2014產業用水效率提升輔導說明會

MBR應用於廢水回收再利用

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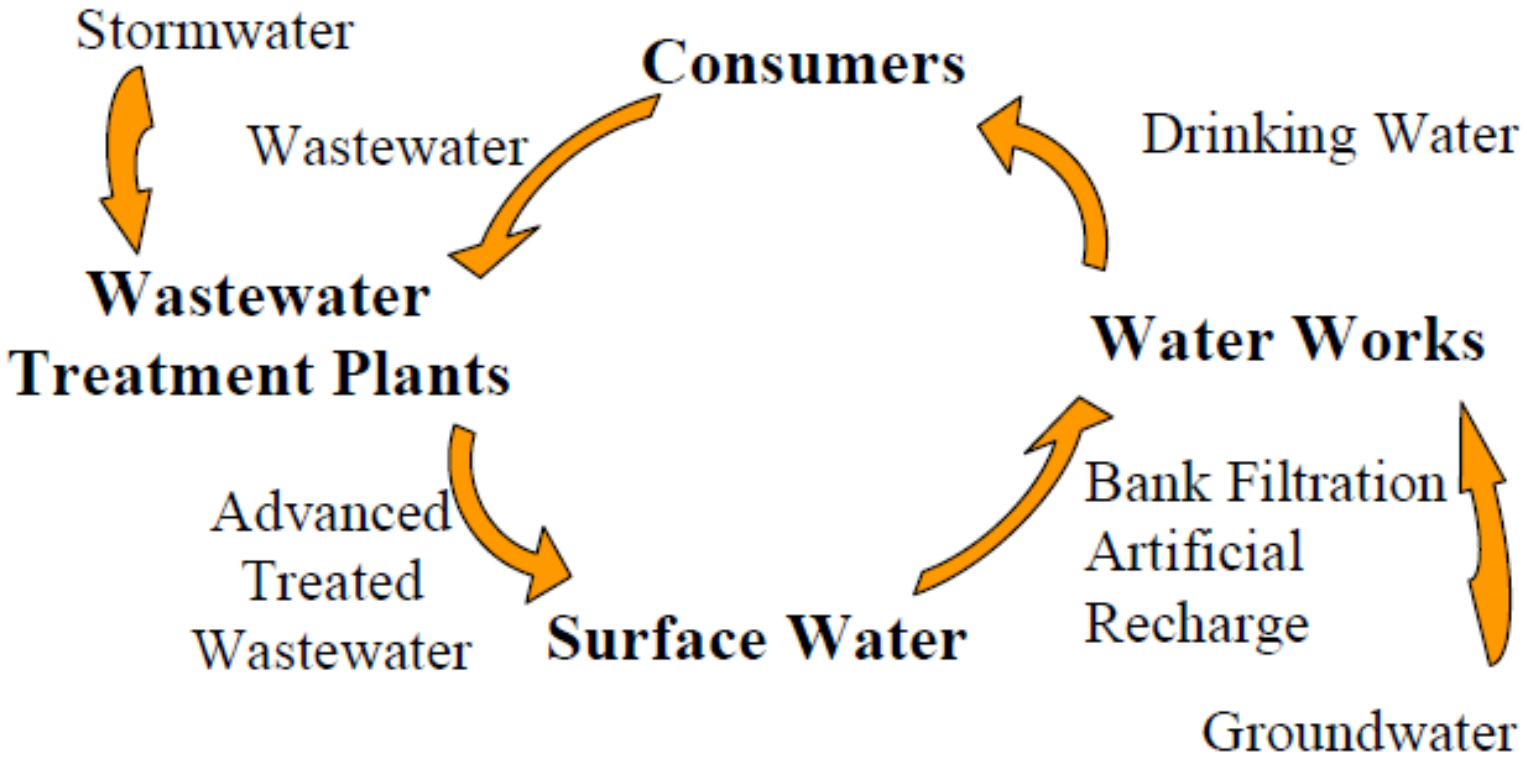
前　言

Schematic representation of the water cycle



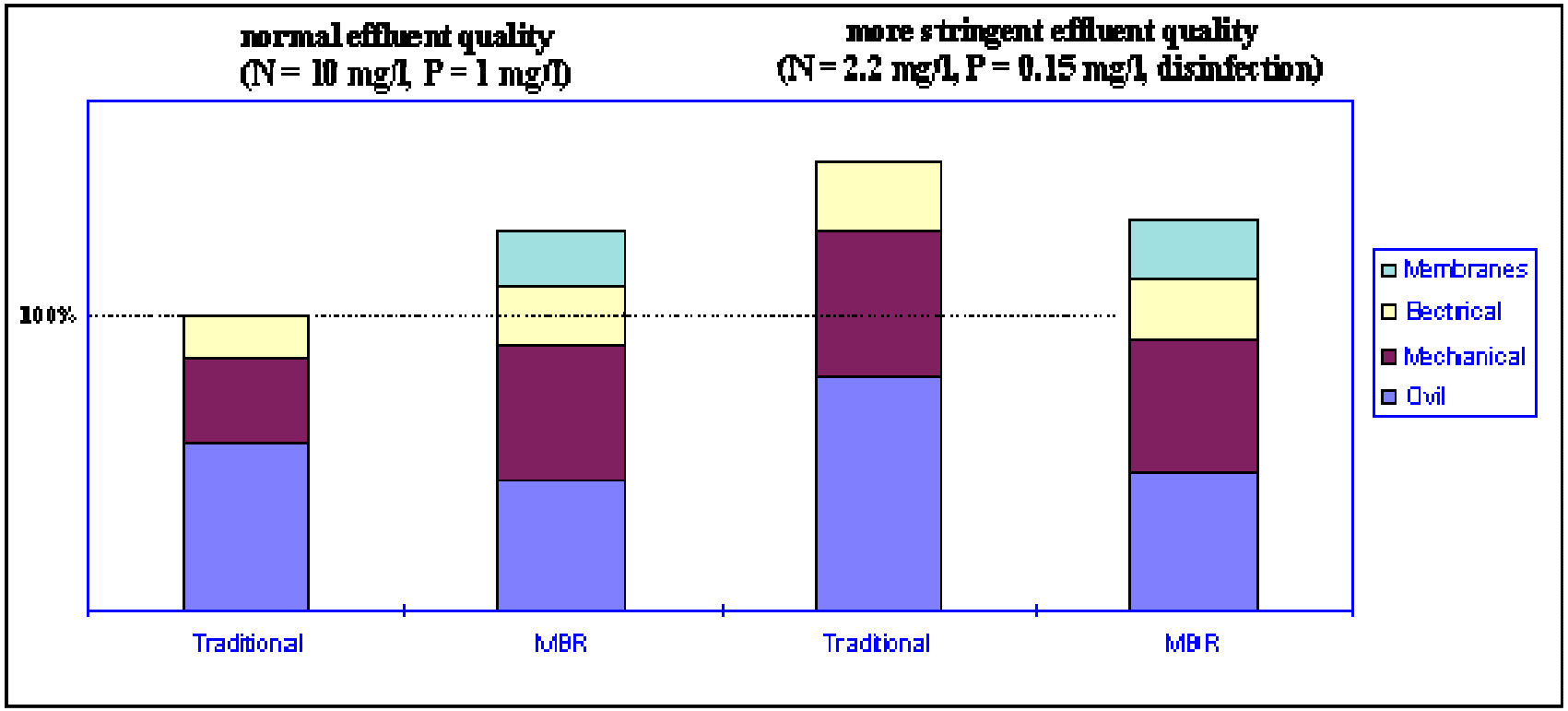
資料來源: Jornades Tècniques(2005)

AS與MBR出流水之比較

Parameter	conventional		MBR
BOD (mg/l)	5 - 50		< 3
NH4-N (mg/l)	1 - 10		< 0,1
TN (mg/l)	10 - 18		< 5
TP (mg/l)	1 - 3		< 0,1
TSS (mg/l)	10 - 50		< 1
SDI	> 6		< 3
Turbidity (NTU)	> 3		< 0,5
coliforms (cfu/100 ml)	> 1.000.000		< 50
fecal coliforms (cfu/100ml)	> 200.000		< 10
Helminth eggs (/ 1000 ml)	> 20		absent

資料來源: Membrane Bioreactors Key Technology for Water Reuse(2010)

MBR 投資及操作成本



資料來源:STOWA(2006)

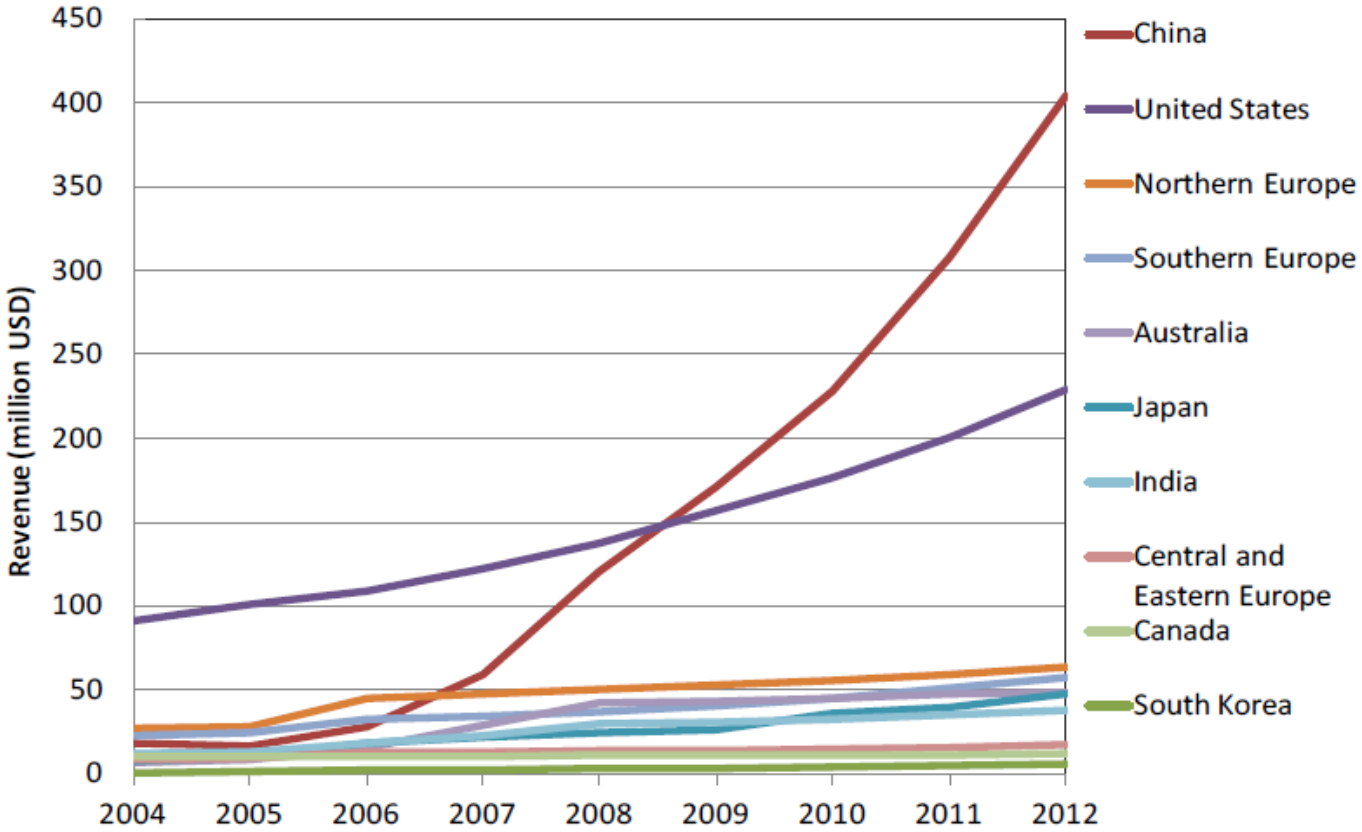
MBR 市場

- Membrane Bioreactor (MBR) Systems Market Growing at CAGR of 14.6% to Reach $2,052 Million by 2017 by MarketsandMarkets
- The primary growth driver for the MBR across the global is however the need to comply with the environmental laws (GIA,2011)
- Asia-Pacific represents the fast growing regional market displaying a CAGR about 20.2 % (GIA,2011)
- The MENA MBR market is expected to increase at a Compound Annual Growth Rate (CAGR) of 17.77 % to reach $ 280.30 million by 2015 (Frost & Sullivan, 2012)

全球MBR之成長趨勢

Region	Annual growth (% / year)
N. America	15 %
Middle East	25 %
Europe	10 %
Asia Pacific	10 %
China	20 %
Japan	10 %
Total	20 %

International Diffusion of MBR Technology Approximated by Sales Trends



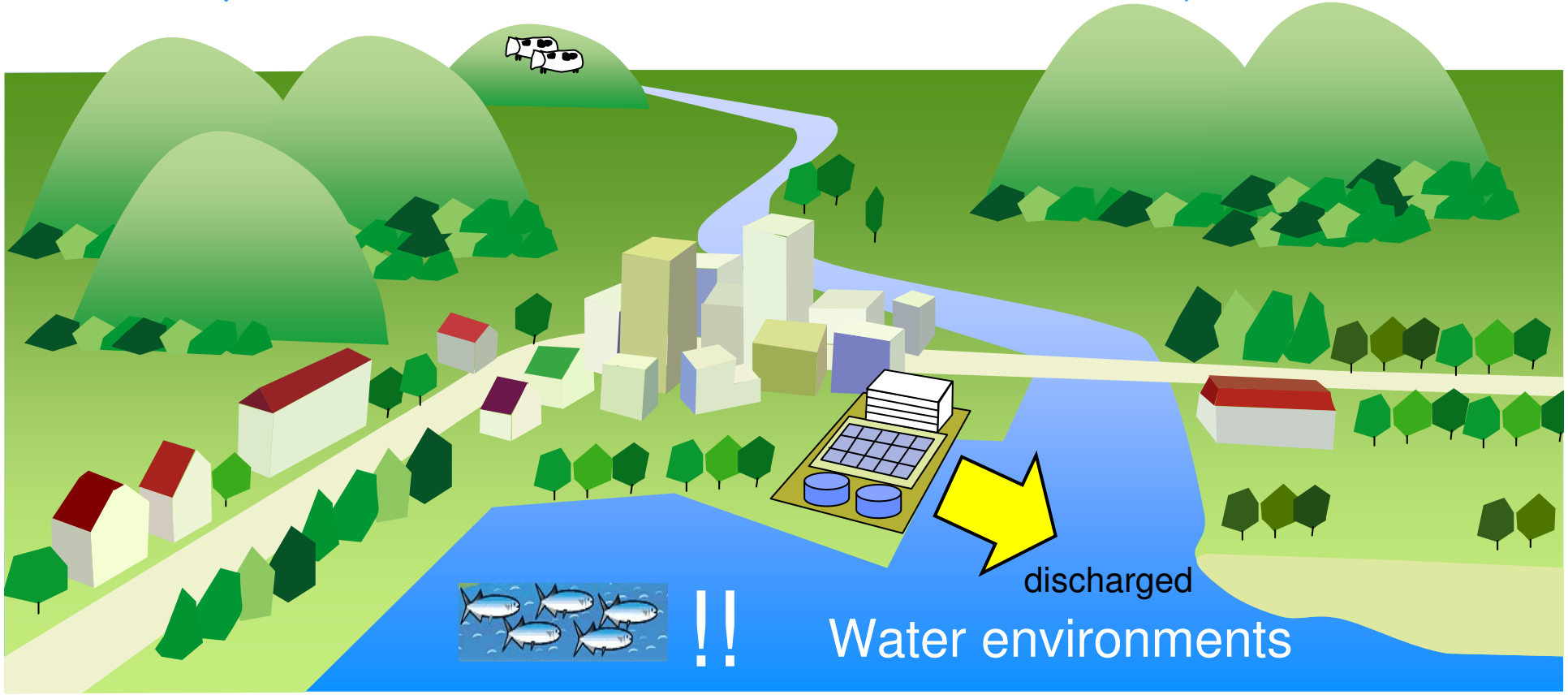
Source: Own calculations based on Frost & Sullivan (2008) and Frost & Sullivan (2011b)

http://kooperationen.zew.de/fileadmin/user_upload/Redaktion/Lead_Markets/Werkstattberichte/WB_11_MBR_Sartorius_et_al.pdf

MBR將是水環境永續發展的關鍵

Experts suggest that membrane bioreactors (MBR) will be a key to global water sustainability.

摘自：database of the Water Environment Research Foundation, June 2004.



全球最大MBR廠

WWTP name	Location	Commissioning	Hydraulic capacity
Jumeirah Golf Estates	Dubai	2010	220,000 m^3/d
Palm Jebel Ali	Dubai	2010	220,000 m^3/d
Brightwater	USA	2010	144,000 m^3/d
Jebel Ali Free Zone	Dubai	2007	140,000 m^3/d
International City	Dubai	2007	110,000 m^3/d
Johns Creek	USA	2007	93,500 m^3/d
Beixiaohe	China	2007	80,000 m^3/d
Al-Ansab	Oman	2006	78,000 m^3/d
Peoria	USA	2007	75,700 m^3/d
Lusail	Qatar	2007	60,200 m^3/d
Qinghe	China	2007	60,000 m^3/d
Syndial	Italy	2007	47,300 m^3/d

資料來源: Research and Technology Development Division(2009)

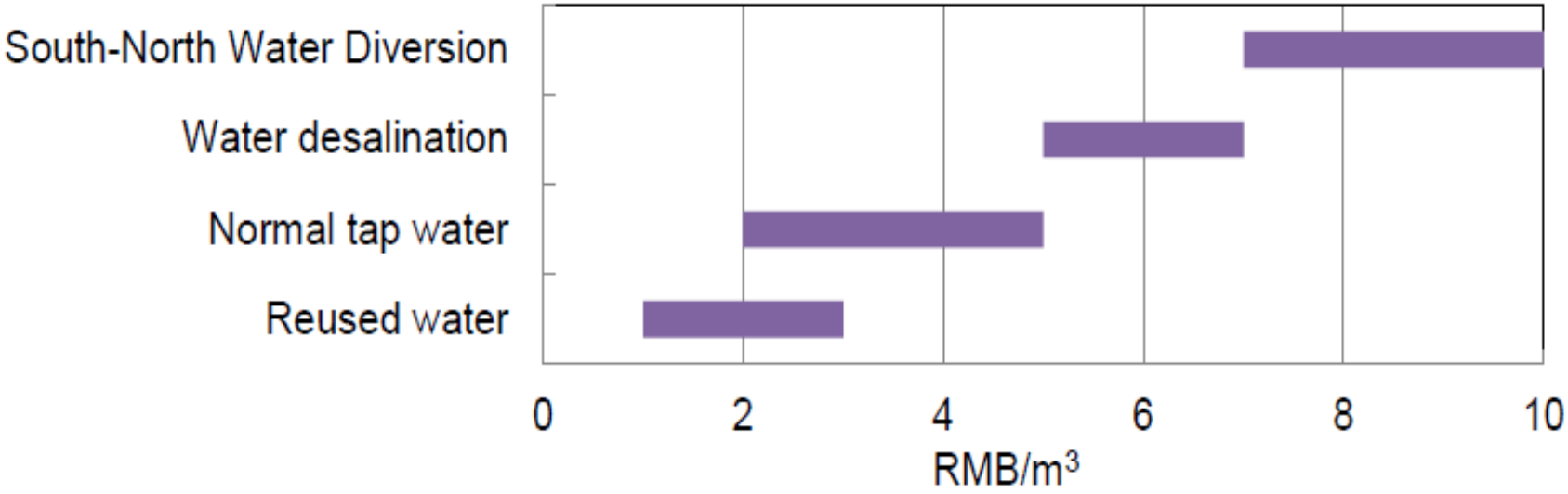
MBR應用於水回收

為何需要廢水回收再利用?

- 提供家庭及城市居民可用的水源
- 協助用水量大的工業，確保水資源的長期供應，以維持生產及人員之穩定
- 保持廢水處理廠全時運轉，同時也控制環境污染
- 協助城市創造新營收，銷售再生水
- 提供水及廢水管理民營化的機會

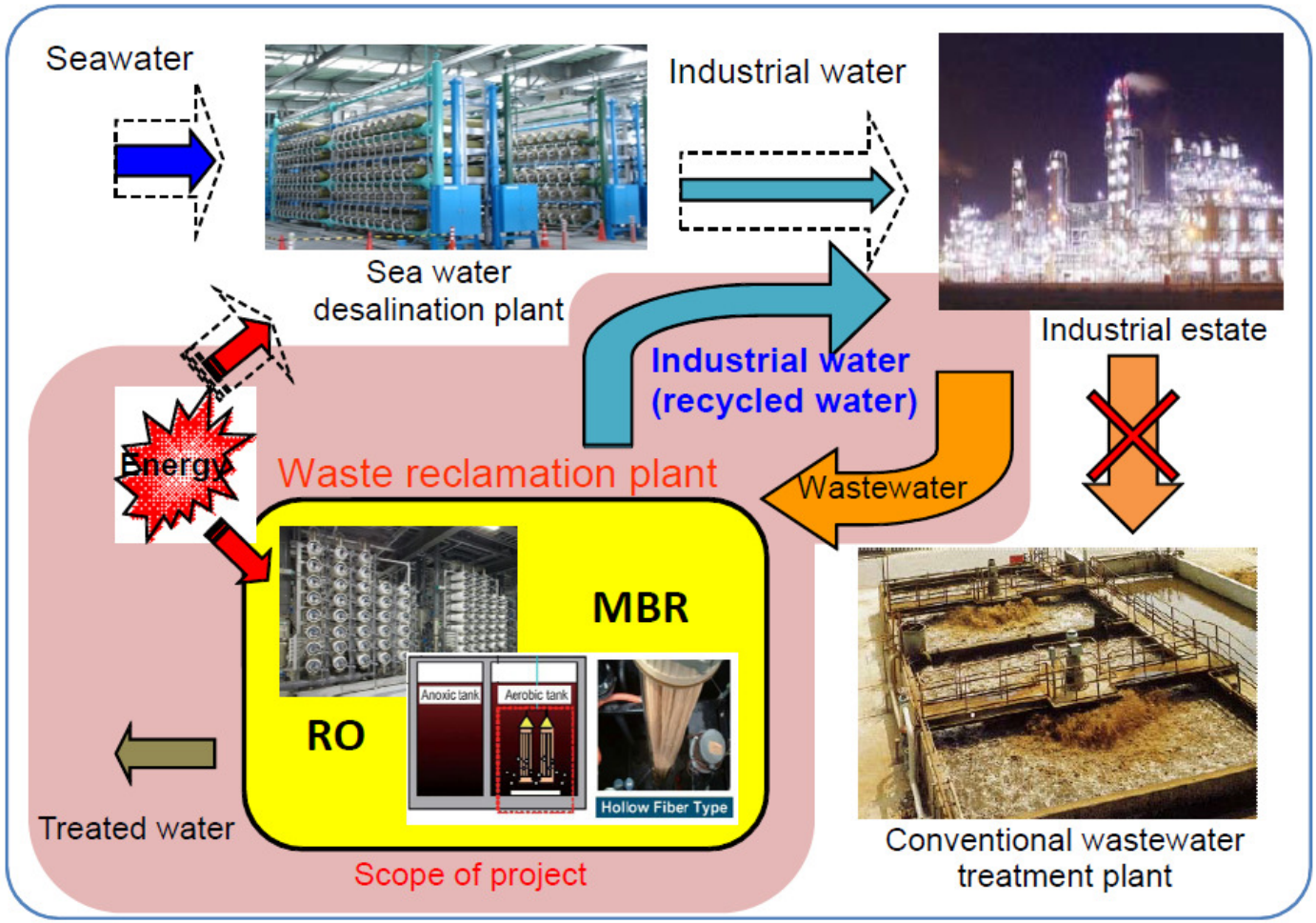
MBR進流出流水比較

Cost Ranges for Different Sources of Water Supply in China



http://kooperationen.zew.de/fileadmin/user_upload/Redaktion/Lead_Markets/Werkstattberichte/WB_11_MBR_Sartorius_et_al.pdf

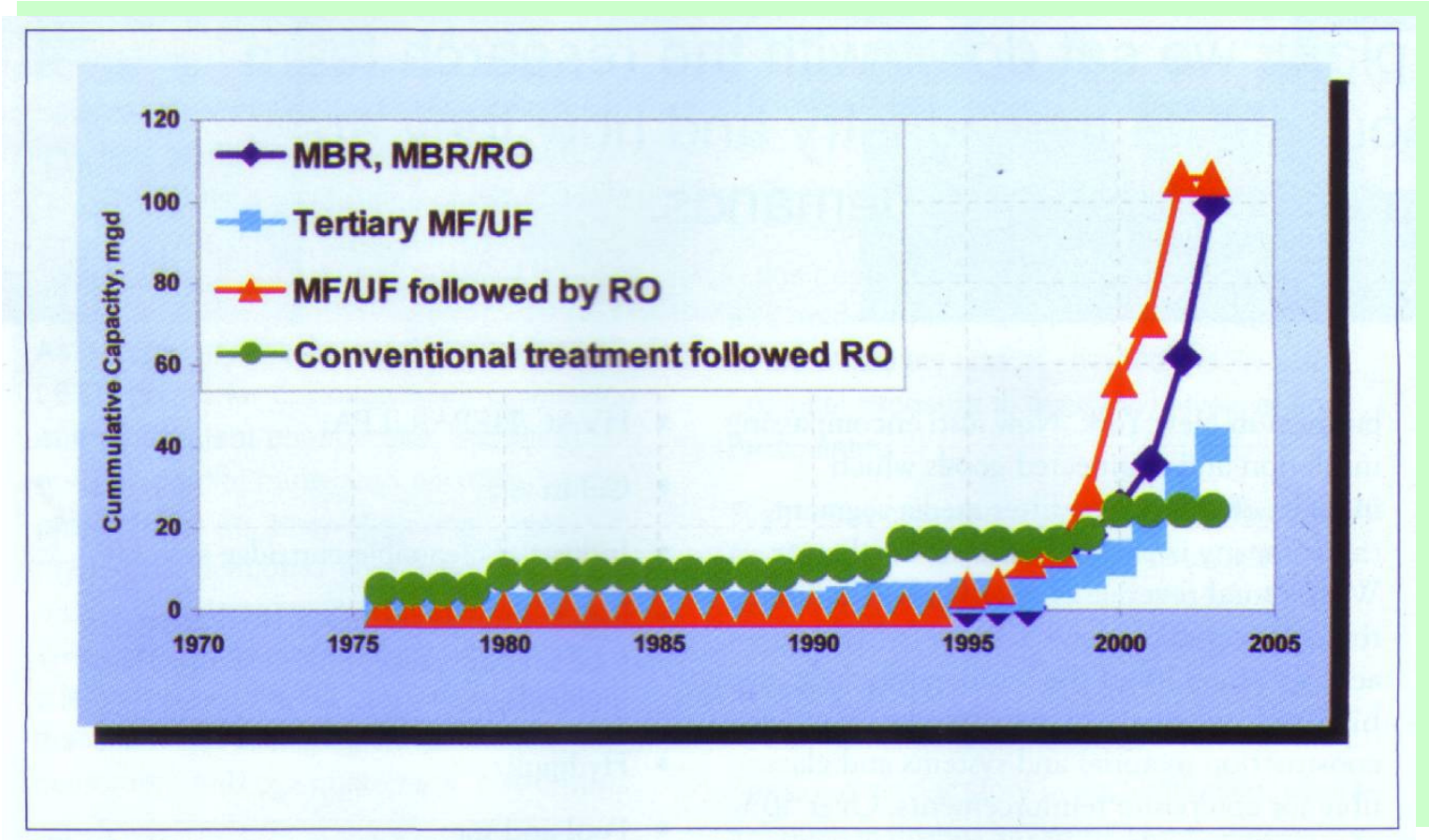
Energy Saving Water Reclamation with Membrane Technology



Demonstration Project in Saudi Arabia: FY2012-FY2014

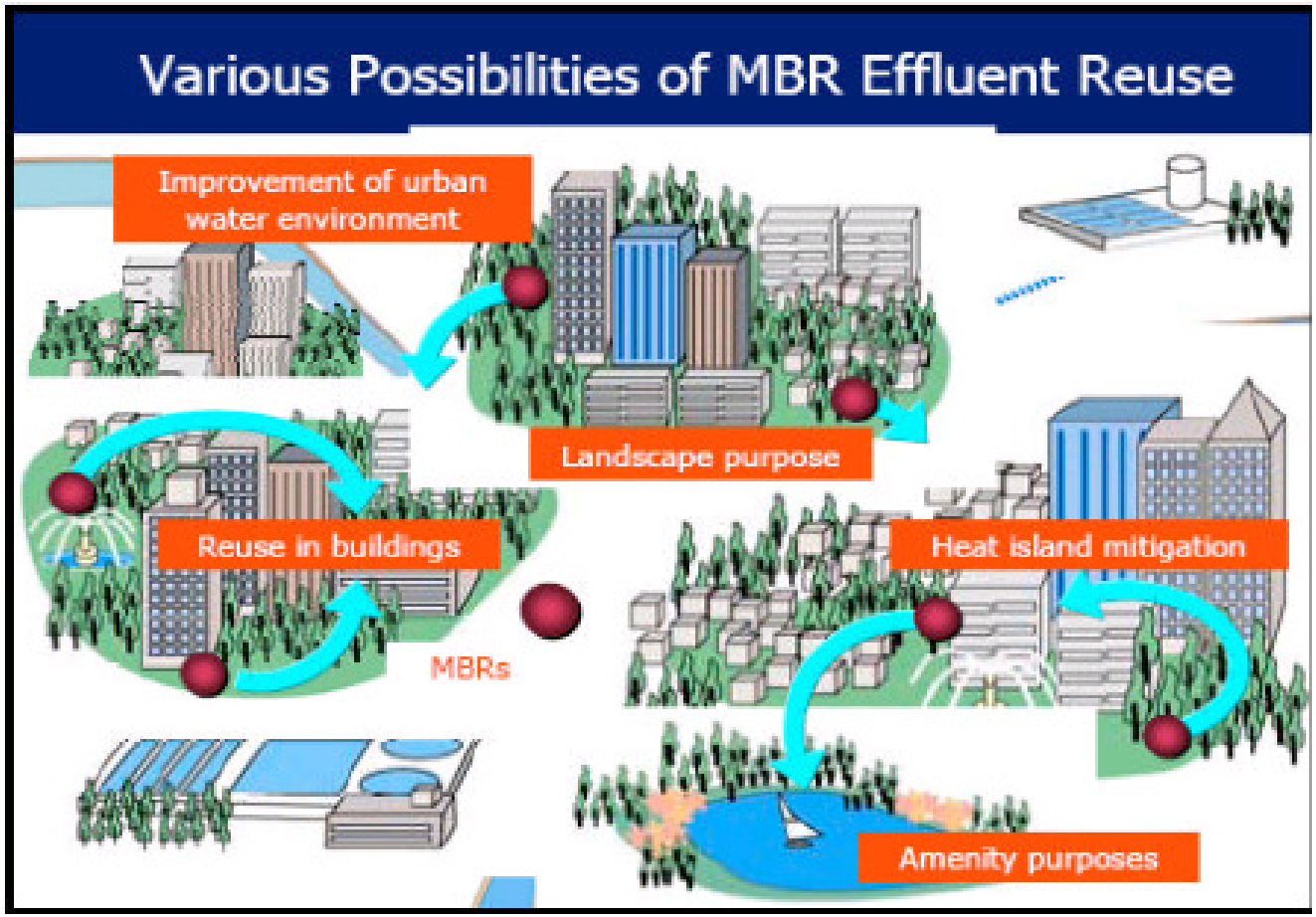
http://www.nedo.go.jp/english/index.html

薄膜技術應用於水回收之發展趨勢



資料來源：Filtration & Separation, Jan-Feb. 2008

MBR 放流水之再利用



資料來源: Int. J. Chem. Technol., 1 (2009)

廢水再利用之應用領域

Industry & Power	65.5 %
Municipal	11 %
Agriculture	23 %
Other	0.5 %

資料來源：Filtration & Separation, Jan-Feb. 2008

全球水再生計畫

- Aquarec project 檢視全球3300水再生計畫，其中有200項歐洲的水回用計畫
- 全球水再生計畫涵蓋7個地區:

(a)北美(美國800件，水回水量最大約650萬噸/d)

(b)拉丁美洲

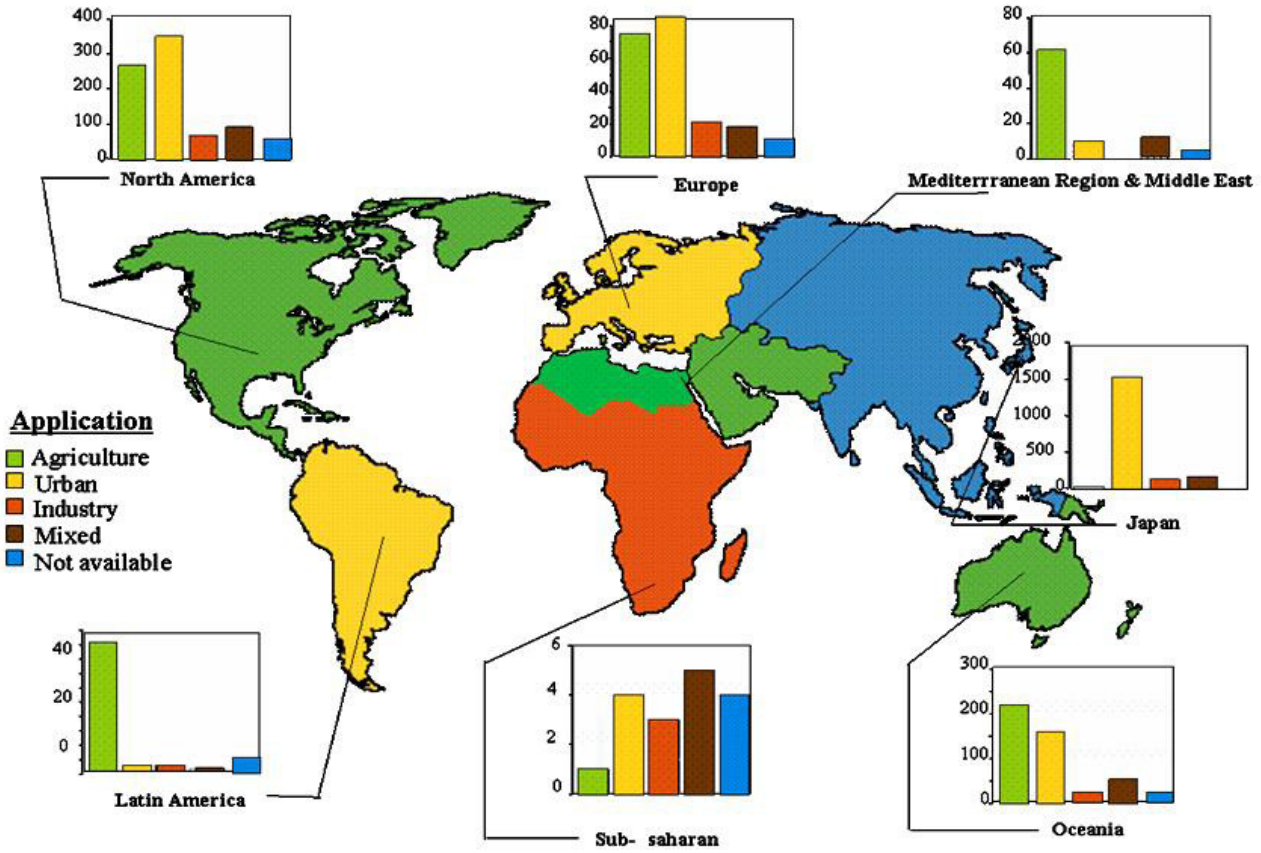
(c)歐洲

(d)中東地區及地中海等

(e)薩哈拉沙漠以南的非洲地區

(f)大洋洲以及日本(1800件)

全球水再生應用分佈



資料來源: Desalination, 178 (2005)

水回用的考量因素

- 水再生之後其用途很多，再生水的水質必須符合應用領域所需要的條件，廢水回用的決定因素：

  1. 當地及地區水供應條件
  2. 水回用應用所需要的水質條件
  3. 現存或構想的水處理設施
  4. 處理流程的可信賴度
  5. 減輕潛在健康風險以及讓大眾接受性
  6. 回用設施的財務規畫，包括:回用水的銷售

歐洲安全實施水回用計畫的主要考量

- 對於回用的需求及準則(guideline)的需求，遠超過對法規的需求
- 提供一份完整的指導文件，確保最低的風險，同時可以讓任何想做水回用的單位有足夠知識可用
- 社會及主其事的人都必須參與其中，他們才會瞭解並全力參與決策
- 產品及系統的安全性必需證明
- 解決方案必須合理且對環保、經濟及社會面都是永續的

資料來源: Technical workshop : The integration of reclaimed water in water resource mangement, Girona, Oct. 2005.

歐洲水再生的應用

- 都市污水處理廠放流水的回收處理再利用，其應用領域分成四類:

  (1)農業

  (2)工業

  (3)都市、休閒及環境用途，包括含水層(aguifer)

  (4)上述幾種搭配使用

美國各洲水再生應用

Type of Reuse	Number of States
Unrestricted Urban	28
Irrigation	28
Toilet Flushing	10
Fire Protection	9
Construction	9
Landscape Impoundment	11
Street Cleaning	6
Restricted Urban	34
Agricultural (Food Crops)	21
Agricultural (Non-food Crops)	40
Unrestricted Recreational	7
Restricted Recreational	9
Environmental (Wetlands)	3
Industrial	9
Groundwater Recharge (Nonpotable Aquifer)	5
Indirect Potable Reuse	5

美國各洲再生水質標準

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Oxidized, coagulated, filtered, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized, coagulated, filtered, and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	5.0 mg/l	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg)	2 NTU (Avg)	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg)
	5 NTU (Max)	5 NTU (Max)					5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	None detectable (Avg)	2.2/100 ml (Avg)	75% of samples below detection	2.2/100 ml (Avg)	2.2/100 ml (Avg)	20/100 ml (Avg)	2.2/100 ml (Avg)
	23/100 ml (Max)	23/100 ml (Max in 30 days)	25/100 ml (Max)	23/100 ml (Max in 30 days)	23/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

[1] NS - Not specified by state regulations

美國廢水處理放流水用於蔬菜灌溉計畫(1980~1985年)

- 再生水水質標準及處理可信賴度(The California Health and Safety code of Regulations)
- 廢水處理MF、UF、NF及RO過濾後，其水質應符合下列規格:
  - 濁度＜0.2NTU，在24小時以內超過規定的時間不得大於5%(任何時間應維持在0.5NTU)
  - 任何薄膜要用在都市污水回收，必須通過CDPH (California Department of Public Health)的核准
  - 要通過CDPH的核准，CDPH規定要有Pilot研究以確保過濾水質能達到The California Health and Safety code of Regulations的規定
  - 再生水的消毒，加氯除外，其消毒放流水中的小兒麻痺病毒(poliovirus)或MS2 必須達到5-log失活或去除(inactivation/removal)

Title 22 MBR模廠試驗核可

- MBR系統通過The California Health and Safety Code of Regulations核可
- MBR系統能力將考量下列條件:
  - 濁度＜0.2 NTU，24小時內只容許5%的時間超出規定
  - 任何時間需維持於0.5 NTU
  - 長時間的操作數據(通量及負壓範圍)
  - 薄膜規格
  - 系統必須達到1-log病毒減除(P_{50})

美國 Arizona 水再生廠

- 北美最大之MBR廠，2008年完工
- 放流水將作為公園澆灌與人工含水層之回填或回用
- 處理水量10 mgd(37,850 CMD)
  可擴充至13 mgd(49,205CMD)

資料來源: http://www.waterworld.com

美國 Broad Run 水再生廠

- 建造費用1.9億美元
- 回收水用途: 澆灌及冷卻水
- 新廠處理能量45,000 ~ 95,000 m^3/day，可擴充至136,000 m^3/day

The award-winning Broad Run Water Reclamation Facility is the first large-scale application of membrane bioreactor-granular activated carbon-ultraviolet (MBR-GAC-UV) disinfection technology in the world.

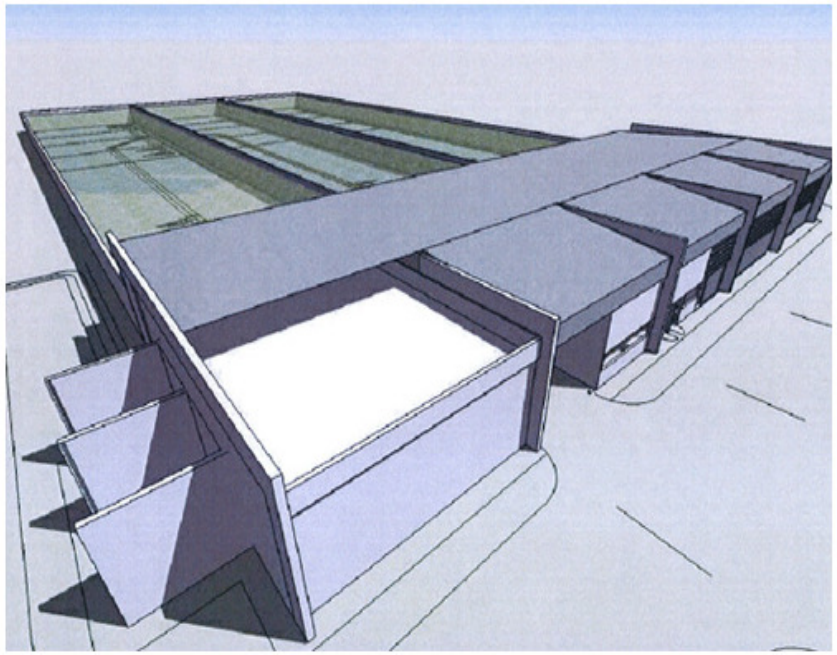
資料來源: CH2M HILL(2010)

新加坡水再生廠

- NEWater 是廢水產生之高級回收水
- 經過生物處理、MF、 RO、消毒
- 處理過後之水與水庫水混合，經過正常之流程處理成為飲用水

資料來源:H. Moeslang, Membrane Bioreactors Key Technology for Water Reuse(2010)

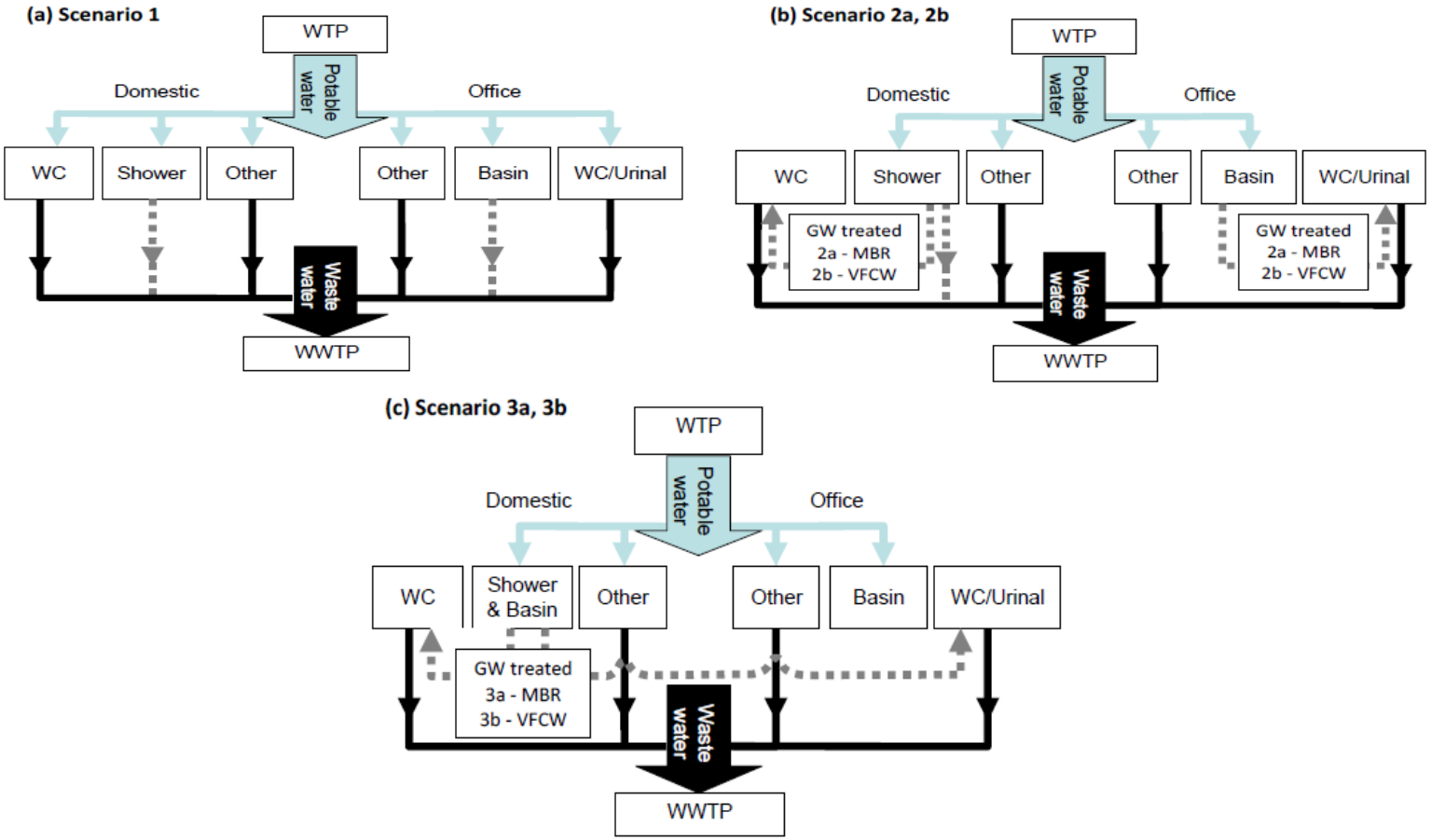
新加坡Jurong MBR水再生廠



資料來源: http://www.desalination.biz

- 此一新加坡最大MBR廠將建於Jurong Water Reclamation Plant
- 處理過的污水將作為Jurong Island的工業用水
- 預計於2011年下半開始營運
- 處理水量:68,000 ton/day
- 總投資費用:3580萬美元

Shared Urban Greywater Recycling Systems



Sustainability **2013**, *5*, 2887-2912; doi:10.3390/su5072887
www.mdpi.com/journal/sustainability

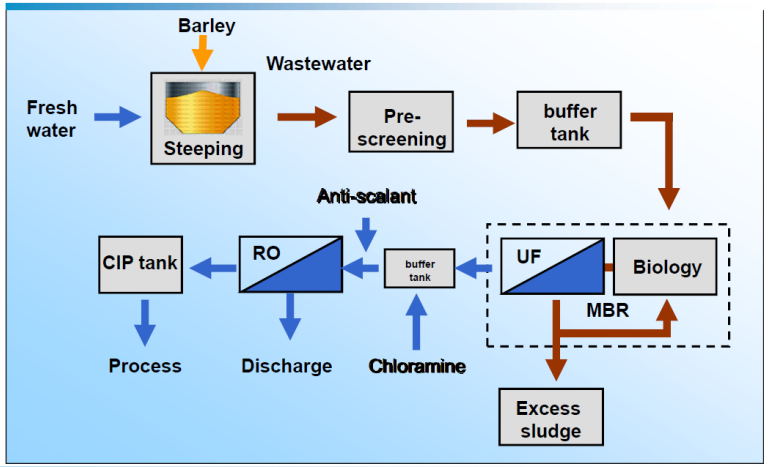
Flow Rates and Related Cost Savings

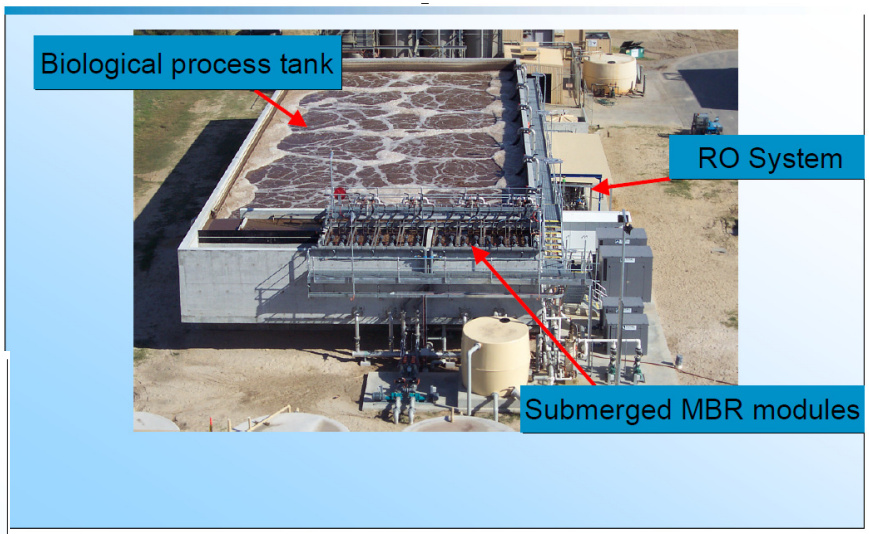
Various flows (*units m^3/day unless stated otherwise*)	Scenario				
	1 (*Domestic, Office*)	**2a**	**2b**	**3a**	**3b**
Potable mains water demand [a]	79.8 *(63.9, 15.9)*	64.4	64.4	57.4	57.4
Domestic GW demand	0.0	12.4	12.4	12.4	12.4
Office GW demand	0.0	10.7	10.7	10.7	10.7
Domestic GW generation	0.0	24.9	24.9	28.9	28.9
Office GW generation	0.0	2.9	2.9	0.0	0.0
Total GW recycled and used	0.0	15.4	15.4	23.1	23.1
Wastewater generation [a]	78.2 *(62.6, 15.6)*	62.6	62.6	56.2	56.2
WTP and WTTP charges *(£K/yr)* [b, c]	74.9 *(63.6, 11.3)*	61.2	61.2	53.3	53.3
Total savings *(£K/yr)*	0.0	13.6	13.6	21.5	21.5

[a] Based on data from Table 1, 2 and 3; [b] assuming a price of £1.62 per m^3 for potable water supply and £1.13 per m^3 for sewerage charges (based on OFWAT (Office of Water Services, United Kingdom), 2011–2012 tariffs [48]); [c] assuming offices are in operation 261 days/yr and domestic flats are in operation 365 days/yr.

Sustainability **2013**, *5*, 2887-2912; doi:10.3390/su5072887
www.mdpi.com/journal/sustainability

Process Flow of Industrial Wastewater Recycling in Australia





Constituent (mg/L)	Influent Wastewater		MBR Permeate		RO Permeate
	50%ile	90%ile	50%ile	90%ile	
BOD	1625	2120	<5	<5	NA
COD	2700	3840	140	162	<10
TSS	145	447	<1	1.4	NA
TDS	2235	2928	1610	1795	256
TN	42.5	55.3	4	6.6	<1
TP	12.5	23	0.2	0.4	<0.1

http://www.watereuse.org/sites/default/files/u3/Water%20Reuse%20in%20Australia%20Halpern%20[Compatibility%20Mode].pdf

Graywater /Blackwater Treatment with MBR

Technology –AquaTex™MBR uses use a four-stage treatment process: Bio reactor, Prefiltration, ultrafiltration, and ultraviolet chamber. The MBR enables up to 85% of treated graywaterto be reusesand minimizessolids production. The graywater and blackwater treatment systems can be used independently or work as an integrated water purification plant.

Wastewater Resources Inc. (WRI)

阿聯Al-Ain Fast Track MBR 廠

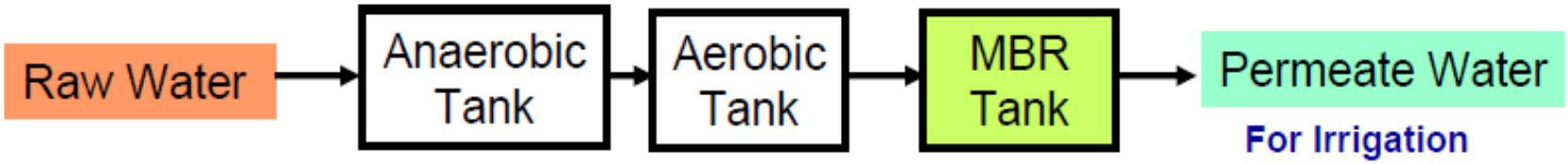
- Sewage Reuse for Irrigation
- Operation started in Mar. 2008
- Capacity : 15,000 m^3/d (5,000 m^3/d x 3 plants)
- Membrane Module : TMR140-200W x 72 units

Location

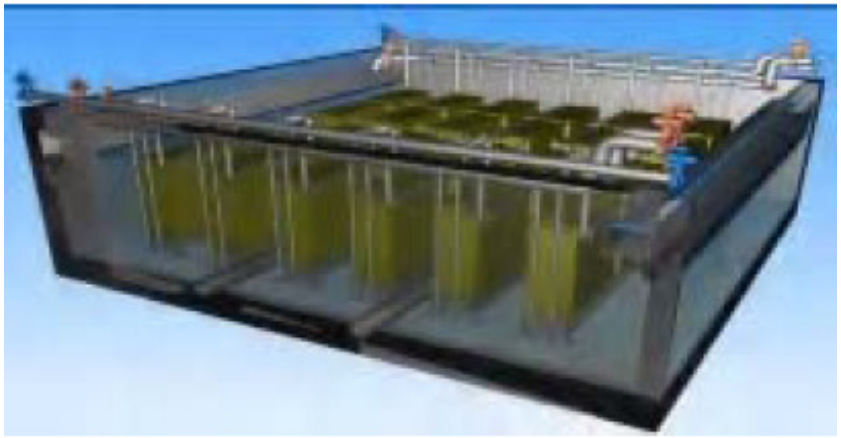
MBR Plant Overview

資料來源: 5th IT-2010 IR Seminar, Expansion Strategy of Water Treatment Business

阿聯Al-Ain Fast Track MBR廠



Process Outline



MBR Tank Design Picture

Water Quality (design value)

		Influent	Effluent
TSS	mg/L	218	1
BOD_5	mg/L	231	10
NH_4-N	mg/L	30	5
Turbidity	NTU	-	≦1

資料來源: 5th IT-2010 IR Seminar, Expansion Strategy of Water Treatment Business

杜拜Sports City MBR 廠

- MBR廠處理能量 25,000 m^3/day
- 處理後之放流水，有10%經RO處理達到飲用水品質，其餘則作為澆灌使用

資料來源: Edward Attwood (2009)

韓國 Donwoo Fine-chem 公司廢水回用

◆MBR Process was applied to treat Wastewater from Donwoo Fine-chem

◆The treated water was re-treat by RO process for Ultra-pure water production process

◆Project Summary

Application	Industrial Water
Site	Pyeongtaek, Gyeonggi-do
Client	D Co.
completion	2009
Capacity	15,000 Ton/d (10,800㎥/day Reuse)
Process	MBR + RO
Feed Water	Industrial Wastewater
Remarks	Water Reuse

◆Water Quality

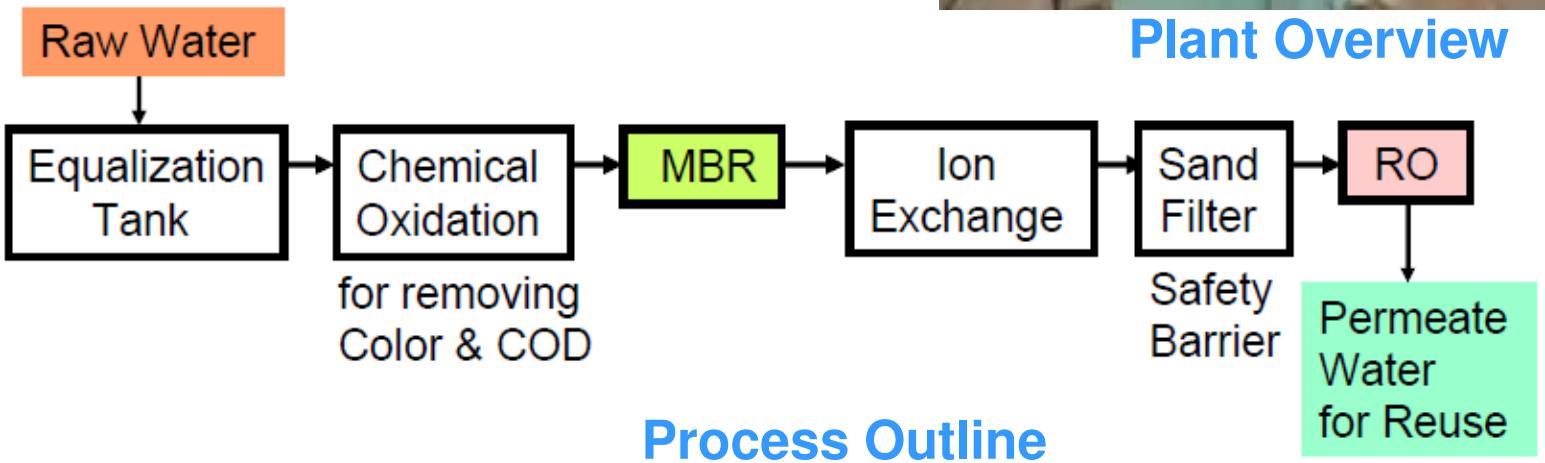
	COD	Conductivity	SDI
Feed	15 ㎎/ℓ	1,000 ㎲/㎝	-
Treated	<1㎎/ℓ	<15 ㎲/㎝	<2

資料來源: Woongjin Coway(2010)

印度Tirupur 紡織廠廢水回用

- Industrial WW Reuse
- Product Water Output: 9,000m^3/d
- Membrane Module :
  TMR140-100S x 128 units
  (MBR Capacity:11,200m^3/d)
- RO Elements:
  TML20- 400 x 600pcs

Plant Overview



Process Outline

資料來源: 5th IT-2010 IR Seminar, Expansion Strategy of Water Treatment Business

重金屬廢水處理

各重金屬處理方法之特性

TABLE 1
Performance characteristics of some heavy metal removal and recovery technologies (Eccles, 1999)

Technology	Performance characteristics				
	pH change	Metal selectivity	Influence of suspended solids	Tolerance to organic molecules	Metal working level (mg/ℓ)
Adsorption (e.g. GAC*)	Limited tolerance	Moderate	Fouled	Can be poisoned	< 10
Electrochemical	Tolerant	Moderate	Can be engineered to tolerate	Can be accommodated	> 10
Ion exchange	Limited tolerance	Some selectivity (e.g. chelating resins)	Fouled	Can be poisoned	< 100
Precipitation as hydroxide	Tolerant	Non-selective	Tolerant	Tolerant	> 10
Solvent extraction	Some tolerant systems	Metal-selective extractants available	Fouled	Intolerant	> 100

*Granulated Activated Carbon

Occurrence and removal of heavy metals from industrial and municipal wastewater: a comparison between MBR and conventional activated sludge processes (CAS)

廢水水質資料

Table 1. Characteristics of feed wastewater.

Value	Unit	Parameter
7.3 ±0.62		pH
223 ± 32	mg/L	SS
250 ± 64	mg/L	COD
250 ±70	µg/L	Al
180 ±80	µg/L	Fe
340 ±190	µg/L	Pb
610 ±170	µg/L	Cu
160± 90	µg/L	Ni
225 ±105	µg/L	Cr

進出流水之重金屬濃度,MLSS及去除率

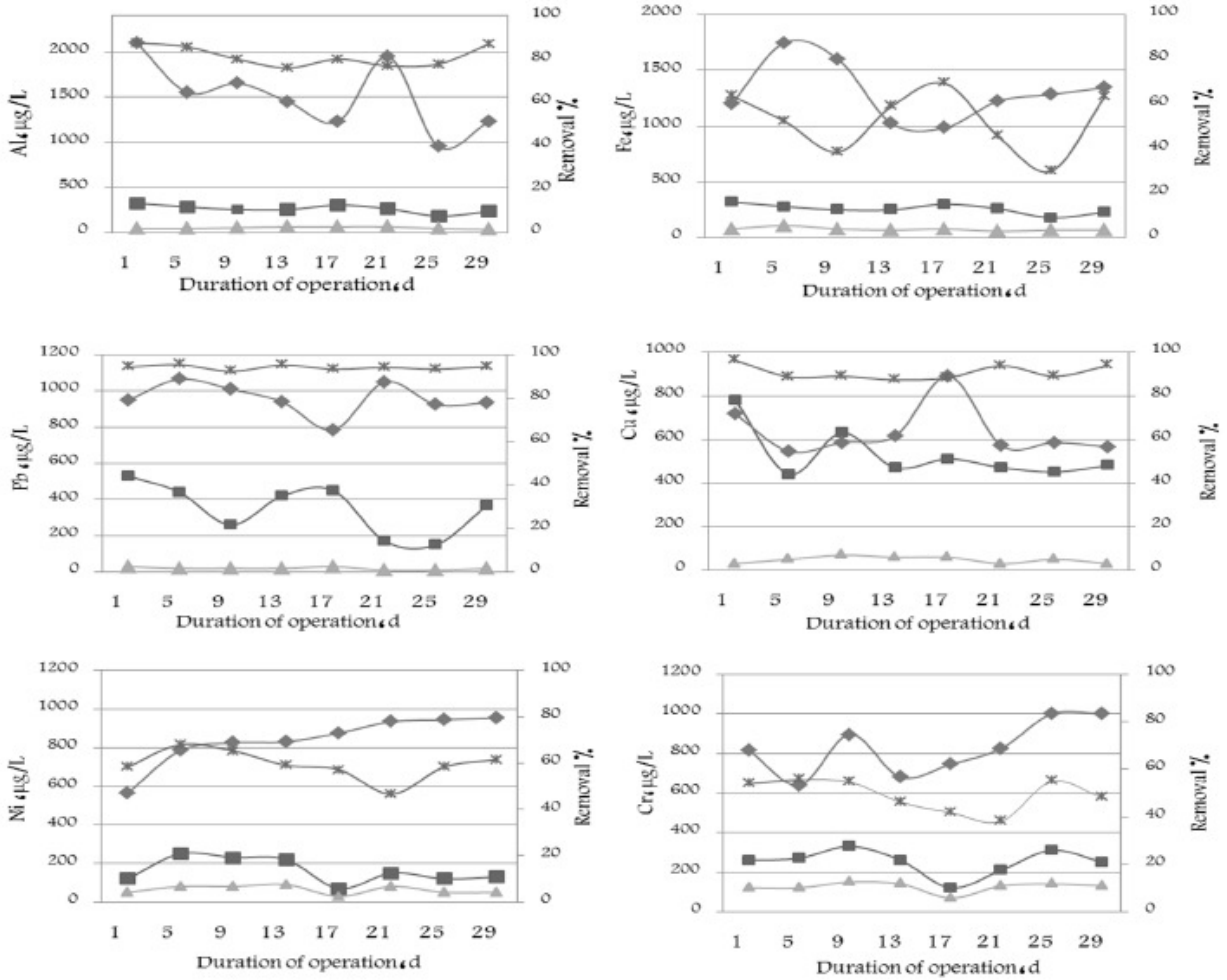
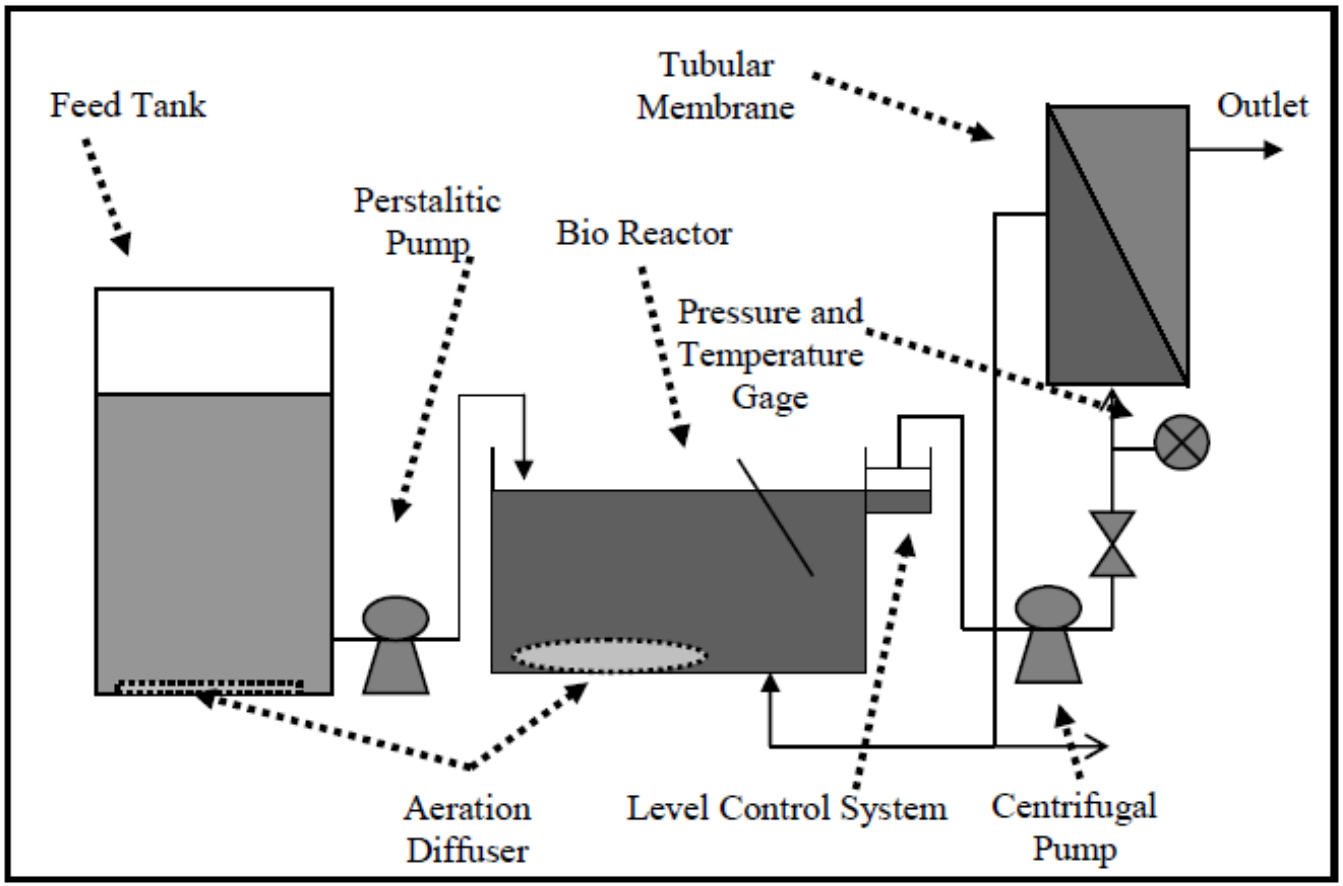


Figure 4. Heavy metals concentrations in inlet, outlet, MLSS and their removal percentage.

Performance of Membrane Bioreactor in Removal of Heavy Metals from Industrial Wastewater

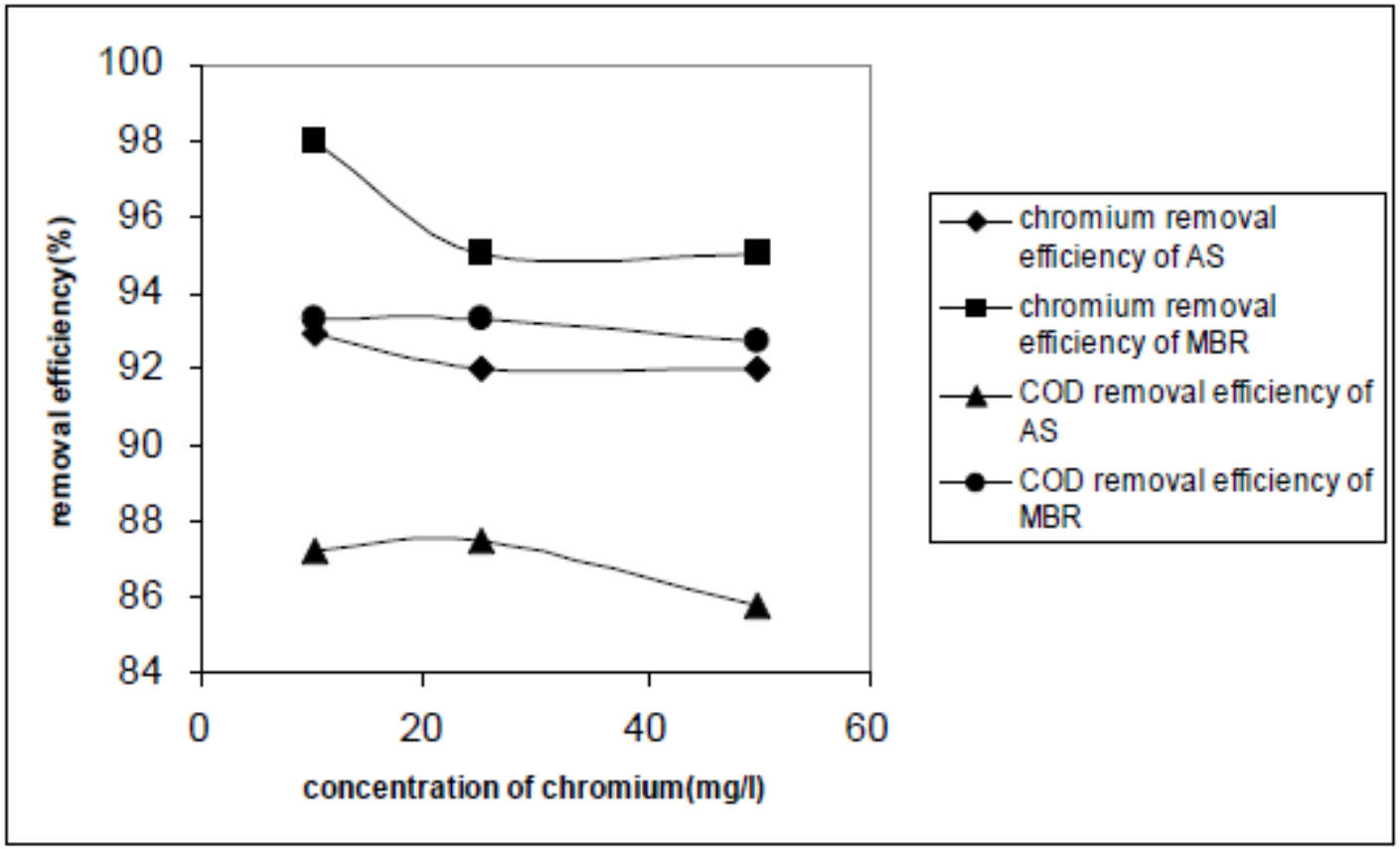


處理參數

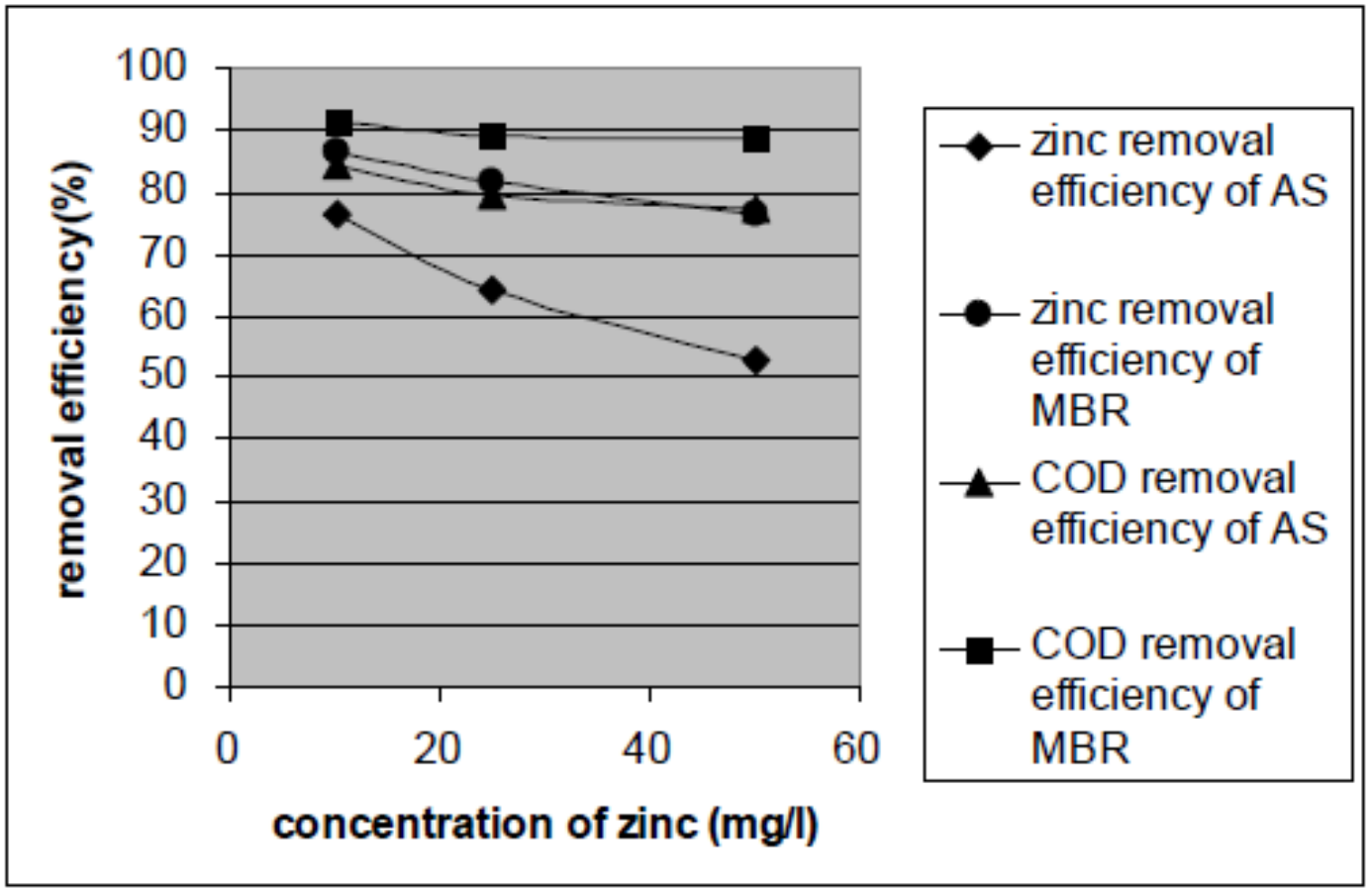
Table 1. Characteristics of the Process

Parameters	Amounts
COD of Feed	900 mg/l
PH of the tank	7-7.5
Dissolved oxygen in the tank	4-5 mg/l
Temperature in the reactor	25 °C
Temperature in the membrane	30-32 °C
Mixed liquor suspended solid (MLSS)	2700 mg/l

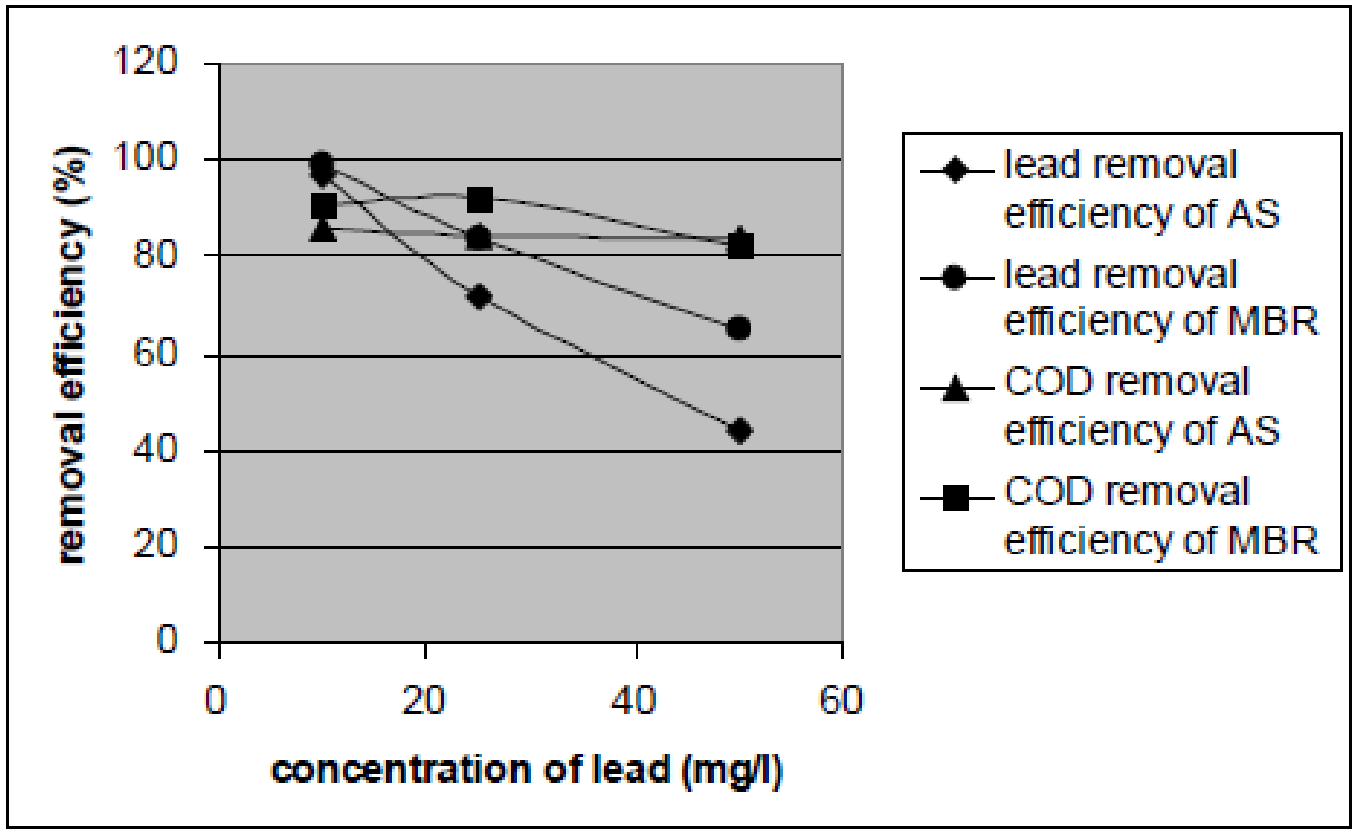
COD and chromium removal efficiencies diagram



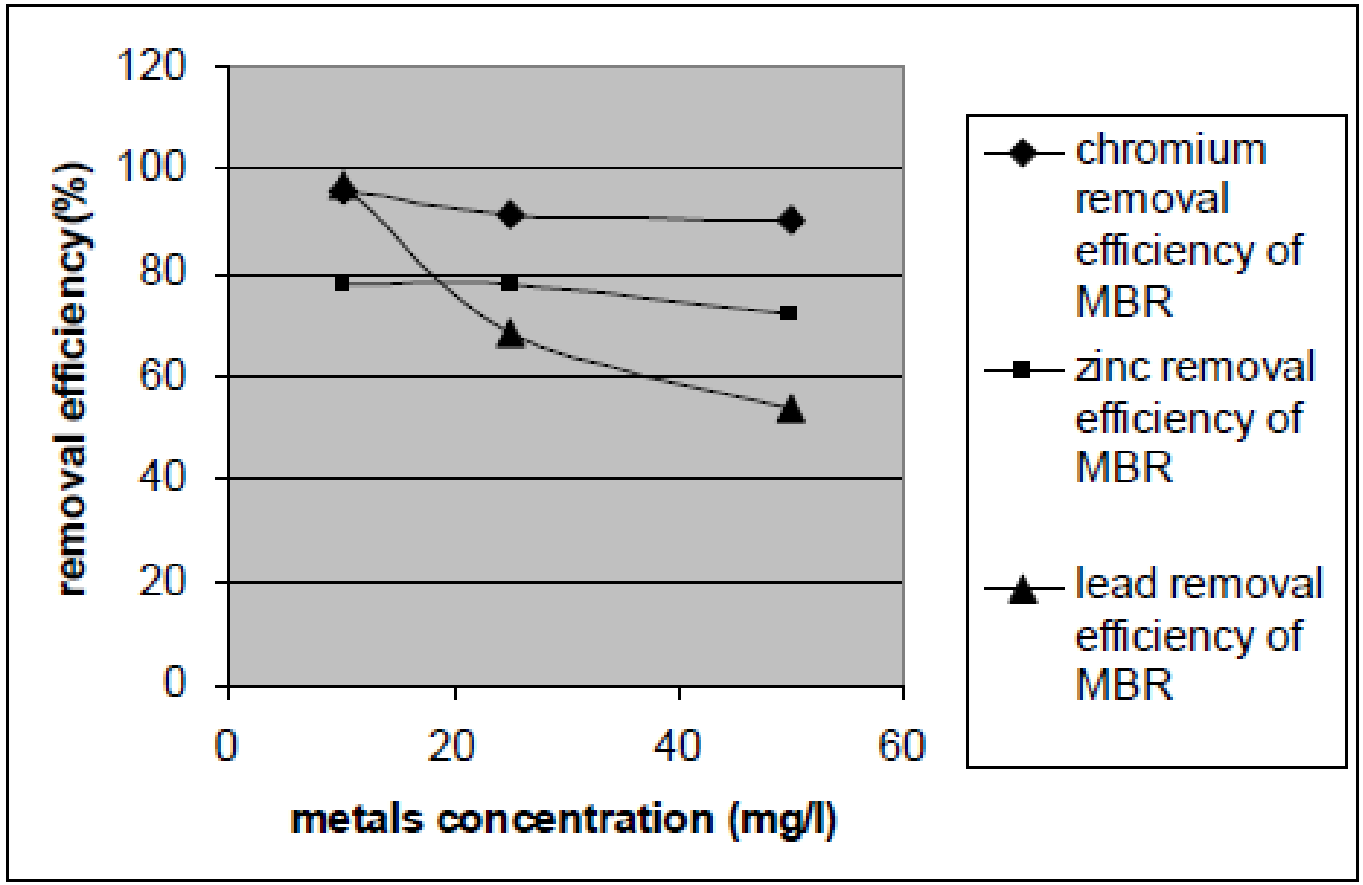
Zinc and COD removal efficiency diagram



COD and lead removal efficiency diagram



Removal efficiencies of metals vs. metals concentrations



AS vs. MBR

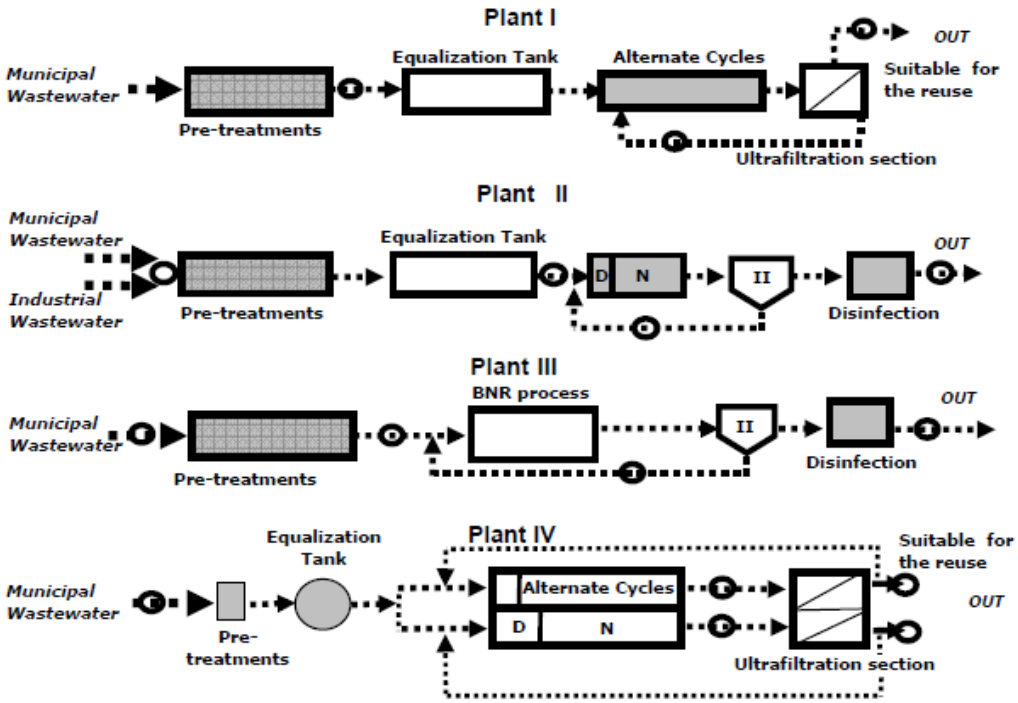
TABLE 4
Performance comparison between activated sludge and an MBR fed an identical synthetic sewage (Cicek et al., 1999)

Performance characteristic	Activated sludge	MBR
Sludge age (days)	20	30
COD[1] removal (%)	94.5	99
DOC[2] removal (%)	92.7	96.9
TSS removal (%)	60.9	99.9
Ammoniacal N[3] removal (%)	98.9	99.2
Total P[4] removal (%)	88.5	96.9
Sludge production (kgVSS[5]/kgCOD·d)	0.22	0.27
Mean floc sizes (µm)	20	3.5

[1]Chemical oxygen demand
[2]Dissolved organic carbon
[3]Nitrogen
[4]Phosphate
[5]Volatile suspended solids

四種廢水廠之處理流程

Table 1. Characteristics of the studied WWTPs



Plant	E.I.	Influent flow (m^3/d)	Effective E.I.	Municipal rate (%)	Industrial rate (%)	SRT (d)	HRT (h)	MLSS (g/l)	MLVSS/ MLSS (%)
I	25000	4700	23000	100	0	20	11,2	7,7	76,5
II	350000	118000	315000	63	37	24	10,5	4,9	65
III	70000	15000	14000	100	0	9	14,4	5,6	63
IV*	-*	36	-*	100	0	20	7,3	9	70

* pre-industrial plant (no scale-up problems).

廢水中微粒與TSS之關係

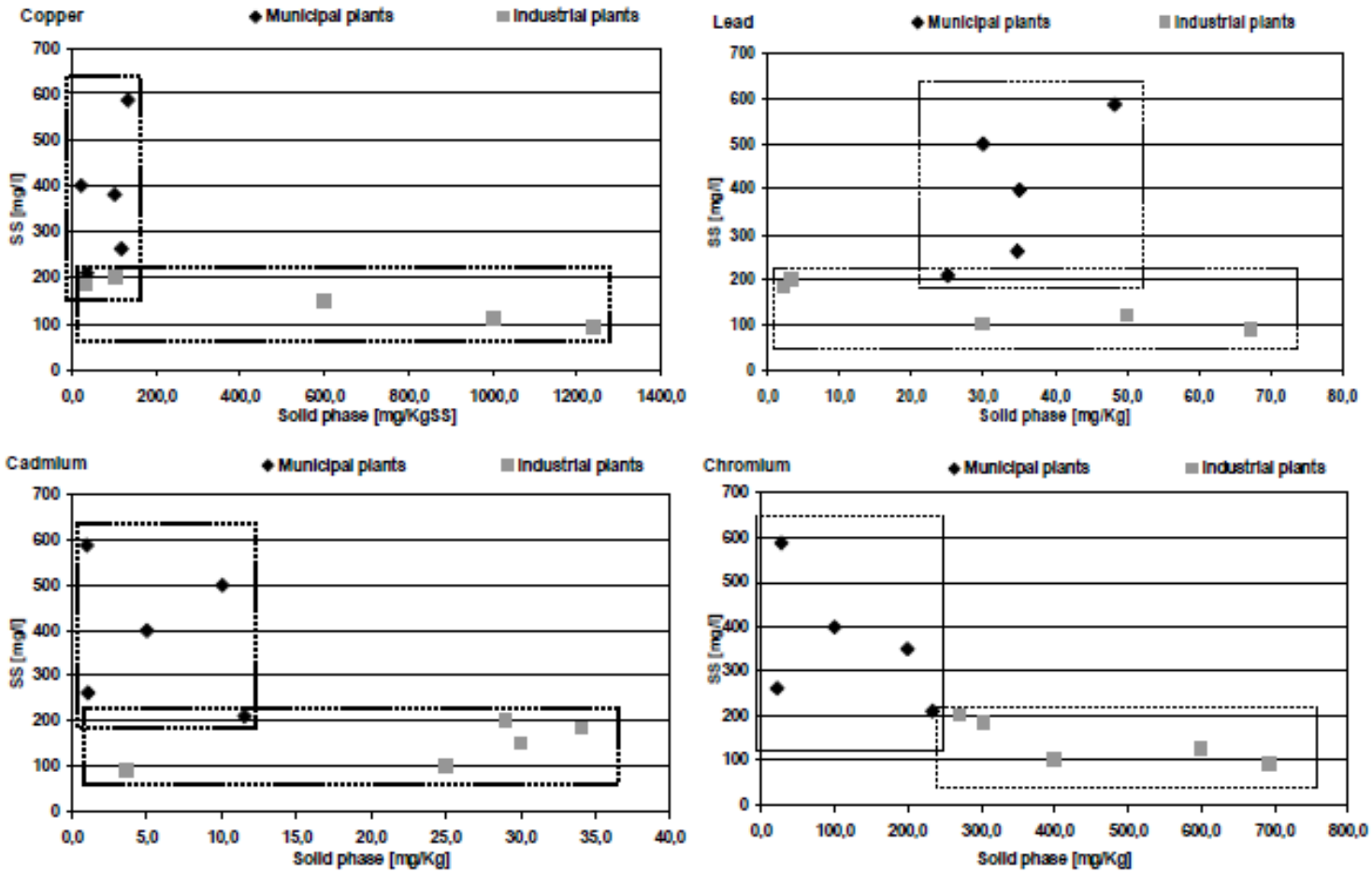


Figure 2. Tendency of particulate phase vs. TSS in municipal and industrial WWTPs

重金屬去除效率

Table 2. Mass balances, removal efficiencies and typical literature values

	IN (g/d)				OUT (g/d)				Total Removal (%)				Typical Values*
	I	II	III	IV	I	II	III	IV	I	II	III	IV	
As	n.d.	314	71	0,076	12,5	189	28,4	0,049	**n.d.**	**40**	**60**	**36**	–
Hg	40,4	236	61,1	0,951	3,29	159	8,53	0,082	**92**	**33**	**86**	**91**	57÷92
Cu	265	6650	1282	1,48	26,3	1789	8,10	0,122	**90**	**73**	**99**	**92**	54÷82
Pb	78	7285	578	0,573	20,7	1939	128	0,015	**74**	**73**	**78**	**97**	68÷100
Cd	n.d.	214	14,2	0,012	n.d.	11,8	n.d.	n.d.	**n.d.**	**94**	**n.d.**	**n.d.**	25÷74
Ni	40,9	3275	255,8	0,330	11,4	844	55,4	0,025	**72**	**74**	**78**	**92**	43÷95
Cr	46	4485	230	0,640	12,7	1651	98	0,085	**72**	**63**	**57**	**87**	68÷85
Zn	1698	62627	11766	12,8	545	38400	10466	1,7**	**68**	**39**	**90**	**87**	87÷88
Fe	5795	284506	59469	65,2	613	62838	6476	1,7**	**89**	**78**	**89**	**97**	67÷90
Al	9118	293737	104663	74,5	981	65697	58783	1,7**	**89**	**78**	**44**	**98**	70÷80

n.d. = not detectable

* Rogers, 1996; Chipasa, 2003; Katsoyannis and Samara, 2004.

** The values are the superior instrumental limits.

厭氧槽排泥之重金屬含量

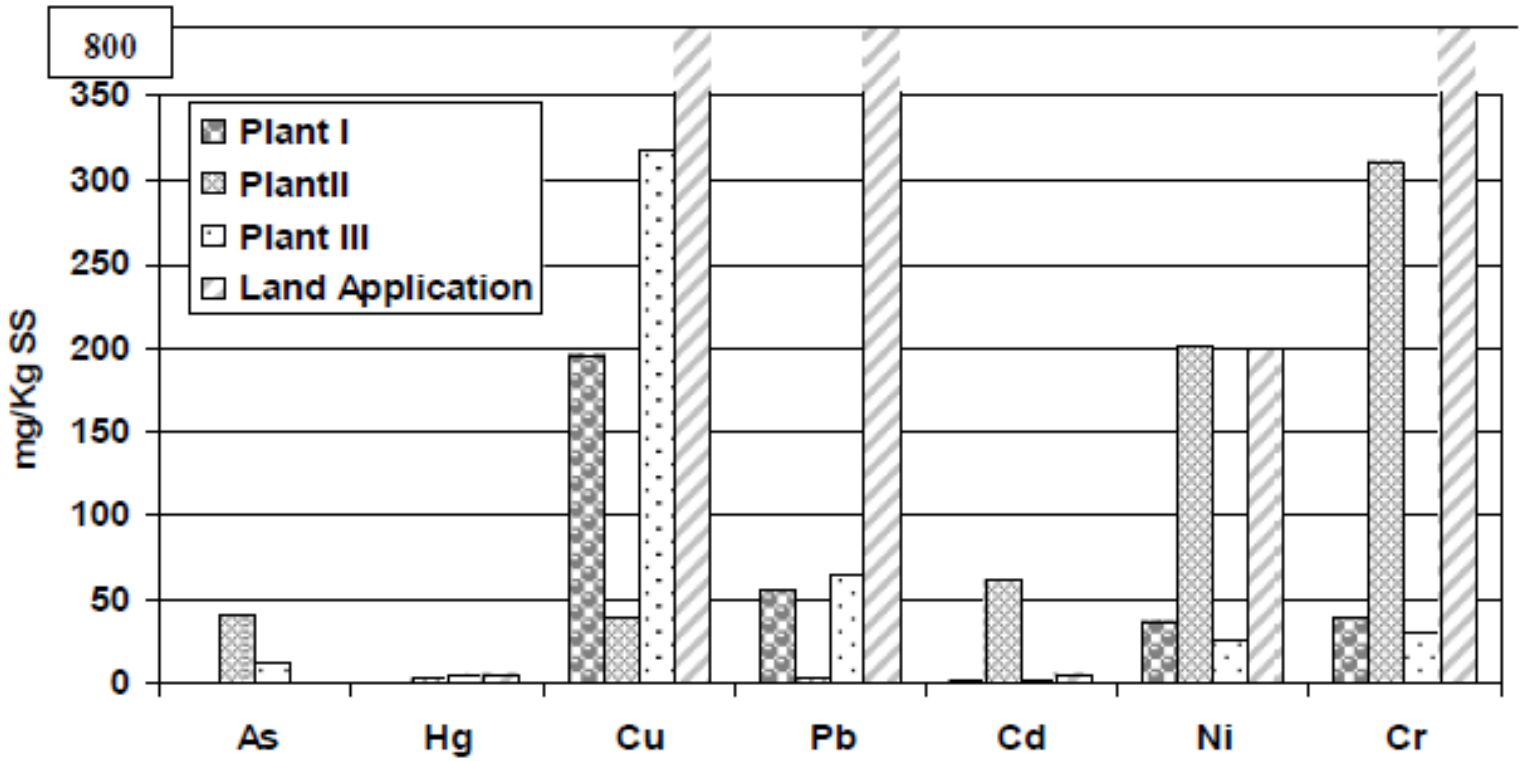


Figure 3. Out of Anaerobic Digester of plant I, II and III and limit for Land Application

康那香MBR經驗分享

N-MBR®過濾模組之薄膜特性

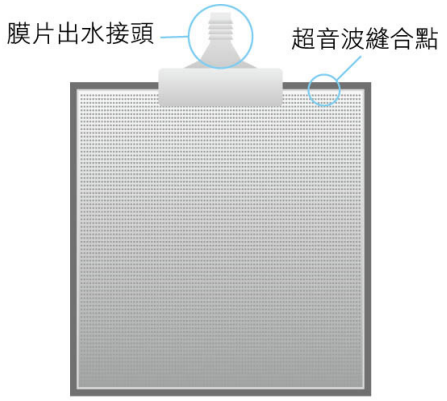
1.平板膜

膜面積垢較易被底部曝氣清除；若發生膜片壞損需更換，可單片式更換或修補，膜片維護成本低。

2.薄膜特殊結構

膜面係由數千層直徑小於5nm的纖維交錯組成。薄膜具有特殊的3D立體結構層，孔隙率高(大於 75%)，故攔截過濾之效佳、通量高、操作負壓低。

特殊3D結構



膜片結構示意圖

N-MBR® 膜片特性

3.膜片材質(雙層結構)

膜面材質強度高，耐化學性高，具有不易沾黏的特性。

內層之支撐材材質為PET材質

4.薄膜及膜片規格

(1)孔徑:

MF(微濾): 0.3 μm

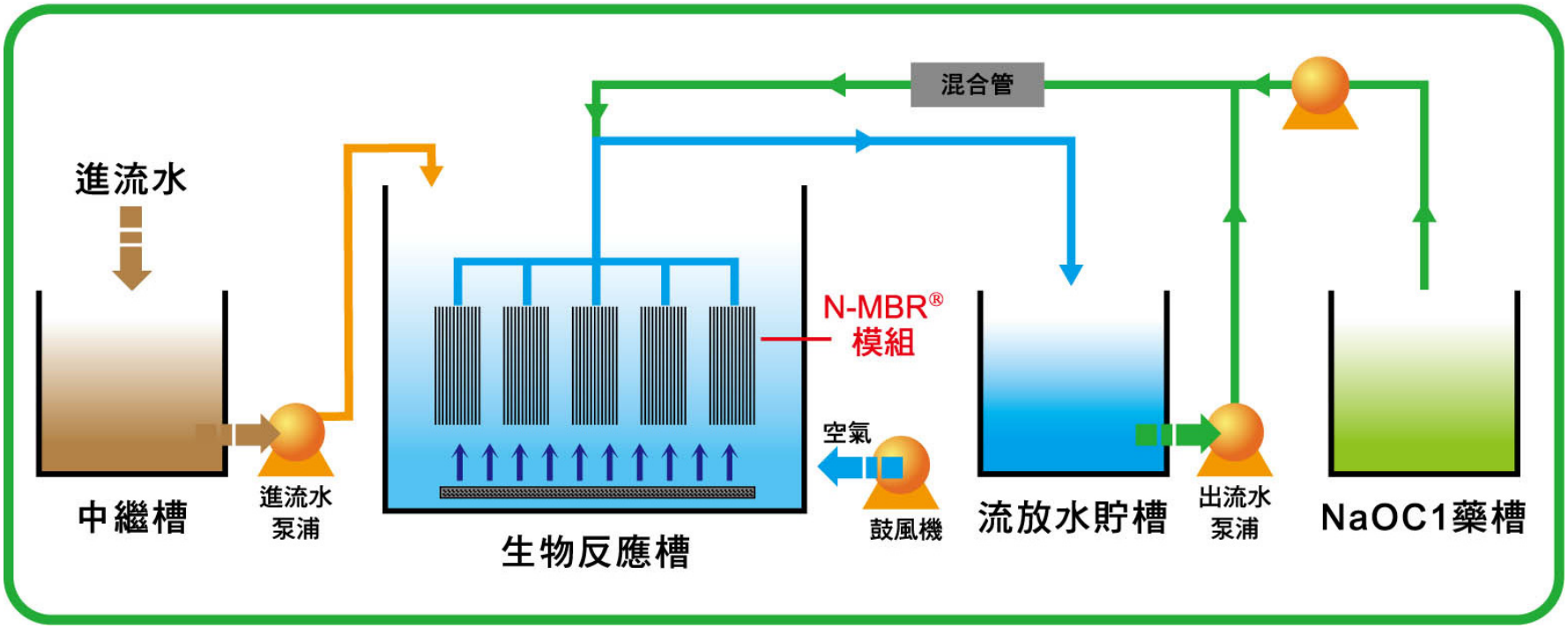
UF(超濾): 0.07 μm

(2)膜片規格:

50 x 100 cm

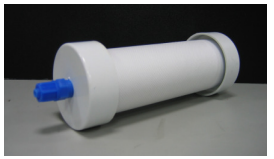
N-MBR® 薄膜生物反應器系統

N-MBR®系統示意圖



KNH水處理技術發展歷程

- 2001年至今參加工研院環安中心科專計畫業界合作
- 2002年1月於康那香一廠建立第一座30 噸/日 N-MBR®廢水處理槽
- 2004年發展 BioWEB® 及 BioMF® 技術
- 2006年元月於內湖污水處理廠建立 100 CMD BioMF®污水處理模廠
- 2008年與工研院能環所合作開發洗車廢水回收再利用套裝設備
- 2008年與中興顧問社合作開發砂濾反沖洗過濾模組
- 2008年與工研院能環所合作廢水兩相產氫技術
- 2009年成功開發細氣泡曝氣盤
- 2012年三月成立康潔環境保護工程股份有限公司



N-MBR® 膜片特性

3.膜片材質(雙層結構)

表層膜面材質為PTFE纖維，材質強度高，耐化性高，具有不易沾黏的特性。內層之支撐材材質為PET材質

4.薄膜及膜片規格

(1)孔徑:

MF(微濾): 0.3 μm

UF(超濾): 0.07 μm

(2)膜片規格:

50 x 100 cm

N-MBR® 膜片特性

8.大腸桿菌及總菌過濾效能

項目	原水	MF薄膜出流		UF薄膜出流	
	CFU/100ml	CFU/100ml	去除率	CFU/100ml	去除率
E.coli	160000	390	99.7563%	1	99.9994%
總菌數	3500000	19000	99.4571%	350	99.9900%

N-MBR® 薄膜過濾模組 (單層式)

N-MBR® 薄膜過濾模組(單層式)

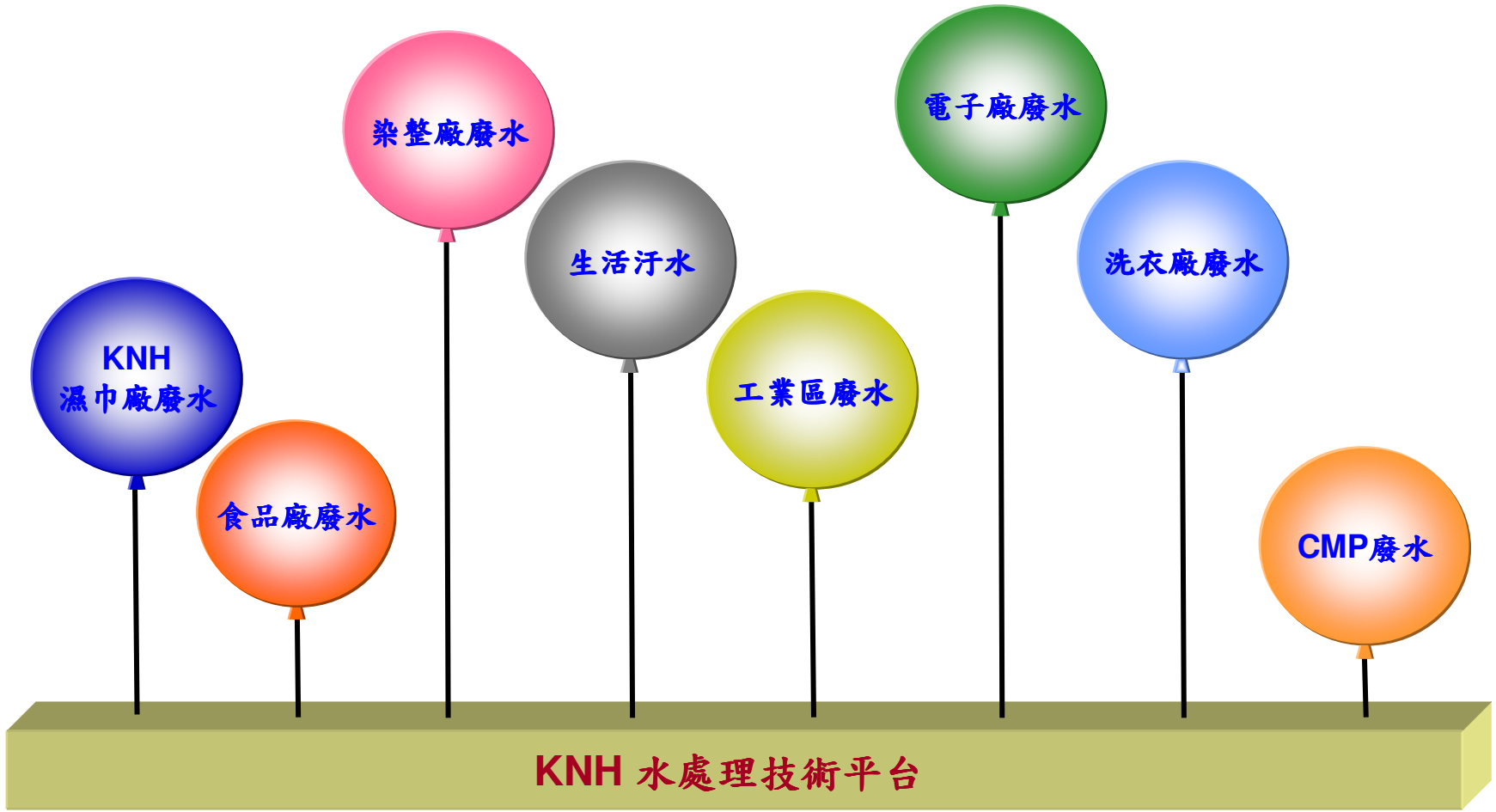
N-MBR® 薄膜過濾模組 (雙層式)

N-MBR® 薄膜過濾模組 (小噸數)

專利技術

Patent	Nation	Patent No.
N-MBR®	Taiwan	I 238737
	Taiwan	I 251581
	Taiwan	I 321487
	USA	US 7,517,454
	Europe	EP 1918253
	Taiwan	I 324138
	USA	US 7,501,060
	China	717440
BioWEB®	Taiwan	I 302905
	Korea	10-0701603
	Taiwan	I 287054
	Korea	10-0658652
	Korea	10-0737968
	Europe	EP 1798204
	China	643799
	China	405248
Air Diffuser	USA	US 768,1867
	Taiwan	I 321492
	China	786274

KNH 水處理技術應用

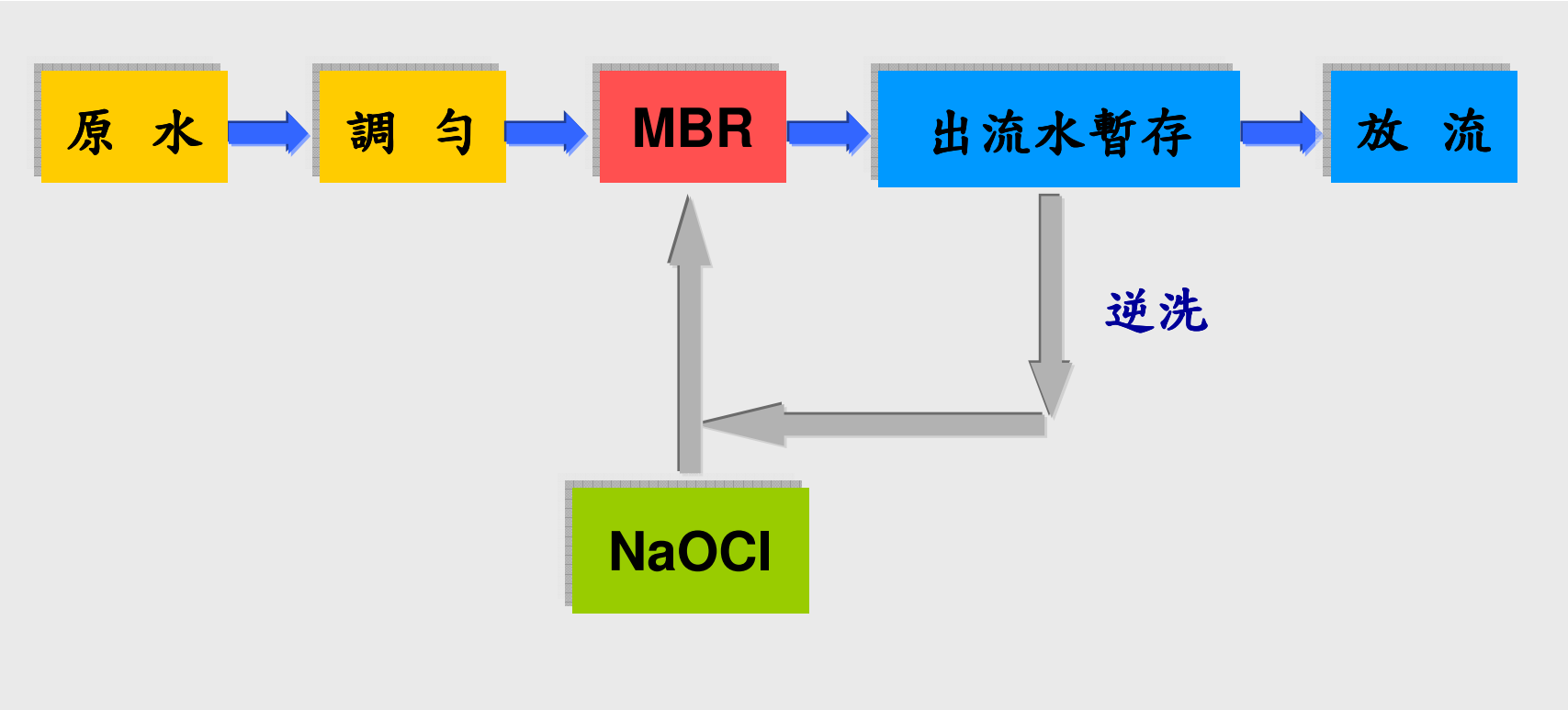

KNH
濕巾廠廢水
食品廠廢水
染整廠廢水
生活汙水
工業區廢水
電子廠廢水
洗衣廠廢水
CMP廢水
KNH 水處理技術平台

TFT-LCD 廠之廢水回收

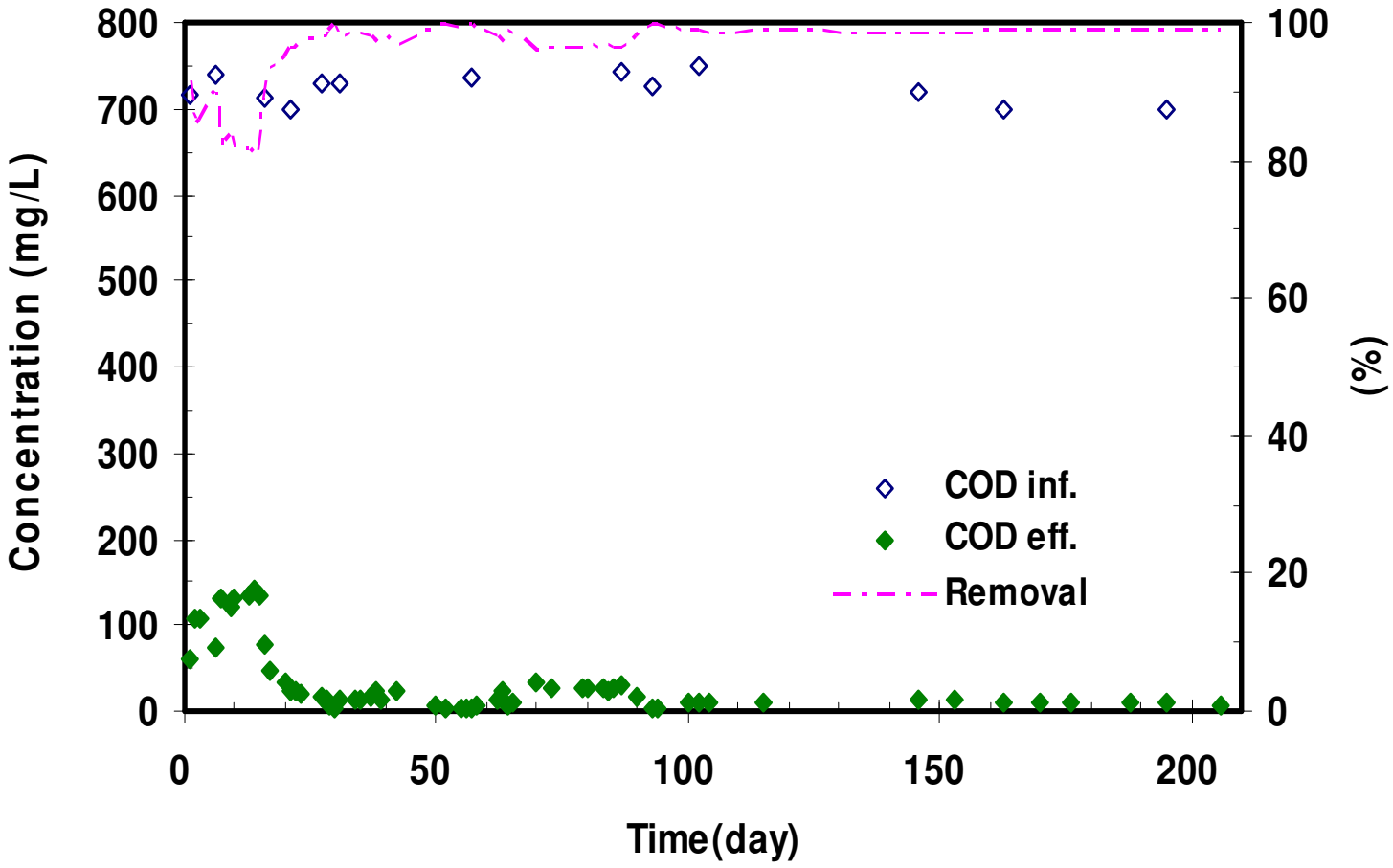
廢水來源與特性

項　目	剝離液	顯影液	清洗溶劑
成份	$(CH_3)_2SO$ (DMSO) $C_2H_5ONH_2$ (MEA)	$(CH_3)_4NOH$ (TMAH)	$CH_3CHOOHCH_3$ (IPA)
pH	9-11	10-13	4-10
SS(mg/L)	< 10	< 10	< 10
COD(mg/L)	800-2000	100-600	500-3700
TKN(mg/L)	70-200	60-90	90 240

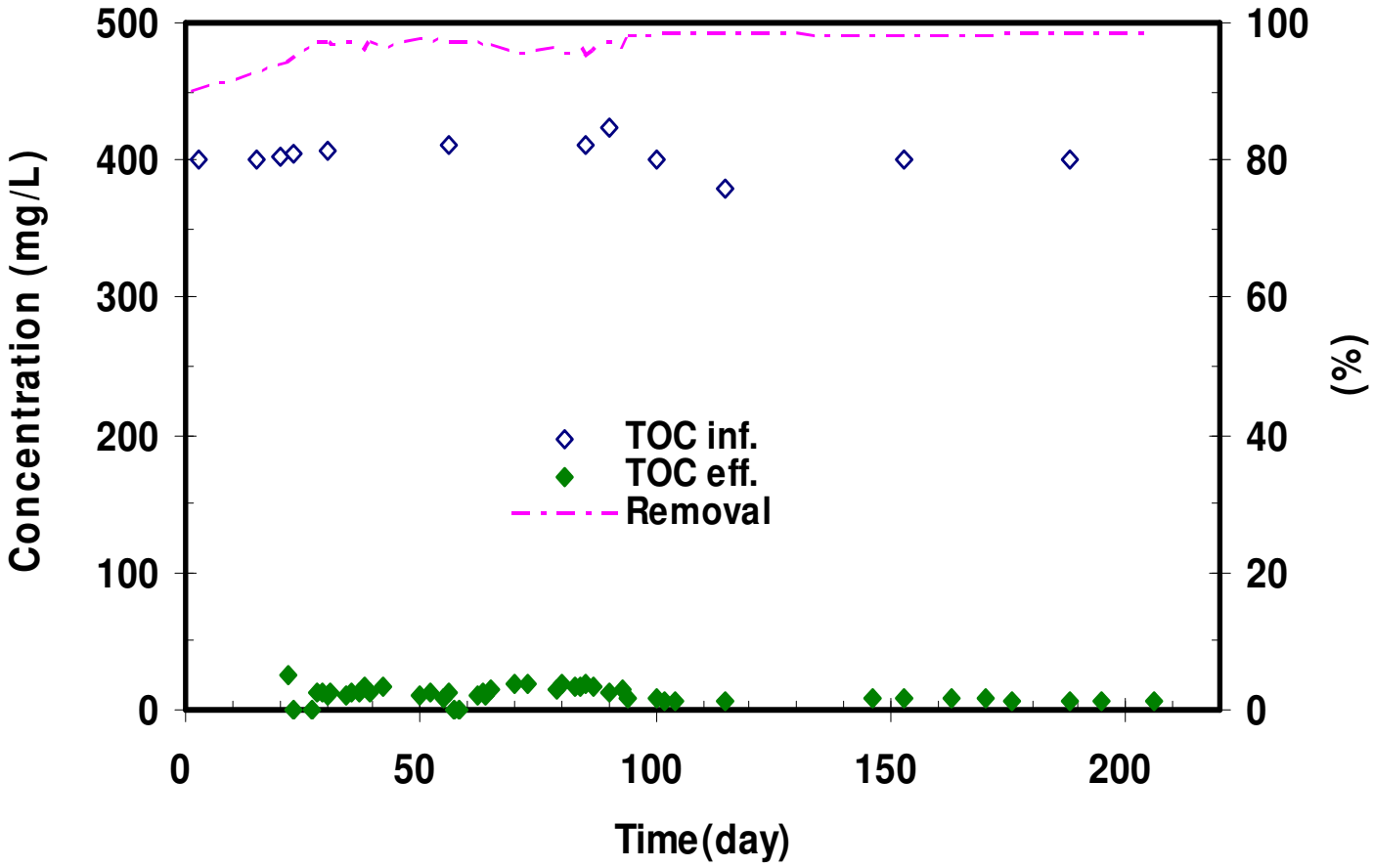
試驗流程



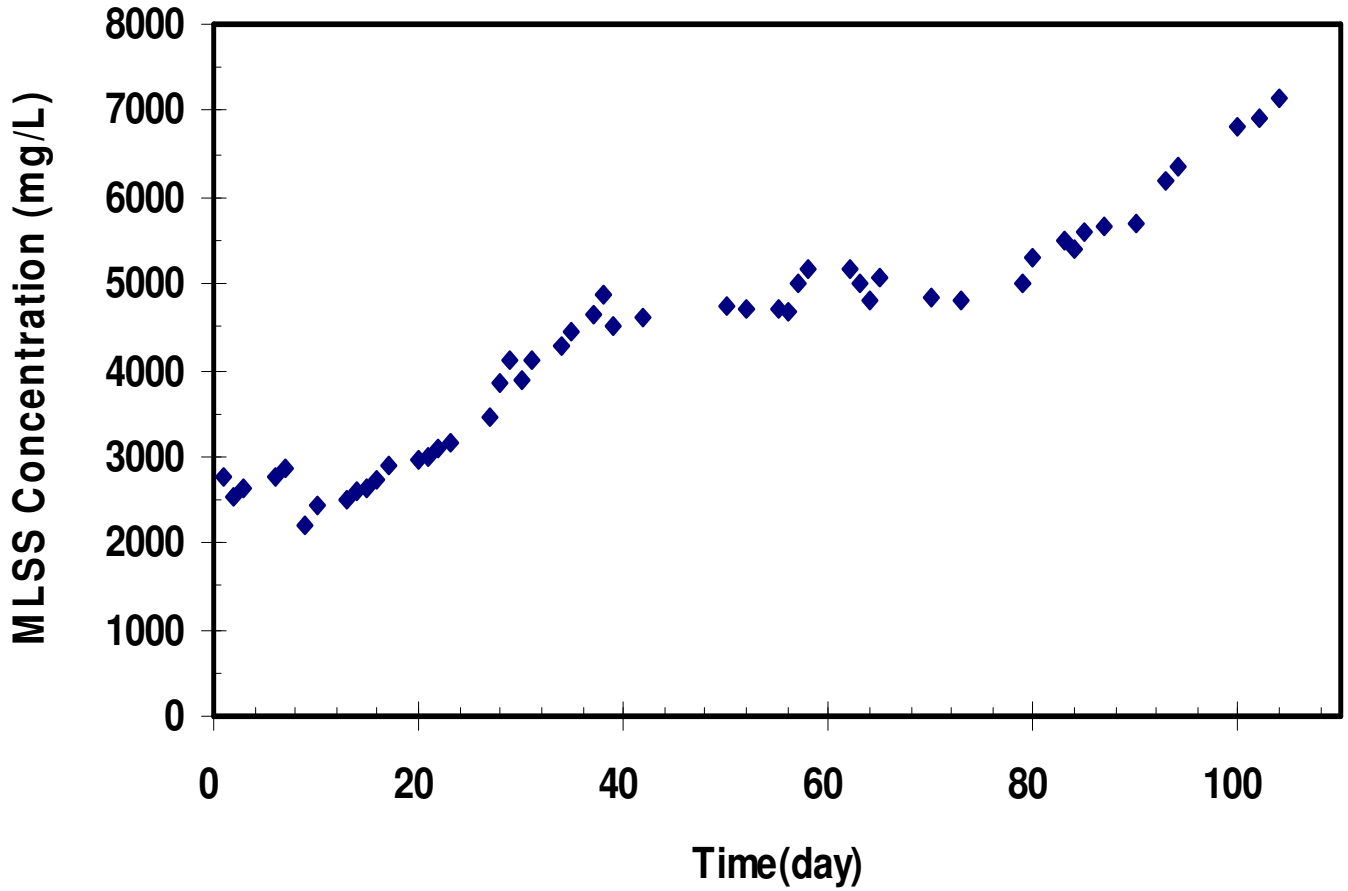
COD


800
700
600
500
400
300
200
100
0
Concentration (mg/L)
100
80
60
40
20
0
(%)
0
50
100
150
200
Time(day)
COD inf.
COD eff.
Removal

TOC


500
400
300
200
100
0
Concentration (mg/L)
100
80
60
40
20
0
(%)
0
50
100
150
200
Time(day)
TOC inf.
TOC eff.
Removal

MLSS


MLSS Concentration (mg/L)
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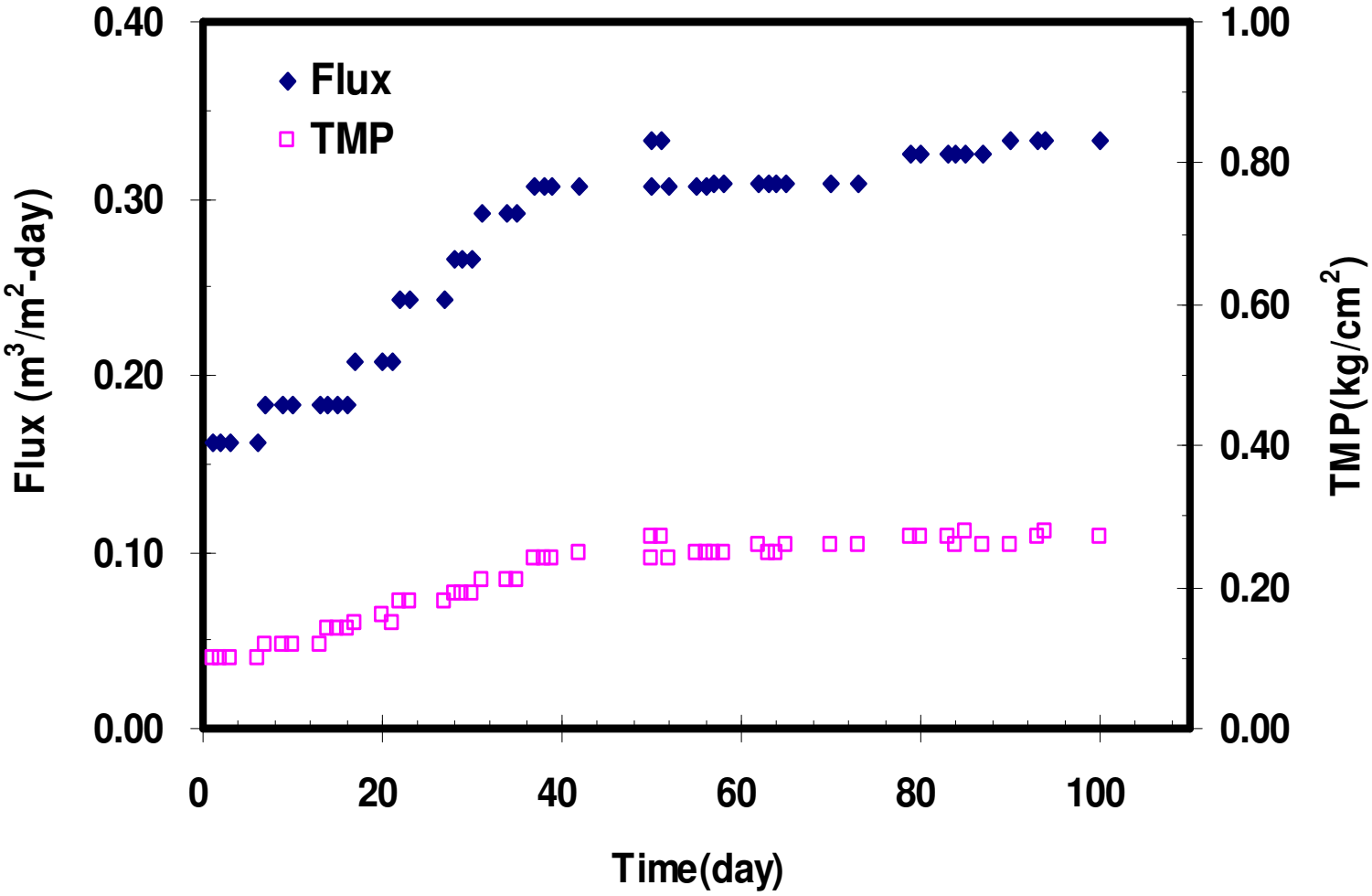
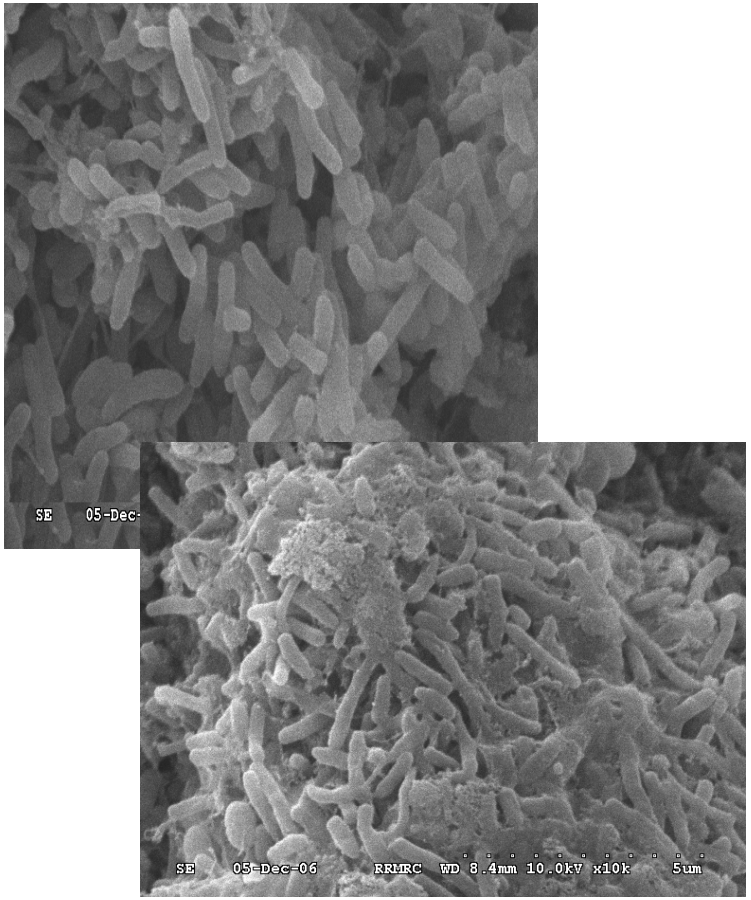
7000
6000
5000
4000
3000
2000
1000
0
0
20
40
60
80
100
Time(day)

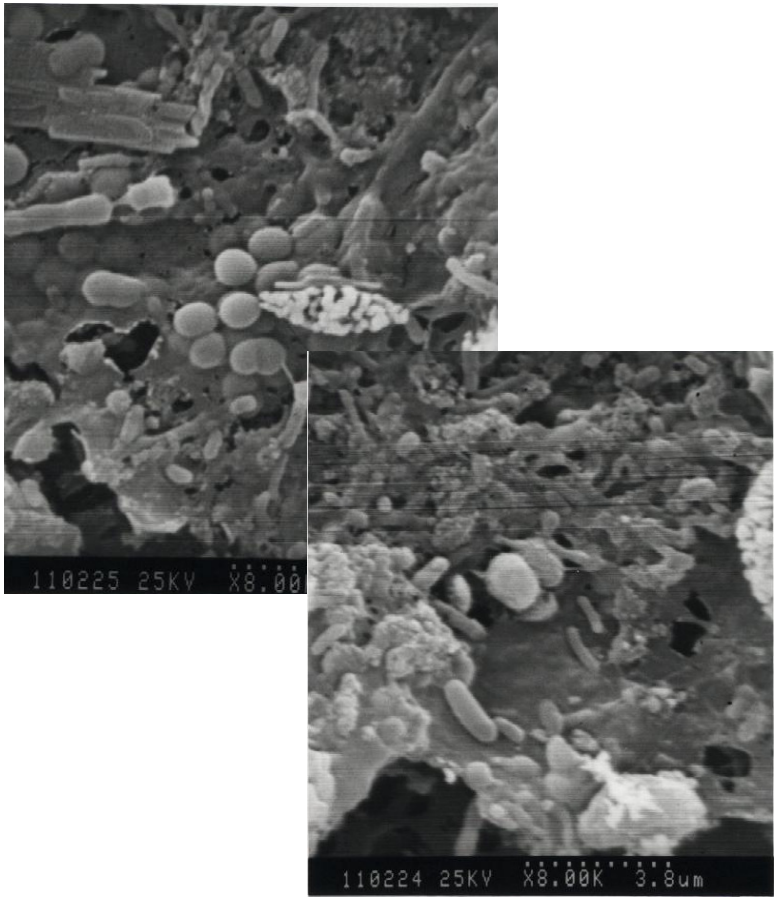
Flux and TMP


Flux
TMP
0.40
0.30
0.20
0.10
0.00
1.00
0.80
0.60
0.40
0.20
0.00
0
20
40
60
80
100
Time(day)
Flux (m3/m2-day)
TMP(kg/cm2)

SEM觀察



廢水廠曝氣池



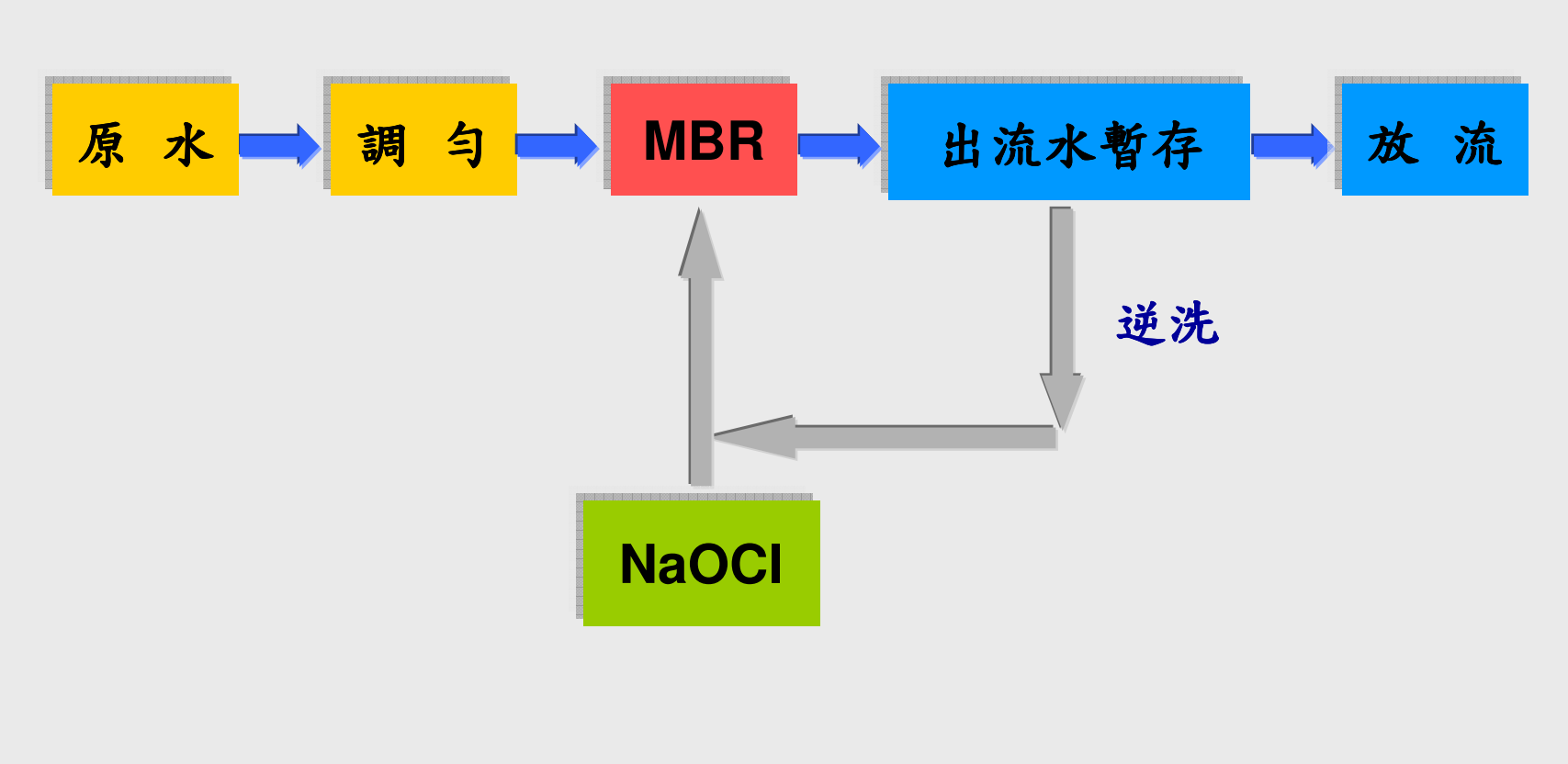
MBR

Polarizer廠之廢水處理與回收

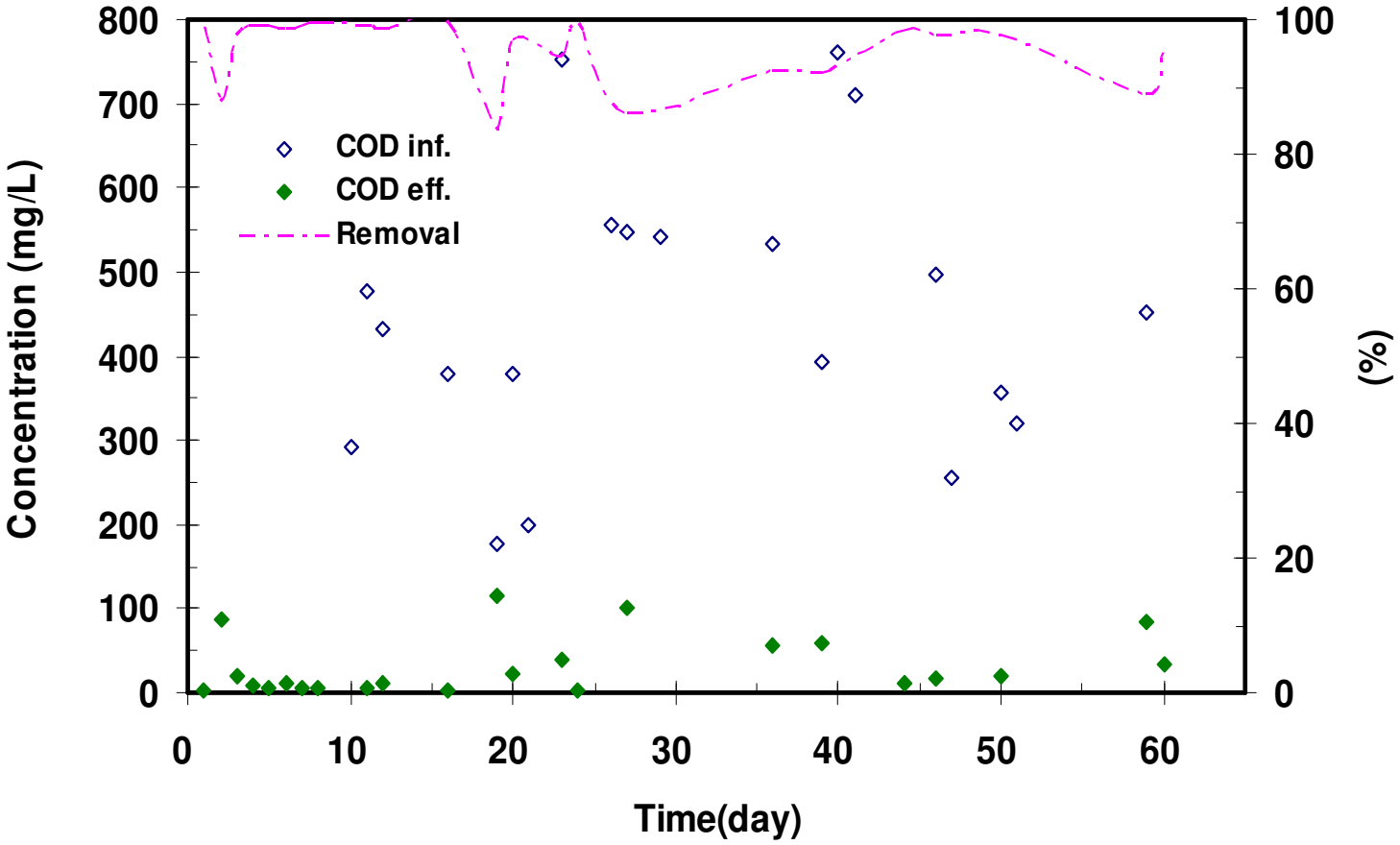
廢水種類與來源

廢水種類	特　　性	處理之難易
TAC原料廢水	低濃度廢水	易
PVA原料廢水	低濃度廢水、COD約300 ~ 800 mg/L	易
蝕刻廢水	強酸、強鹼廢水	酸鹼中和
染色廢水	高濃度、具生物毒性	難
水膠廢水	高濃度、COD約3000 ~ 5000 mg/L	難
生活污水	低濃度廢水、COD約200 ~ 400 mg/L	易

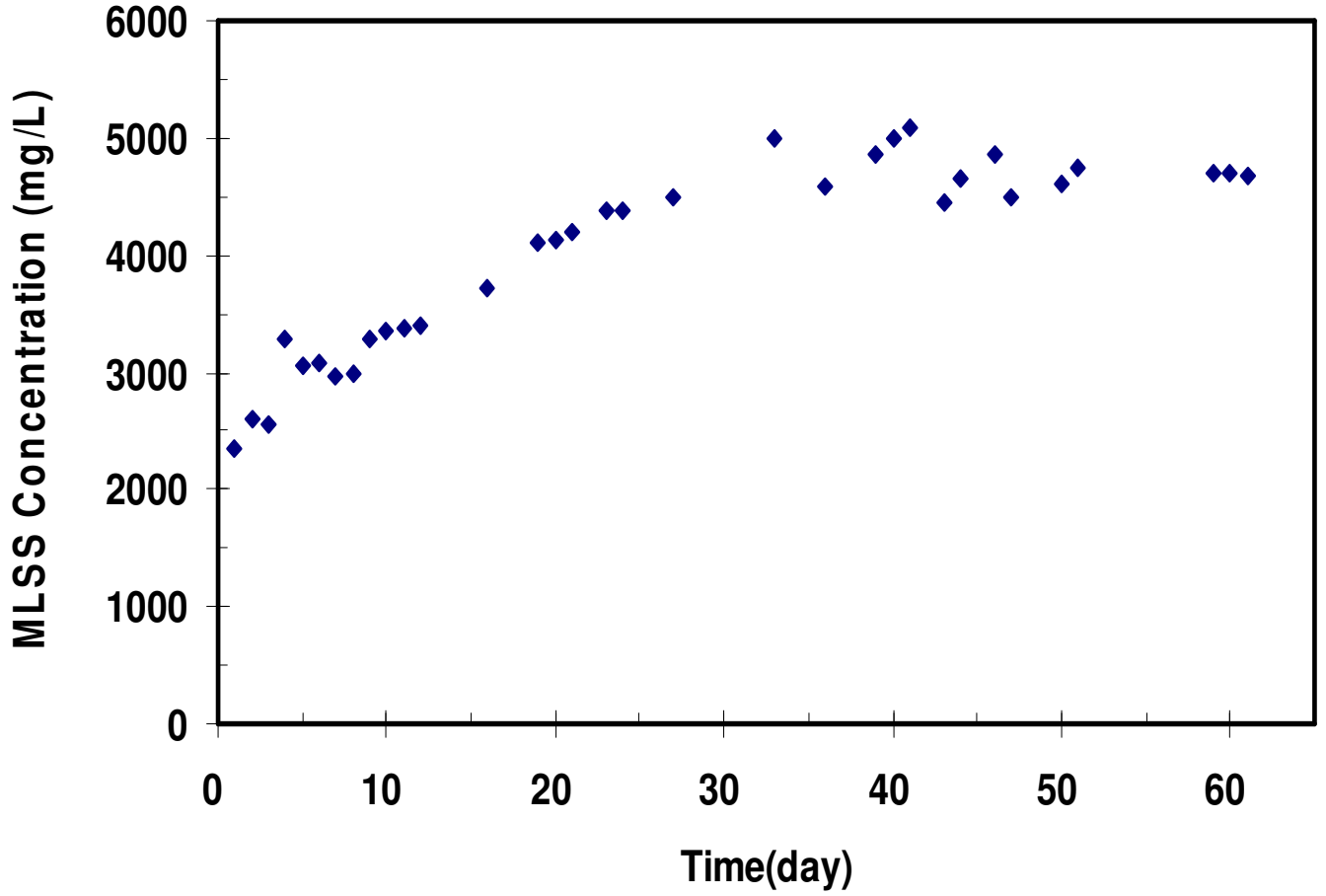
試驗流程



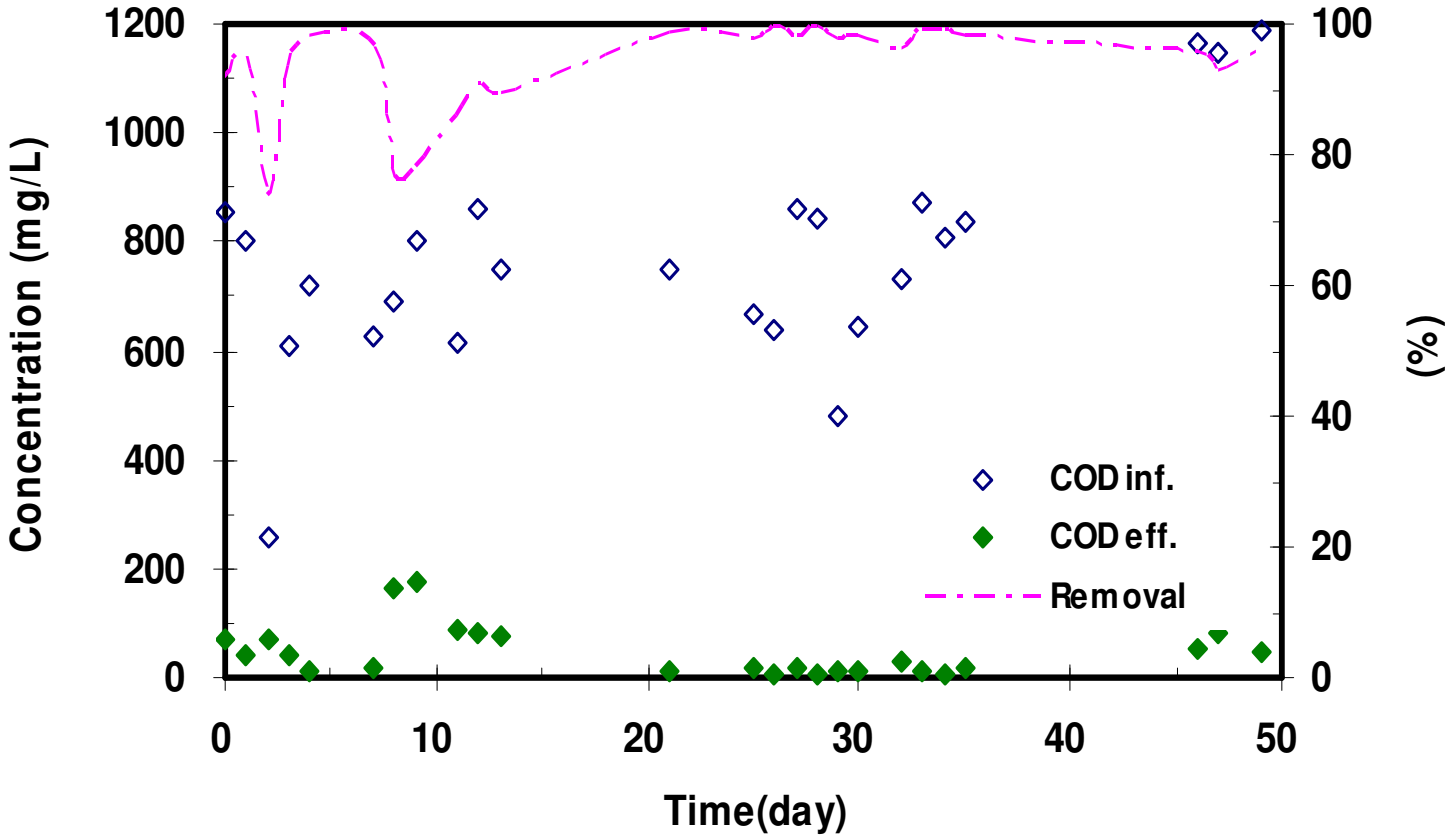
COD


800
700
600
500
400
300
200
100
0
100
80
60
40
20
0
0
10
20
30
40
50
60
Concentration (mg/L)
(%)
Time(day)
COD inf.
COD eff.
Removal

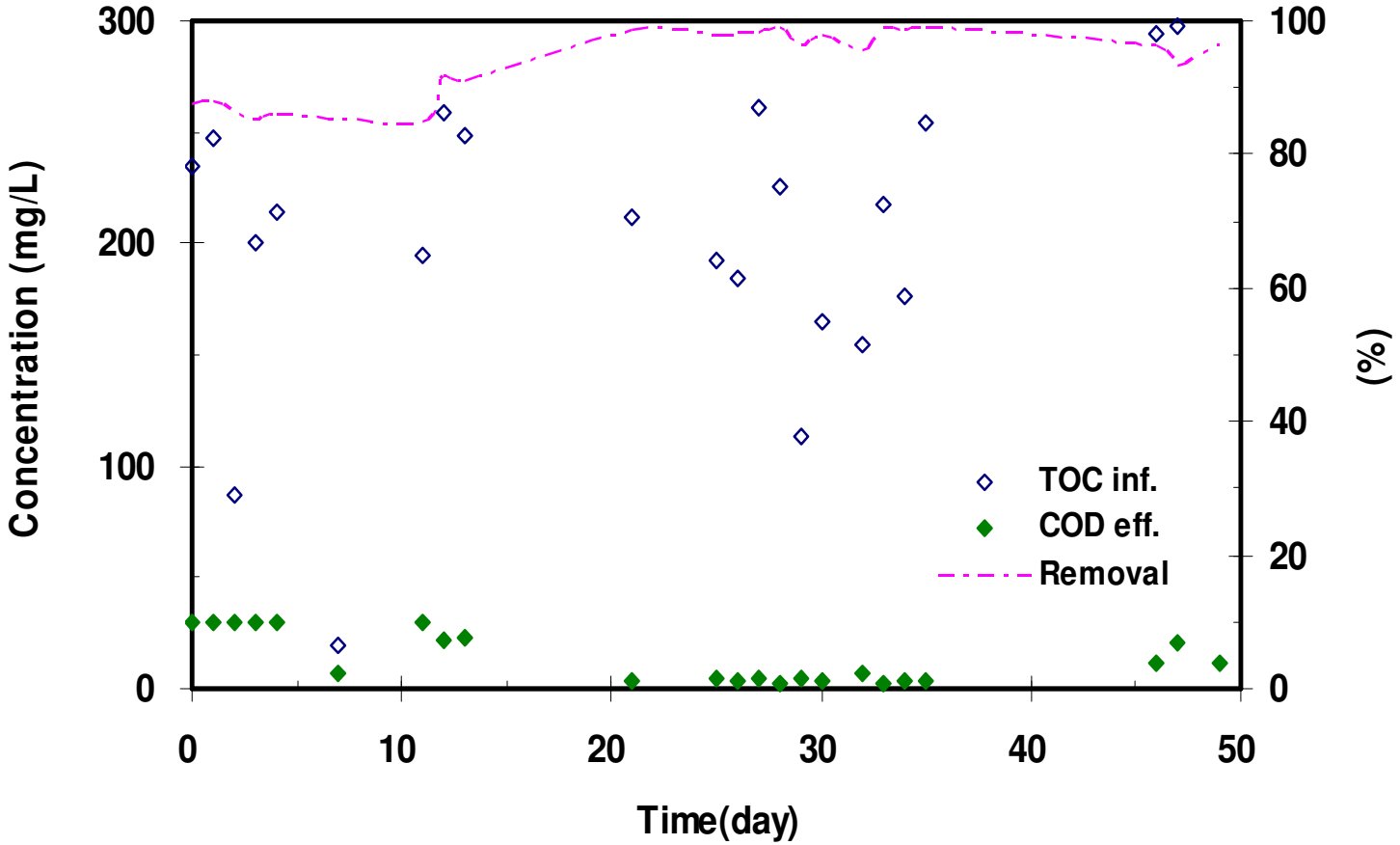
MLSS


MLSS Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
60
Time(day)

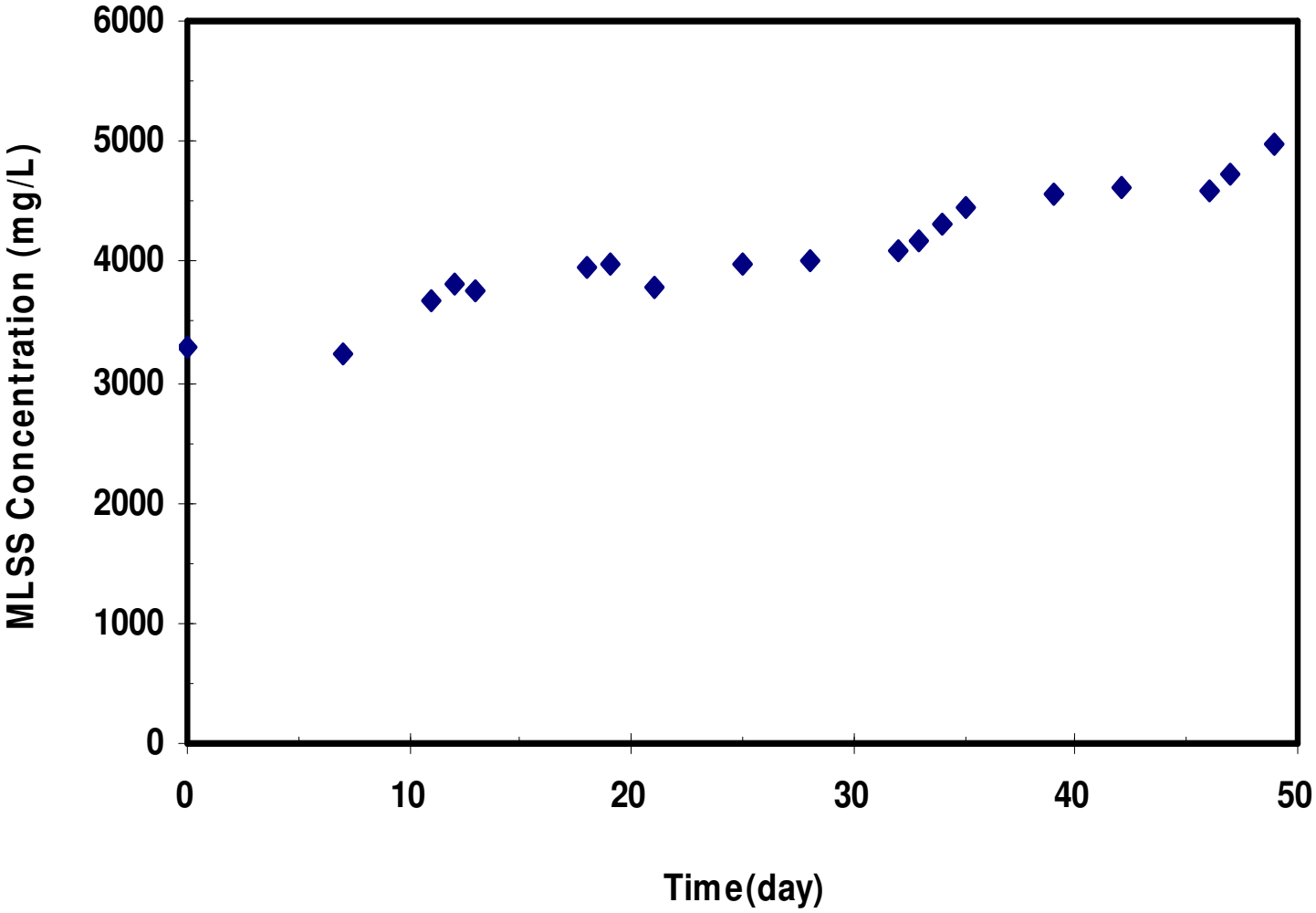
COD


Concentration (mg/L)
1200
1000
800
600
400
200
0
100
80
60
40
20
0
(%)
0
10
20
30
40
50
Time(day)
COD inf.
COD eff.
Removal

TOC


300
200
100
0
Concentration (mg/L)
100
80
60
40
20
0
(%)
0
10
20
30
40
50
Time(day)
TOC inf.
COD eff.
Removal

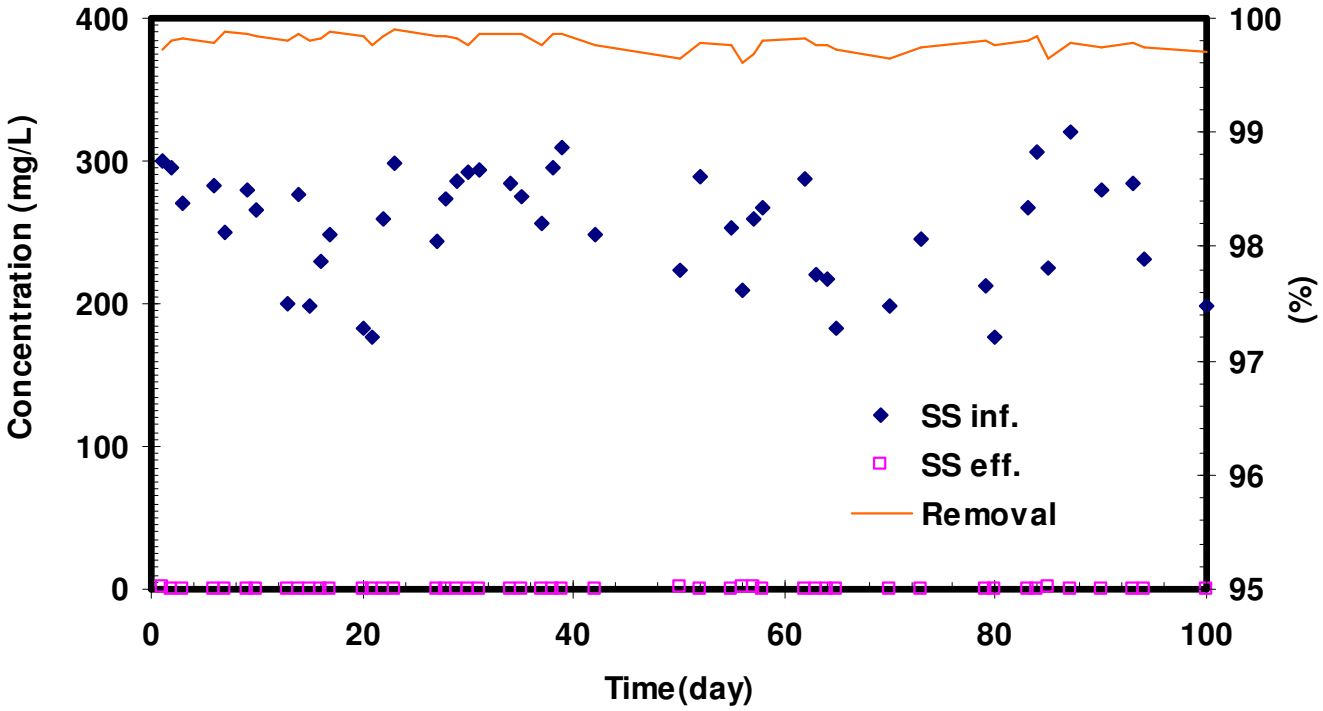
MLSS


MLSS Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0
0
10
20
30
40
50
Time(day)

小結

- **TFT-LCD 廠之廢水回收**
  - 可有效截留微生物,使菌相多元化
  - MLSS可達7000 mg/L，可有效提昇處理效能
  - 出流水TOC < 10ppm,可回收再利用
  - SDI < 3,有助於後段製程壽命之延長
- **Polarizer廠之廢水處理與回收**
  - 出流水TOC < 10ppm,可回收再利用
  - 負壓低,有助於動力之節省

電子廠CMP廢水之SS去除效率



玻纖廠工業廢水處理中水回用

改善後之效益: 95 % 回收率

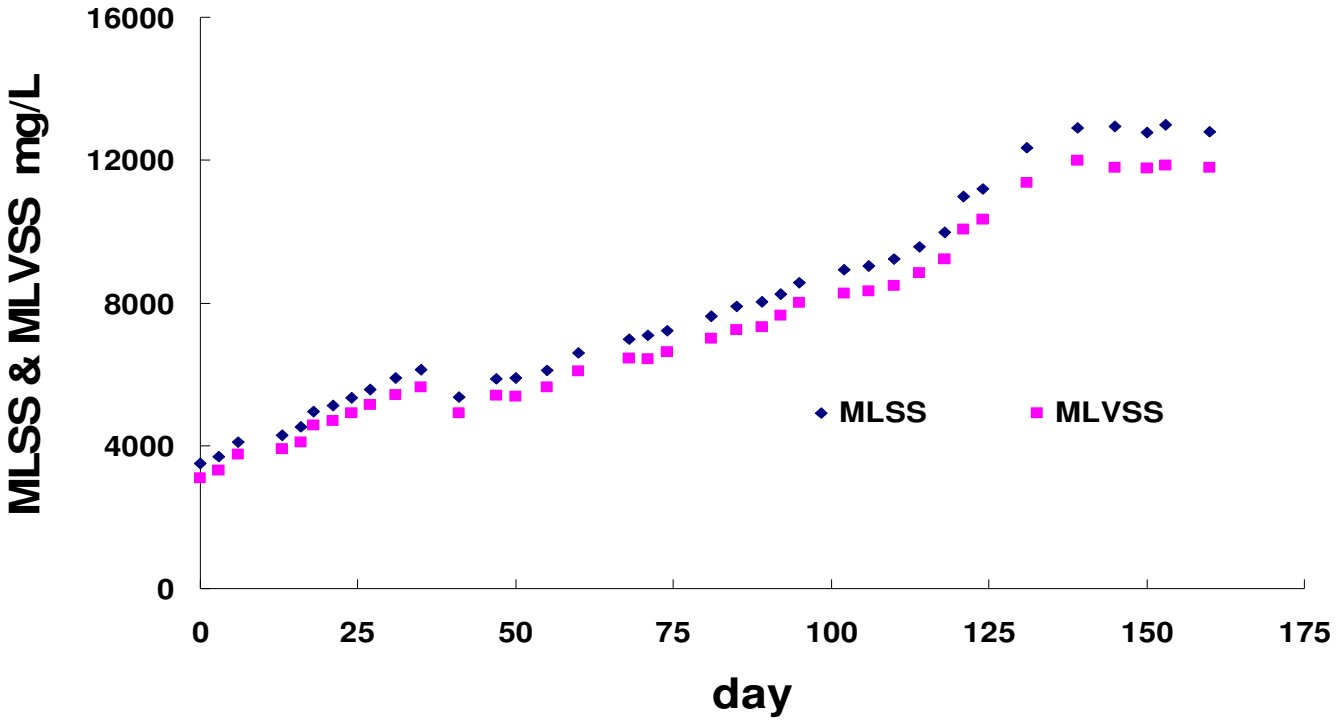
項目		既有處理程序	MBR處理程序
自來水費用（NTD/月）		256,000	12,800
排污費	正常（NTD/月）	156,000	7,800
	過載（NTD/月）	80,000	—
合計（NTD/月）		492,000	20,600
年節省費用（NTD/年）		5,656,800	

※ 建廠日期： 2007/07/01　※ 處理水量： 800 CMD　※ 佔地面積： 435 m^2

玻纖廠廢水之MBR處理系統之操作條件

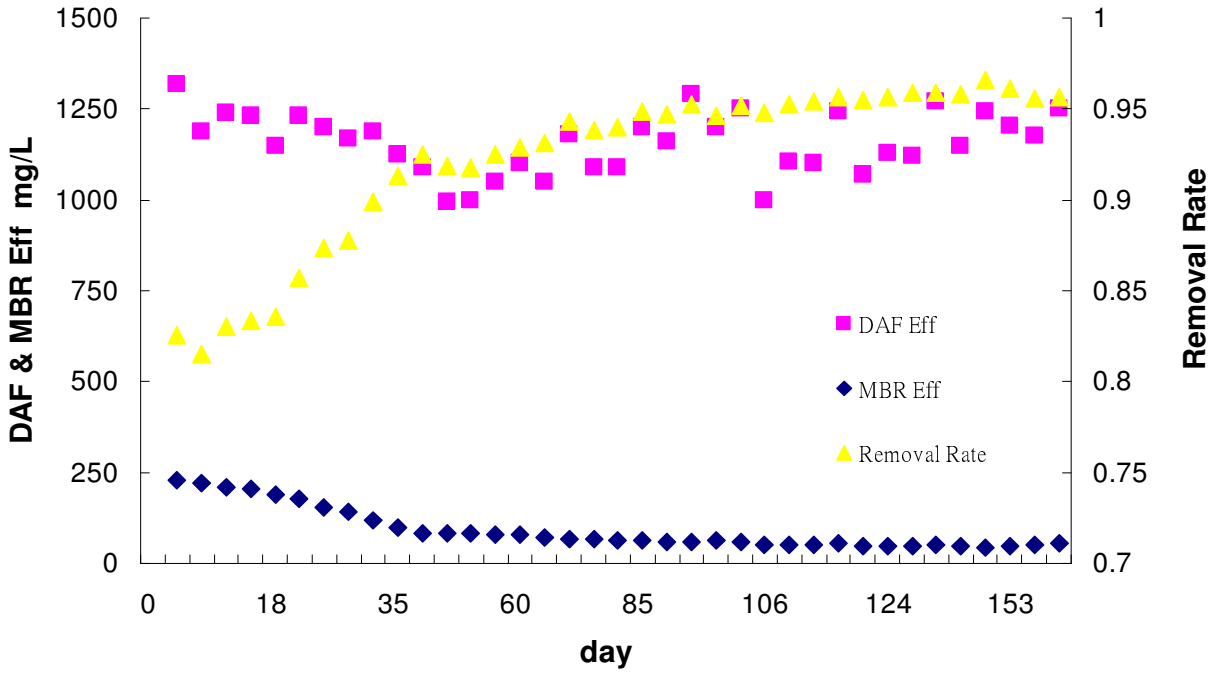
- HRT(hrs): 12
- Flux（$m^3m^{-2}d^{-1}$）: 0.42
- MLVSS（mg/L）: 10,000~12,000
- F/M（kg COD/kg MLVSS-d）: 0.2±0.05

玻纖廠廢水之MBR系統處理效能(1/3)



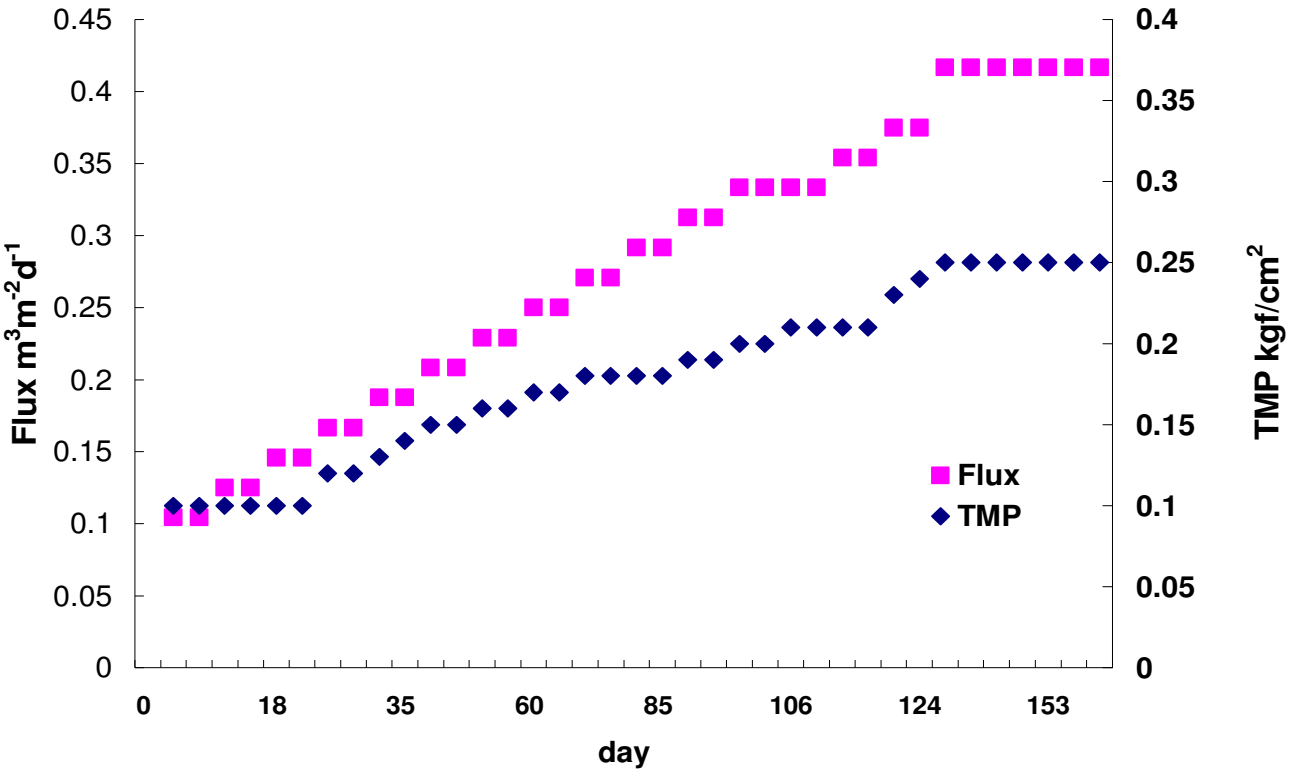
MBR系統之污泥濃度變化

玻纖廠廢水之MBR系統處理效能(2/3)



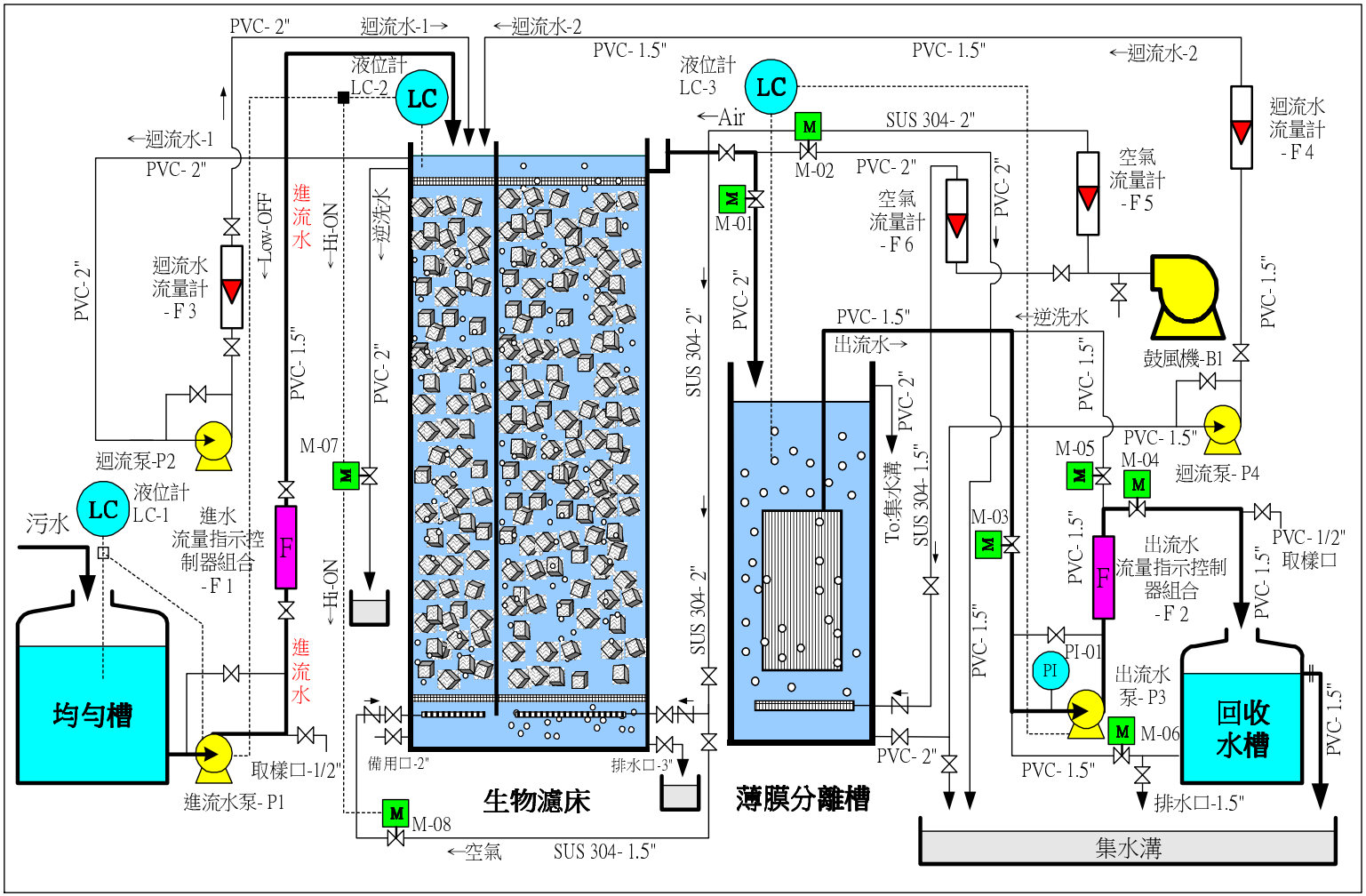
MBR系統之COD處理效能

玻纖廠廢水之MBR系統處理效能(3/3)



MBR系統之Flux及TMP之關係

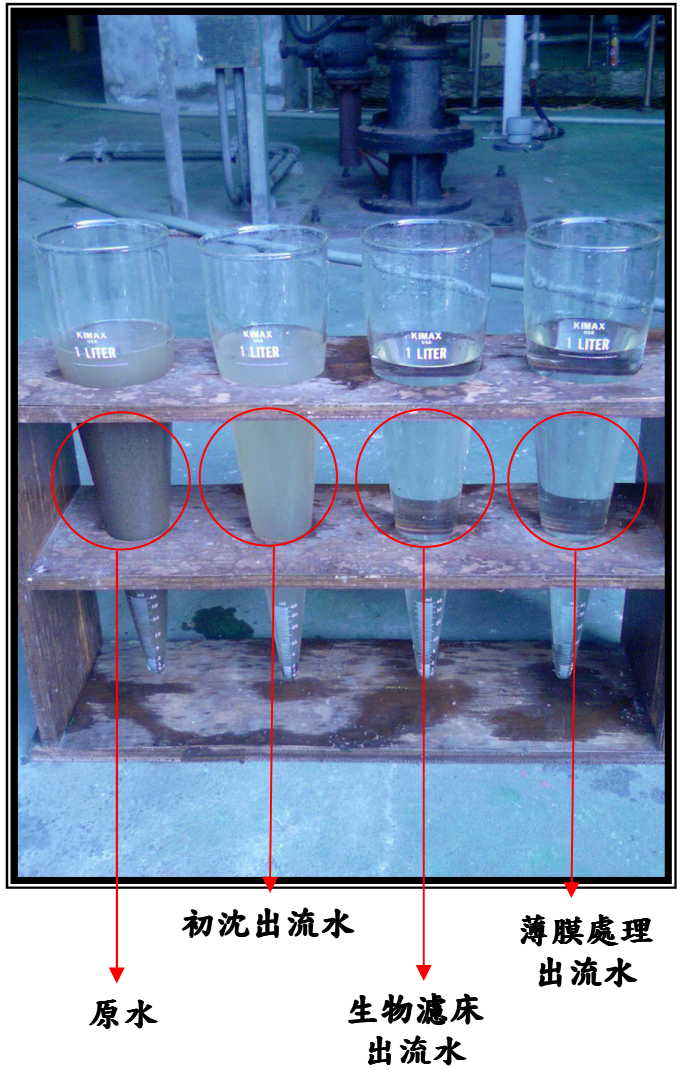
100 CMD 污水處理模廠



資料來源:工業技術研究院 能源與環境研究所

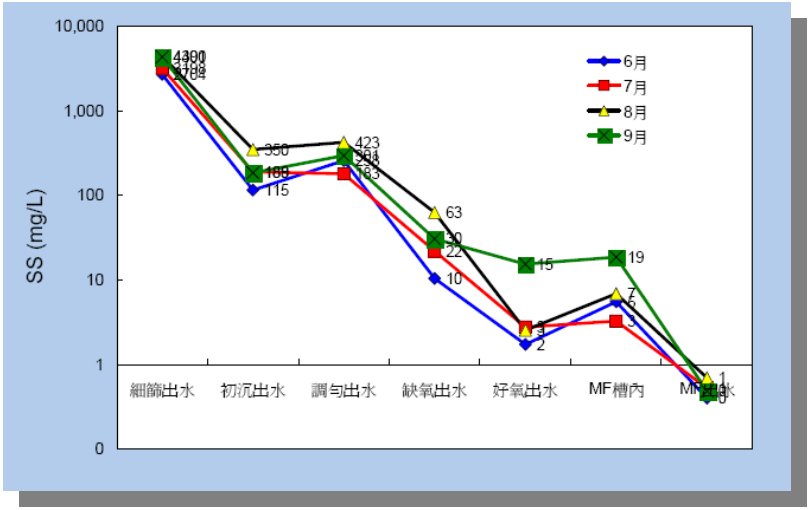
模廠試驗-內湖污水處理廠

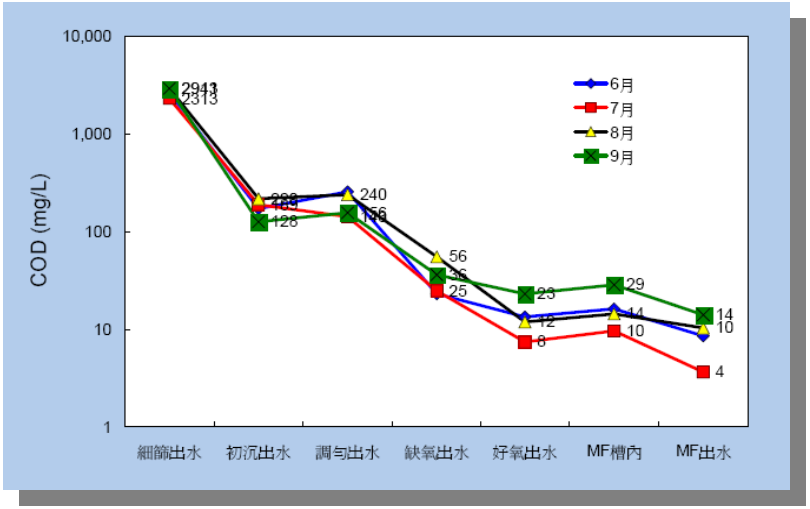
實驗模廠組裝完成之外觀

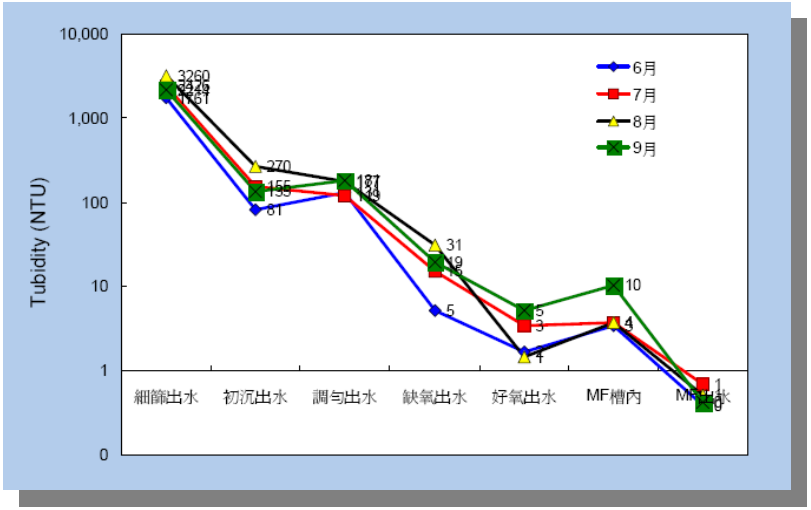


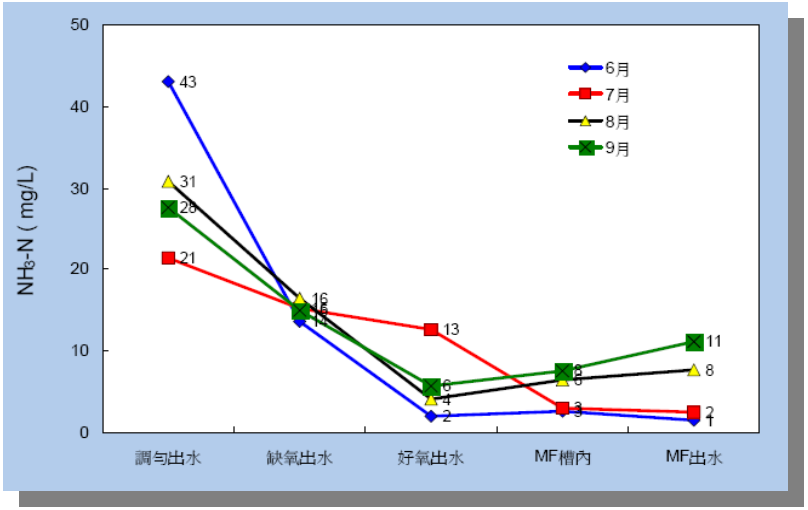
模廠各單元水質比較

內湖污水處理廠試驗



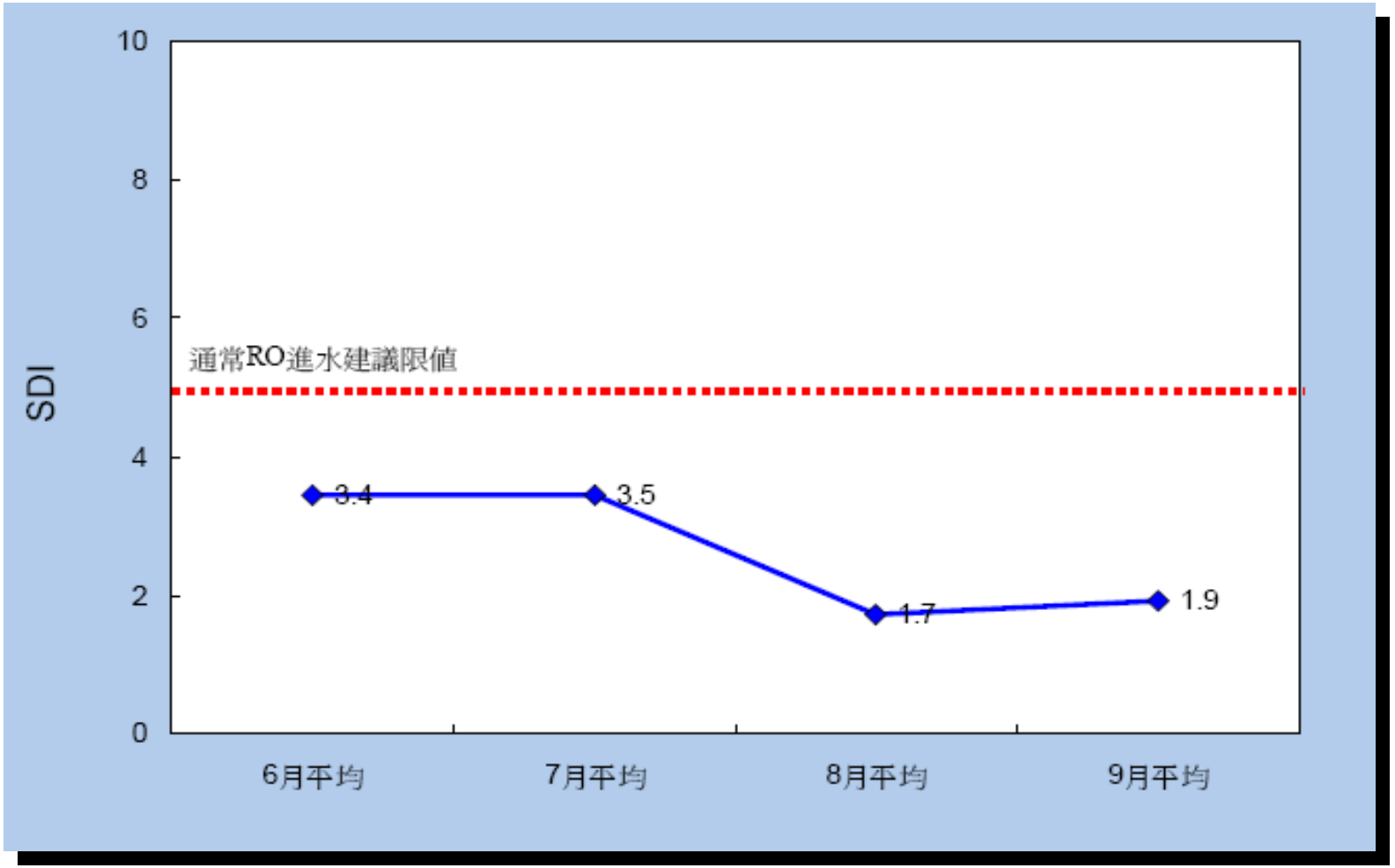






Year 2006

BioMF處理水之SDI值



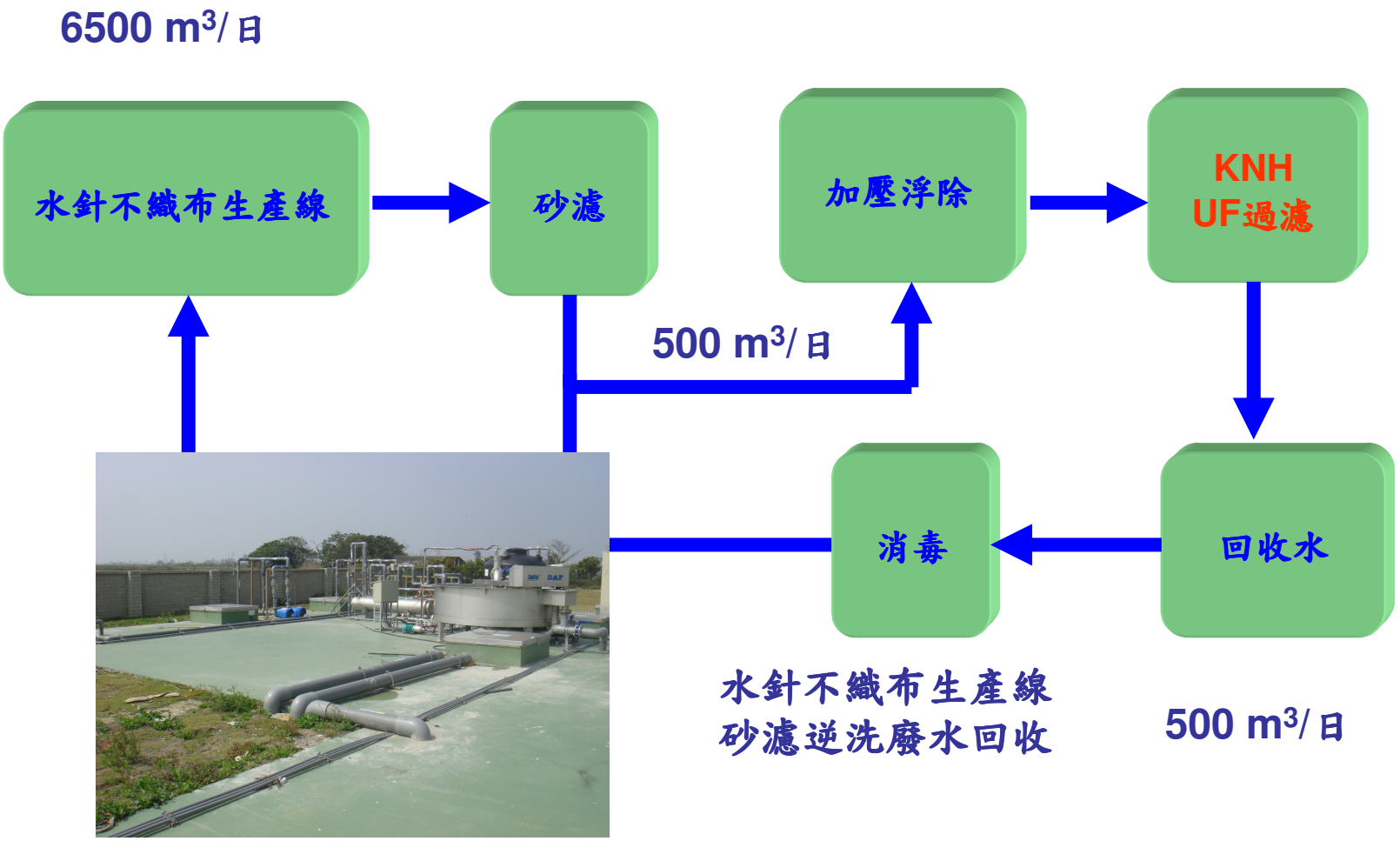
Year 2006

RO出流水水質

項目	原水	RO	去除率
pH	3.64~6.71	3.48~6.52	-
導電度(μs/cm)	445~462	11~136	70.3~97.5
TOC(mg/L)	6.58~4.45	0.32~0.41	92.8~93.7
COD(mg/L)	9.2~11.5	ND	100.0
色度(ADMI)	26	5	80.8
濁度(NTU)	0.01	-	-
硬度(mg/L as $CaCO_3$)	139.4	13.5	90.3
TS(mg/L)	380	8	97.9
Na^+(mg/L)	35.1	1.6	95.3
NH_4^+(mg/L)	7.9	0.2	97.3
K^+(mg/L)	12.8	1.4	88.7
Cl^-(mg/L)	93.2	4.6	95.0
NO_2^-(mg/L)	ND	ND	-
NO_3^-(mg/L)	46.8	2.0	95.6
PO_4^{3-}(mg/L)	6.7	ND	100.0
SO_4^{2-} (mg/L)	24.7	2.2	91.3
SDI	2.91	-	-

資料來源：萬能科技大學，莊連春，2006年

康那香水針不織布製程廢水回收



結　論

Reuse, Reclaim, Recycle

- 人口成長及水資源短缺，促使水回用成長迅速
- 相較於其他替代水資源，水回用已有明顯的經濟效益
- 水再利用已經從「正面環保替代」轉變為「需求性的成長」
- 薄膜生物反應器技術(MBR)可以協助吾人在缺水之時，找出可用之水
- 愈來愈多的廢水回收再利用採用衛星式處理廠(satellite treatment plants)模式
- MBR及薄膜過濾為水回用的關鍵技術


感謝您的指教!