應用薄膜技術進行鋼廠廢水回收之評估
Use Membrane Technologies To Evaluate The Possibility of Wastewater Reuse In Steel Plant

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INTRODUCTION

- STEEL PRODUCTIVITY: ~10,000,000 Tons/Y
- UNIT WATER CONSUMPTION: 5.2~5.3M^3/T steel
- IND. WATER CONSUMPTION:155,000~165,000CMD
- DISCHARGE: ~45,000CMD

- 鋼液產能:~1,000萬噸/年
- 單位耗水量: 5.2~5.3M^3/噸 鋼液
- 每日用水量: 156,000~160,000CMD
- 每日排放量:~45,000CMD

INDUSTRIAL RAW WATER FLOW

DONG-KONG RIVER
東港溪

(HIGH NH_3-N & COD)

(Qave:~300,000CMD)

FENGSHAN DAM
鳳山水庫

F.S.W.T.P.
鳳山淨水場

(Qave:~160,000CMD)

(Cond.:~700 μ S/cm)
(High Chloride & Hardness)

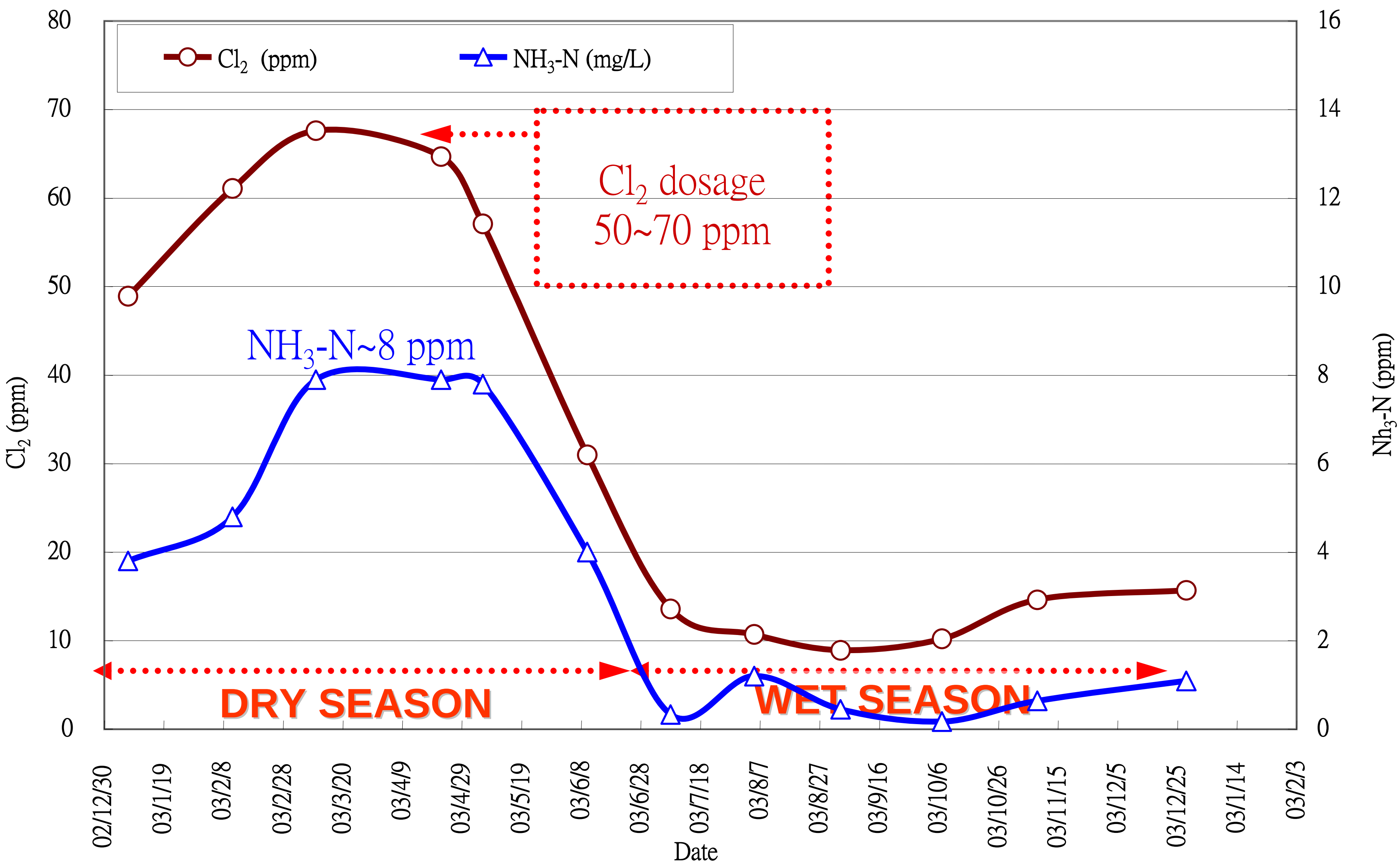
STEEL PROCESS
鋼廠製程

(Qave:~45,000CMD)

DISCHARGE
排放

OTHERS PLANTS
其他工廠

CHLORINATION IN INDUSTRIAL RAW WATER



Wastewater Reclamation ~ the Concerning of Enterprice

Global Crisis→Water Shortage

Bottle Neck of Reclaimed Water ~ Tariff

Technical OK but financial? ············➤

DEVELOPED COUNTRY		$/M³
Germany		$1.91
Denmark		$1.64
Belgium		$1.54
Netherlands		$1.25
France		$1.23
United Kingdom of Great Britain and Northern Ireland		$1.18
Italy		$0.76
Finland		$0.69
Ireland		$0.63
Sweden		$0.58
Spain		$0.57
U.S.A	NT$17	$0.51
Australia		$0.50
South Africa		$0.47
Canada	NT$13	$0.40

1. Membrane Cost Down.
2. Electrical Power Cost increase.
3. Tariff increase.
4. W.W.discharge cost increase

Recent Trend in France

	1995	2000
City water	1.01	1.11
Sanitary	0.71	0.83
Tax	0.57	0.71
Total (€/m³)	2.29	2.65

~106NTD/m³

2006······

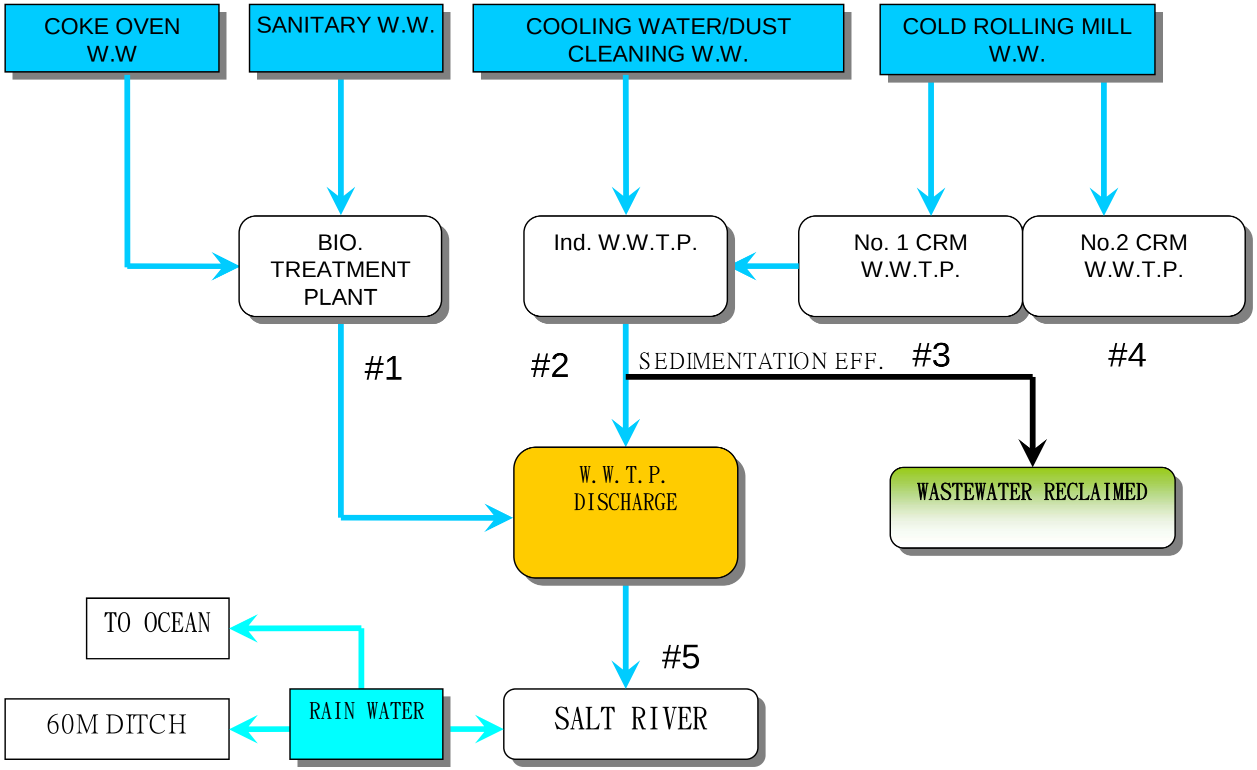
Taiwan ~11NTD/m³

資料來源： Extracted from the *Executive Summary of the World Water Development Report. Watertech online, 2001.*

FROM PILOT TO SCALE-UP PLANT

2003.1

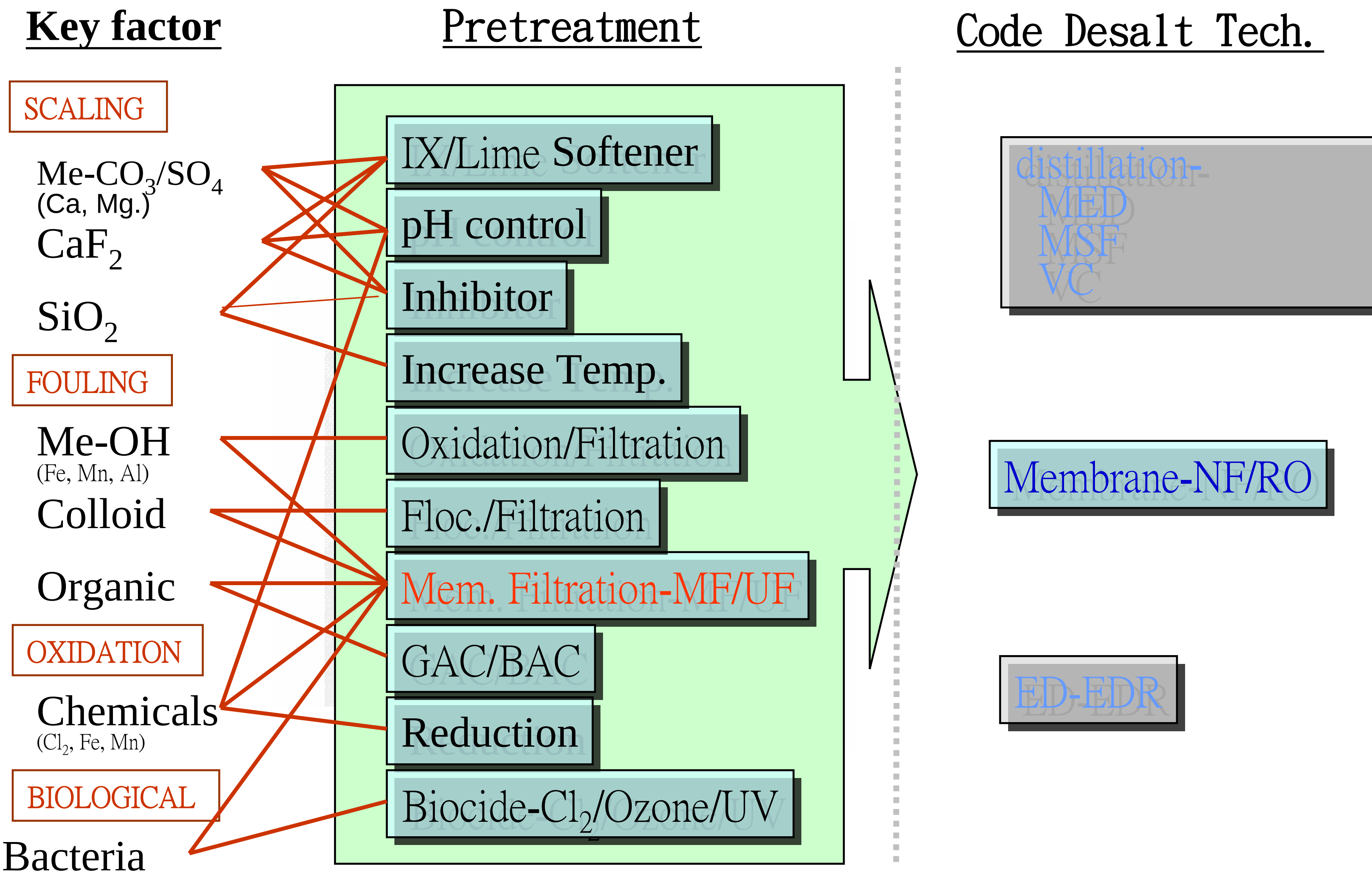
PRELIMINARY W.W.RECLAIMED POSSIBILITY STUDY



Wastewater Quality/quantity & Reclaimed Feasibility

Item \ No.	#1	#2	#3	#4	#5
Flow(CMD)	~7,000	~32,000	~2,800	~4,800	46,600
Cond.(μ S/cm)	~5,100	~2,300	~7400	~6,000	~3,000
SiO_2(mg/L)	~26	~24	~12	~11	~26
COD(mg/L)	~200	~100	~190	~50	~65
Reclaimed Feasibility	NG	OK	NG	OK, flow too small	NG

TECH. FOR WASTEWATER RECLAMATION



Membrane Clogging Factor

- **Scaling(**結垢**)**
- **Biofouling(**微生物污染物**)**
- **Organic Fouling(**有機污染物**)**
- **Colloidal Fouling(**膠狀物質污染物**)**

RO Membrane Trouble Shooting

Trouble	Cause	Detection	Prevention
Fouling	•Filtration no good •S.S. clogging •colloid(orgainc、 Silica) •Metal Oxide(Fe、 Mn、 Al)	Silt Density Index(SDI)	UF/MF FILTRATION (SDI<3)
Scaling	•supper saturation •($CaCO_3$、 $CaSO_4$、 CaF_2、 $BaSO_4$、 $SrSO_4$)	Langeliar Saturation Index(LSI)	Chemical Agent •Inhibitor •Acid Dosing •Softener
Oxidation	•Chemical agent	Fe 、 Mn , pH & Cl_2 Anal.	•$NaHSO_3$ Dosing •pH Adjust
Bacteria	•Bacteria Clogging	Total Bac. Count	UF Filtration Biocide

FROM PILOT TO SCALE-UP PLANT

2003.1

PRELIMINARY
RECLAIMED
POSSIBILITY
STUDY

2003.2

1 year project:
6 Months (2CMD)
PILOT TEST

PRESSURE TYPE MF+RO PILOT

SUBMERGED TYPE UF+RO PILOT

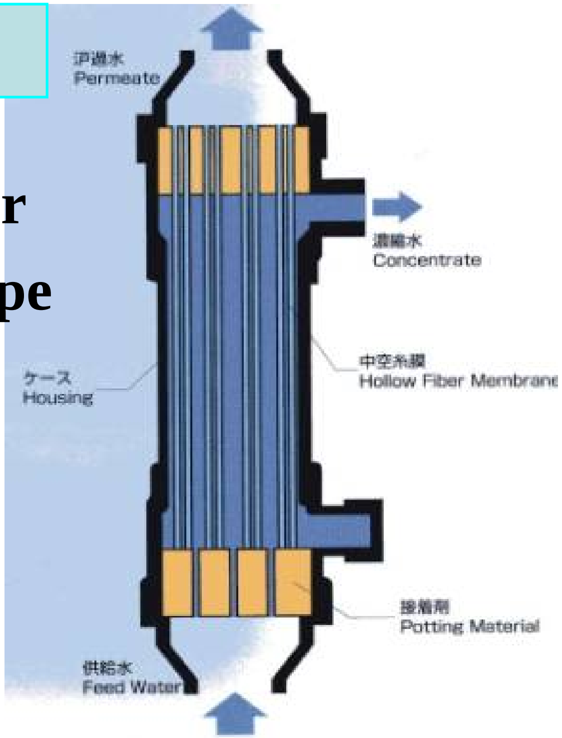
PRESSURE TYPE MF + RO PILOT TEST

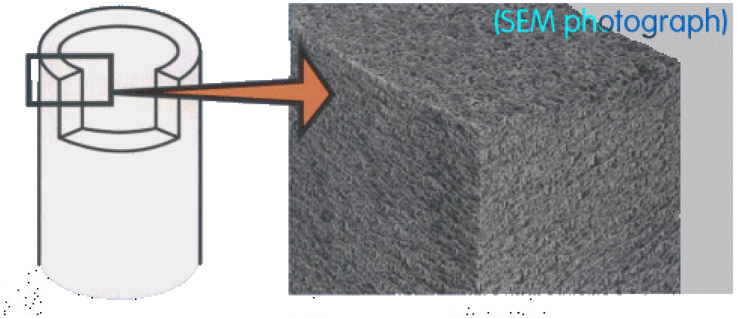
Pall MF

Hollow fiber

Pressure type

Outside-in





SUBMERGED TYPE UF + RO PILOT TEST

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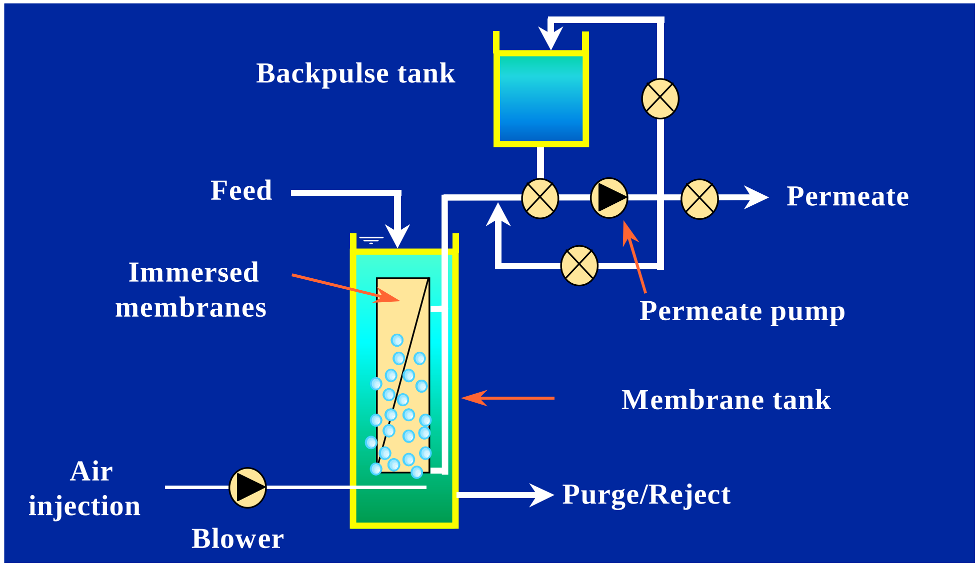
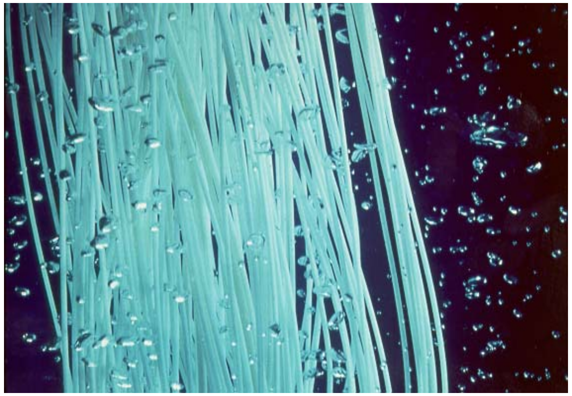




Pilot System Treated Water Quality

Item	MF/RO System Effluent Quality	UF/RO System Effluent Quality
Turbidity (NTU)	~0	~0
Conductivity(μ S/cm)	~128	~100
SO_4^{2-} (mg/L)	~6.0	~1.0
Cl^- (mg/L)	~24.0	~17.5
SiO_2 (mg/L)	~0.1	~0

FROM PILOT TO SCALE-UP PLANT

2003.1

PRELIMINARY RECLAIMED POSSIBILITY STUDY

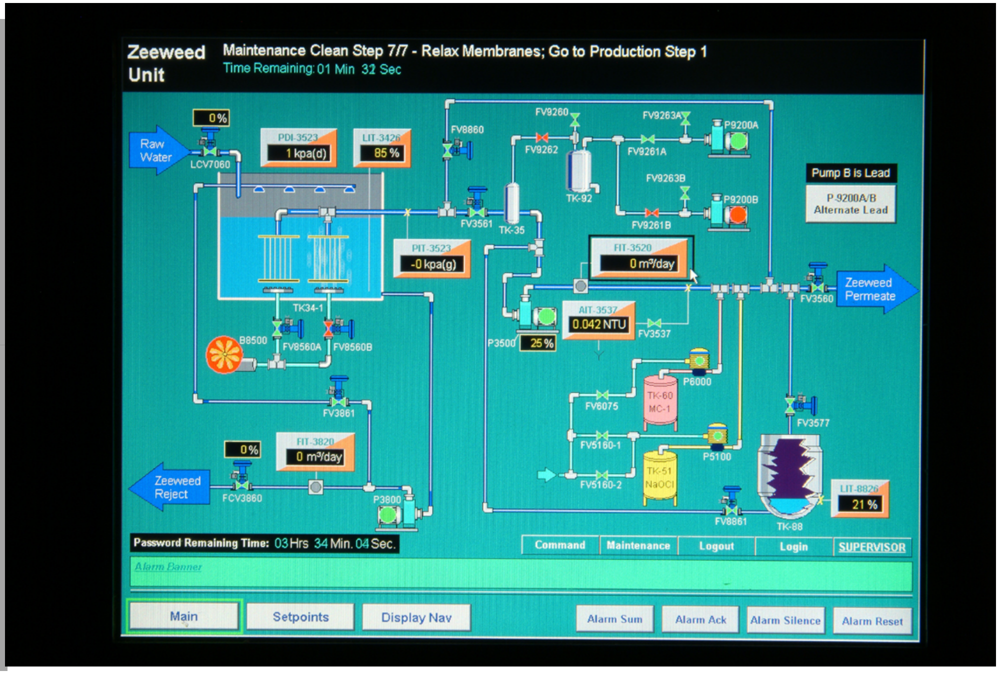
2003.2

6 Months (2CMD) PILOT TEST

2006.1

DEMO PLANT ~300CMD

SUBMERED TYPE UF + RO

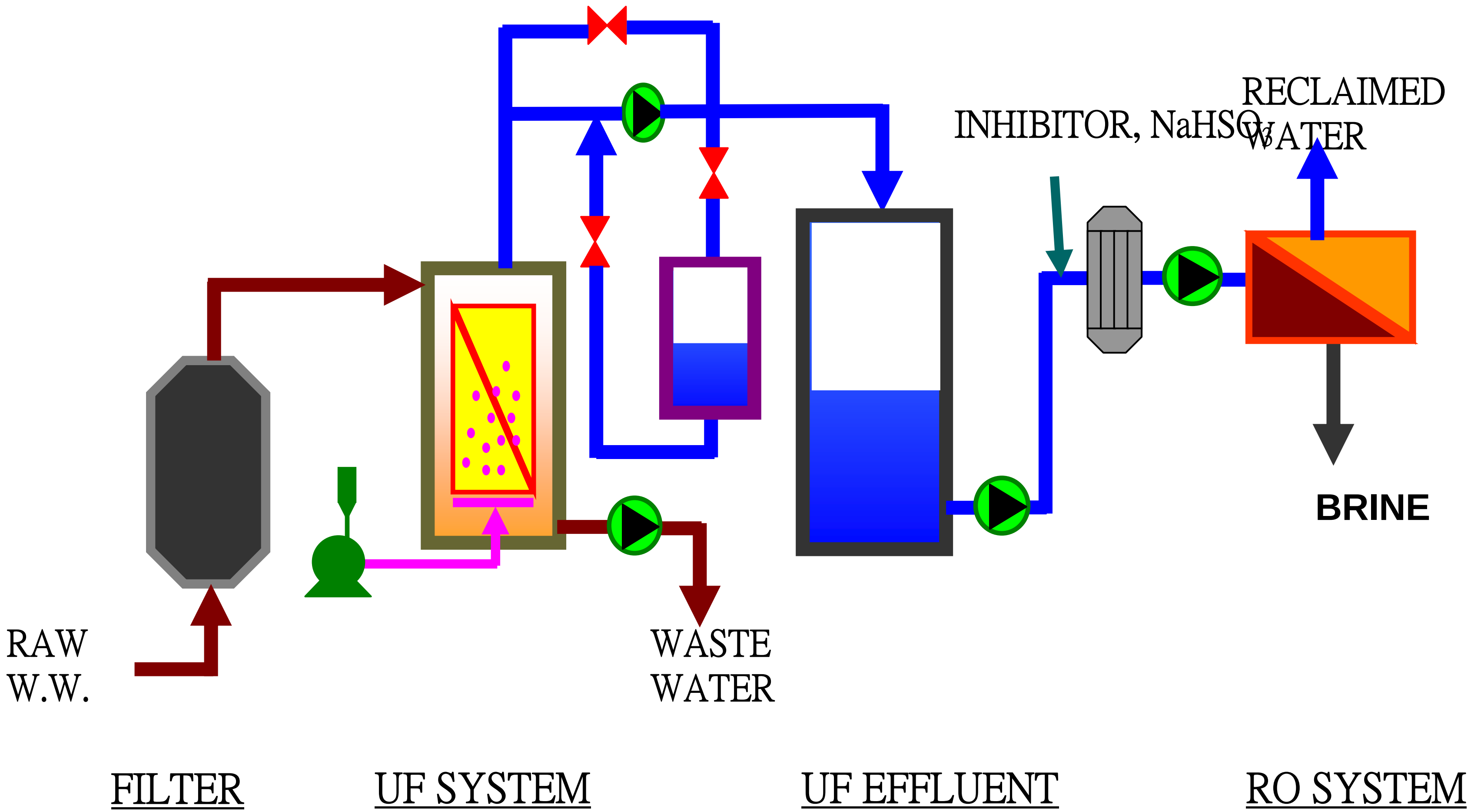


SPECIFICATION OF DEMO PLANT

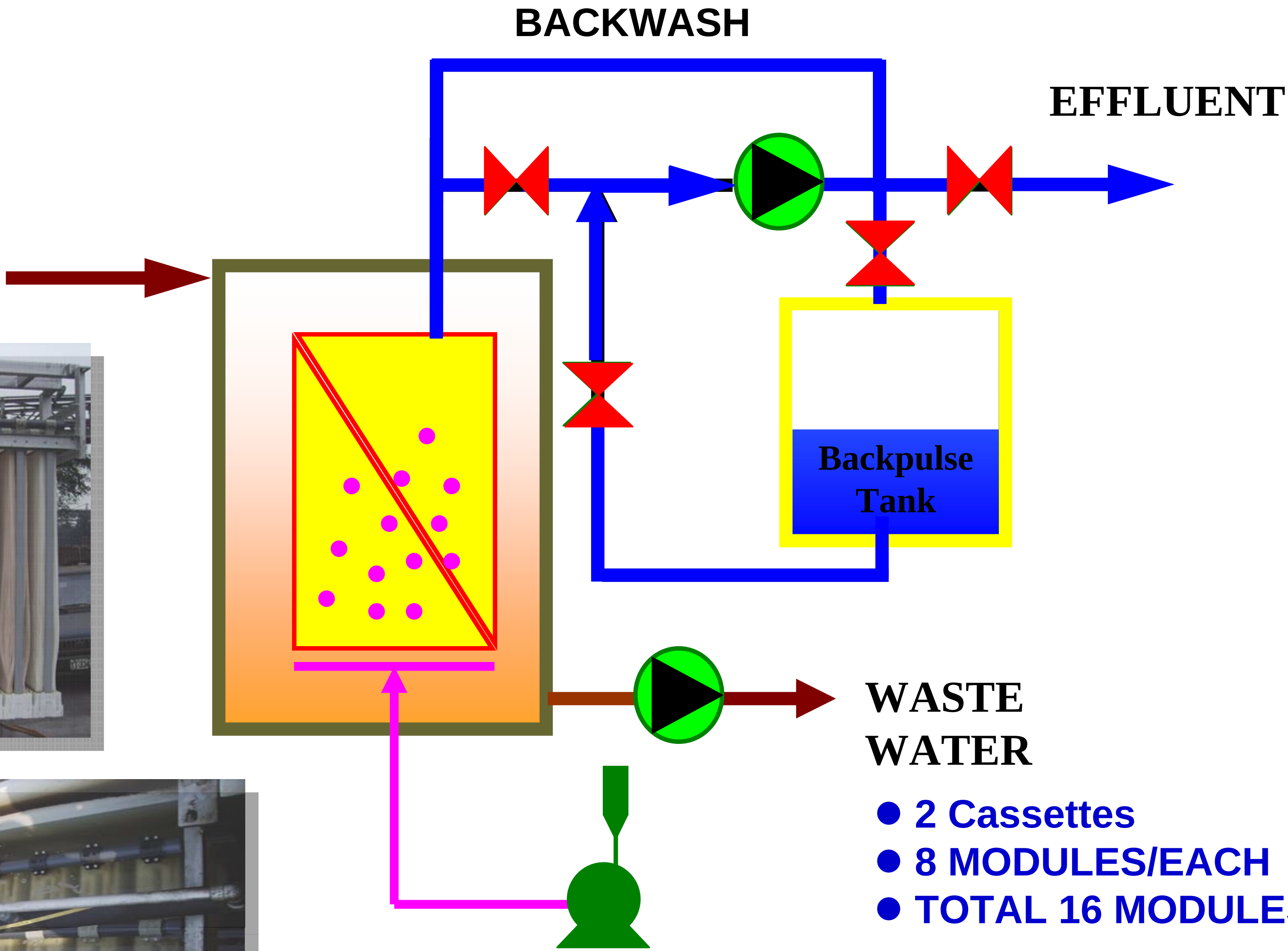
ITEM		DEMO PLANT
UF	PRODUCTION FLOW	~520 CMD
	RECOVERY	90%
	CIP DURATION	2-3 MONTH
	Maintenance Clean	ONCE/DAY
RO	PRODUCTION FLOW	~300CMD
	NET THROUGH PUT	255~270CMD
	CIP DURATION	ONCE/MONTH
	RECOVERY	65~75%

PROCESS FLOW OF DEMO PLANT

DESIGN CAPACITY:
~300CMD



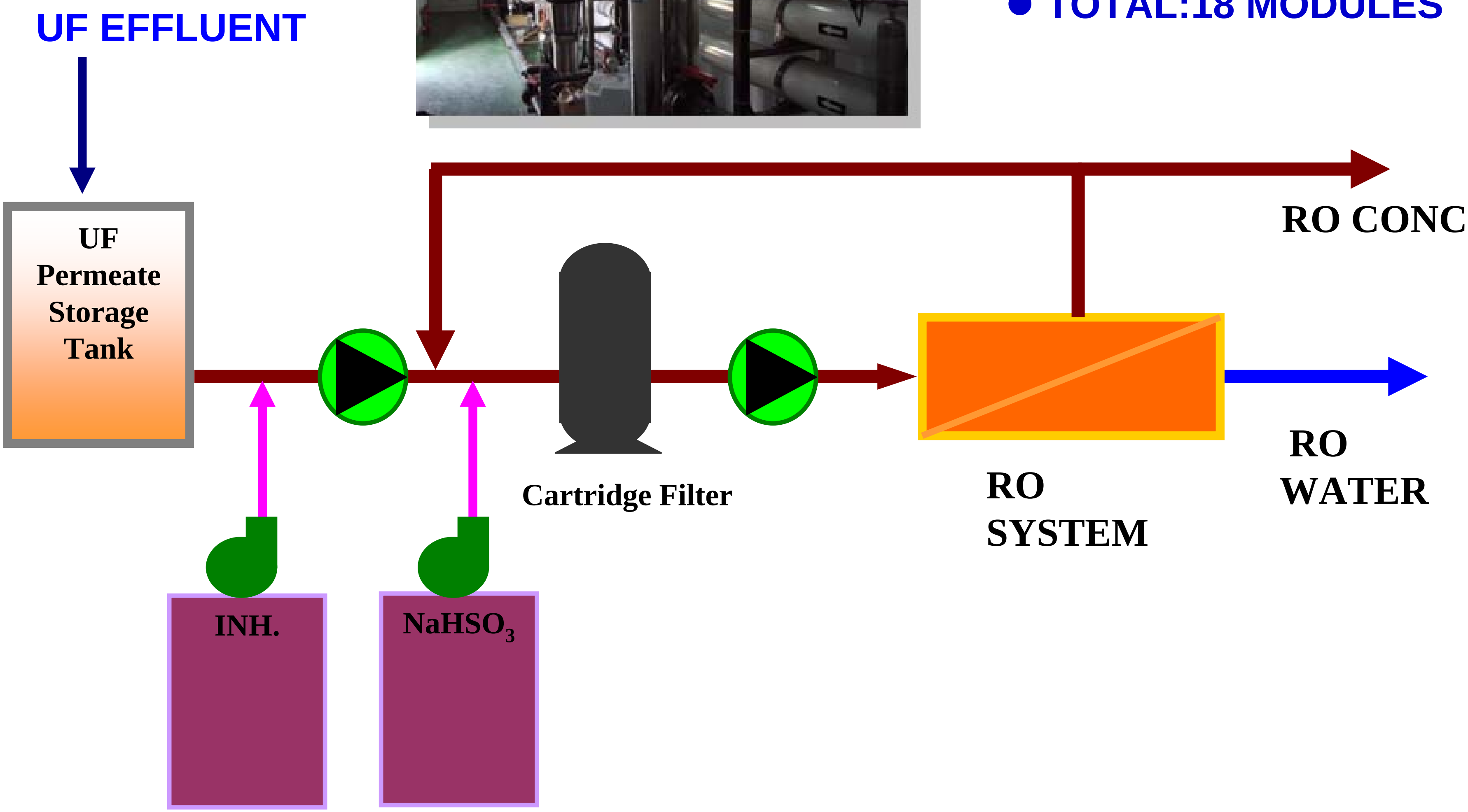
UF SYSTEM



- 2 Cassettes
- 8 MODULES/EACH
- TOTAL 16 MODULES

RO SYSTEM

- ARRANGEMENT 2:1
- 6 MODULES/VESSEL
- TOTAL:18 MODULES



DEMO PLANT

Average Water Quality of The Demo Plant

ITEM			Demo Plant	Removal Rate
Conductivity	μ s/cm	Raw water	~3900	~97%
	μ s/cm	RO-Perm.	~105	
pH		Raw water	~8.1	
		RO-Perm.	~7.1	
COD	mg/L	Raw water	~34.0	~85%
	mg/L	RO-Perm.	~5,0	
Ca^{2+}	mg/L	Raw water	~170	~99%
	mg/L	RO-Perm.	~1.5	
Mg^{2+}	mg/L	Raw water	~30.0	~99%
	mg/L	RO-Perm.	~0.1	
$SO4^{=}$	mg/L	Raw water	~460	~98.7%
	mg/L	RO-Perm.	~6.0	
Cl^{-}	mg/L	Raw water	~770.0	~97.8%
	mg/L	RO-Perm.	~17.0	
SiO_2	mg/L	Raw water	~14.0	~98.6%
	mg/L	RO-Perm.	~0.2	

RECLAIMED WATER QUALITY v.s. INDUSTRIAL WATER

ITEM		*IND. WATER*	*RECLAIMED*
Cond	mg/L	567 ~ 686	~ 105
pH	mg/L	7.3 ~ 7.5	~ 7.1
COD	mg/L	6 ~ 13	~ 5
Ca^{2+}	mg/L	63 ~ 66	~ 1.5
Mg^{2+}	mg/L	13 ~ 20	~ 0.1
$SO_4^{=}$	mg/L	93 ~ 115	~ 6.0
Cl^-	mg/L	75 ~ 86	~ 17.0
SiO_2	mg/L	9 ~ 14.3	~ 0.2

FROM PILOT TO SCALE UP PLANT

2003.1 — PRELIMIARY RECLAIMED POSSIBILITY STUDY

2003.2 — 6 Months (2CMD) PILOT TEST

2006.1 — DEMO PLANT ~300CMD

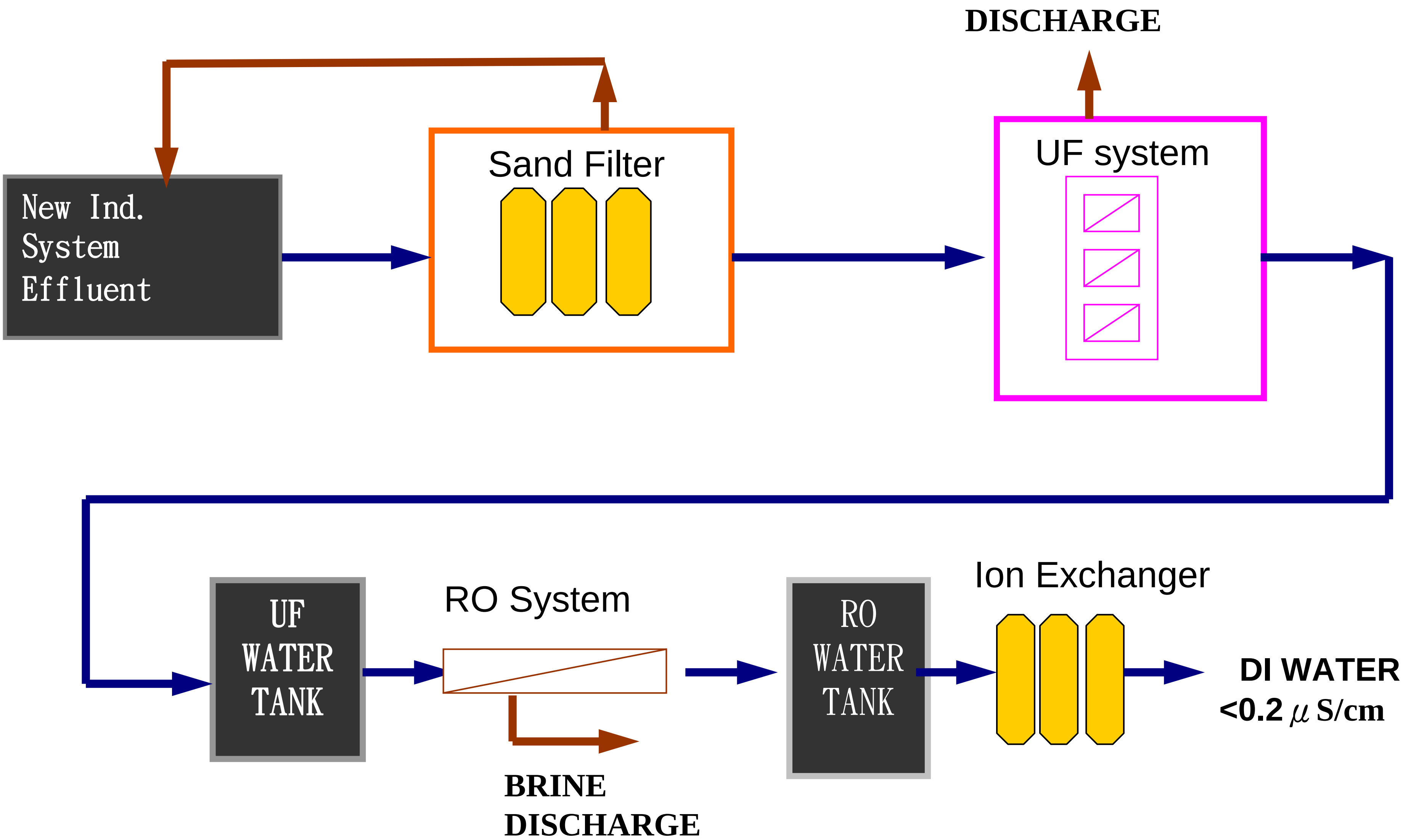
2007.- — SCALE UP TO 8000-16,000CMD

PRE-FILTER → UF → RO → ION EXCHANGER

FROM WASTEWATER to DI WATER FOR BOILER MAKE-UP



SCALE-UP PLANT FLOW SHEET



Conclusions and Discussion

- Use the UF + RO process to reclaim the steel plant wastewater is technically feasible. Use the demo plant to validate the design criteria and operating condition is a good way to minimize the risk of the scale up procedure.
- Although the capital cost + O&M cost of the reclaimed water is higher than the present tariff. But there are many benefits that use reclaimed water to the ion exchanger system such as extend the running cycle and saving the regeneration chemicals.
- Reduced the total discharge flow volume that can reduce the discharge fee.

Cost & Benefit Analysis of Wastewater Reclamation

Wastewater Cond.~3900 μS/cm → DI Water Cond. <0.2 μS/cm

Item	Cost (USD/M^3)	Benefit (USD/M^3)
E.P.C + O&M	< **1.0**	
City Water Saving		~0.34
City Water Demineralization		~0.5
City Water Tariff Increasing		?
Wastewater Discharge Fee		?
Tolerance During Water Shortage		?
Company Reputation Enhancement		?

敬請指教

Thank You

中宇環保工程股份有限公司