xylem
Let's Solve Water

White Paper
Dr. Tao Su
April 3rd, 2023

Sludge Level Measurement

Introduction

Biological wastewater treatment is the most widely used process across the world due to its high efficiency and lower cost. As is known, the foundation of biological treatment is the utilization of micro-organisms to metabolize organic materials, which are then transformed into new micro-organisms (George et al., 2002).

$$\text{Organic material} + O_2 + NH_3 + PO_4 \longrightarrow \text{New cells} + CO_2 + H_2O$$

This process produces activated sludge, which must be removed every day following the introduction of new wastewater, or else the treatment plant will become overrun with sludge, ultimately leading to the deterioration of the treatment process.
Therefore, the continuous management of activated sludge is essential for the proper functioning of a wastewater treatment plant.

Benefit of Sludge Level Measurement

As depicted in Fig. 1, in a standard biological wastewater treatment process, sludge management depends significantly on sludge level measurement, which can be utilized in the pre-sedimentation tank, post-sedimentation tank, and sludge thickener tank. Accurate sludge measurement is not only critical for regular wastewater treatment plant operations, but it also offers many advantages.

Firstly, energy savings can be realized by controlling the appropriate sludge volume recycled, thus avoiding the waste of energy in the aeration tank. Secondly, cost savings can be achieved by controlling the appropriate amount of precipitant chemical dosing in the sludge thickener. Lastly, electrical efficiency can be achieved by controlling the appropriate amount of sludge pumped to the digester, thereby improving bio gas-electricity transformation. Manual monitoring is avoided and therefore saves workload.

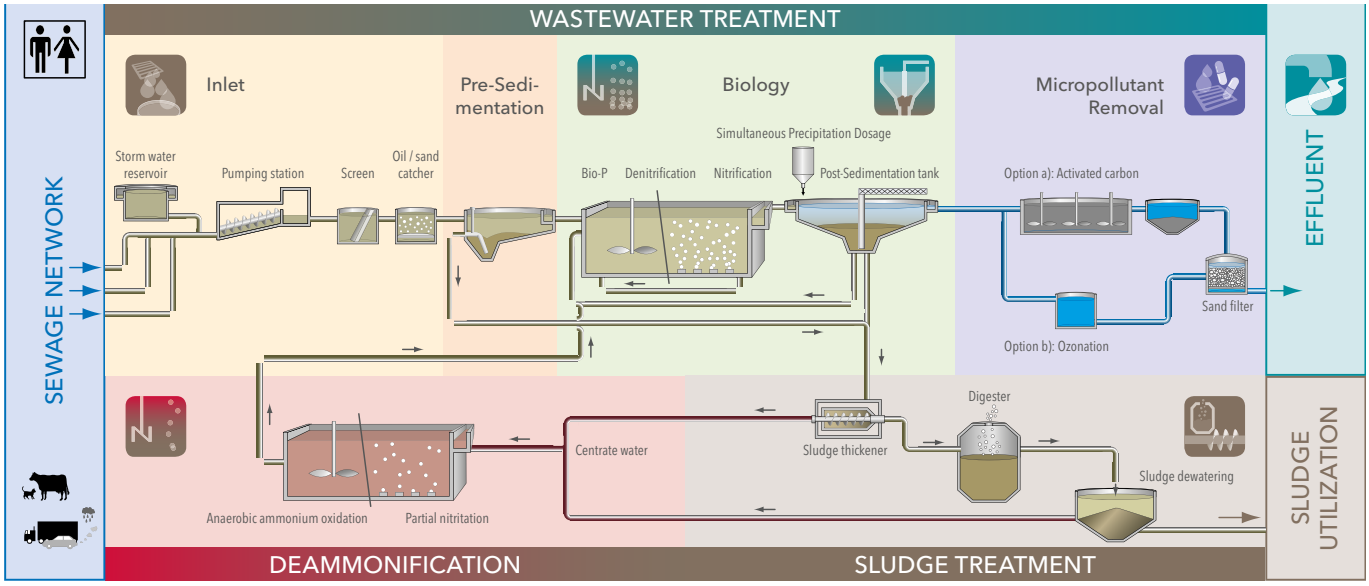

Fig. 1, Basic Biological wastewater treatment process and activated sludge treatment process.

WTW
a xylem brand

Main Technologies on Sludge Level

There are numerous technologies available for sludge measurement (Maxwell et al. 2020) . In this article, the author will focus on the main ones used in wastewater treatment plants and they are summarized in Table 1.

Table 1, Summary of Sludge Depth Determination Techniques

Technique	Advantages	Disadvantages
Sludge Judge	Portable and easy to use	Affected by human error, Not continuously monitored.
Contact Sensor	Simple to use	Electrode needed to be calibrated frequently
Radar Sensor	Automatically and continuously monitored	Cost high, mounting limitation
Ultrasonic Sensor	Automatically and continuously monitored	Mounting limitation

Sludge Judge is a device used to measure the settling rate of sludge in wastewater treatment systems. It consists of an upright cylinder with a graduated scale inside, as well as a weighted stopper at the bottom. The Sludge Judge is employed to gauge the rate of sludge settling in the tank and provide a visual indication of the amount of sludge that has settled.

The contact sensor method utilizes sensors, such as portable TSS optical meters or pH meters, to directly measure the sludge's physical parameters and thus determine the sludge level. This method is easy to use, but expertise in sludge physical characteristics is essential, and the sensor must often be calibrated.

Radar sensors employ electromagnetic waves (typically in the range of 1 G Hz to 100 G Hz) to detect objects and measure distances. They emit electromagnetic waves and measure the time it takes for the waves to bounce back from objects in their path. Radar sensors have high accuracy and can work in harsh environments; however, they can be affected by foam and air bubbles, and their accuracy can be diminished by obstructions in the tank.

Ultrasonic sensors use sound waves to detect objects and measure distances. They emit high frequency sound waves (typically in the range of 20 kHz to 200 kHz) and measure the time it takes for the sound waves to bounce back from objects in their path. These sensors use sound waves to measure the distance between the sensor and the surface of the sludge.
Both Radar Sensors and Ultrasonic sensors are non-contact sensors, that can work in harsh environments and continuously monitor the sludge level. Ultrasonic sensors have an advantage of much lower investment cost than Radar sensors, so much popular for the application in wastewater treatment plant.

WTW IFL 700 IQ Sensor

The Xylem Brand, WTW IFL Sensor is a highly efficient sludge level sensor based on the ultrasonic measuring principle. It has been sold in over 2,000 units, and is evaluated highly around the world. Fig. 2 shows the IFL used in a post-sedimentation tank of a wastewater treatment plant.

Fig. 2, Typical location of the IFL 700 IQ on a scraper bridge in the secondary clarifier.

Compared with other sludge sensors, the WTW IFL 700 sensor has many significant advantages as follows:

- Intelligent signal processing
- Maintenance free non-contact cleaning system
- Wireless radio connection system

WTW IFL 700 IQ can intelligently filter out undesired signals caused by floating sludge, internal fittings, or moving skimmers, thus the sensor always offers tracking of the correct echo, that always keep a stable signal even in hydraulically turbulent events. As shown in Fig.3, WTW IFL 700 IQ senor is much more reliable and stable compared with our competitor sensor.

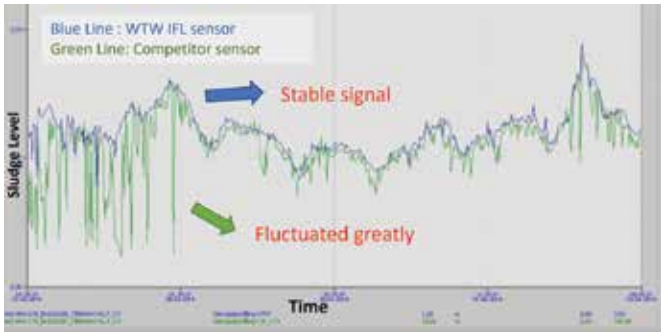

Fig. 3, Sludge level measurement by using WTW IFL sensor (Blue line) and a competitor sensor (Green line)

Additionally, its contact-free cleaning system (Fig. 4) removes bubbles and layers from algae and grease without interference of signal reception. This makes plant management, cleaning and maintenance and field work easier for operators.

Fig. 4, WTW IFL 700 IQ sensor. (a) IFL sensor body. (b) Bottom of IFL sensor; (c) Bottom of IFL sensor even in application full of algae.

Lastly, the WTW IFL 700 IQ sensor can also be used with a wireless connection in different settlement tanks. As is well-known, especially in a rotating scrapper settlement tank, it is difficult to set up a sludge level sensor for continuous monitoring. Although a controller and a sensor can be installed on the bridge, creating a connection from the bridge to a central controller or even the PLC is difficult. Fig. 5 shows that a radio connection can overcome these challenges: it allows for an ideal measuring location on the bridge, and facilitates a connection to an existing controller and thus easily integrate with the PLC.

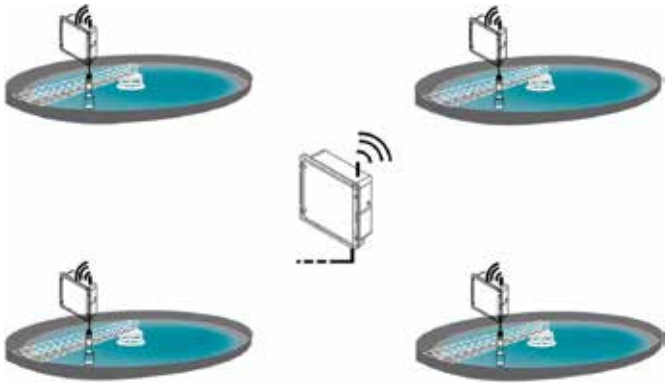

Fig. 5, WTW IFL 700 IQ sensor. Set up of radio networks with one master and four slaves

Application Case

WTW IFL 700 IQ sensor has been applied in many municipal wastewater treatment plants around the world, making it easier to continuously monitor sludge levels in rotating scrapper settlement tanks in Japan and South Korea, automating sludge level data collection in a Beijing WWTP, and helping a Chongqing drinking water plant dose precipitate chemicals more precisely, thus contributing to cost savings (Fig. 6).

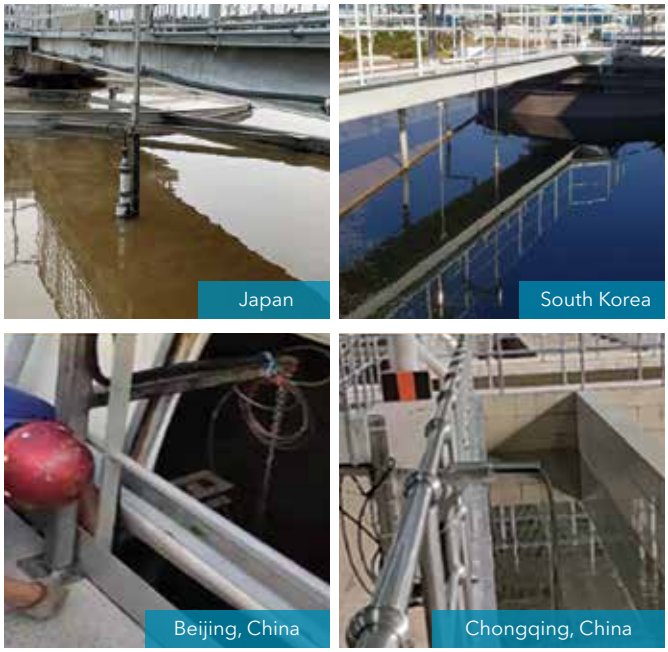

Fig. 6, WTW IFL 700 IQ sensor applied in different countries.

Summary

The Xylem, Brand WTW IFL Sensor, is an efficient ultrasonic measuring based sludge level sensor, with the advantages of intelligent signal processing, low maintenance and wireless radio connection system. It can help the customer achieve better sludge management.

Acknowledgments

The author wish to thank Dr. Patrick Wolf for his correction and revision.

References

George Tchobanoglous, Franklin L. Burton and H. David Stensel (2002) Wastewater Engineering: Treatment and Reuse 4th Edition, Metcalf & Eddy, Inc.

Maxwell Y. Owusu-Twum and Mahmoud A. Sharara (2020) "Sludge management in anaerobic swine lagoons: A review" Journal of Environmental Management, vol. 271, 0301-4797

xylem
Let's Solve Water

info.em@xylem.com

xylem.com