Membrane Filtration Technology for Drinking Water Treatment & Night Soil Treatment

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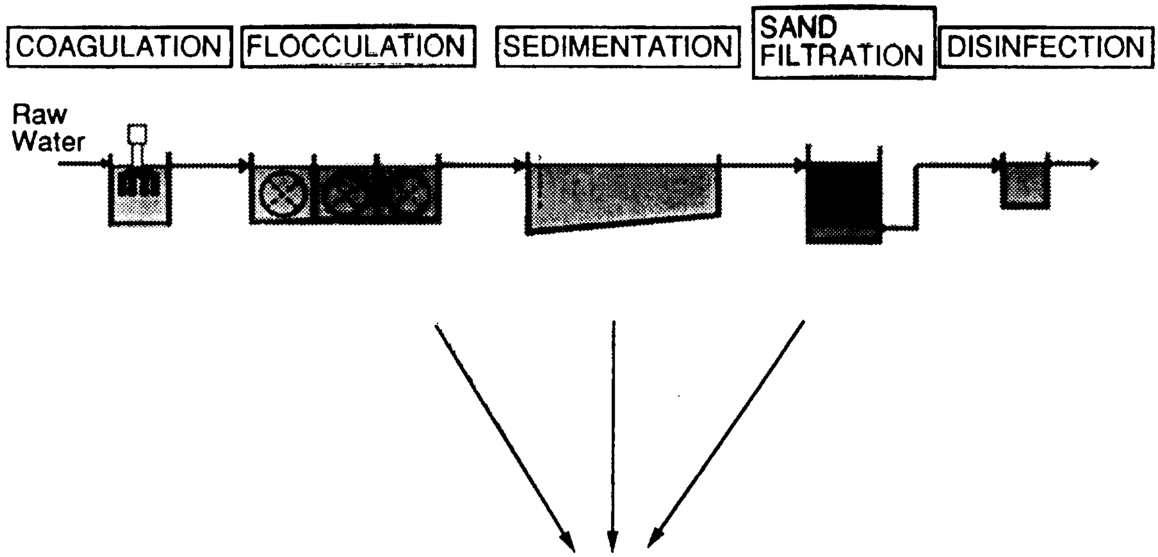
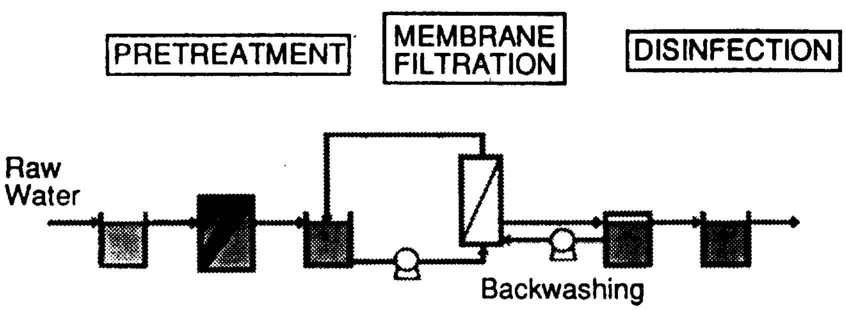
MEMBRANE TREATMENT AND CONVENTIONAL TREATMENT IN DRINKING WATER TREATMENT.

CONVENTIONAL TREATMENT



MEMBRANE TREARTMENT



Membrane Aqua Century 21 (*MAC 21*) Project

Plant Location : Matsudo City, Chiba Prefecture

Raw Water Source : Edo River (Average turbidity: 14 unit)

Number of Experimental Systems : 35

Number of Participating Plant Manufactures : 18

Experimental Period :

First Run : May 1992 to November 1992
Second run : January 1993 to July 1993
Third run : September 1993 to March 1994

Membrane Materials : Organic (28), Inorganic (7)

Membrane Kinds : UF (13), MF (22)

Module Types : Hollow Fiber (26), Multitube (5), Tube (2), Flat Sheet (2)

Table 1 Experimental methods of the thirty-five membrane systems

No.	Module				Operation method			
	Kind	Material	Type[1)]	Skin	Flow type[2)]	Flow control[3)]	Pretreatment[4)]	Others[5)]
Run 1								
1	MF	Inorg	MT	In	F/T	CF/CP	Ind(o)	H-P
2	MF	Org	HF	Out	F	CF	Ind(w)	T-S
3	UF	Org	HF	In	T	CF	Ind(w/o)	H-P
4	MF	Inorg	T	Out	T	CF	Ind(w)	T-S
5	MF	Org	HF	Out	F/T	CF	Ind(w)	H-P
6	UF	Org	HF	In	T	CF	None/Com(w/o)	H-P
7	MF	Org	HF	Out	F	CF	Com(w)	H-P
8	UF	Org	HF	In	T	CF	Ind(o)	H-P
9	MF	Org	HF	Out	F	CF	Ind(w)	H-P
10	MF	Org	HF	Out	T	CF	Ind(w)	H-P
11	MF	Org	HF	Out	F	CF	Ind(o)	H-P
12	MF	Org	HF	In	F	CP	Ind(o)	H-P
Run 2								
13	UF	Org	HF	In	T	CF	Ind(w)	H-P
14	MF	Inorg	T	Out	T	CF	Ind(w)	T-S
15	UF	Org	HF	In	T	CF	Ind(w)	H-P
16	MF	Org	B	Out	F	CF	Com+Ind(w)	T-P
17	MF	Org	HF	Out	F	CF	Ind(o)	H-P
18	MF	Org	HF	Out	T	CF	Ind(w)	H-P
19	UF	Org	HF	In	T	CF	Com/Ind(w/o)	H-P
20	UF	Org	HF	In	T	CF	Ind(o)	H-P
21	UF	Org	HF	In	T	CF	Ind(o)	H-P
22	MF	Inorg	MT	In	F	CF	Ind(w)	H-P
23	UF	Org	HF	Out	F	CF	Ind(w)	H-P
24	UF	Org	HF	In	T	CP	Ind(o)	H-P
Run 3								
25	MF	Inorg	MT	In	T	CF	Ind(w)	T-P
26	MF	Org	HF	Out	F	CF	Ind(w)	T-P/S
27	UF	Inorg	MT	In	T	CF	Ind(w)	H-P
28	MF	Org	HF	Out	T	CF	Ind(w/o)	T-S
29	MF	Org	HF	Out	T	CF	Ind(w)	H-P
30	UF	Org	HF	Out	T	CF	Ind(o)	H-P
31	MF	Org	PF	Out	T	CF	Ind(w)	T-S
32	UF	Org	HF	In	T	CF	Ind(o)	H-P
33	MF	Inorg	MT	In	F	CF	Ind(w)	H-P
34	MF	Org	HF	Out	F	CF	Ind(w)	H-P
35	MF	Org	HF	In	F	CF	Ind(o)	H-P

1) "HF": hollow fiber, "T": tube, "MT": multitube, "PF": plate and frame, "B": bag.
2) "T": crossflow, "F": deadend.
3) "CF": constant flow, "CP": constant pressure.
4) "Com": coagulation and sedimantation by the common pretreatment facility, "Ind": individual pretreatment in each membrane plant, "w": coagulation with polyaluminum chloride, "o": without coagulation.

MAJOR PROBLEM OF MEMBRANE PROCESS

MEMBRANE FOULING

[Organic and inorganic substances in raw water absorb into membrane pores and deposit on membrane surface.]

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REDUCTION IN PERMEATE FLUX

METHOD FOR FOULING CONTROL

1. SUITABLE MEMBRANE MATERIAL
2. SUITABLE OPERATING CONDITIONS

IN THIS STUDY

1. Performed UF of river water by using two types of UF hollow fiber membranes: hydrophilic membrane and hydrophobic membrane.
2. Investigated the effects of membrane material, operating conditions and raw water quality on the filtration behavior.

Hollow fiber membranes used in this study

	CA	PES
Hollow fiber material	Cellulose acetate	Polyethersulfone
Molecular weight cut-off	150000	30000
I.D./O.D. of hollow fiber (mm)	0.8/1.3	0.8/1.3
Filtration area (m2)	0.14	0.14
Hydrophilicity	Hydrophilic	Hydrophobic
Contact Angle	55~60	65~70
Water absorption (%)	1.7~6.5	0.43
Adsorption of BSA (mg/m2 at pH 7)	0.5	3.5
Zeta potential (mV at pH7)	-30	-4.2

EFFECT OF MEMBRANE MATERIAL

Backwashing	A	B	C
Interval (min)	30	30	30
Duration (s)	20	45	70

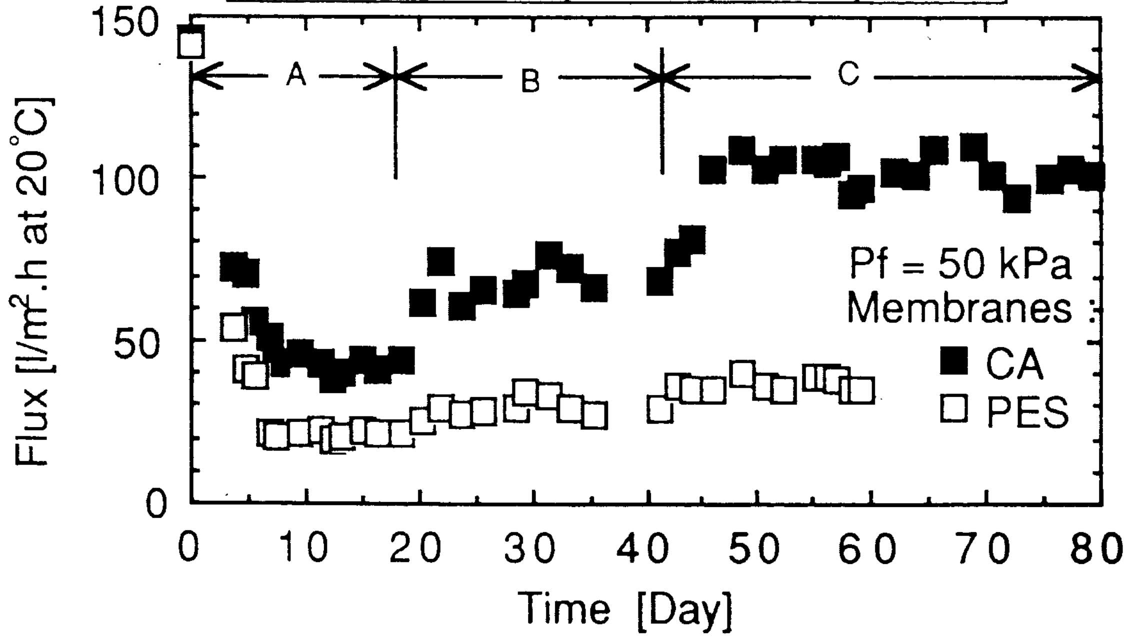


Figure UF flux vs. time, for hydrophilic cellulose acetae (CA) and hydrophobic polyethersulfone (PES) membranes.

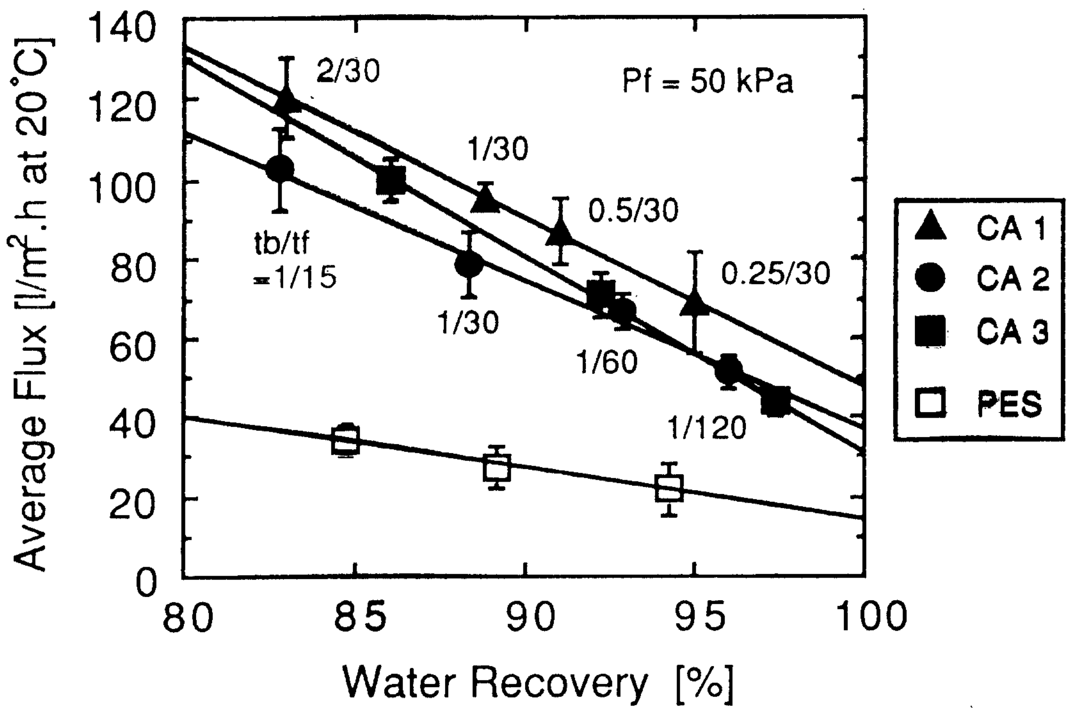
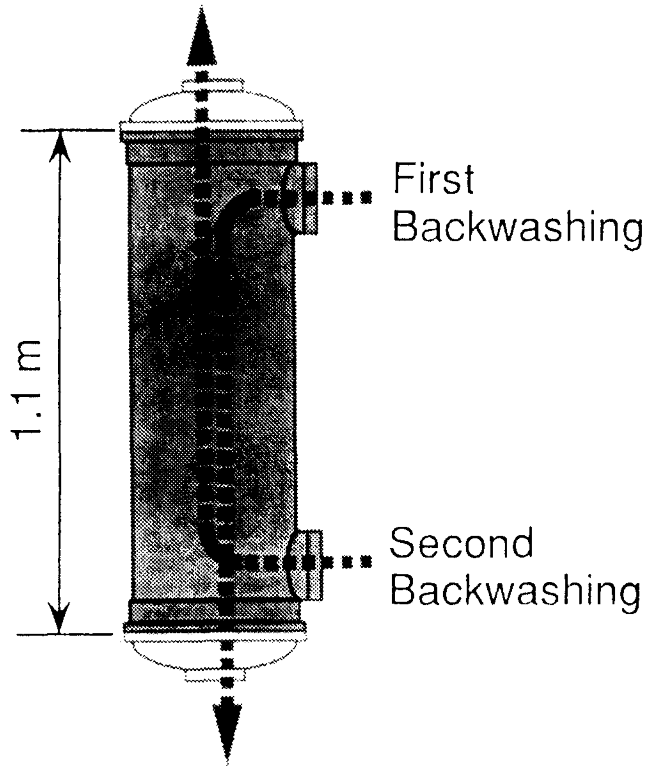


Figure Effect of water recovery on the fluxes for CA and PES membranes. (tb : Backwash duration tf : Backwash Interval)



Membrane Area	50 m^2
Module Length	1.1 m
Module Diameter	0.3 m

Figure Two steps backwashing configuration for large-sized hollow fiber membrane module

CONCLUSIONS

(1) The flux for hydrophilic CA membrane is higher than that for hydrophobic PES membrane at any operating conditions. The difference in both fluxes becomes greater as the water recovery is lower.

(2) Backwash pressure should be more than twice as high as filtration pressure in order to maintain the higher flux. Backwash frequency is independent of the flux when the UF is operated under the same water recovery.

(3) The relatively lower crossflow velocity of around 0.1 m/s would be appropriate because of the lower energy consumption per treated water.

(4) The membrane fouling occurring at high turbidity and high concentration of organic compounds in raw water can reduce the flux and increase the removal of the organic compounds.

(5) It is confirmed by the pilot plant testing that the UF by using the CA membrane module was well applicable to the drinking water treatment.

PILOT PLANT UF TEST

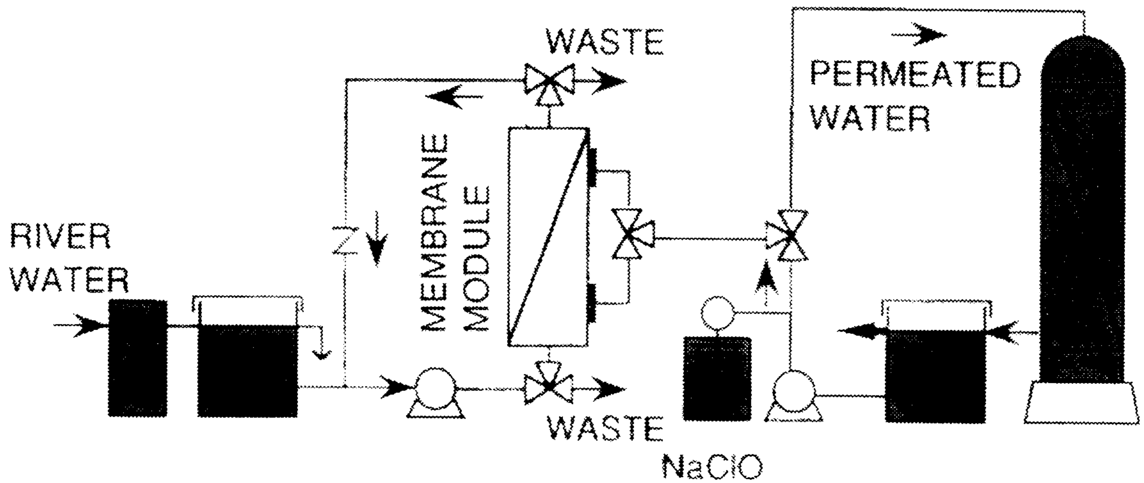


Figure Schematic diagram of the pilot plant test by using large-sized membrane module

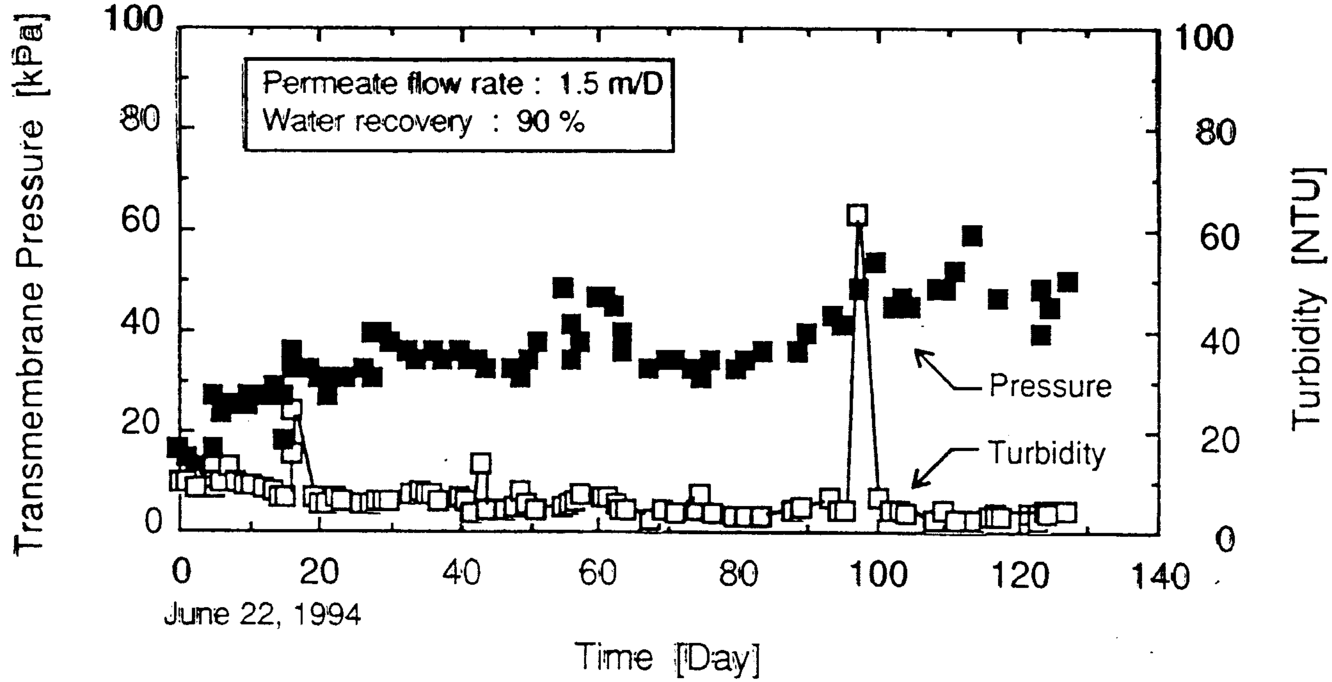


Figure Transmembrane pressure and raw water turbidity vs. time, for test plant of large-sized CA membrane module with 50 m^2 membrane area.

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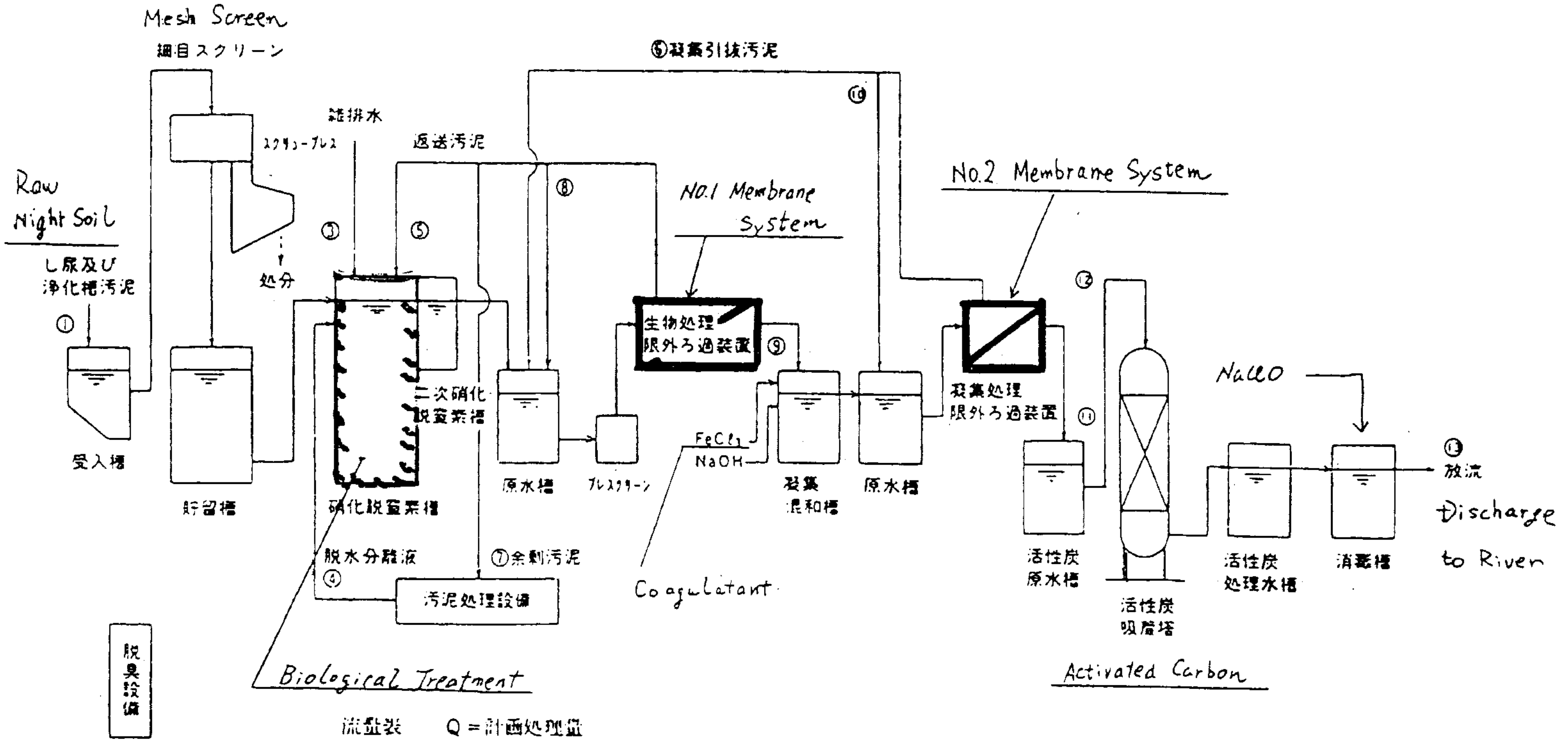
Flow of Typical "Night Soil" Treatment



流量表　　Q＝計画処理量

番号	①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬
1日当たりの処理量 m³／日	1 Q	1 Q	0.5Q	0.4Q	3 Q	0.2Q	0.4Q	45 Q	1.7Q	30 Q	1.5Q	1.5Q	1.5Q

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Water Quality for Night Soil Treatment

Item	Raw NIGHT SOIL	No1 Membrane (BIOLOGICAL TREATMENT)	No2 Membrane (COAGULATION TREATMENT)	Activated Carbon
pH (−)	7~8	6~8	5~6	6~8
MLSS (mg/l)	14,000	N. D.	N. D.	N. D.
BOD (mg/l)	11,000	10>	10>	10>
COD (mg/l)	6,500	100~300	60~100	10>
T−N (mg/l)	4,200	20~35	10~15	10>
T−P (mg/l)	480	80~100	1	1>
Color (−)	not measure	2,000	150	30>

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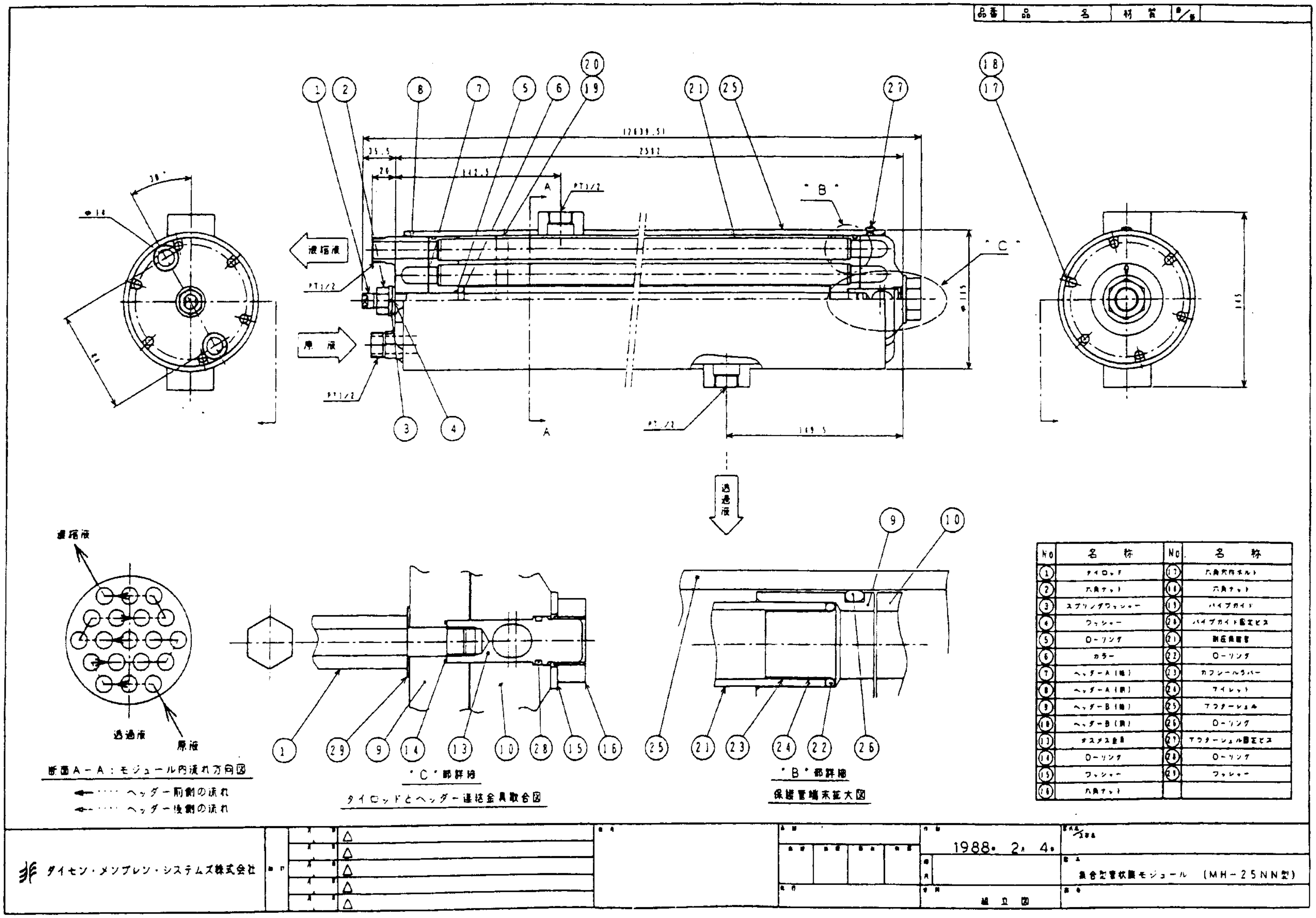

No	名称	No.	名称
1	タイロッド	17	六角穴付ボルト
2	六角ナット	18	六角ナット
3	スプリングワッシャー	19	パイプガイド
4	ワッシャー	20	パイプガイド固定ビス
5	O－リング	21	耐圧保護管
6	カラー	22	O－リング
7	ヘッダーA (軸)	23	カプシールラバー
8	ヘッダーA (胴)	24	アイレット
9	ヘッダーB (軸)	25	アウターシェル
10	ヘッダーB (胴)	26	O－リング
11	オスメス金具	27	アウターシェル固定ビス
14	O－リング	28	O－リング
15	ワッシャー	29	ワッシャー
16	六角ナット		