Advanced Water Treatment System Using Ozone and Ozone Resistant Microfiltration Module

Masatoshi Hashino
(Asahi Kasei Corp.)

Advanced water treatment system using ozone and ozone resistant microfiltration module

(Advanced Aqua Clean Technology for 21 Project)

M. Hashino[a], Y. Mori[a], K. Nakatani[b], H. Hori[b],
K. Takahashi[c], N. Kadokawa[c], S. Suda[d], T. Minegishi[d]

[a]Asahi Kasei Corporation
[b]Isomura Hosui Kiko Co., Ltd.
[c]Fuji Electric Co., Ltd.
[d]NKK

Outline

1.Ozone resistant microfiltration(MF) module

2. Study on high flux of the MF membrane by using ozone in ACT21 Project

2.1 Advanced drinking water treatment system combining ozone and ozone resistant MF module

2.1.1 Influence of ozone dose, ozone feeding method and filtration method on flux

2.1.2 Long run test with high flux ($5m^3/m^2/d$)

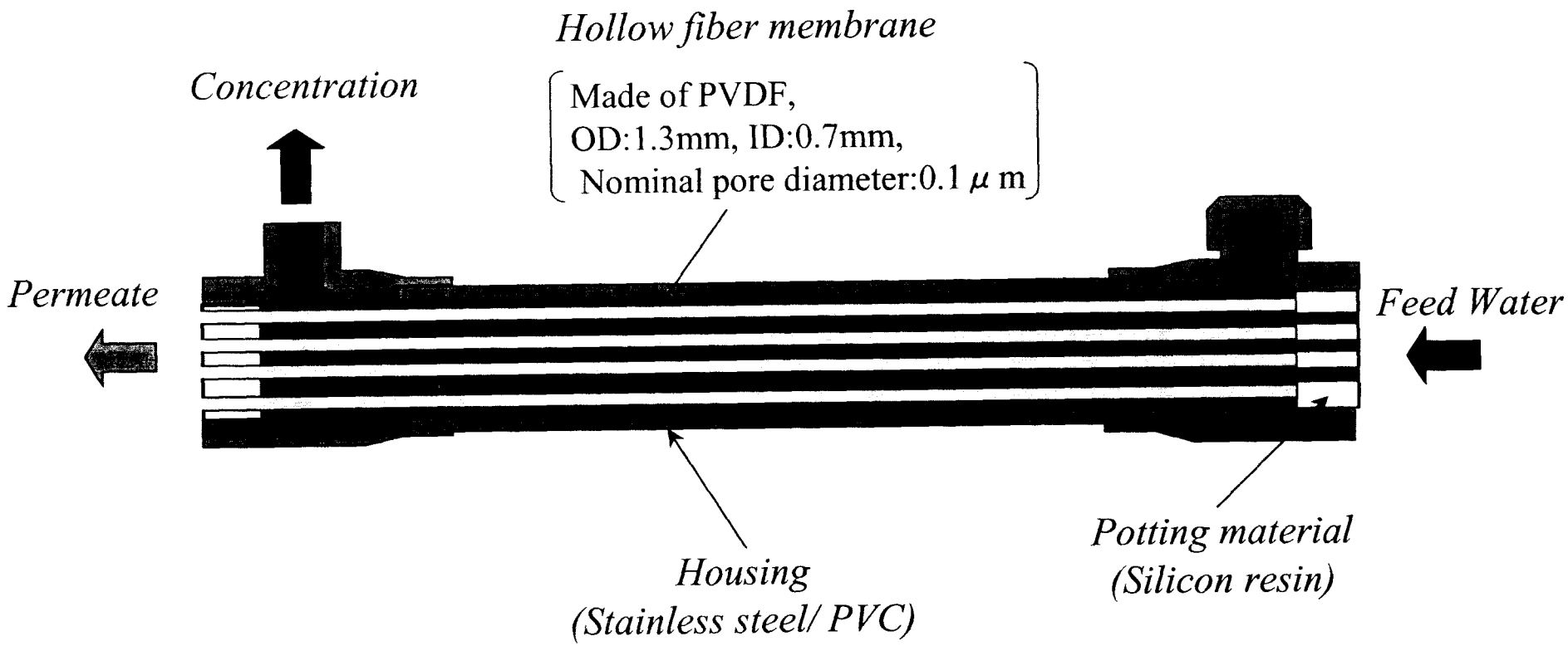
2.1.3 Qualities of treated water

2.1.4 Mechanism of high flux of MF membrane by using ozone

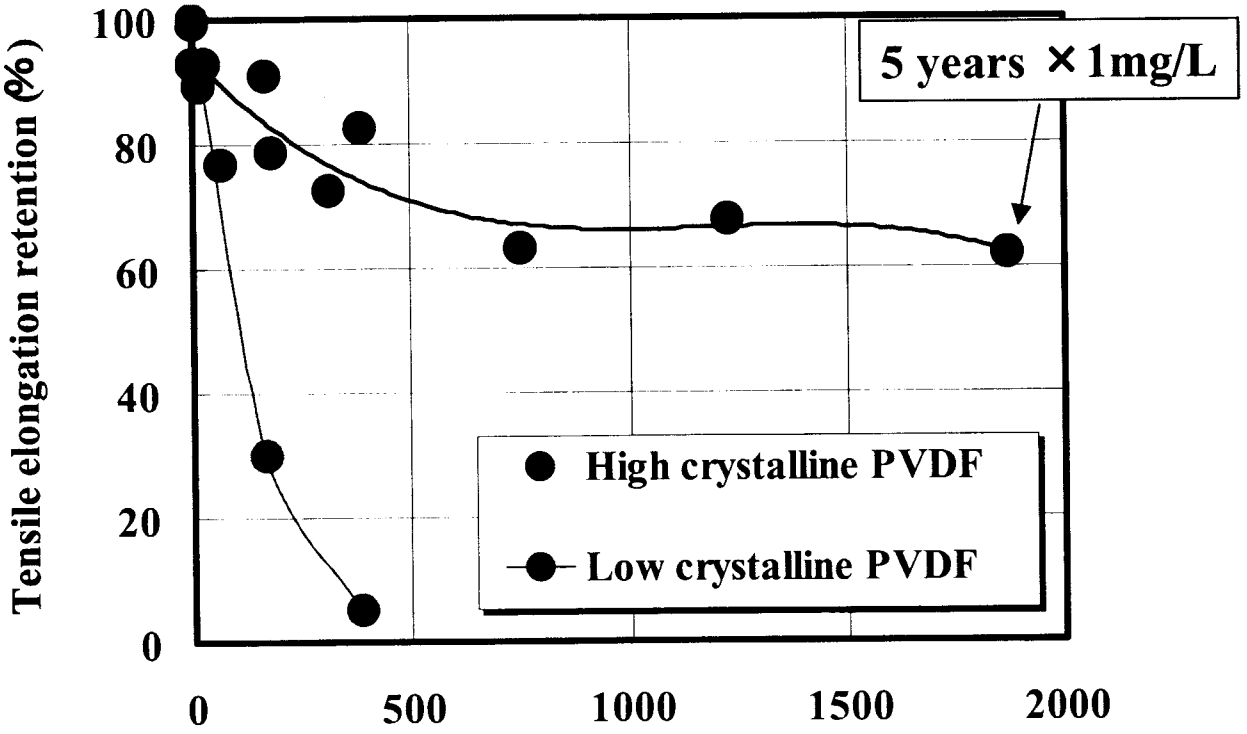
2.2 Study on high flux of the MF membrane by using reverse filtration with ozone dissolved water

3.Conclusions

Structure of ozone resistant MF module



Ozone resistance of hollow fiber membrane



◆Hollow fiber membrane has ozone resistance of over 5 years of exposure under 1mg/L of dissolved ozone.

Applications of membrane filtration methods (MF,UF) to water purification plants

◆Merit

(1)High reliability for produced water quality, (2) Less footprint, (3)Easiness of operation

Spread in small scale plants

◆Problems to be solved

(1)Control of membrane fouling ⇒ Increase in flux ⇒ Reduction in costs

(2)Removal of dissolved organic matters ⇒ Improvement of water quality

◆Trials by combining ozone and the ozone resistant MF module

(1)Water which needs advanced water treatment (high flux &advanced water treatment)

Raw water → Ozonation → MF module → GAC →

(2)Water which does not need advanced water treatment (high flux)

Raw water → MF module →

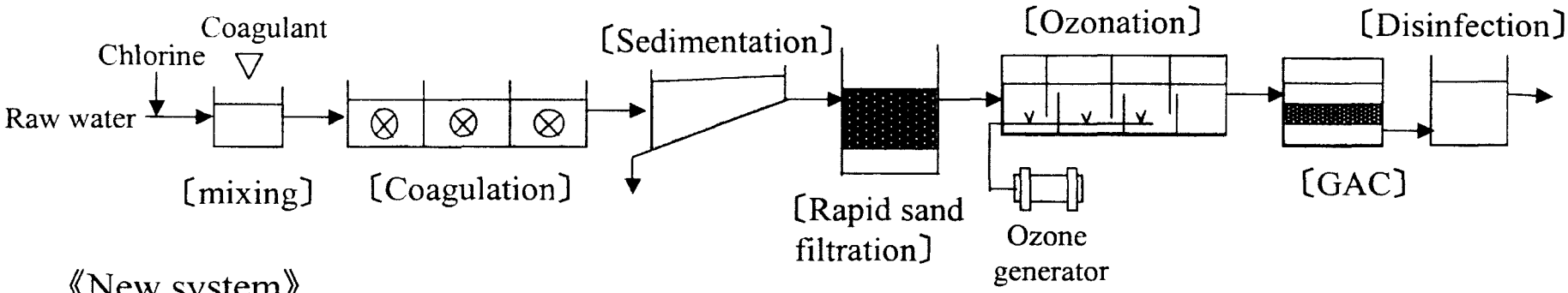
↑

Reverse filtration with ozone dissolved water

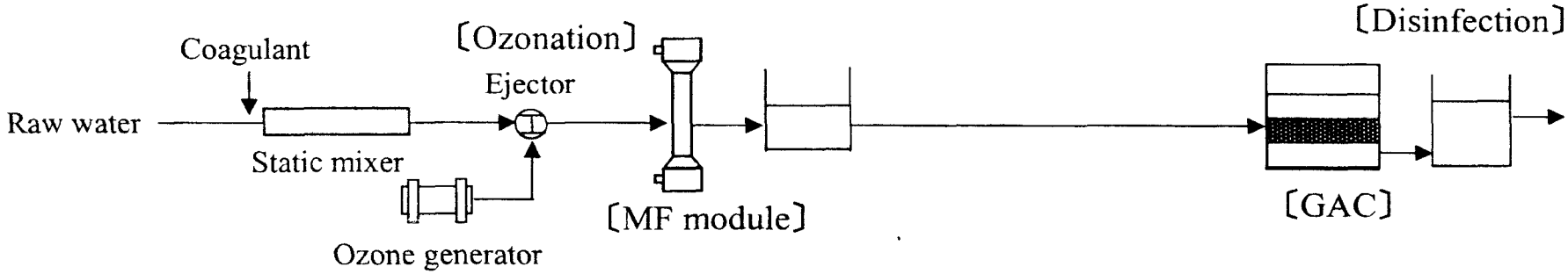
Advanced drinking water treatment system combining ozone and ozone resistant MF module

Advanced drinking water treatment system combining ozone and MF module

《Conventional system》



《New system》



◆Coagulation / Sedimentation / Rapid sand filtration

➡ (Direct coagulant injection) + MF membrane ➡ Space saving

◆Combination of ozone and MF membrane

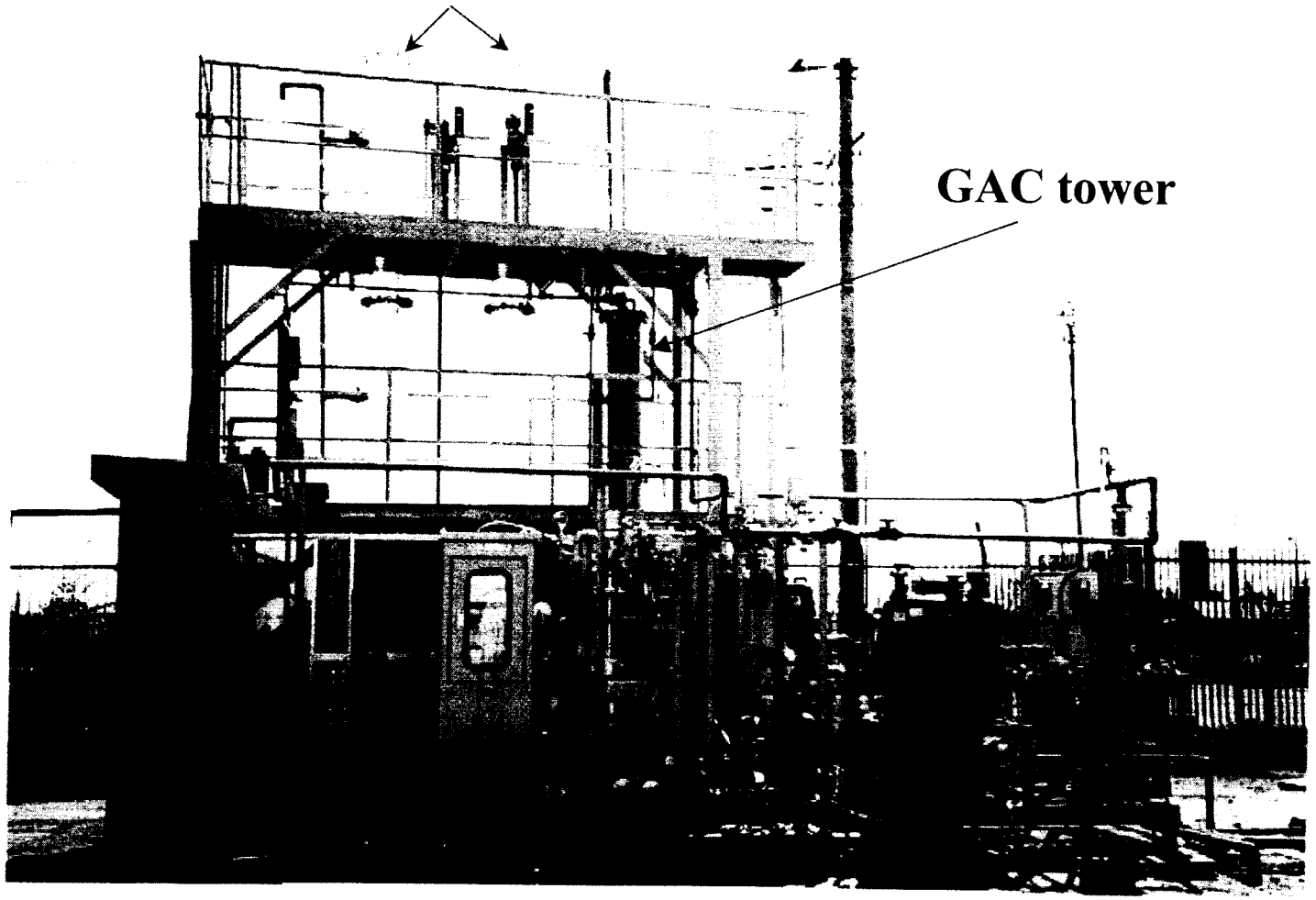
➡ Control of membrane fouling ➡ High flux ➡ Low cost

Advanced water treatment ➡ Better quality water

Raw water quality

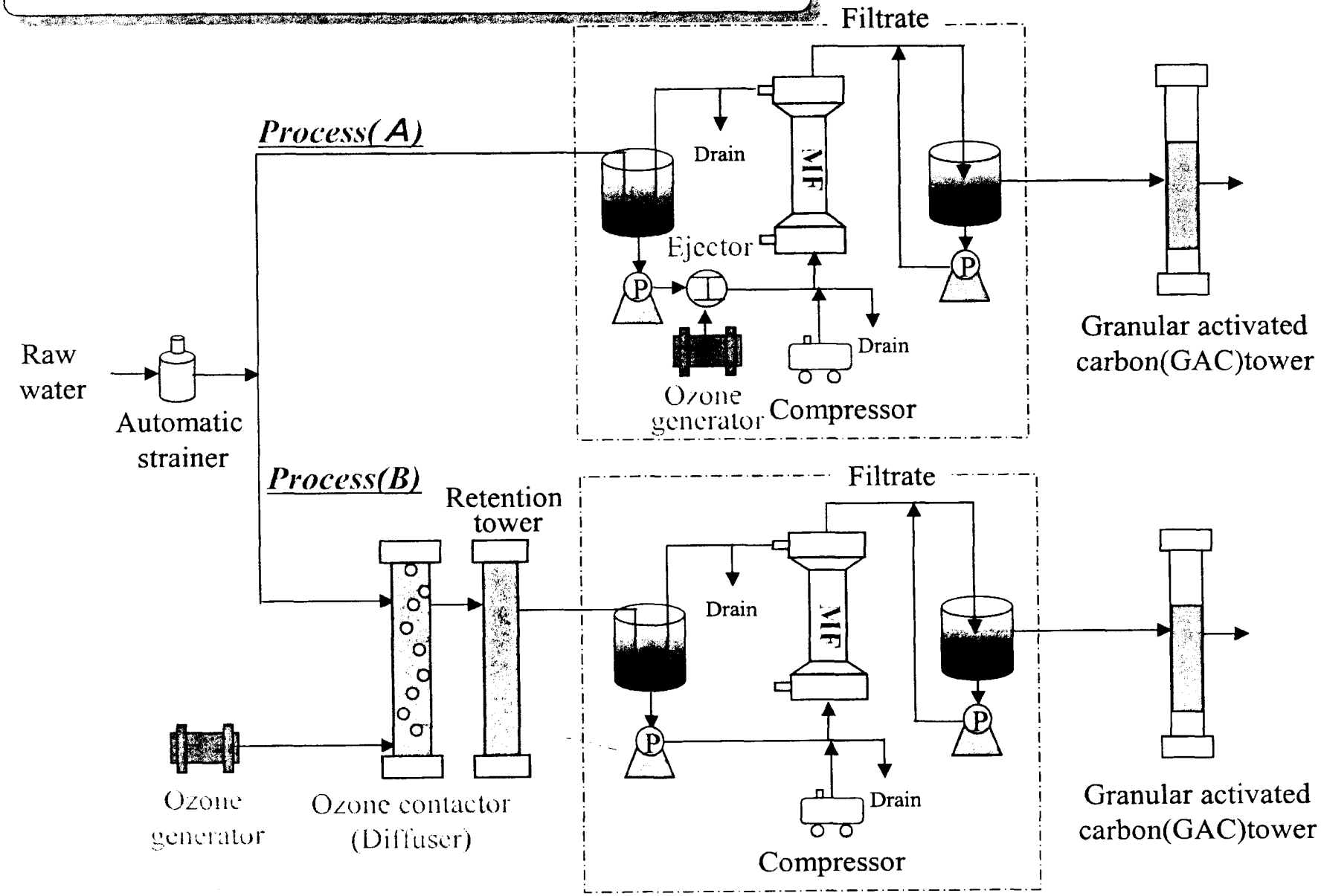
parameter	unit	Min.	Max.
Turbidity	degree	5.6	39.0
Color	degree	4	28
$KMnO_4$ consumption	mg/L	6.3	18.8
E260 (50mm cell)	-	0.144	0.25
NH_4-N	mg/L	0.02	0.29
T-Mn	mg/L	0.029	0.111
T-Fe	mg/L	0.21	3.15
THMFP	mg/L	0.035	0.059
TOC	mg/L	2.00	5.01
DOC	mg/L	0.98	2.44

Photograph of the pilot plant (35m^3/day)



Ozone resistant MF module (7m^2)

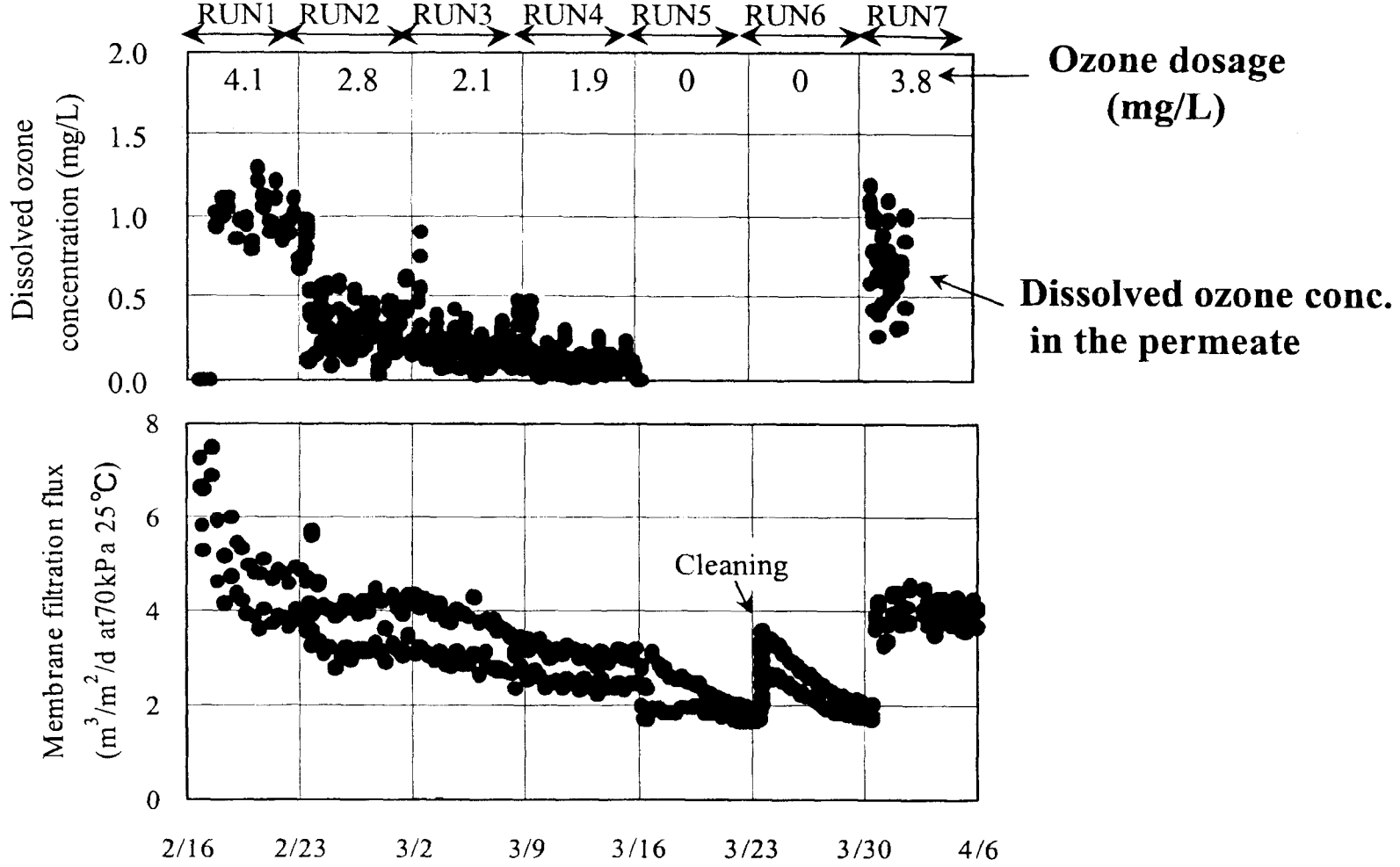
Schematic flow diagram of the pilot plant



Operating conditions

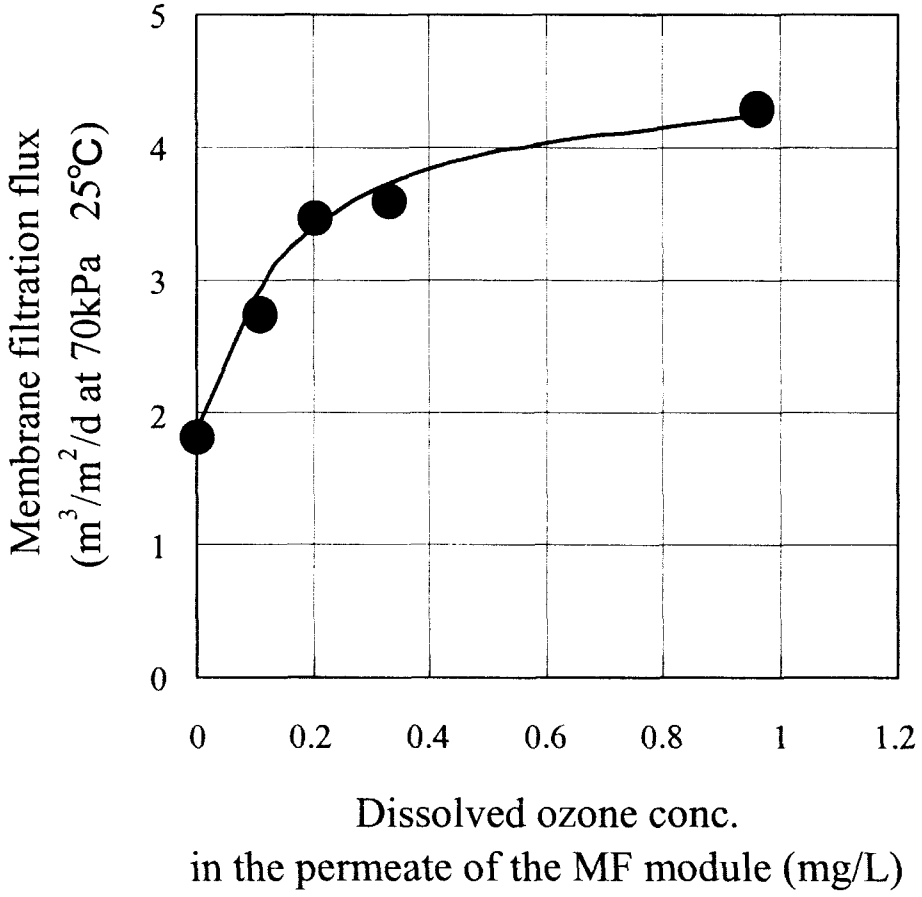
Run No.		Run 1-7	Run 9-11	Run 13-16
Average temp.	℃	10.7	22.2	26.1
Filtration method	-	Cross-flow	Cross-flow	Cross-flow or Dead-end
Filtration mode	-	〔Filtration(70kPa) 20min ⇒ Backwash 20sec〕 ×6 ⇒ Air-scrubbing 2min ⇒Flushing		
Ozone feeding method	-	Ejector	Ejector or Diffuser	Ejector
Ozone dosage	mg/l	0-4	2	2.5-3

Influence of ozone dosage on flux



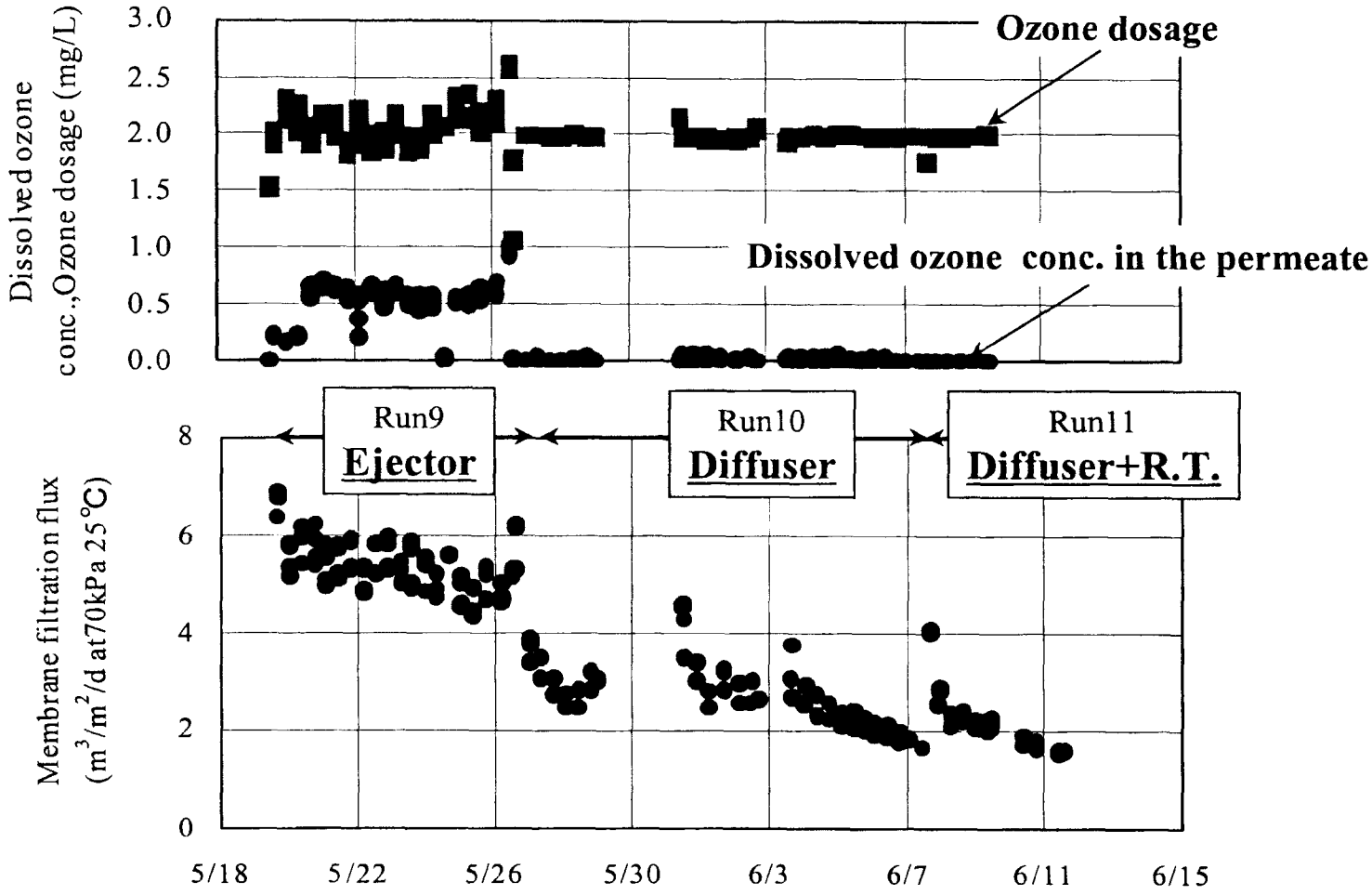
◆Flux was higher for higher ozone dosage and dissolved ozone conc. in the permeate

Relationship between dissolved ozone concentration and flux



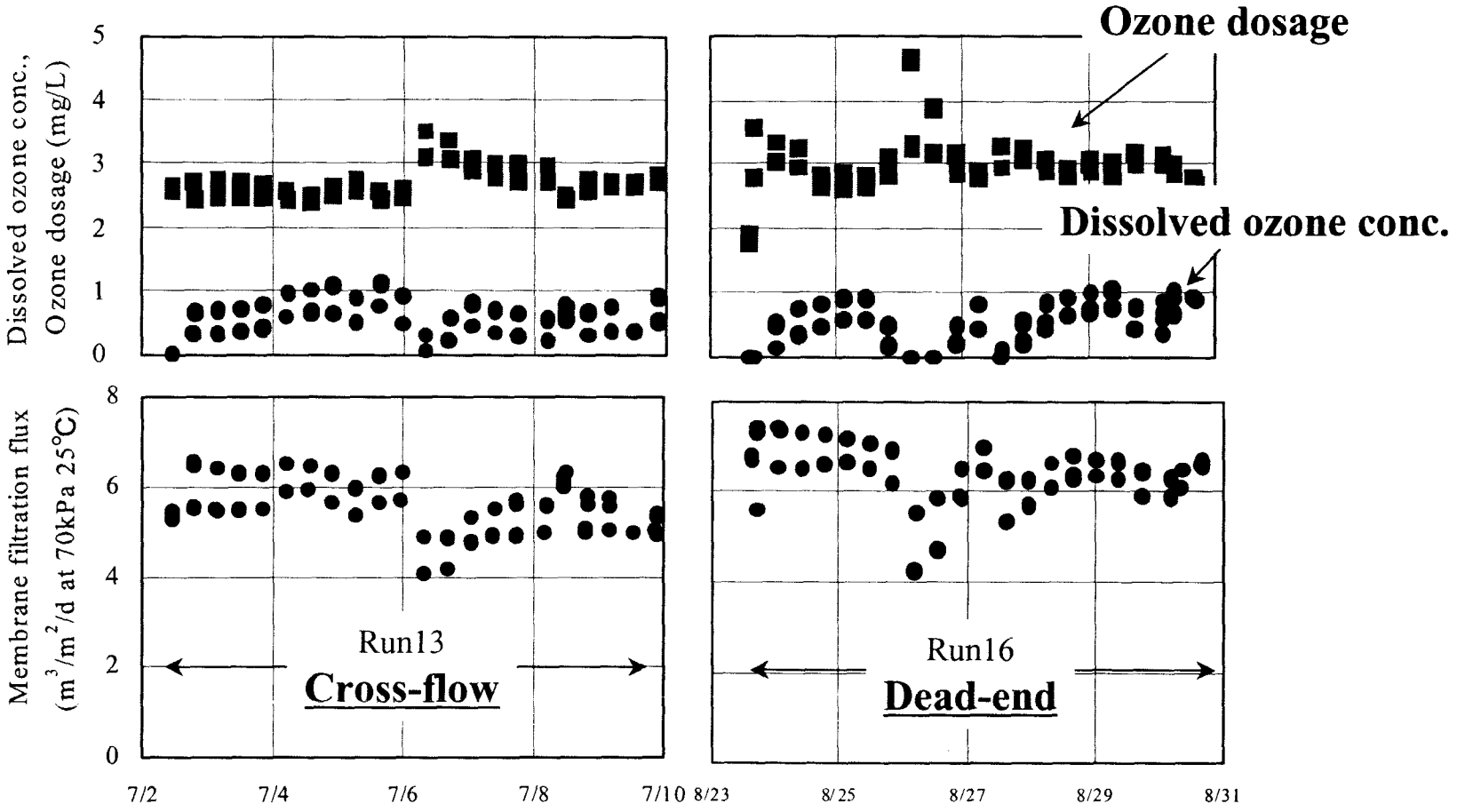
◆It is necessary to keep dissolved ozone of more than 0.3 mg/L in the permeate of the MF module in order to achieve high flux.

Influence of ozone feeding method on flux



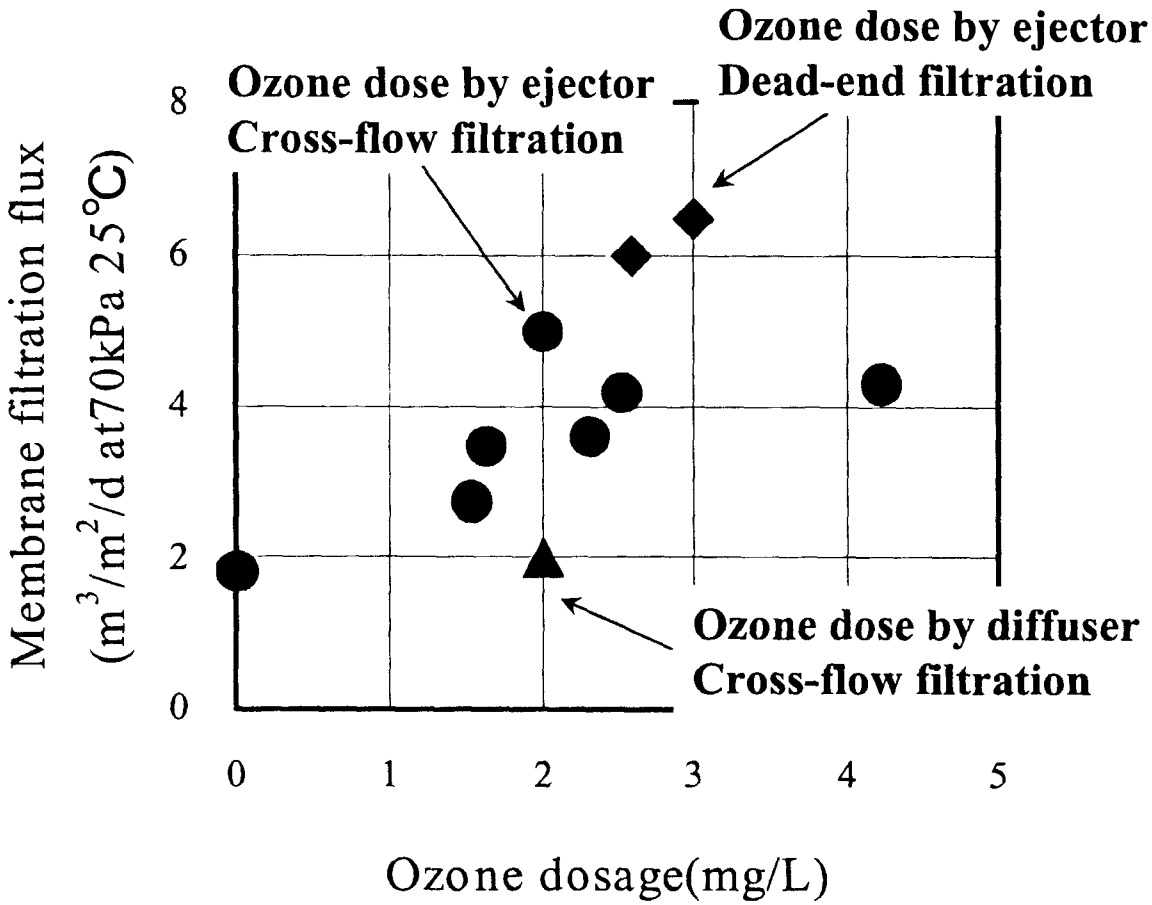
◆It is important to keep residual ozone on the membrane surface in order to achieve high flux.

Influence of filtration method on flux



◆Flux from the dead-end mode was higher than flux from the cross-flow filtration.

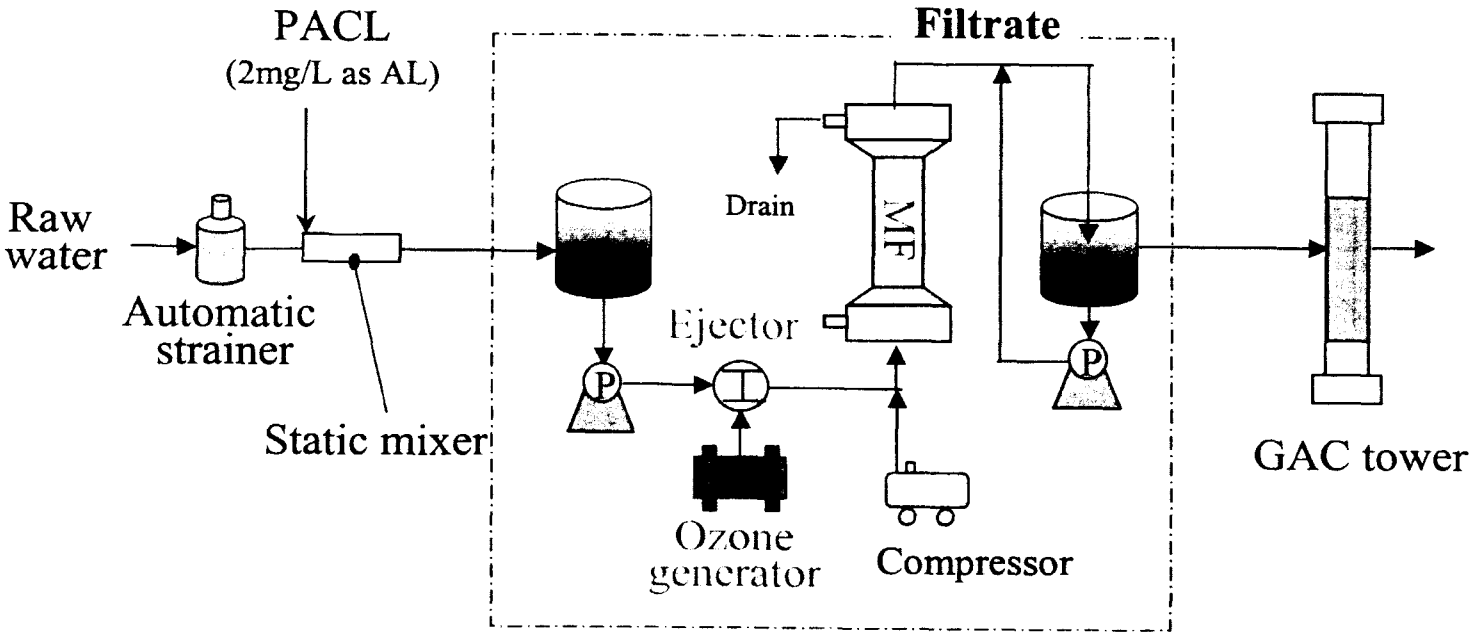
Relationship between ozone dosage and flux



◆With ozonation by ejector and filtration by dead-end mode, a high flux of more than $5m^3/m^2/day$ was achieved.

Schematic flow diagram of the pilot plant for the long run test

Process(A)

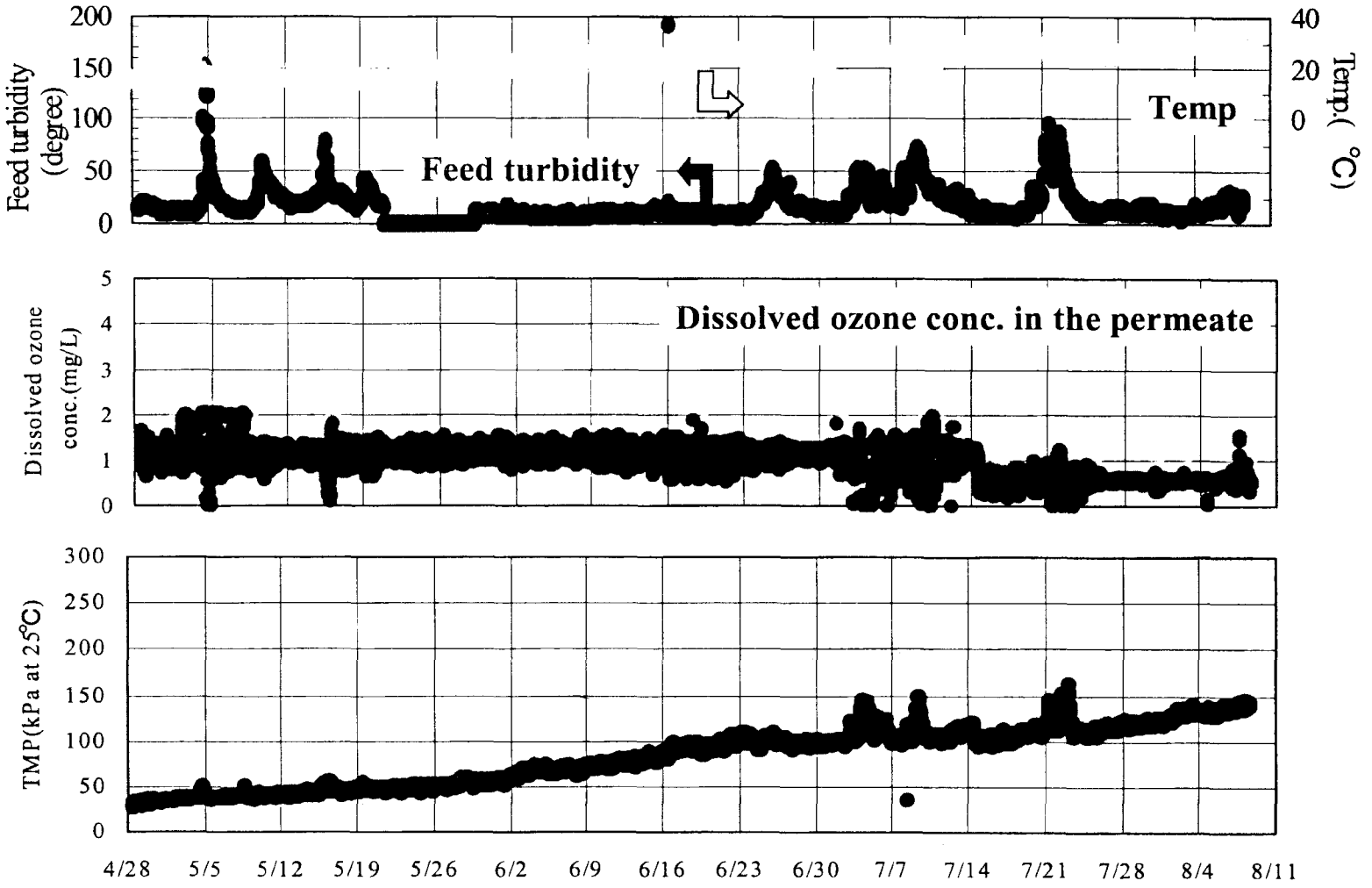


Filtration mode

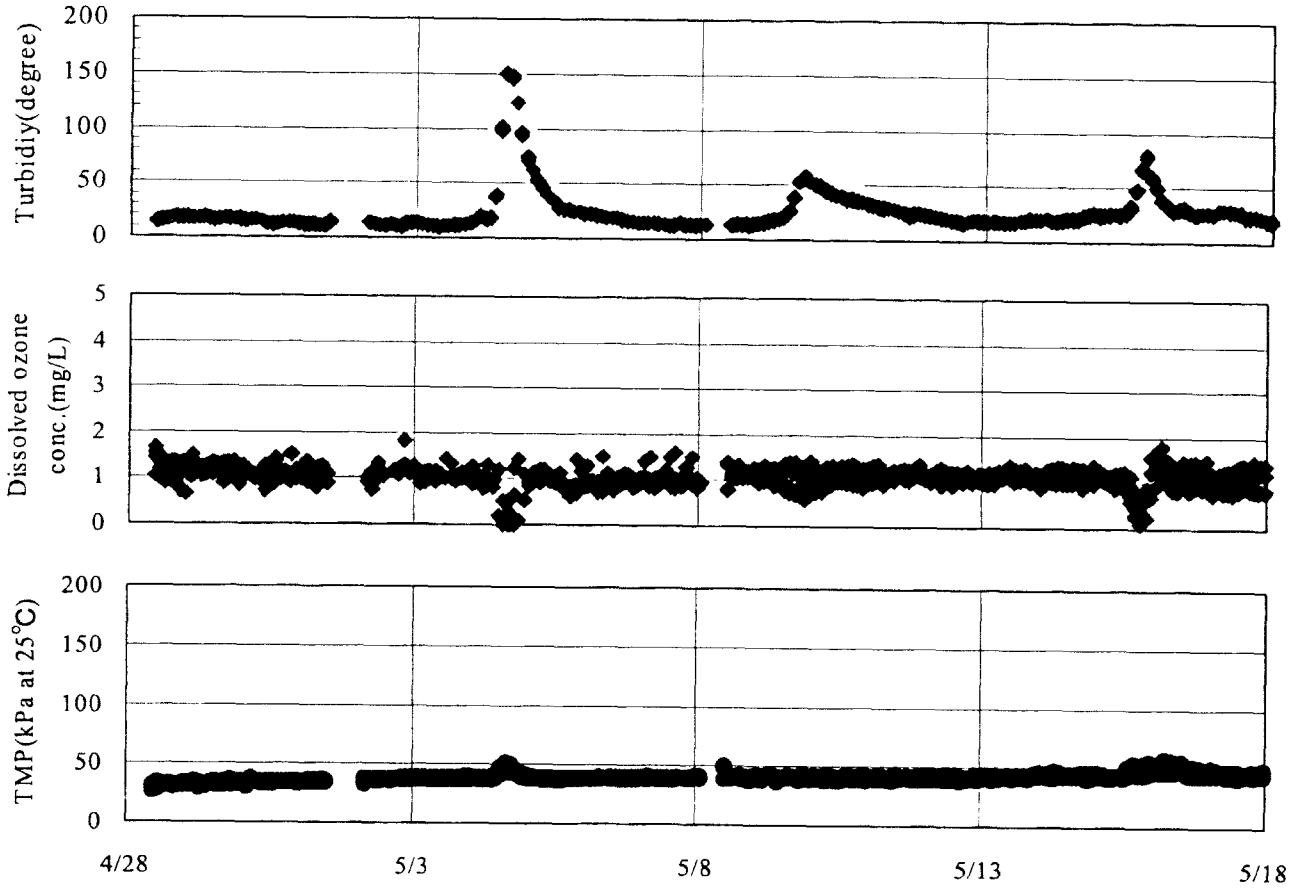
Filtration 20min ⇒ Backwash & Air-scrubbing 1min ⇒ Flushing

(Dead-end)

The long run test 5m³/m²/d & Dead-End filtration



Stabilization of filtration by controlling dissolved ozone conc. in the permeate



◆By keeping dissolved ozone of 1mg/L in the permeate of the MF module, filtration was carried out stably, even at high turbidity.