Long Term Operation of KUBOTA Submerged Membrane Unit (SMU) in Sakai Rinkai

KUBOTA Corporation
Membrane System Department

1. Objective

Examine treatment condition and treated water quality of MBR facility in operation for a long term (more than 5 years)

2. Wastewater being treated

Black water and domestic wastewater with wastewater from cafeteria kitchen included

Owner：Rinkai Factory in Sakai Manufactory of KUBOTA Corporation

Address：Sakai City, Osaka

Competent Authority: Sakai City

3. Details on Wastewater Treatment Facility

Method of Treatment

Install Submerged Membrane Unit in Activated Sludge Treatment (Biological Treatment)

Tanks contain equalization tank, anoxic tank, aeration tank (Membrane Separation Tank, MBR tank), and effluent tank (disinfection tank)

Also known as BOD type Activated Sludge Membrane Separation Method by Japanese Jokaso Standard.

Method of Membrane Filtration

A suction filtration method, which suction pump is installed on the permeate side of KUBTOA SMU, is utilized. Suction pump, as driving force to produce effluent, discharges treated water.

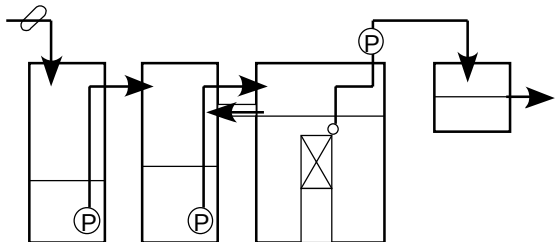

Fig. 1: BOD-type Jokaso Flow

The system is controlled by PID, hence an instantaneous permeate flow is kept stable.

A liquid level in MBR tank is stable. However, the equalization tank, which receives overflow from MBR tank, has varying liquid levels. As permeate pump is in operation, it is operated with intermittent mode with 8 min. ON and 2 min. OFF.

Facility Details

Tank Volumes: MBR Tank 36 m^3, Anoxic Tank 12m^3, Total 48 m^3

Membrane Unit: E 50 ×4units ×2 trains

Membrane Area: 320 m^2

Method of Flow Measurement: Electromagnetic Flowmeter

Method of Total Flow Measurement: Water Meter

Operation Condition

Aeration Flow:	10 NL/min･Cartridge （5 Nm³/min）
Treatment Capacity:	Design 110m³/d 、 Actual 30～100 m³/d
MLSS Concentration:	10000 ～20000 mg/L
MLSS Viscosity:	20 ～100 mPa・s
Temp. in MBR tank:	15 ～33 ℃

4. Period of Operation: Start up of the facility in 1994 ～ November 2005

Period of service for Membrane Unit

As for membrane cartridge replacement, all of the membrane cartridges were replaced in the year of 1999and 2000 since it was taken a place only because of the replacement time for the Maintenance Contract they have arranged. One train out of 2 trains, train A had 200 membrane replacements in June 1999, and the other train, train B had 200 membrane replacements in February 2000. In addition, there were 9-membrane cartridge replacement in train A and 17-membrane cartridge replacement in April 2003 after the careful membrane inspection.

Therefore, up until now in January 2006, average membrane replacement period is determined as follows:

（2006/1 － 1999/6） in other words, 6.6-year x (200 -9)
（2006/1 － 2000/2） in other words, 5.9-year x (200 -17)
＋（2006/1 － 2003/4） in other words, 2.75-year x (9 +17)

Average 6.1 years have been past since the last full replacement
and will extend as more time passes

5. Evaluation of Plant Performance

Method of Data Process

Hydraulic data such as flow and water level are taken by logger as well as manually recorded.

Those data are processed in order to quantify membrane performance accordingly:

①Daily Average Flux： determined by weekly permeate flow from operation and maintenance records

②Normalized Trans-membrane Pressure (1/Permeability)＝ TMP／instantaneous Flux

As for the Permeability, one point TMP datum per day, when pump is not suspended, is taken and averaged over a whole week. The instantaneous flux is decided by the setting value used on PID Control in order to control flow rate.

Method of Water Quality Analysis

Permeate sample taken is analyzed accordingly as follows:

TSS	Announcement # 59 Appendix 8 from Environmental Agency (Ministry of the Environment nowadays)
BOD5	JIS K 0102 21,32 .3
CODMn	JIS K 0102 17

6. Operation Data

Weekly Flow Variation

The graph shows how flow varies over a week. There is not much flow on Saturdays and Sundays, when operation goes to Low-Loading Operation where permeate pump and aeration blower output are decreased.

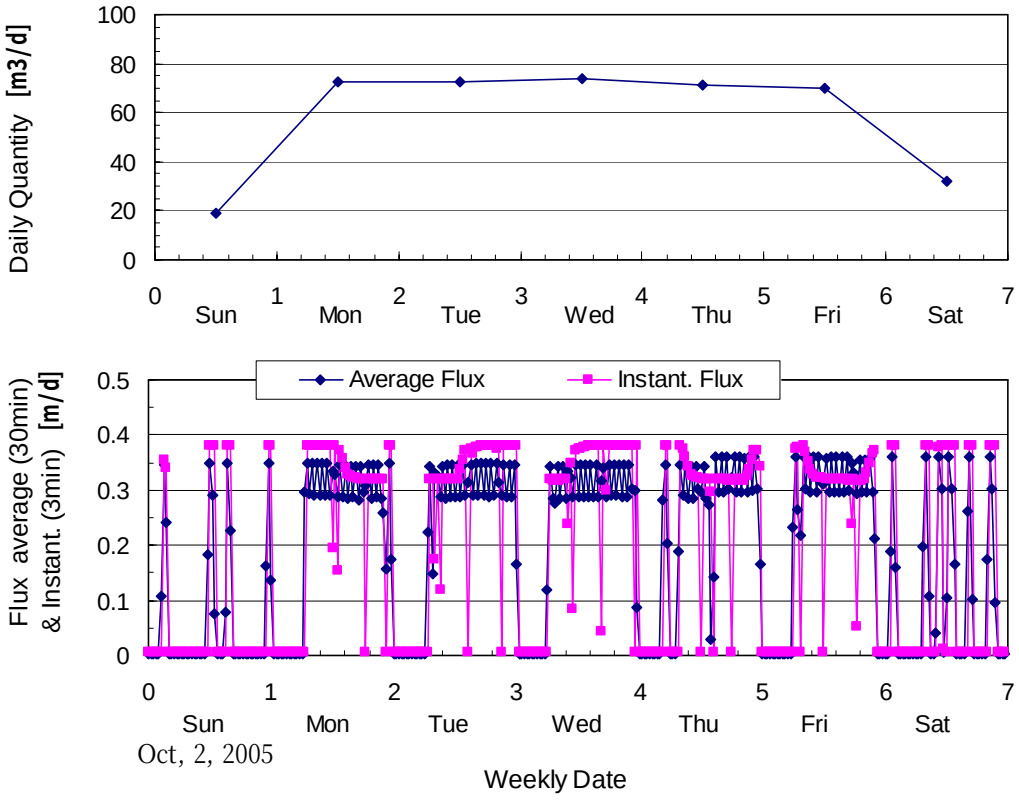

Figure 2. Weekly Variation in a week of Oct. 2～8, 2005

Quantified Membrane Performance of KUBOTA SMU

The following graphs show flow variation, Trans-Membrane Pressure, TMP, of each unit, and normalized Trans-Membrane Pressure (reciprocal of Permeability) since 2002 to December of 2005.

Design flow is 110 m3/d and an average flow is approximately 70 m3/d.

TMP increases as time passes since membrane fouling takes place. The initial TMP

value of 3kPa can increase to more than 20kPa. By performing a Chemical Cleaning to membrane with fouling, TMP can be recovered (in other words, decreased). For reference's sake, a recommended maximum TMP is 20kPa and a recommended time of chemical cleaning is when TMP increases 5kPa from the initial value.

In addition, the chemical cleaning is done separately by each line. The chemical cleaning was done approximately once a year. They were usually done during October and November, which is before low temperature operation period in winter.

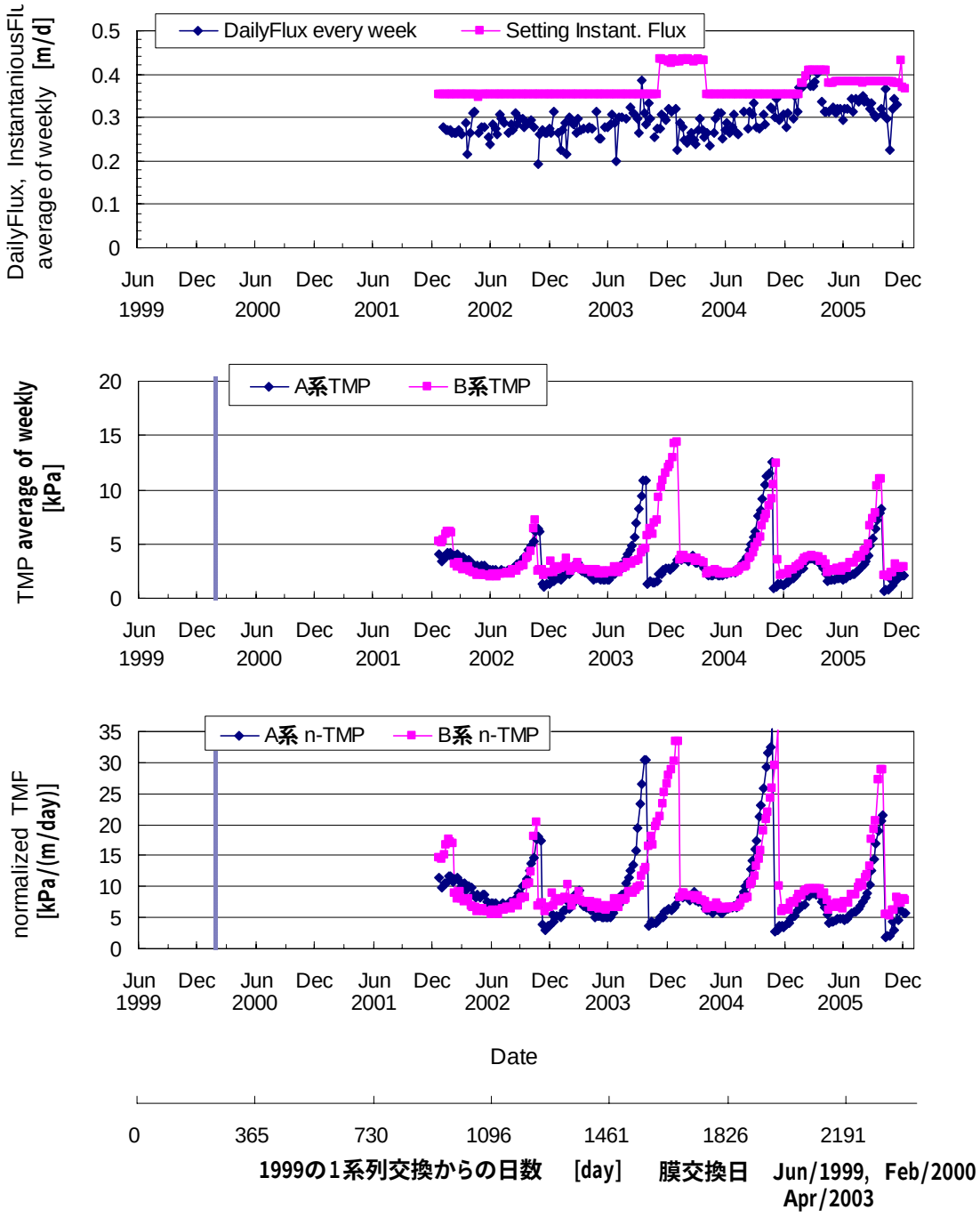

Figure 3. Flux and Membrane Performance in each line

Water Quality of the Plant

The following graphs show water quality (BOD and COD) variation of fed wastewater (Feed) and permeate water (Permeate) from a year of 2001 to March 2005.

Fluctuation of BOD in Raw wastewater showed between 100～600（Avg. 320）and that of CODMn showed 100～500（Avg. 160）. The variation of water quality was in rather abroad range and the water quality itself as domestic wastewater was said to be more contaminated than the average. Treated water quality without any operational problem showed BOD of 2～15 mg/L and CODMn of 10～20 mg/L. As for TSS, it was less than detectable for most of the time. The table follows graphs show a yearly summary of average treated water quality.

In addition, rather high BOD with the average value of even 10 mg/L is observed in this facility. This is because the treatment flow was not design to remove Nitrogen in the first place, so it is concluded that the BOD includes nitrifying BOD coming from T-N, NH4-N left in the system.

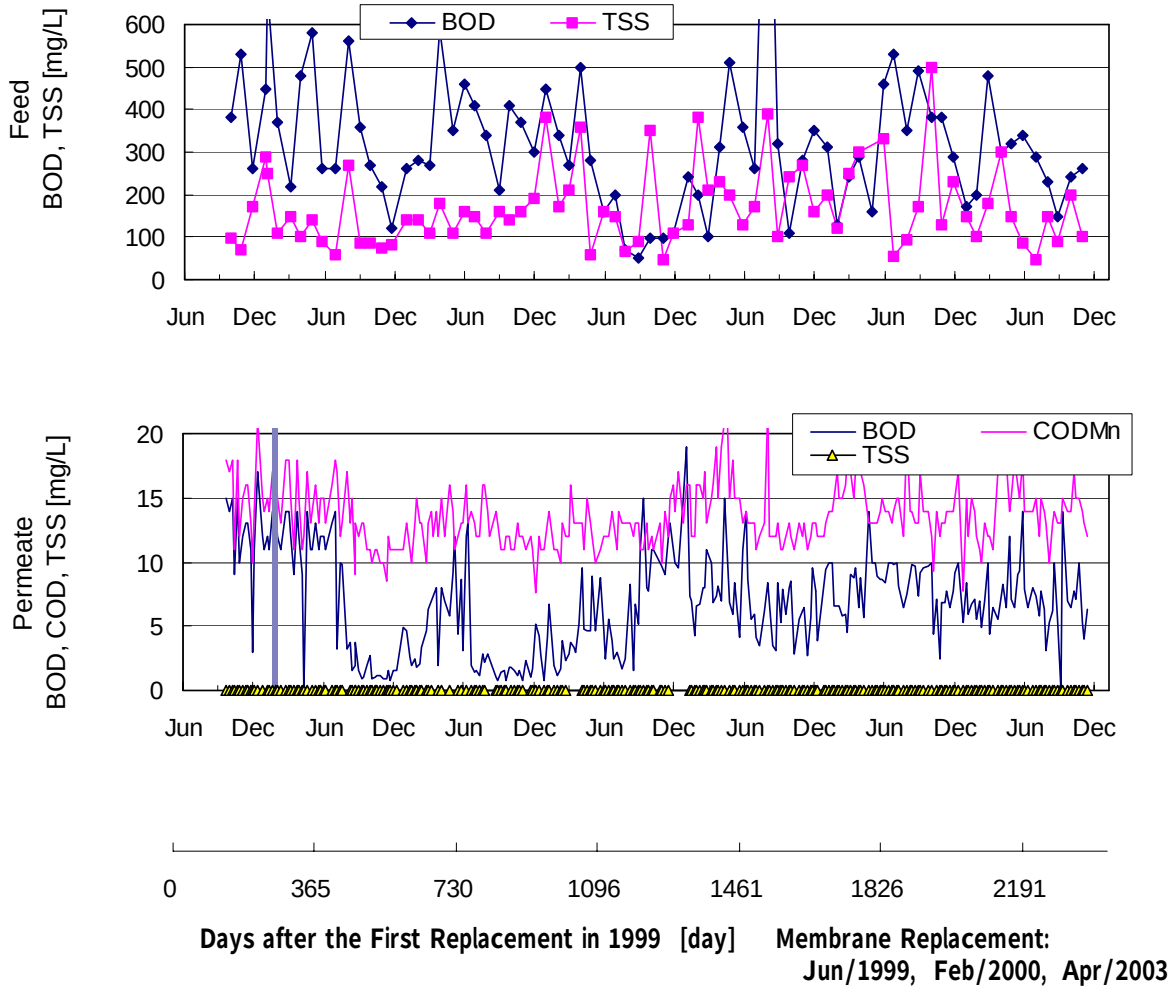

Figure 4. BOD, COD, TSS Variation in Permeate

Table 1. Water Quality Yearly Variation in Permeate

Item / Fiscal year	pH -	BOD mg/L	CODMn mg/L	TSS mg/L	(O&G) n-Hex mg/L
2000	7.37	12.8	15.9	0.08	0.4
2001	7	5.4	12.8	0.07	1.7
2002	6.79	3.6	12.6	0.7(0.1)	1.3
2003	7.04	7.6	13.2	0.33(0)	1.0
2004	7.07	7	14.3	0.03	1.2
2005	6.96	8	13.7	0	1.0

7. Conclusion

In conclusion, the report shows an excellent MBR performance on both membrane lives and treatment ability for more than 5 years. The table below shows the comparison of effluent requirements at Cleveland Bay WFT to our average permeate qualities over 6 years of operation at Sakai Rinkai MBR Facility, which proves that the excellent MBR performance will likely to achieve the effluent requirement at Cleveland Bay.

Criteria	Cleveland Bay Effluent Limit (50%tile)	Average Permeate Quality from Sakai Rinkai MBR Facility
pH	6.5 – 8.5	7.03
BOD	< 10 mg/L	7.4 mg/L
COD	< 50 mg/L	13.75 mg/L (as COD_{Mn})
TSS	< 2 mg/L	0.05mg/L