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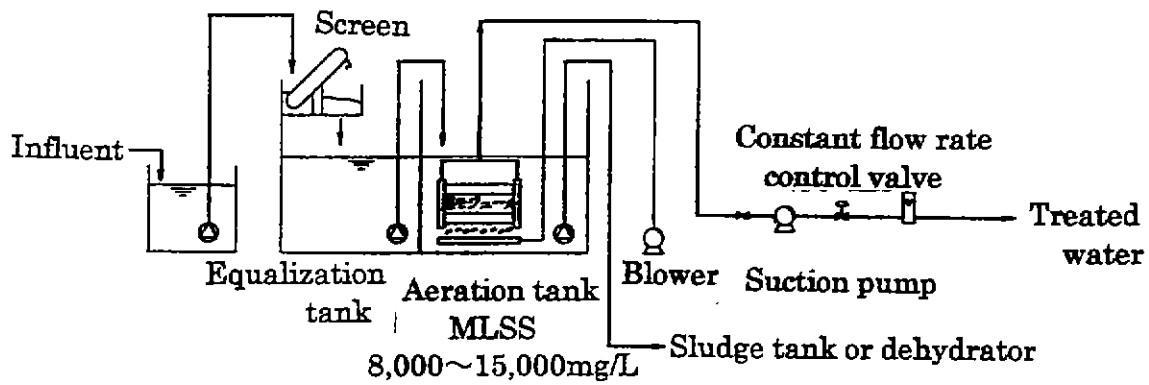
Plants for Wastewater Treatment with  
Tank-submerged Type Filter Unit  
Composed of Hollow Fiber Membrane

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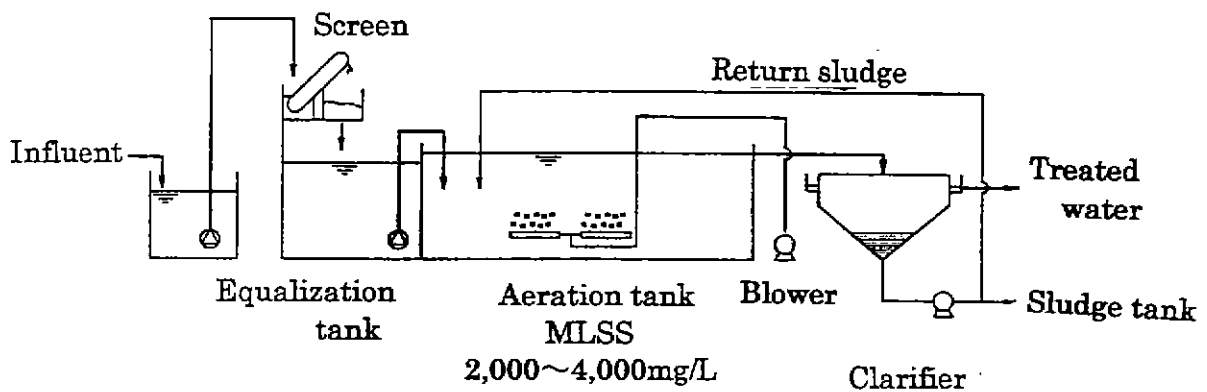
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角田 務 次長(Mitsubishi rayon)

**WASTEWATER TREATMENT PLANT  
 WITH TANK-SUBMERGED UNITS SYSTEM  
 COMPOSED OF HOLLOW FIBER  
 MEMBRANE**



(conventional activated sludge system)



## **DISTINCTIVE FEATURES OF SUBMERGED HOLLOW FIBER MEMBRANE SYSTEM**

**This system is superior to conventional activated sludge methods at following points .**

### **1.Space for installation of plants**

- 1)Concentration of MLSS can be increased up to 15,000mg/L . That is 3 to 5 times higher than that of the conventional system . So the aeration tank volume can be drastically reduced.**
- 2)No sedimentation tank is required because MLSS is separated from clarified wastewater not by sedimentation tanks but by hollow fiber membranes.**

### **2.Cost**

- 1)Existing plants are easily upgraded to improve the treated capacity by this system.**
- 2)Cost of construction is reduced owing to the smaller space for installation**

### **3. Quality of treated water**

- 1)Excellent, virtually solids free ,effluent qualities can be achieved by hollow fiber membranes with particle cut off 0.4  $\mu$  m.**
- 2)When hollow fibers are cut off by accident , quality of treated water is kept clean by the phenomena of hollow fiber self-clogging with suspended solids.**

### **4.Maintenance**

- 1)No sedimentation tank is required. That leads to easy maintenance because this system needs no attention to sludge sedimentation conditions .**
- 2)Operation of plants can be done even with the presence of bulky floc like of fibrous bacteria .**
- 3)Wastewater with high concentration can be treated without dilution .**

**WASTEWATER TREATMENT PLANTS WITH SUBMERGED HOLLOW FIBER  
MEMBRANE SYSTEM**

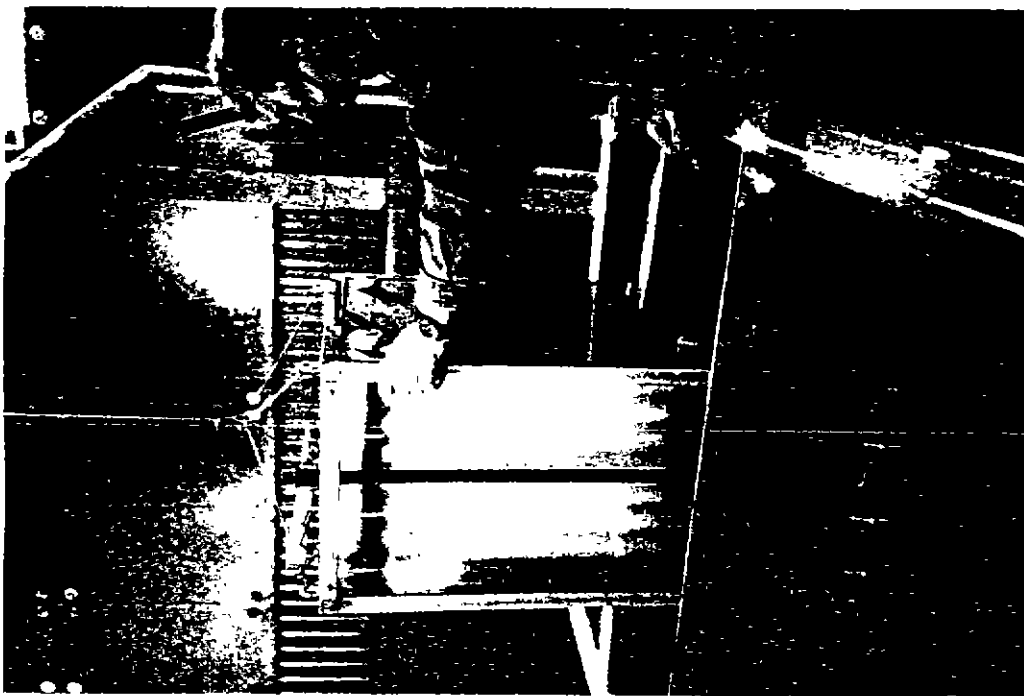
1. NUMBER OF PLANTS INSTALLED FROM 1992      500 PLANTS  
2. AMOUNT OF TREATED WATER      50,000m<sup>3</sup>/day IN TOTAL

THE FIELD WHERE THIS SYSTEM BEING USED	PERCENTAGE OF NUMBER OF PLANTS (%)	TREATED WASTEWATER OF THE BIGGEST PLANT (m <sup>3</sup> /DAY)
1. Domestic sewage plant	28	1000
2. Food processing industry (tofu,soysuce,soybean paste,boiled fish paste,etc)	THE	1500
3. Beverage (beer,sake)	9	300
4. Food producing industry (noodles,bean jam,sesame seed,etc)	7	750
5. Artificial dialysis	7	30
6. Dairy product industry	6	80
7. Marine product industry (scallops,fish,etc)	5	200
8. Meat processing industry	4	100
9. Catering business	4	50
10. Livestock breeding industry	3	40
11. Confectionery industry	2	1000
12. others (gray water,cleaning plant,compost plant)	8	450

**QUALITY OF WASTEWATER TREATED BY SUBMERGED HOLLOW FIBER MEMBRANE SYSTEM**

KIND OF WASTEWATER	AMOUNT OF WATER (m <sup>3</sup> /day)	RAW WATER(mg/L)			TREATED WATER(mg/L)		
		BOD	SS	T-N	BOD	SS	T-N
1.Noodle producing plant wastewater	750	1,000	150	50	2	2	1
2.Confectionery wastewater	250	5,000	200	90	1	1	15
3.Ice cream plant wastewater	1,000	2,000		50	3	1	1
4.Beer brewery wastewater	300	1,000	69	42	5.4	1	34
5.Milk and plum processing wastewater	27	1,500	200	70	2	2	
6.Pig breeding wastewater	50	18,000	12,000	3,100	14	1	60
7.Domestic sewage	56	190	111	40	1.5	1	18

AN EXAMPLE OF THE PROCEDURE FOR SUBMERGED  
MEMBRANE SYSTEM



SETTING THE UNITS INTO  
AN AERATION TANK



LIFTING UP MEMBRANE  
UNITS



PLACED THE UNITS  
IN THE TANK

SEEDING ACTIVATED SLUDGE  
INTO THE TANK  
(MLSS MORE THAN 3,000mg/L)





**LIST OF PLANTS TREATING LIVESTOCK WASTEWATER WITH  
SUBMERGED HOLLOW FIBER MEMBRANE SYSTEM**

No	CUSTOMER	LOCATION (PREFECTURE)	START OF OPERATION	PIG OR COW	TREATED WATER	
					(m <sup>3</sup> /day)	BOD(mg/L)
1	H livestock breeder	miyagi	1994	pig	25	3,000
2	A stock farm	gunnma	1995	cow(milking)	6	2,000
3	F stock farm	fukushima	1996	pig	12	2,000
4	AT stock farm	mie	1996	cow(milking)	18	2,000
5	O stock farm	nagano	1996	cow(milking)	3	2,000
6	T pig farm	gunnma	1996	pig	12	8,000
7	OU stock farm	aichi	1997	cow(milking)	8	2,000
8	S pig farm	kumamoto	1997	pig	30	8,000
9	HA livestock breeder	akita	1997	pig	50	
10	SA livestock breeder	miyagi	1997	pig	60	18,000
11	AK livestock breeder	akita	1998	pig	50	
12	Y stock farm	akita	1998	cow	10	
13	SH stock farm	gifu	1998	cow(milking)	9	5,000
14	HK livestock breeder	gunnma	1999	pig	10	
15	JA livestock breeder	fukuoka	1999	pig	30	
16	SH pig farm	ibaragi	1999	pig	7	6,300
17	FD livestock breeder	gunnma	2000	pig	80	
18	GD livestock breeder	gunnma	2000	pig	40	
19	K stock farm	shizuoka	2000	cow(milking)	16	3,000

**LIST OF PLANTS TREATING TOFU WASTEWATER WITH  
SUBMERGED HOLLOW FIBER MEMBRANE SYSTEM**

No	CUSTOMER	TEATED WATER	START OF OPERATION	LOCATION
		(m3/day)		
1	S tofumaker	750	2000	shizuoka
2	H tofumaker	30	1999	kumamoto
3	G food company	100	1998	gunnma
4	I foodmaker	7	1998	ehime
5	B dennshuukann	3	1998	ehime
6	M tofucenter	70	1998	chiba
7	A coop.	5	1998	yamaguchi
8	M food company	750	1998	shizuoka
9	E trade company	200	1997	ibaragi
10	S tofumaker	750	1997	shizuoka
11	M food company	600	1997	shizuoka
12	K food processingcompany	15	1996	kumamoto

**RE-USE OF TREATED WATER FROM LANTS WITH  
SUBMERGED HOLLOW FIBER MEMBRANE SYSTEM**

No	CUSTOMER	TREATED WATER		REUSE PURPOSE	REMARKS
			(m <sup>3</sup> /day)		
1	H hotel		350	restored stream	
2	K cleaning		136	cleaning water	reverse osmosis
3	A company		40	flush water	
4	S center		7	flush water	
5	I market		50	flush water	
6	H office		21	flush water	
7	N cleaning		288	cleaning water	reverse osmosis
8	K station		120	flush water	
9	S office		25	flush water	
10	S tofumaker		750	cooling tower	
11	E hotel		450	flush water,water spray	
12	N foodmaker		140	boiler,floor cleaning	reverse osmosis

## The Experiences of Industrial Wastewater Treatment system

Mitsubishi Rayon Co., Ltd.

number	start of operation year, month	customers	location (prefecture)	facilities	discharge volume (m3/day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
1	92.11	K company	Saitama		20		
2	92.11	E company	Chiba		75		
3	93.04	E company	Kanagawa		10		
4	93.04	O company	Okinawa		5		
5	93.07	T company	Nagano		6		
6	93.07	M company	Ibaraki		25		
7	93.08	O company	Okinawa		5		
8	93.09	O company	Okinawa		5		
9	93.10	H company	Hyougo		100		
10	93.12	H company	Kanagawa		10		
11	93.12	H company	Kanagawa		35		
12	93.12	R company	Shiga		15		
13	94.01	T company	Shiga		8		
14	94.02	M company	Nagano		6		
15	94.02	Y company	Kyoto		12		
16	94.03	H company	Hyougo		6		
17	94.03	T company	Hyougo		6		
18	94.03	H company	Fukuoka		10		
19	94.04	H company	Hyougo		17		
20	94.04	E company	Tokyo		8		
21	94.04	E company	Ibaraki		45		
22	94.05	T company	Ibaraki		4		
23	94.05	H company	Hyougo		4		

number	start of operation year, month	customers	location (prefecture)	facilities	discharge volume (m <sup>3</sup> /day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
24	94.07	D company	Ehime		15		
25	94.07	Y company	Shimane		20		
26	94.07	E company	Mie		45		
27	94.07	Y company	Chiba		25		
28	94.08	A company	Ishikawa		25		
29	94.09	T company	Fukuoka		5		
30	94.09	O company	Osaka		5		
31	94.09	D company	Mie	stockbreeding wastewater	35		
32	94.09	H company	Ibaraki	snack factory wastewater	6	800	20
33	94.09	E company	Mie	egg plant wastewater	45	2,500	MAX.15
34	94.11	T company	Tokyo		12		
35	94.11	D company	Ehime		12		
36	94.12	F company	Aichi		5		
37	94.12	I company	Aichi		5		
38	95.01	E company	Ibaraki		12		
39	95.01	S company	Mie		2		
40	95.01	T company	Chiba		6		
41	95.01	D company	Chiba		13		
42	95.01	K company	Chiba		12		
43	95.02	E company	Kanagawa		17		
44	95.03	T company	Fukuoka		6		
45	95.03	S company	Tokyo		4		
46	95.03	E company	Kanagawa		20		
47	95.03	M company	Kanagawa		32		
48	95.05	D company	Kumamoto	combine type johkasou	54		

number	start of operation year, month	customers	location (prefecture)	facilities	discharge volume (m3/day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
49	95.05	D company	Ehime		30		
50	95.05	D company	Ehime	food plant wastewater	27		
51	95.05	D company	Ehime	food plant wastewater	12		
52	95.05	D company	Ehime	food plant wastewater	5		
53	95.05	D company	Ehime	food plant wastewater	12		
54	95.06	E company	Yamaguchi	food plant wastewater	55		
55	95.06	S company	Kouci	aloe factory wastewater	50	500	5
56	95.07	T company	Fukushima	food plant wastewater	8		
57	95.07	K company	Chiba	combine type johkasou	12		
58	95.07	A company	Ishikawa	combine type johkasou	20		
59	95.08	M company	Kanagawa	regenerated water	4		
60	95.09	D company	Nagano	food plant wastewater	35		
61	95.09	E company	Tokyo	food plant wastewater	115		
62	95.09	S company	Ehime	food plant wastewater	10		
63	95.09	U company	Ehime	beer brewery wastewater	30	1,400	10
64	95.09	E company	Saitama		30		
65	95.10	A company	Aomori	food plant wastewater	55	2,000	10
66	95.10	E company	Tokyo	food plant wastewater	6		
67	95.10	M company	Kanagawa	regenerated water	4		
68	95.11	B company	Fukushima	food plant wastewater	46		
69	95.11	D company	Hiroshima	fertilizer plant wastewater	23	1,350	30
70	95.11	A company	Nagano	stockbreeding wastewater	10		
71	95.11	K company	Nagano	stockbreeding wastewater	10		
72	95.11	I company	Ehime	food plant wastewater	8		
73	95.12	S company	Tokyo	industrial wastewater	15		

number	start of operation year/month	customer	location (prefecture)	facilities	discharge volume (m <sup>3</sup> /day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
74	95.12	T company	Ehime	industrial wastewater	30		
75	95.12	S company	Nagano	SAKE plant wastewater	40	840	30
76	95.12	D company	Kagoshima	stockbreeding wastewater	15	3,700	120
77	95.12	S company	Yamaguchi	fish paste factory wastewater	95	500	20
78	95.12	D company	fukushima	industrial wastewater	23		
79	95.12	D company	Yamaguchi	food plant wastewater	13		
80	96.01	D company	Chiba	needle plant wastewater	1,000	1,000	10
81	95	J company	Gumman	stockbreeding wastewater	6	2,000	20
82	95	A stock farm	Gumman	stockbreeding wastewater	6	2,000	20
83	95	J company	Ibaraki	chicken factory wastewater	21	1,900	10
84	95	K company	Ibaraki	fermented soybeans factory wastewater	30	2,400	20
85	96	S company	Ibaraki	mustard factory wastewater	40	4,500	10
86	95	Y company	Gifu	wastewater from plum washing	8	3,000	60
87	95	O company	Okayama	marine products wastewater	15	1,500	20
88	96	I company	Ibaraki	foodindustry wastewater	200	1,200	10
89	96	K company	Kumamoto	bean curd wastewater	15	1,380	10
90	95	C company	Ehime	marine products wastewater	7	600	120
91	96	I company	Ehime	beer brewery wastewater	32	1,400	10
92	96	S company	Yamaguchi	ice-cream factory wastewater	1,000	2,000	10
93	96	O stock farm	Aichi	wastewater from chicken farm	40	570	10
94	96	K company	Ehime	meat plant wastewater	3	750	20
95	96	S company	Yamaguchi	food plant wastewater	5	800	20
96	96	K company	Ibaraki	chicken factory wastewater	25	1,200	20
97	96	F company	fukushima	wastewater from pigpen	12	2,000	20
98	96	M hospital	Kanagawa	waste water from artificial kidney	18	1,200	20

number	start of operation year, month	customers	location (prefecture)	facilities	discharge volume (m <sup>3</sup> /day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
99	96	S company	Aichi	needle plant wastewater	750	650	10
100	96	J company	Ibaragi	wastewater from reclaimed land	12	50	15
101	96	J company	Yamaguchi	fish paste factory wastewater	120	500	50
102	96	T company	Hyougo	wastewater from kitchen	10	800	5
103	96	T company	Ehime	miso factory wastewater	17	2,800	10
104	96	T company	Kouci	daily dishes wastewater	100	2,000	20
105	96	H company	Kyoto	miso factory wastewater	132	3,500	20
106	96	N company	Ehime	kitchen wastewater	10	350	10
107	96	A company	Ehime	confectionery factory wastewater	250	3,000	10
108	96	Y company	Ehime	restaurant wastewater	140	600	30
109	96	T company	Miyagi	wastewater from pigpen	6	10,000	50
110	96	H company	Ibaraki	wastewater from dining room	40	450	10
111	96	O stock farm	Mie	stockbreeding wastewater	18	2,000	60
112	96	T company	Kumamoto	meat products wastewater	5	1,500	20
113	96	O stock farm	Nagano	stockbreeding wastewater	3	2,000	20
114	96	S company	Fukuoka	food products wastewater	3	1,000	20
115	96	Y stock farm	Gumman	stockbreeding wastewater	3	2,000	20
116	96	M company	Hiroshima	kitchen wastewater	4	800	20
117	96	A company	Hiroshima	food products wastewater	30	500	20
118	96	O company	Tottori	beer brewery wastewater	10	1,500	60
119	96	H company	Hiroshima	bean jam factory wastewater	45	3,200	20
120	96	K company	Saga	miso factory wastewater	10	4,000	20
121	96.07	T hospital	Kagawa	combine type johkasou	120		
122	96.07	N company	Tokyo	combine type johkasou	32		
123	96.08	F company	Chiba	industrial wastewater	36		



number	start of operation (year, month)	customers	location (prefecture)	facilities	discharge volume (m <sup>3</sup> /day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
124	96.09	A institution	Chiba	river water purification	96		
125	96.10	A company	Tokyo	combine type johkasou	48		
126	96.10	T company	Aichi	food products wastewater	60		
127	96.11	M company	Tokyo	milk plant wastewater	16		
128	96.12	T company	Tokyo	combine type johkasou	4		
129	96	M department store	Tokyo	regenerated water	100		
130	96	H hotel	Tokyo	regenerated water	300		
131	96	P building	Chiba	regenerated water	460		
132	95	H company	Tokyo	regenerated water	10		
133	95	S company	Tokyo	regenerated water	120		
134	95	M company	Kanagawa	wastewater treatment	3		
135	96	M company	Aichi	household wastewater	50		
136	96	U civil hall	Okinawa	regenerated water	25		
137	96	N company	Fukuoka	regenerated water	2		
138	94	I company	Chiba	household wastewater			
139	95	I company	Aichi	household wastewater			
140	95	U civil hall	Mie	combine type johkasou			
141	95	H corporation	Gumman	milk plant wastewater			
142	96	M company	Kanagawa	meat products wastewater			
143	96	E company	Aichi	combine type johkasou			
144	97	T company	Gifu	beer brewery wastewater	350		
145	97	G company	Kumamoto	beer brewery wastewater	350		
147	97.03	( ) ranch	Aichi	milk plant wastewater	8	2,000	20
148	97.01	J company	Ehime	waste water from plant of daily dishes	10	800	20
149	97.06	N hospital	Kagoshima	waste water from artificial kidney	12	1,200	20

number	start of operation year, month	customers	location (prefecture)	facilities	discharge volume (m3/day)	raw water quality BOD(ppm)	treated water quality BOD(ppm)
175	97.06	Y company	Yamaguchi	beer brewery wastewater	20	1,200	20
176	97	S corporation	Gumma	milk plant wastewater	80	800	20
177	97.03	S company	Shiga	beer brewery wastewater	10	1,400	15
178	97.03	M company	Kagawa	waste water from plant of daily dishes	300	500	5
179	97	B company	Kumamoto	stockbreeding wastewater	30	8,000	100
180	97	A hospital	Kumamoto	waste water from artificial kidney	5	1,500	20
181	97.09	S company	Chiba	combine type johkasou	10	200	5
182	98.03	S company	Wakayama	combine type johkasou	840	200	5
183	98.03	S company	Hyogo	combine type johkasou	142	200	5
184	98.03	Y town	Shiga	combine type johkasou	110	200	5
185	98.06	A company	Okinawa	combine type johkasou	450	200	5
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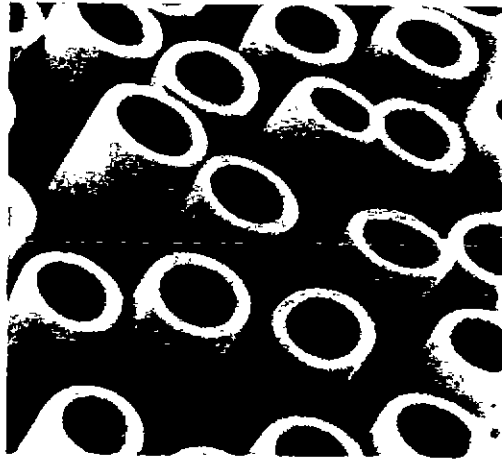
number	start of operation (year/month)	customers	location (prefecture)	facilities	discharge volume (m <sup>3</sup> /day)	raw water quality (BOD(ppm))	treated water quality (BOD(ppm))
150	97.02	S company	Tochigi	beans paste plant	20	2,800	20
151	97.03	T university	Tochigi	stockbreeding wastewater	4	3,100	20
152	97.03	I ranch	Fukuoka	milk plant wastewater	10	1,800	20
153	97.02	A ranch	Gumma	stockbreeding wastewater	12	8,000	80
154	97.09	S center	Kumamoto	waste water from kitchen	13	600	20
155	97.03	C company	Miyagi	waste water from sea food plant	40	1,000	20
156	97	K company	Wakayama	egg plant wastewater	120	1,700	20
157	97	H company	Ehime	fish paste factory wastewater	30	1,200	60
158	97.07	H hospital	Kumamoto	waste water from hospital	30	1,500	20
159	97	M ranch	Yamaguchi	milk plant wastewater	3	2,000	20
160	97	K hospital	Kohch	waste water from artificial kidney	12	800	20
161	97	F company	Ehime	various waste water	50	600	20
162	97.04	M company	Shizuoka	beans paste plant	600	870	15
163	97	T company	Hokkaido	compost plant	10	1,000	20
164	97	O company	Fukushima	bean jam factory wastewater	1	2,400	50
165	97	B company	Saitama	regenerated water	3	325	5
166	97.03	M company	Aomori	sea food plant	200	2,300	120
167	97	D company	Saitama	waste water of rice washing	20	2,000	20
168	97	A company	Akita	beer brewery wastewater	27	750	30
169	97	Y company	Yamaguchi	cooling oil plant	10	800	20
170	97	M hospital	Kohchi	waste water from artificial kidney	6	1,500	20
171	97.05	G company	Gifu	beer brewery wastewater	300	2,000	10
172	97.05	G company	Kumamoto	beer brewery wastewater	300	2,000	10
173	97.06	S company	Kumamoto	cooking oil plant	15	900	20
174	97.06	M company	Iwate	beer brewery wastewater	3	3,000	3

The Experiences of Industrial Wastewater Treatment System

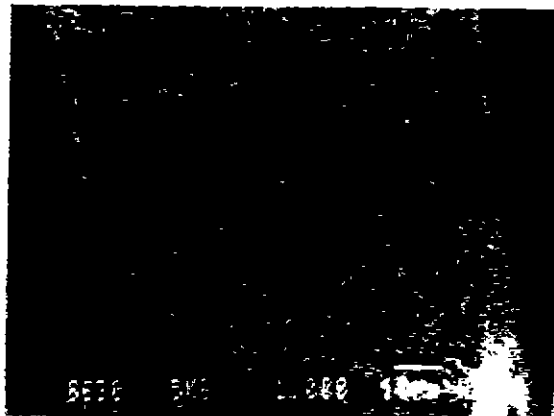
Mitsubishi Rayon co.,ltd

number	start of operation year,month	customers	facilities	discharge volume m3/day	raw water quality BOD(ppm)	treated water quality BOD(ppm)	remarks
186	97.09		household wastewater	50			
187	97.09		school wastewater	42			
188	97.09		food plant factory	80			
189	97.09		food products factory	91			
190	97.10		combine type Johkasou	35			
191	97.10		milk plant wastewater	65			
192	97.10		chemical factory wastewater	20			
193	97.10		johkasou	17			
194	97.10		industrial wastewater	50			
195	97.11		johkasou	300			
196	97.11		marine products factory	17			
197	97.11		medicine plant	26			
198	97.11		food products factory	38			
199	97.11		household wastewater	20			
200	97.12		bean curd plant	30			
201	97.12		food products factory	38			
202	97.12		household wastewater	34			
203	97.12		food products factory	57			
204	97.12		pig farm wastewater	76			
205	97.12		wastewater after car wash	13			
206	97.12		food products factory	10			
207	97.12		combine type Johkasou	100			
208	97.12		combine type Johkasou	40			
209	97.12		industrial wastewater	290			
210	98.01		soy sause plant wastewater	29			
211	98.01		car parts products wastewater	550			
212	98.01		pig farm wastewater	8			
213	98.01		cosmetic plant wastewater	8			
214	98.01		river water purification	17			
215	98.01		combine type Johkasou from hotel	84			
216	98.01		food products factory	101			
217	98.01		pig farm wastewater	10			
218	98.01		wine plant wastewater	17			
219	98.01		wastewater from dairy kitchen	50			

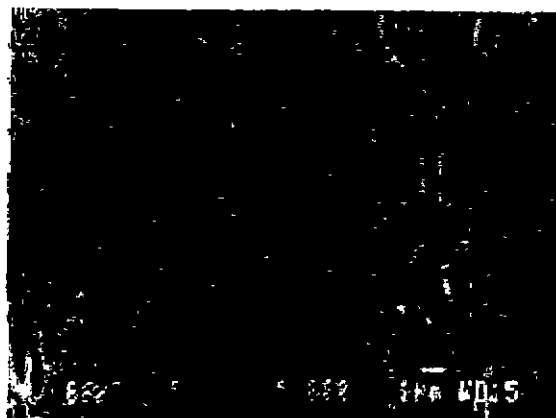




**cross section of hollow fiber(X50)**



**cross section of hollow fiber wall(X1000)**



**surface of hollow fiber(X5000)**

## CONDITIONS OF PLACING UNITS IN THE AERATION TANK

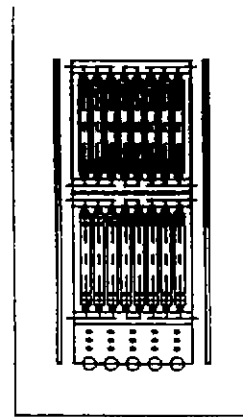
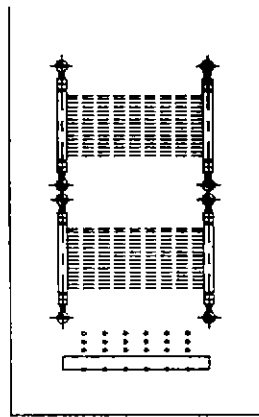
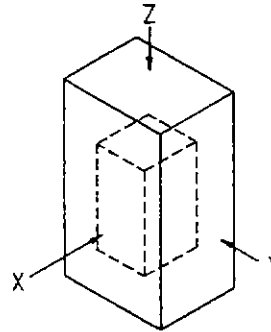
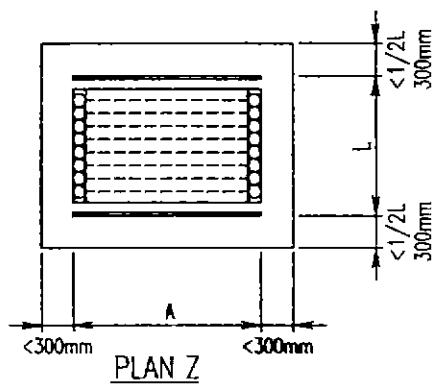
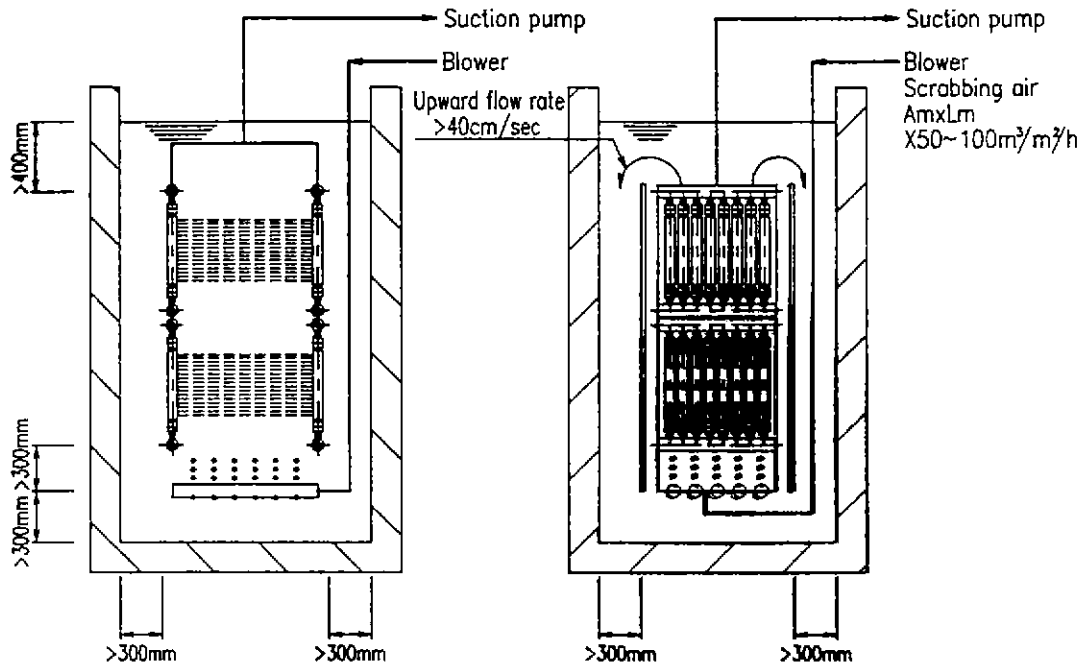
It is necessary to carry away sludges from inside of membrane units and to keep the surface of membrane clean without clogging membrane fibers for the proper operation of systems.

It is important to make an upward flow of more than about 40cm/sec in the units and to keep some extent of downward flow outside and around the units.

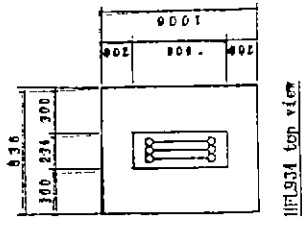
The flow rate is secured by supplying a **fixed amount** of air to the units through aeration pipes set at the **bottom of the units**.

Following the manual, **adequate space is put at the top and the bottom** as well as the left side and the **right side** of the units.

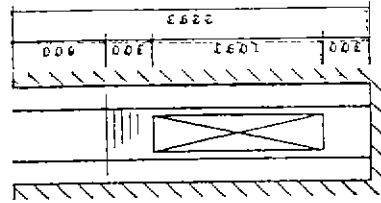
The placing and scrubbing way of submerged type filters in a tank



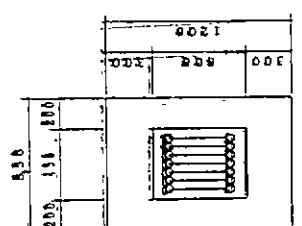




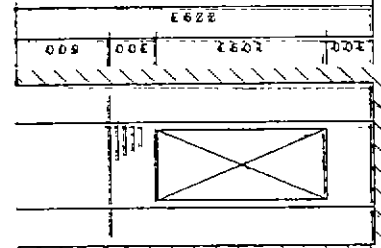
HPL834 top view



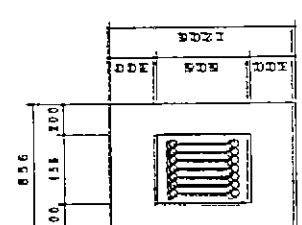
HPL834 front view



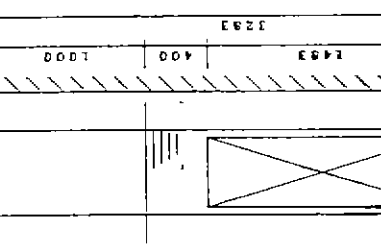
HPL814 top view



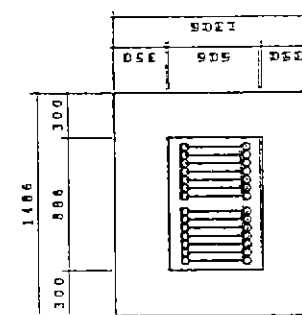
HPL814 front view



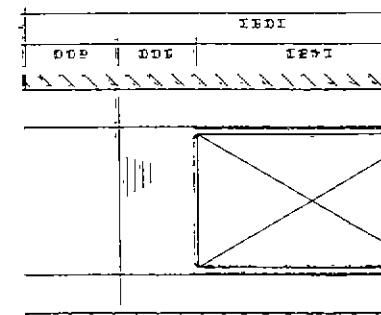
HPL824 top view



HPL824 front view



HPL844 top view



HPL844 front view

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FIG7-1 Example (1) of design for placing the unit in the tank

