SiC MBR Systems Basic Operational Uptime Procedures

The following are basic operational procedures to maintain maximum uptime of the SiC membrane unit.

a.) Membrane Specifications

The following specifications are for membrane plates and modules used in MBR applications.

Table 1.1. Membrane Specifications

Membrane Module Part No.	322-00476
Nominal Membrane Pore Size	0.1 micron
Membrane Clean Water Permeability	>120 gfd/psi
Maximum Allowable TMP During Filtration	10.0 psi
Maximum Pressure During Backwash	30.0 psi
Active Membrane Area per Plate	1.625 ft^2
No. Plates per Module	40
Active Membrane Area per Module	65 ft^2

b.) Mixed Liquor Characteristics

A healthy, properly functioning biology is critical for maintaining membrane performance. Poor quality sludge can lead to rapid fouling, frequent chemical cleaning, and low production rates. The following guidelines in Table 1.2 provide the necessary parameters for achieving a healthy biology. It should be noted that MLSS quality is site specific and other external factors can easily impact sludge quality.

Table 1.2. MLSS Requirements and Characteristics

MLSS Maximum	30,000 mg/l
RAS Flow	3-6Q
Recycle Screen	(see table 1.5)
Sludge Wasting	As needed to maintain design MLSS concentration
Temperature	5 – 37^{o}C due to biology
Soluble COD	< 50 ppm
Dissolved Oxygen (standard)	>1 ppm
Dissolved Oxygen (SNdN)	0.5-0.7 ppm
pH	6 - 8
Alkalinity	Sufficient to ensure uninhibited nitrification; BioWin modeling required for determination of minimum alkalinity requirements
Coarse Suspended Solids (CSS)	<200 mg/l
Sludge Filterability	$\geq$15 ml in 5 min

c.) Membrane Basin Design

Proper design basin is required to ensure adequate hydraulics, roll pattern, and RAS rates. Required design guidelines for the MBR basin are shown in Table 1.3.

Table 1.3. MBR Basin Design Guidelines

Maximum Aspect Ratio	4:1
Minimum Membrane Submergence[1]	1.5 ft
Maximum Membrane Submergence	5.0 ft
Minimum Clearance, Basin Floor to Bottom of Stack	>15.7 in
Minimum Clearance, Stack to Stack	4.72 in
Minimum Clearance, Stack to Basin Wall	2.36 in

d.) Influent/Pre-Treatment

Influent to the MBR system must be properly pre-treated to avoid common problems such as ragging, oil & grease accumulation and fouling, and grit accumulation. It is imperative that all MBR systems meet the minimum inlet screening requirements. Influent requirements are shown in Tables 1.3.

Table 1.4. MBR Influent Requirements

Grit & Debris Concentration	<5 mg/l of particles with a specific gravity >1.6 and diameter >0.2 mm
Oil & Grease Concentration (Plant Influent)	<20% of influent BOD concentration

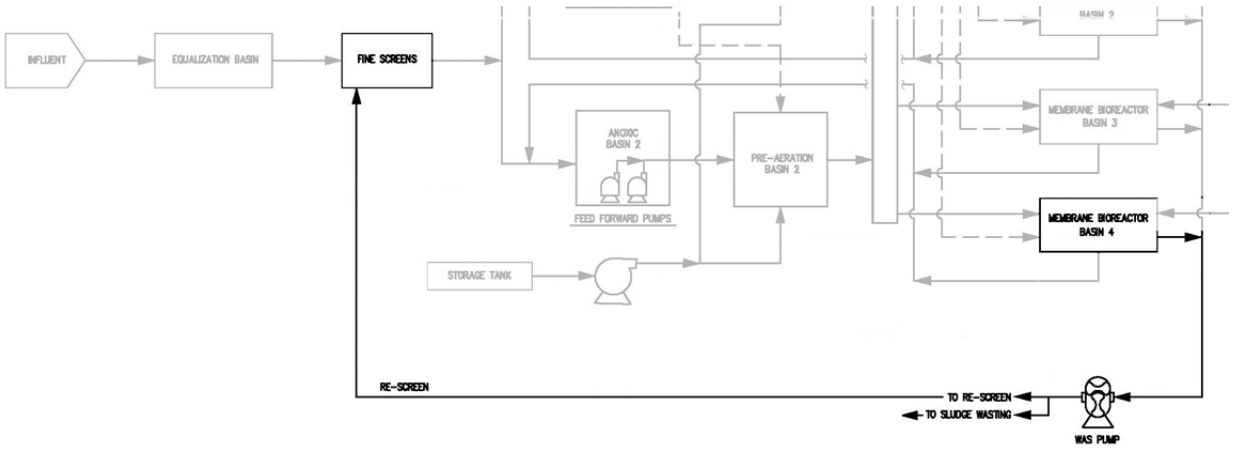
e.) Screening Requirements

Screening is a critical component of any MBR system as it is the key barrier to operational issues due ragging, bearding, and debris. Screening must be performed on the inlet to the MBR plant as well as the MBR basin, in the form of recycle screening. Rescreening can be accomplished in an automated process, by diversion of the WAS flow as shown in See Fig 1.1. Both coarse and fine screens are applied to inlet screening requirements while only coarse screening is required for recycle screening. Screening specifications are listed in Table 1.5.

Table 1.5. MBR Screening Requirements

Inlet Screening Configuration	Coarse followed by fine screens
Coarse Screen Size and Type	≤5.0 mm screen (perforated or bar)
Minimum Capture Rate, Coarse Screen	≥75.0%
Fine Screen Size and Type	≤2.0 mm perforated screen, or ≤1.0 mm bar screen
Minimum Capture Rate, Fine Screen	≥90.0%
Recycle Screen Size and Type	≤5.0 mm screen (perforated or bar)
Minimum Capture Rate, Recycle Screen	≥75.0%
Recycle Screen Sizing	15% of MBR basin volume over 24 hr period

Figure 1.1. Rescreen Process Flow



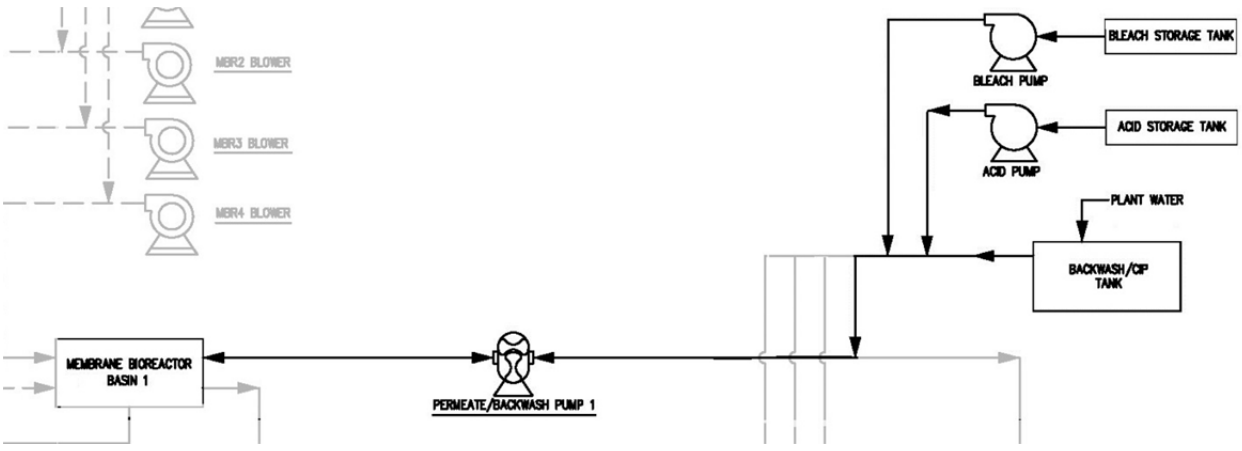
f.) Backwash and Relaxation

SiC MBR systems are regularly backwashed to remove accumulated solids on the membrane surface. Automated backwashing occurs during each production cycle and is combined with membrane relaxation. Backwashing utilizes reversible permeate pumps, automated shut-off valves and a backwash tank, see Figure 1.2. Backwash length, sequence, duration is operator selected based on application conditions. Table 1.6 shows typical design guidelines for membrane backwashing:

Table 1.6. Backwash Guidelines

Backwash Flux	2Q of MMF
Cycle Length	10 min
Backwash Sequence	1.) 1st relaxation 2.) Backwash 3.) 2nd relaxation
Backwash Duration	30 sec
Maximum Backwash Pressure	30.0 psi
1st Relaxation	15 sec
2nd Relaxation	15 sec

Figure 1.2 Backwash & Maintenance Clean Process flow



g.) Membrane Maintenance Clean (MC)

MBR systems require periodic chemical cleaning to remove accumulated solids from the membrane surface and/or pores. Cleaning frequency and requirements may vary by site, but the following guidelines provide the minimum requirements.

There are two types of chemical cleaning: maintenance cleaning (MC) and extended maintenance cleaning (EMC). MC is intended as a preventive maintenance procedure to extend run times in between EMCs. A typical MC involves the use of chlorine or acid to restore permeability to its original starting point. However, over time fouling will accumulate and a more aggressive cleaning in the form of an EMC is needed to restore membrane permeability. Maintenance Clean is automated utilizing reversible permeate pumps, automated shut-off valves, chem dosing pumps and a CIP tank, see Figure 1.2. MC and EMC, duration and dose is operator selected based on application conditions.

Table 1.7. Chemical Fill Rates

Stack Size	Min. Fill Rate (gfd)
M1 – M5	2X MMF Design Flux
M5 – M10	2X MMF Design Flux

Table 1.8. Chlorine Maintenance Clean

Target Frequency	Once every 4 weeks
Concentration	0.1 wt%
Fill Volume	10.0 gal/module (0.153 gal/ft^2)
Fill Rate	Equal to BW Flow Rate (2Q of MMF)
Soak Period	4 hrs
Maximum Backpressure During Fill	30.0 psi
Maximum pH During Clean	14.0

Table 1.9. Acid Maintenance Clean

Target Frequency	Once every 3 months
Acid Type	Citric, muriatic, oxalic
Concentration	Citric – 0.2 wt% Muriatic – 0.3 wt% Oxalic – 0.1 wt%
Fill Volume	10.0 gal/module (0.153 gal/ft^2)
Fill Rate	Equal to BW Flow Rate (2Q of MMF)
Soak Period	2 hrs
Maximum Backpressure During Fill	30.0 psi
Maximum pH During Clean	3.0
Minimum pH During Clean	1.0

Table 1.10. Chlorine Extended Maintenance Clean

Target Frequency	Twice per year
Concentration	0.2 – 0.5 wt%
Fill Volume	10.0 gal/module (0.153 gal/ft^2)
Fill Rate	Equal to BW Flow Rate (2Q of MMF)
Soak Period	6 - 12 hrs
Maximum Backpressure During Fill	30.0 psi
Maximum pH During Clean	14.0

Table 1.11. Acid Extended Maintenance Clean

Target Frequency	Once every 12 months
Acid Type	Citric, muriatic, oxalic
Concentration	Citric – 0.2 wt% Muriatic – 0.3 wt% Oxalic – 0.1 wt%
Fill Volume	10.0 gal/module (0.153 gal/ft^2)
Fill Rate	20 gfd
Soak Period	4 – 6 hrs
Maximum Backpressure During Fill	30.0 psi
Maximum pH During Clean	3.0
Minimum pH During Clean	1.0