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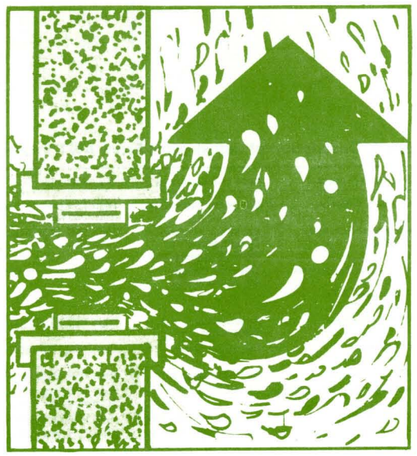
Sidestreams in Advanced Wastewater Treatment Plants

Problems and Remedies



Sidestreams in Advanced Wastewater Treatment Plants - Problems and Remedies

Introduction

In wastewater treatment plants, sidestreams constitute the flows generated within the plant in addition to the plant influent. Such flows include supernatants, backwash waters, rinse waters, plant drainage water, and any other types of liquid streams that are produced in the operation of the wastewater treatment processes. These sidestreams are, in most cases, recycled to the head end of the treatment plant, although in some cases selected sidestreams are sometimes recycled into secondary treatment units. The volumes of the sidestreams are generally small (5 to 10 percent) relative to the influent flow. Although the volume of the sidestreams is small in comparison with the forward flow of the treatment facility, the recycling of the sidestreams to the head end of the POTW can increase the organic loading by as much as 50 percent with a similar increase in solids loading. The characteristics of sidestreams vary considerably depending on the type of treatment process and operation practices at the facility.

A recent study sponsored by EPA, which included visits to a number of advanced wastewater treatment (AWT) facilities, identified sidestreams as one of the potential causes of performance problems in POTW's with advanced treatment processes. Based on this evaluation, the major problems created by the recycling of sidestreams on the operation and performance of POTW's are identified, and methods to minimize or eliminate the problems are discussed.

Types of Sidestreams

The types of sidestreams generated from different AWT processes vary according to the type of process and its method of operation. Figure 1 shows a process schematic of a POTW and the types of sidestreams that may be generated in the facility.

Backwash wastewater and supernatant/filtrate are the two major types of sidestreams common in AWT processes. Tertiary filters and granular activated carbon systems produce backwash wastewater as a sidestream. The volume of backwash water may vary between 1 to 5 percent of the amount of wastewater influent to the AWT unit.

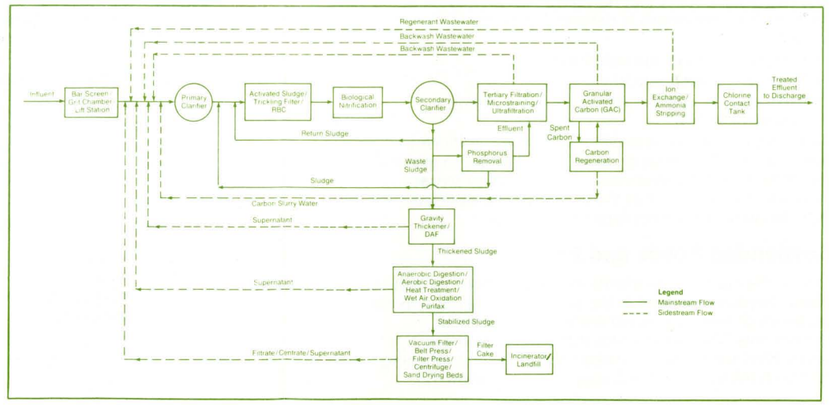
In wastewater treatment facilities with granular activated carbon (GAC) systems, a carbon regeneration system utilizing a multiple hearth furnace is often used. As shown in Figure 2 this process generates unique sidestreams of its own. Sidestreams generated from this system include: (1) the water used to transport the spent carbon to the regeneration facility, and (2) the water used to quench and wash the regenerated carbon to remove the carbon fines. These sidestreams are typically recirculated to the head end of the wastewater treatment facility.

In addition to the sidestreams generated by AWT processes, there are a number of non-AWT processes in POTW's that produce sidestreams. These sidestreams are also recirculated to the head end of a POTW and ultimately combine with those sidestreams emerging from the AWT processes. The combined effect of these sidestream flows can have significant adverse effects on the operation and treatment efficiency of the mainstream treatment processes.

Characteristics of Sidestreams

Very little data on sidestream characteristics are available. This is mainly because POTW operators typically concentrate on monitoring mainstream processes and seldom monitor sidestreams. Based on the limited information obtained from POTW's and literature review, a description of the characteristics of the sidestreams emerging from AWT processes is presented in Table 1. It is evident that the two major characteristics of sidestreams are high organic content (BOD) and total suspended solids (TSS). These sidestreams can exert a high oxygen demand on mainstream processes. The characteristics of

Figure 1. Process Schematic of Advanced Wastewater Treatment (AWT) Facility.



sidestreams from non-AWT processes are presented in Table 2.

The data indicate two salient features. First, there is a wide range in the concentration of BOD and TSS present in sidestreams. For example, the BOD of the supernatant from an anaerobic digester varies from 100 to 2,000 mg/L, and the TSS ranges between 100 and 10,000 mg/L. Second, BOD and TSS concentrations in the sidestreams can be extremely high. Assuming a concentration of 300 mg/L of BOD in the raw wastewater influent to a POTW, the organic strength of a sidestream can be 5 to 10 times that of the mainstream. However, the sidestream flow volume may be considerably small relative to the mainstream flow, and sidestream flows are generally intermittent. Therefore, the impact of these sidestreams on AWT process performance must be determined on a case-by-case basis, considering these factors.

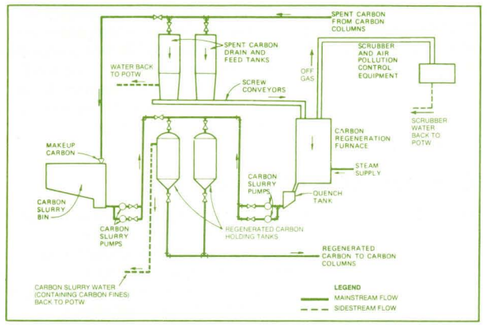


Figure 2. Sidestreams Generated in the Carbon Regeneration System.

Problems Due to Sidestreams

The degree of impact that recycling of sidestreams will have on AWT processes is determined by the following factors:

- Characteristics of the sidestreams.
- Volume of sidestream flows.
- Frequency of sidestream flow addition to the mainstream flow.

As mentioned earlier, it is difficult to obtain sufficient quantitative information on all of these factors to generalize the impacts of the sidestreams on the AWT processes. However, the operators at the plants visited reported definite cause-and-effect type observations.

Suspended Solids and Fines

One of the common problems reported is the poor settling characteristics observed in the primary clarifier due to the presence of fine suspended solids in recirculated sidestreams. The sidestreams that contribute these suspended solids are: (1) carbon slurry water containing carbon fines from the GAC regeneration system, (2) backwash wastewater from tertiary filters and GAC units, and (3) filtrate from vacuum filters. The fine suspended solids are not easily removed in the primary and secondary treatment processes and are carried over to the AWT process units. High suspended solids concentration in the GAC influent can coat the surface of the carbon media. This reduces the adsorptive capacity of the carbon and results in poor BOD removal. The frequency of backwashing is also increased due to the fouling of the media by the suspended solids. In tertiary filters, high suspended solids in the influent can clog the media and result in short filter runs.

In order to minimize the impact of the suspended solids loading from these sidestreams, flocculants such as alum, ferric chloride, or organic types of coagulants (polymers) may be added to primary or secondary clarifiers to capture the fine suspended solids for improved settling (Figure 3). If the sidestream flow is significant relative to the plant influent flow and creates major problems in clarification, pretreatment of the individual sidestreams might be considered. As shown in Figure 3, the flow from the backwash wastewaters and the carbon slurry water can be equalized and the suspended solids removed by settling before the flow is recycled. Flocculant may be added to improve settling of the solids.

Hydraulic Surging

Another impact of the recycling of sidestreams is the hydraulic surge induced on the mainstream flow. This occurs when the backwash wastewaters from the tertiary filters and GAC units are recycled to the head end of the plant. As a result of the hydraulic surge, suspended solids removal in the primary clarifier is adversely affected. A cascading effect follows and results in high suspended solids loading on the subsequent secondary and AWT processes.

The impact of the hydraulic surge can be minimized by equalizing the sidestream flows (Figure 3) and controlling the recyle to the mainstream flow using a flow pacer. It is suggested that the equalized sidestream flow be recycled during periods of low influent flow to the plant.

Organic Overloading

Recycling of sidestreams can create significant problems of overloading of treatment processes due to high concentration of organic matter in the sidestreams. This problem arises primarily from sidestreams generated by non-AWT processes (Figure 1). These sidestreams often cause intermittent organic peak loads. It is suggested that these sidestreams be equalized and aerated before being recycled into the head end of a treatment facility to minimize the oxygen demand exerted on the mainstream flow. One way to accomplish this preaeration is to pass the recycled sidestream through an aerated grit chamber if one exists.

In biological phosphorus removal processes, (PhoStrip, A/O, and Bardenpho) a fraction of the phosphorus enriched sludge is often thickened in a gravity thickener and the supernatant (which is a sidestream) is returned to the head end of the treatment plant. In the sludge thickener, under anaerobic conditions, part of the phosphorus in the sludge is resolubilized and returned to the primary clarifier, along with the thickener supernatant. As indicated in Figure 3, this problem can be minimized by either of the following measures: (1) addition of dilution water to the thickener to prevent the sludge from becoming anaerobic or (2) use of the dissolved air flotation process for sludge thickening.

Figure 3. Suggested Modifications in AWT Facility to Minimize Sidestream Problems.

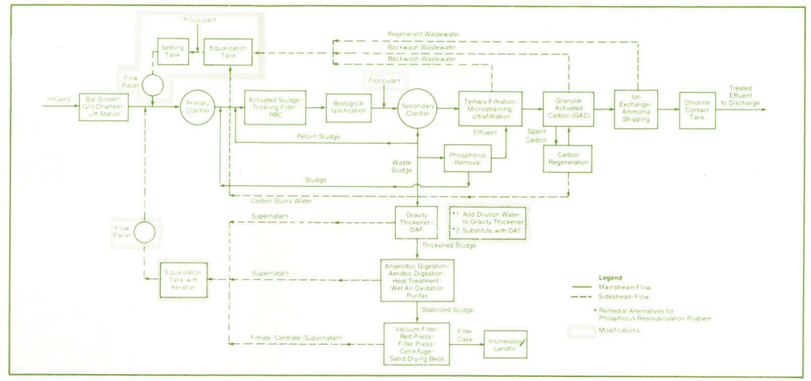


Table 1. Description of Sidestreams From AWT Process Units

Treatment Process	Type of Sidestreams	Characteristics
• Tertiary Filtration	Backwash Wastewater	High TSS (100-1000 mg/L), High BOD (100-1300 mg/L)
• Granular Activated Carbon	Backwash Wastewater Carbon Slurry Water (Regeneration)	High TSS; High BOD High TSS
• Phosphorus Removal Processes (PhoStrip, A/O, Barden Pho)	Chemical Sludge Biological Sludge	High Phosphorus and Lime
• Ion Exchange	Regeneration Wastewater	High TSS; High BOD, Low pH
• Biological Nitrification	Biological Sludge	High TSS; High BOD
• Denitrification	Biological Sludge	High TSS; High BOD
• Independent Phy-Chem.	Chemical Sludge	High TSS; High BOD, High Concentration of Lime, Alum, Ferric Chloride Etc.
• Fluid Bed	Backwash Wastewater	High TSS; High BOD
• Microstraining	Backwash Wastewater	High TSS; High BOD

Table 2. Description of Sidestreams From Non-AWT Process Units

Treatment Process	Type of Sidestream	Characteristics BOD (mg/L)	Characteristics TSS (mg/L)
• Gravity Thickener	Supernatant	100 - 1,200	200 - 2,500
• Dissolved Air Flotation	Supernatant	50 - 1,200	100 - 2,500
• Anaerobic Digestion	Supernatant	100 - 2,000	100 - 10,000
• Aerobic Digestion	Decant	100 - 2,000	100 - 10,000
• Heat Treatment	Decant Liquor	1,600 - 12,000	100 - 10,000
• Wet Air Oxidation	Decant Liquor	3,000 - 15,000	100 - 10,000
• Purifax	Decant Liquor	1,000 - 3,000	100 - 3,000
• Sludge Lagoon	Supernatant	100 - 200	50 - 200
• Sludge Drying Bed	Underdrainage	20 - 500	20 - 500
• Vacuum Filter	Filtrate	100 - 1,000	200 - 4,000
• Belt Filter Press	Filtrate	50 - 500	100 - 2,000
• Filter Press	Filtrate	50 - 250	50 - 1,000
• Centrifuge	Centrate	100 - 2,000	200 - 20,000

Summary

The performance evaluation of sidestreams in AWT plants indicates that sidestream flows, although small in volume relative to the mainstream flow, can adversely affect the treatment processes. The significant problems due to the recycling of the sidestreams are: (1) poor settling in clarifiers due to fine suspended solids, (2) shock loads of high organic matter & TSS, and (3) hydraulic overloading due to intermittent flow surges. Possible remedial measures to consider include the following: (1) addition of flocculant to the sidestream flow to improve the settling characteristics, (2) sidestream flow equalization, and (3) aeration of sidestreams containing high concentrations of BOD to minimize the oxygen demand on the mainstream flow.