6.5.2 MBR System Process Control

The MBR process equipment is controlled automatically through the system's controls. The operator has a number of set-points available that control the flows to the system and optimize the performance of the system.

MBR System Flow

The MBR system flow is controlled through the intermediate pump controls. The operator can set the flow to the MBR system using one of four control modes. These are:

- **Mode 1: Percent Influent** - The percent influent flow mode controls the set point flow as a percent of the plant influent flow. Under this mode, the flow to the membranes will vary with the plant influent flow diurnal curve. This mode will be used if it is desired to maximize the flow treated in each facility. There will be limitations in using this flow mode as a low minimum flow during the low flow nighttime period may cause issues with disinfection in the CAS system.
- **Mode 2: Constant Flow** - The constant flow mode controls the setpoint flow as a constant flow rate. The MBR system will run at a constant flow rate no matter the plant influent flow. This can cause problems during low flow periods with disinfection in the CAS system. In addition, this mode will increase the peaking factor during higher flow periods to the CAS system. The advantage of this mode is that it will optimize the operation of the MBR system by providing a constant feed to the aertion basin and minimize the changes in flux rate to the membranes.
- **Mode 3: Diversion Flow** - The diversion flow mode controls the set point flow as the same flow as the diversion flow. Under this mode, the flow to the membranes will vary with the diversion flow diurnal curve. This mode provides the capability to ensure that the volume of flow that is diverted through the CCSD#1 diversion is treated in the MBR facility. This mode should be used with care if the flow from the diversion gets less than 1.5-mgd at any point during the diurnal cycle as this is the lowest flow that can be treated by the MBR system.
- **Mode 4: Diurnal Table** - The diurnal flow control mode allows for setting the flow rate on an hourly basis. The MBR plant flow will then match the desired set point. The operator can set the flow rate for each hour on the diurnal flow set point table. This mode provides the operator hour-by-hour control of the flow to the MBR system. This mode provides the advantages of each of the other three modes while providing the capability to limit the problems that can occur with the other modes.

MBR Biological Process Control

The biological system is controlled through the three control variables. These variables control the rate of nitrification, denitrification, oxygen efficiency and sludge age. These variables are:

- **MLSS Concentration** – The MLSS concentration is controlled by the volume of solids wasted from the system each day. The design MLSS for the system is 8,000 mg/L. The system can be operated at MLSS concentrations up to 12,000 mg/L at lower flows, but needs to be lower during high flow periods to minimize the flux rate on the membranes. The MLSS concentration needs to be maintained to provide a sludge age high enough to provide complete nitrification. A well-nitrified sludge is directly related to a well-oxidized MLSS that will provide efficient filtration by the membranes.
- **MLTR Flow Rate** – The system was designed for a mixed liquor transfer return flow rate percentage of 400% of MBR plant flow. This flow rate moves the MLSS through the MBR basins at a rate that the solids concentration in the basins does not inhibit filtration. This rate must be higher if the MLSS concentration is greater than 10,000 mg/L.
- **MLSS Recycle Flow Rate** – The MLSS recycle flow rate is adjustable between 100% and 400% of MBR plant flow. This recycle rate determines the volume of MLSS that is returned to the anoxic zones for denitrification. The recycle rate is dependent on the amount of nitrate in the system and the amount of readily available BOD (rBOD) in the incoming wastewater. The optimum recycle rate is one that minimizes the nitrate concentration in the MLSS that overflows anoxic zone 2B.

Foam Management

Foam is not removed from the MBR system as the MBRs filter the MLSS below the surface of the MBR basins. Therefore, the only way to remove foam from the system is to waste it into the WAS pit. There are two ways to send foam to the WAS pit.

- Mixed Liquor Transfer Channel – The mixed liquor transfer channel is the channel that takes flow from the MBR aeration basin and distributes it to the MBR basins. There is a baffle located in this channel at the WAS pit. The WAS gate can be lowered to direct foam that has accumulated in front of the baffle into the WAS pit during wasting. In this mode, wasting is done at the concentration of the MLSS.
- Mixed Liquor Transfer Return Channel – This mixed liquor transfer return (MLTR) channel receives flow from the MBR basin overflow for recycle back to the MBR basins. The WAS pit is located at the end of this channel. Foam that was generated in the MBR basins accumulates at the end of this channel near the WAS pit. Lowering the WAS gate for this channel will waste WAS and remove foam from this channel. In this mode, wasting is done at a higher concentration as the MLSS has been thickened in the MBR basins.

MBR Process Alkalinity

The MBR process is designed and operated to nitrify. When nitrification occurs, the alkalinity in the wastewater is consumed and the pH drops. The influent wastewater to the Tri-City WPCP is low in alkalinity and requires a supplemental source of alkalinity. This is provided by the lime feed system. Alkalinity of the filtrate needs to be measured on a daily basis and the feed rate adjusted to make sure adequate alkalinity is provided in the process. If the alkalinity gets too low, the pH of the MLSS will drop to levels that will inhibit nitrification resulting in high effluent ammonia concentrations and a possible pH violation. The pH of the MLSS for nitrification is optimum at a pH of 7.2, but should never get less than a pH of 6.8. This relates to an effluent alkalinity target of 80 to 100 mg/L.

Membrane Cleaning

The membranes must be cleaned periodically to ensure optimum system performance and optimum membrane life. The system cleaning is provided at three levels of the system operation: production cycle, maintenance clean and recovery clean.

In the production cycle, the membranes go through a cycle of production and relax. When they are relaxed, the flow through the membranes is stopped for a period of time. An alternative to relaxing is backpulsing. In this mode, filtrate is pumped back through the membranes to clean them. The mode and timers or the production cycle is set in the MBR Plant Setpoints entry screen.

Maintenance cleans are scheduled cleans that occur on a periodic basis to clean the membranes. In maintenance clean the MBR train is removed from service and hypochlorite is pump back through the membranes. The maintenance clean timers for the maintenance clean are set on the Maintenance Clean Setpoints screen.

Recovery cleans are performed on a seasonal basis. This clean is done by draining the MBR basin and filling the basin with either sodium hypochlorite or citric acid and soaking the basins for a period of time. The recovery clean timers for the recovery clean are set on the Recovery Clean Setpoints screen. Recovery cleans are manually initiated but the recovery clean cycle is automated.

See the 6.6.2.1 GE Process Control Narratives for more information.