Application Note AN-SS1

Monitoring Suspended Solids/Turbidity in Liquid Processing Stages of Municipal Wastewater Treatment Plant

Many kinds of sewage enter a municipal wastewater treatment plant. Domestic waste is the most common. It includes all wastewater coming from households within the population served by the plant. Manufacturing plants also contribute industrial waste. This waste may contain dissolved metals from a plating company, residual chemicals from a pharmaceutical plant, or organic materials from a food processing plant. In some cases, a company may need to pre-treat its waste to reduce heavy loading on the municipal wastewater treatment plant. The combination of domestic waste and industrial waste is called municipal waste. In some cities, surface run-off storm water is also combined with the municipal waste. Wastewater treatment plants are necessary to protect public health from disease-causing bacteria and viruses that would result if municipal waste was allowed to enter the drinking water supply. Municipal wastewater must be treated using a series of stages to cleanse and disinfect it before safely returning it to the environment.

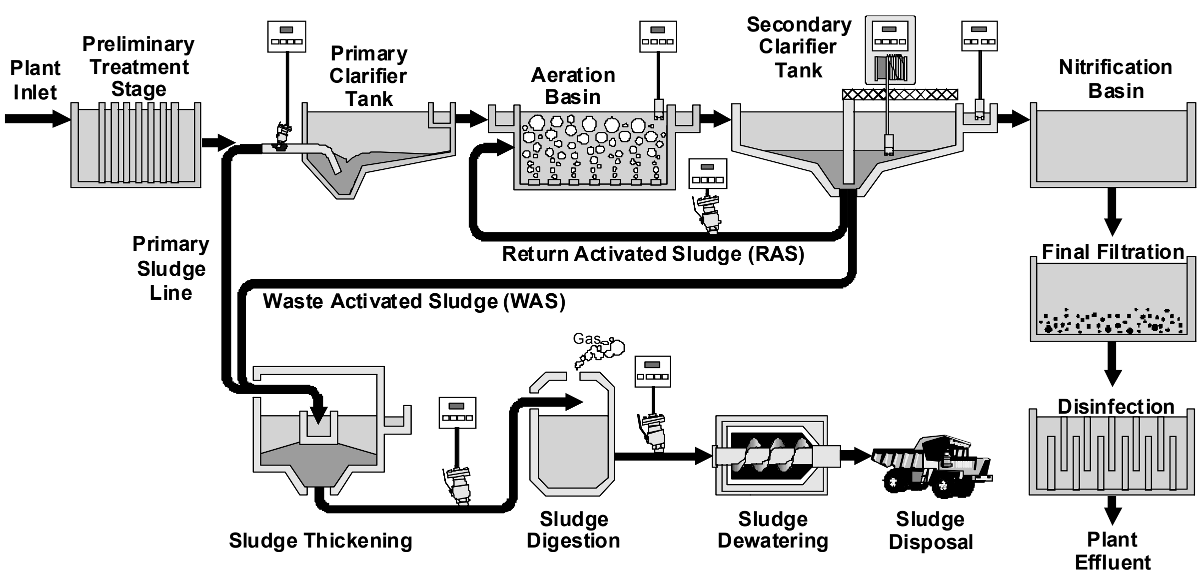
Benefits of Monitoring Suspended Solids/Turbidity

Monitoring suspended solids/turbidity in the liquid processing stages of a wastewater treatment plant offers these important benefits:

1. Improves plant efficiency by providing stability and continuity to the treatment process.
2. Continuous on-line monitoring reduces the need for time-consuming laboratory analysis.
3. Real-time monitoring provides more accurate process control.
4. Monitors compliance with limitations placed on the concentration of solids entering and leaving the plant.

Figure 1 shows the basic arrangement of a typical wastewater treatment plant.

Figure 1 Typical Wastewater Treatment Plant



The typical liquid processing stages used in a municipal wastewater treatment plant are:

- Preliminary Treatment Stage
- Primary Treatment Stage
- Aeration Basin Stage
- Secondary Clarifier Tank Stage
- Return Activated Sludge (RAS) Line
- Waste Activated Sludge (WAS) Line
- Nitrification Basin Stage
- Final Filtration, Disinfecting, and Plant Effluent Stage

Preliminary Treatment Stage

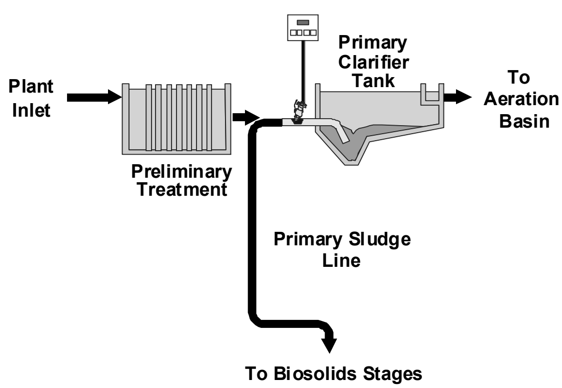
In this stage, evenly spaced bar screens are used to initially remove large debris such as rags, cans, leaves, and sticks while the wastewater passes through. After the debris is removed, it is taken to a landfill or incinerated.

Primary Treatment Stage

After pretreatment, the wastewater moves into a grit chamber to reduce the flow, allowing sand, grit, and other heavy solids to settle to the bottom of the chamber. These settled solids are removed and sent to a landfill. The wastewater continues into the primary clarifier tank, shown in Figure 2, in which the average detention time is approximately two hours. During this time, grease and scum are allowed to float to the surface and be removed by a skimmer. Also, any remaining solids settle to the bottom of the tank. This watery solids mixture, called primary sludge, is then scraped into a sump and removed. The concentration of this sludge and the rate at which it is removed from the primary clarifier depends on the type of solids handling equipment being used. If the sludge is being pumped to a digester, it is typically a thicker sludge with a concentration of approximately 5%. Conversely, if the first solids handling unit is a gravity thickener, fresher solids in a thinner sludge concentration (0.5% to 1.0%) is essential.

Product Application: Monitoring suspended solids content in the primary discharge pipe helps to automate the primary sludge discharge. The goal of control at this stage is to thicken the sludge in the funnels of the primary settling tank as much as possible. Proper control ensures that the sludge will not become anaerobic and helps avoid a discharge of primary sludge into the activated sludge stage. It also guards against a water breakthrough to the biosolids treatment stage. Monitoring suspended solids concentration enables the operator to close the sludge discharge valve when a predetermined sludge concentration is reached, instead of depending on detention time in the primary clarifier.

Figure 2 Primary Treatment Stage



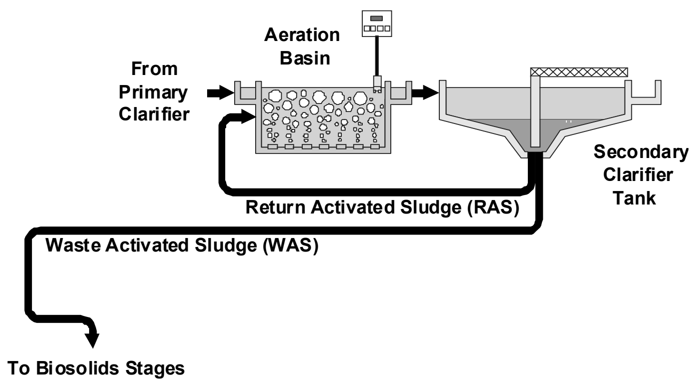
Aeration Basin Stage

The effluent from the primary clarifier is step-fed to the aeration basin where it is mixed with the return activated sludge (RAS) from the secondary clarifier. This return sludge is a biomass or blend of beneficial microscopic organisms, bacteria, and solids that converts the non-settleable solids (dissolved and colloidal matter) into settleable solids, carbon dioxide, water, and energy.

The mixture of primary clarifier effluent and return sludge, often called "mixed liquor," fed to the aeration basin, shown in Figure 3, is now mixed with air through diffusers located along the bottom of the basin. This air produces the turbulence to mix the biomass with the primary effluent, and provides the needed oxygen to sustain the biomass.

Product Application: Monitoring suspended solids content in the aeration basin helps to ensure that the proper amount of biomass is present. This saves energy without risking inefficient organic pollution removal. Too much biomass in the aeration basin causes excess air to be added, wasting energy. Conversely, too little biomass forces inefficient removal of the organic pollution that is present. Controlling the suspended solids content in the aeration basin also allows the operator to adjust the process based on changing plant loading conditions.

Figure 3 Aeration Basin Stage



Secondary Clarifier Tank Stage

The aeration basin effluent (also called "mixed liquor") is transferred to the secondary clarifier. Here the activated sludge settles to the bottom and the clear effluent is pumped to a nitrification basin. The activated sludge taken from the bottom of the secondary clarifier is split into two different flows, as shown in Figure 3. The waste activated sludge (WAS) is removed to maintain the correct biomass population. The remaining return activated sludge (RAS) is returned to the aeration basin for reuse.

Return Activated Sludge (RAS) Line

Controlling waste sludge rates helps the plant run more efficiently. This can be accomplished many ways, but most plants choose to keep their mixed liquor suspended solids (MLSS) concentration in the RAS line within a specific concentration range.

Product Application: A variety of mechanical controls can be used to set and maintain the RAS concentration and flow rate. The most common and simple control method is to operate with a constant pumping rate throughout the entire 24 hour day. By using a constant pump speed, the solids in the secondary clarifier will change as the incoming plant flow rate changes. During the day, the flow is higher which tends to push the solids into the clarifier. At night, when the plant flow rate is lower, the RAS line will feed solids back to the aeration basin faster than they are entering the clarifier. This control method provides a continual daily shifting of solids. An alternate control method is to use a variable pump speed that changes as the plant flow rate changes. The logic behind this control strategy is that as the plant flow rate increases, more aeration basin solids are pumped into the secondary clarifier. Unless the RAS flow rate is increased during these time periods, the clarifier may build up an excessive solids balance (as evidenced by high sludge blankets) resulting from the increase in solids detention time.

Generally, this control method works well. It also has the added benefit of assisting the operator during periods of slow and rapid settling sludge by allowing a change in the percent return during the day to better match the settling rates being experienced in the clarifier. The best proven control method uses a suspended solids sensor mounted in the RAS line to provide continuous measurement of the solids concentration. This method provides better control because it can slow down or speed up the RAS flow based on the actual concentration in the RAS line, not the incoming plant flow.

Waste Activated Sludge (WAS) Line

How efficiently the RAS line is controlled directly effects the amount of sludge being wasted. Regulating the amount of waste activated sludge (WAS) is the most dramatic control the operator has available to change the sludge and effluent quality. Through wasting, the operator has direct control over the inventory of sludge carried in the aeration and clarification systems. The solids inventory level will either increase or decrease with a corresponding decrease or increase in waste sludge quantities. Any change in sludge inventory will also specifically change the sludge characteristics and the relationship of the biomass population to the available influent food supply. It is this direct control over sludge characteristics that makes waste sludge control and the resultant solids inventory very important to efficient plant operation.

Nitrification Basin Stage

As previously stated, the effluent from the secondary clarifier is pumped to the nitrification basin where chemicals are added to provide additional alkalinity, raising the pH of the wastewater. A long detention time encourages a different type of bacteria to develop in the biomass. This bacteria converts ammonia nitrogen to nitrates, a form of nitrogen that does not deplete oxygen from the receiving stream.

Final Filtration, Disinfection, and Plant Effluent Stages

The nitrification basin effluent flows into a mix tank where aluminum sulfate (alum) is added to precipitate phosphorus. This is followed by adding polymer and flocculent to improve settling characteristics. The effluent is then polished by a gravity filtration process typically consisting of anthracite coal and/or sand filters. The effluent from the gravity filters is disinfected with chlorine and aerated to increase the dissolved oxygen in the water. Finally, it is dechlorinated with sulfur dioxide and released from the plant.

Product Application: Depending on the plant size and population served, state governments impose limitations on the concentration of solids leaving the plant. Consequently, most plants are required to monitor suspended solids concentrations in the plant effluent to comply with permit requirements. Monitoring turbidity at the final discharge of the plant ensures compliance with any limitations placed on the concentration of solids leaving the plant.

Summary

Within the liquid processing stages of a municipal wastewater treatment plant, activated sludge oxidizes the organic wastes using beneficial bacteria. This is followed by separating the suspended solids from the treated wastewater. The goal of the wastewater treatment plant is to break down the sludge and separate it from the wastewater. When too much sludge accumulates at designated checkpoints, the plant becomes overloaded, and the sludge is not properly treated. When too little sludge is used within the plant, it is not operating at maximum efficiency and energy may be wasted. The versatile GLI suspended solids/turbidity measurement systems are ideal for monitoring all solids concentrations throughout a wastewater treatment plant.

References

Simplified Wastewater Treatment Plant Operations, Edward J. Haller, 1995

Basic Activated Sludge Process Control; Water Environment Federation, 1994

Solid Content Measurement in Wastewater Plants – Measuring Principle and Application Examples, Franz Winter, 1998

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