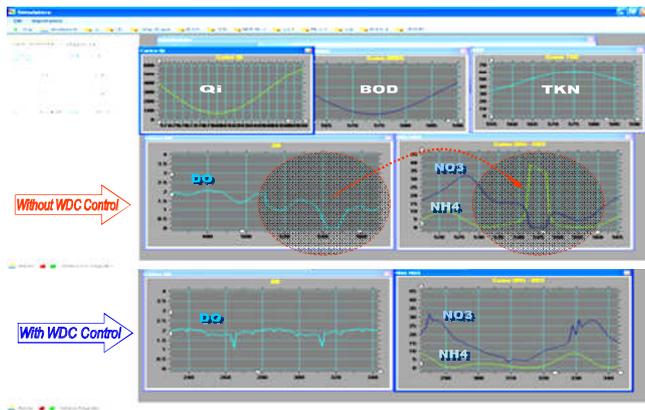
In this case, WDC is applied to N-C removal process. The control is done through online measuring of produced ammonia and nitrate, dissolved oxygen, pH and temperature.

The device consists of a knowledge base, produced by external inputs, which come into play several components that determine the neural network process. The basic data to monitoring the process are collected every 30 seconds and, through the study of them it's recognized phase sequencing of nitrification and denitrification that involves the whole process of crossing the water in the tube: the need of nitrification or denitrification is established

through information from load of ammonia in the waters respecting some constraints.

The simple architecture of the system can access its functionality via a Wi-Fi ad hoc.

You can also consult a web page to insert the range of the basic parameters for the process. It is also useful to control the compressor on the analysis of water flow in a basin. The system is equipped with a communication function which data is recorded in an Excel file.



## Advantages and Innovation

WDC is an innovative device, because it allows a “wise” control of an industrial process. In particular it use a not-deterministic approach and it has a knowledge base embedded, that allows economy and energy saving.

The device allows for the retrieval key advantages in the field of industrial research:

- Dynamic response to current conditions;
- Reduce energy costs for the aeration (aeration on demand);
- Targets of nitrification;
- Compliance with the limit values.

## Conclusion

WDC is a Wise Device Control for “wise” control of industrial processes. In this application note, it has been introduced an application of this device to N-C removal process.

The device consists of a knowledge base, produced by external inputs (pH, dissolved oxygen, etc.), which come into play several components that determine the neural network process.

In has been introduced a “Wise” approach (WDC/SCn) in process control strategy with:

- process monitoring through “Easy” measurements;
- a not-deterministic approach strategy.

## References

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