

# **“Development of Selective Membranes Composition and Configuration for Water Treatment”**

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# Crossflow Membrane Processes

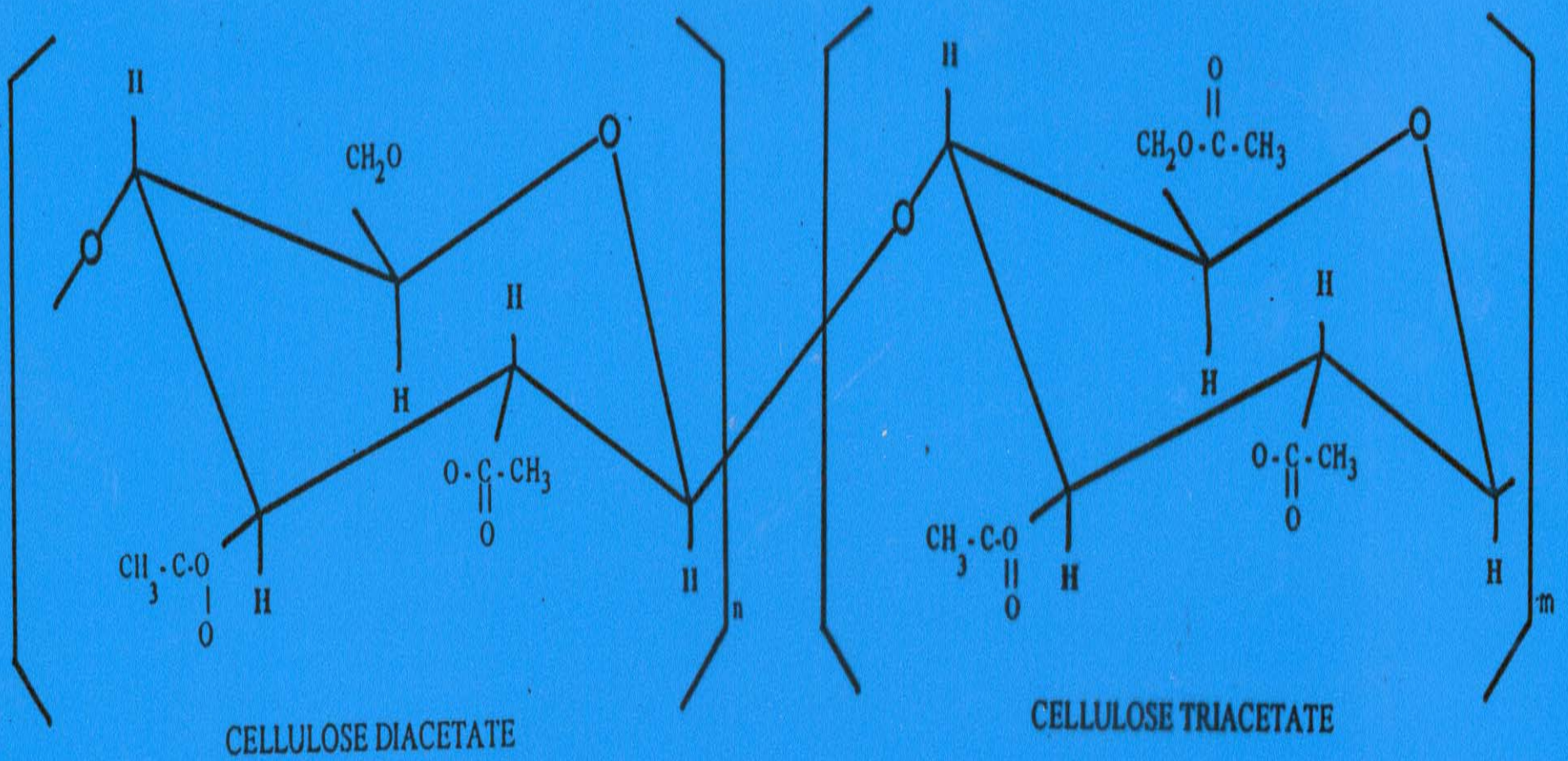
Process	Components Retained	Transmembrane Pressure	Process Applications
RO	99% of most ions, most organics over 150 MW	200-1000 psig (13.8-69.0 bar)	Brackish and sea water desalting, boiler feed purification, blowdown reclamation, pretreatment to ion exchange, ultrapure water production.
NF	95% divalent ions, 40% monovalent ions, organics greater than 150-300 MW	135-230 psig (9.3-15.9 bar)	Hardness removal, heavy metals removal, organic and microbiological removal, dye desalting, color removal
UF	Most organics over 1000 MW	25-100 psig (1.7-6.9 bar)	Pre- and post-treatment to ion exchange, beverage clarification, concentration of industrial organics and dilute suspended oils, removal of pyrogens, bacteria, viruses, and colloids.
MF	Small suspended particles greater than 0.1 $\mu$	25-50 psig (1.7-3.4 bar)	High volume removal of small suspended solids.

## Industrial Waste Water Treatment by Membrane Process

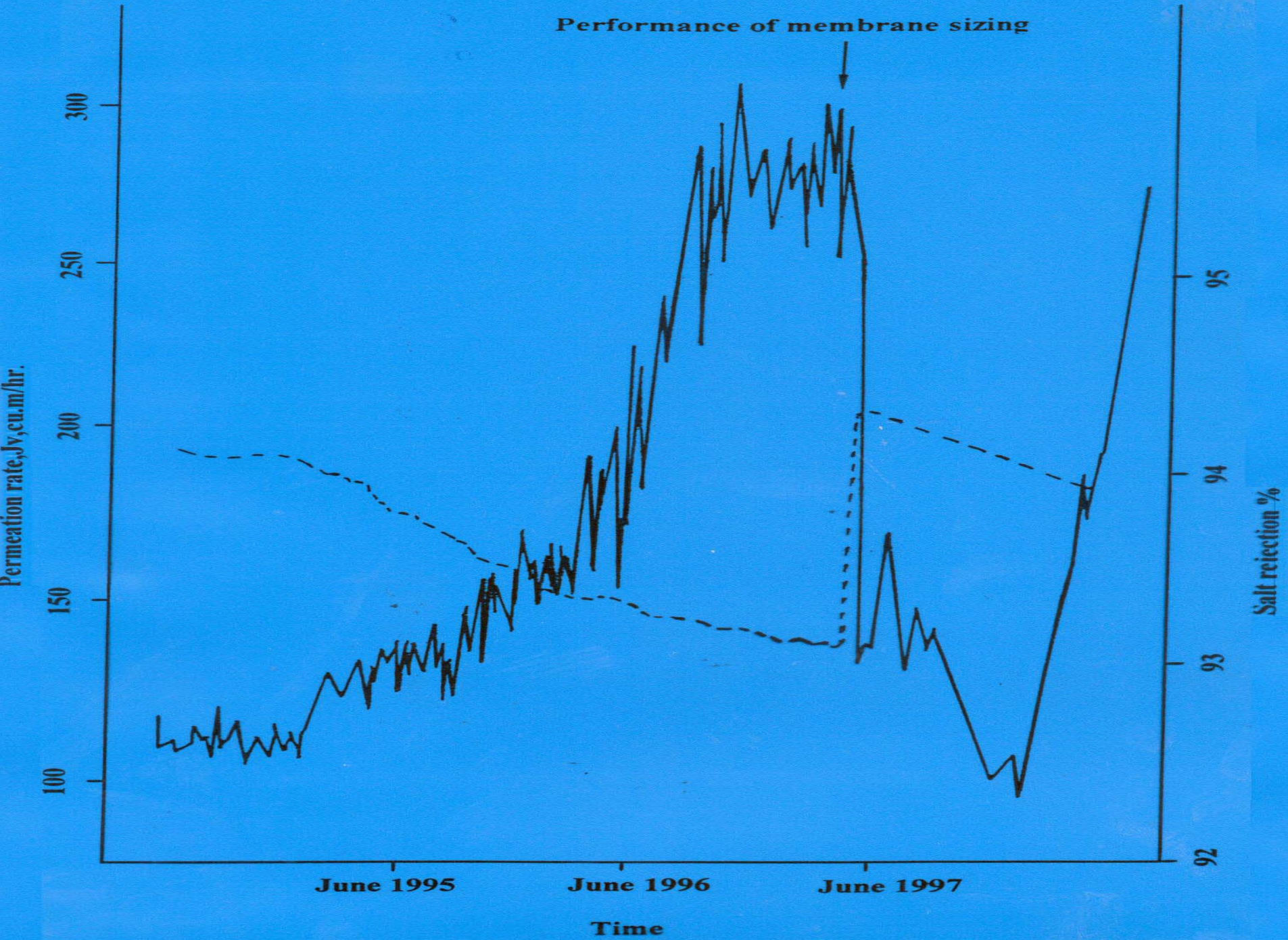
SN	Industry	Product Made	Membrane Function	Membrane Process
01	Power	Boiler feedwater	SiO <sub>2</sub> /TDS removal	RO
			Colloidal silica removal	UF
			Colloidal iron removal	UF
02	Electronics	Semiconductors	Ultrapure water polishing	RO
03	Pharmaceutical	Biologicals	Fractionation-concentration of biologically active substances	UF
04	Textile	Woven fabrics	PVA recovery	RO
05	Food	Fruit juice	Fruit juice concentration	RO / NF
		Food grade dyes	Dye purification and concentration	UF
		Sugar	Sugar juice concentration and decolorization	NF / UF
06	Dairy	Whey based food additives	Concentration of whey	RO
			Concentration of whey proteins	RO
			Demineralization and concentration of whey	NF
07	Metal finishing	Electrocoat painted products	Electrocoat paint recovery	RO
		Aluminum parts	Quenchant recovery	UF
		Copper foil	Concentration of copper sulfate	RO
		Plated parts	Metal reclamation from rinse waters	NF

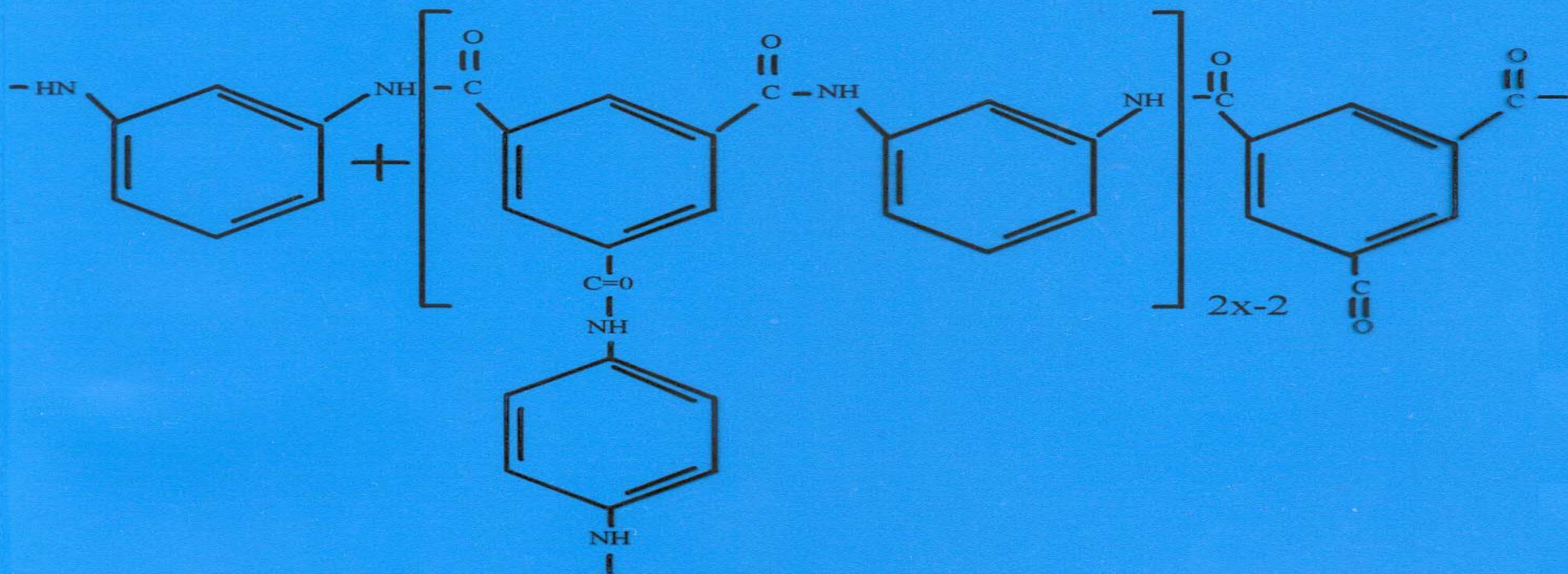
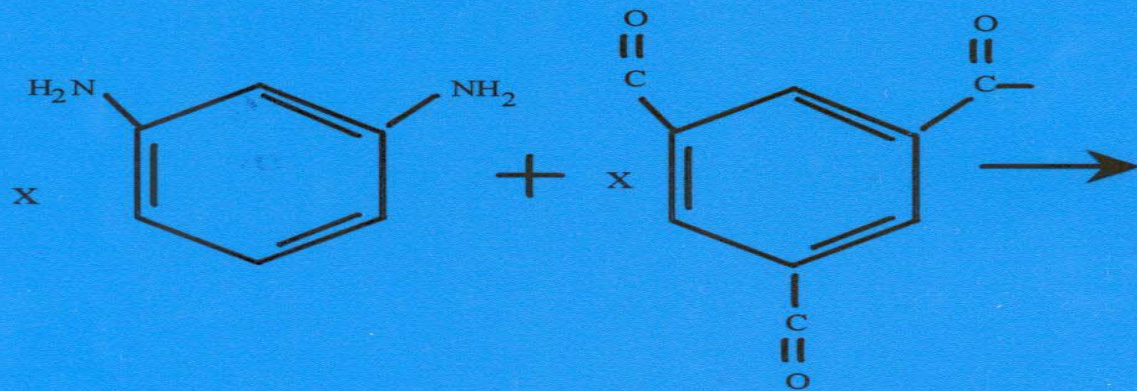
# Municipal Waste Water Treatment by Membrane Methods

Raw Water	Product Water	Membrane Function	Membrane Process
Municipal waste water	– Pure water for irrigation purposes and some municipal uses	Removal of suspended matter, bacteria and viruses	MF UF
		Removal of organics, colour and THM precursors	UF
	– Potable water	Desalination	RO
	– High purity water for industrial processes	Removal of hardness components	NF

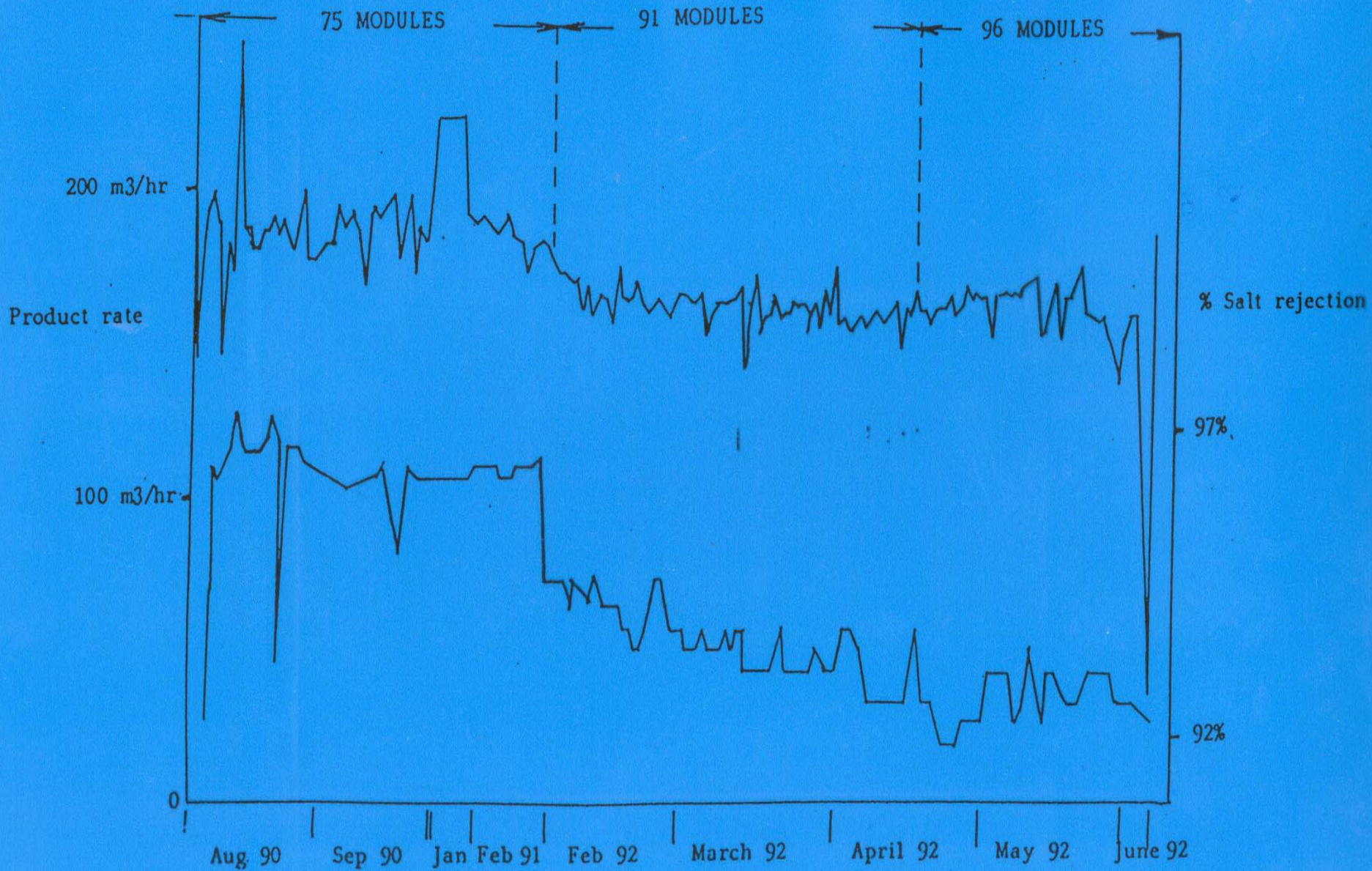


MODIFIED ASSYMETRIC BLEND CELLULOSE DI- TRI ACETATE MEMBRANE

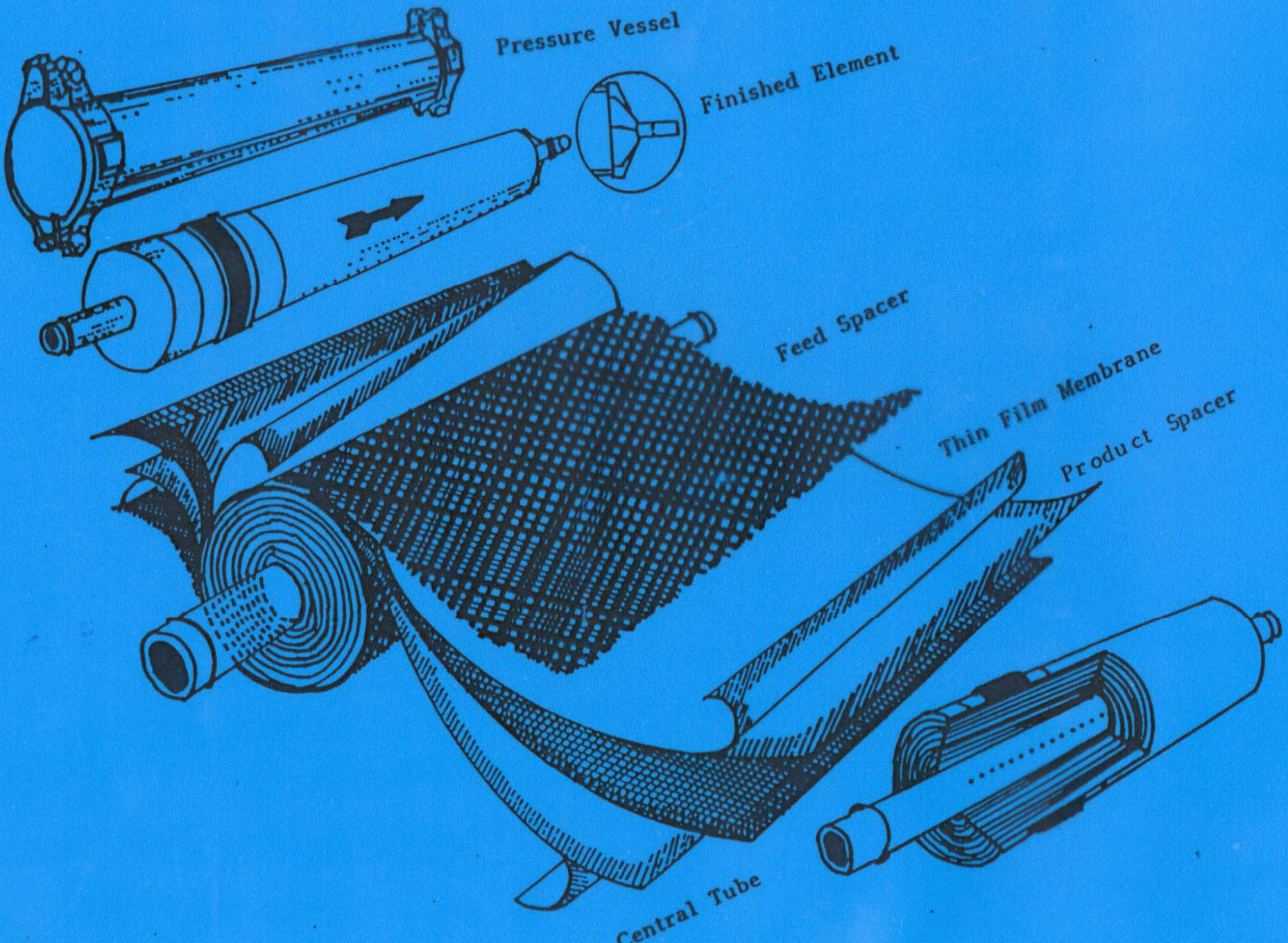




PERFORMANCE OF SALBOUKH WATER TREATMENT PLANT FROM (AUG 90 - JUNE 92) OF SKID # 02







Pressure Vessel

Finished Element

Feed Spacer

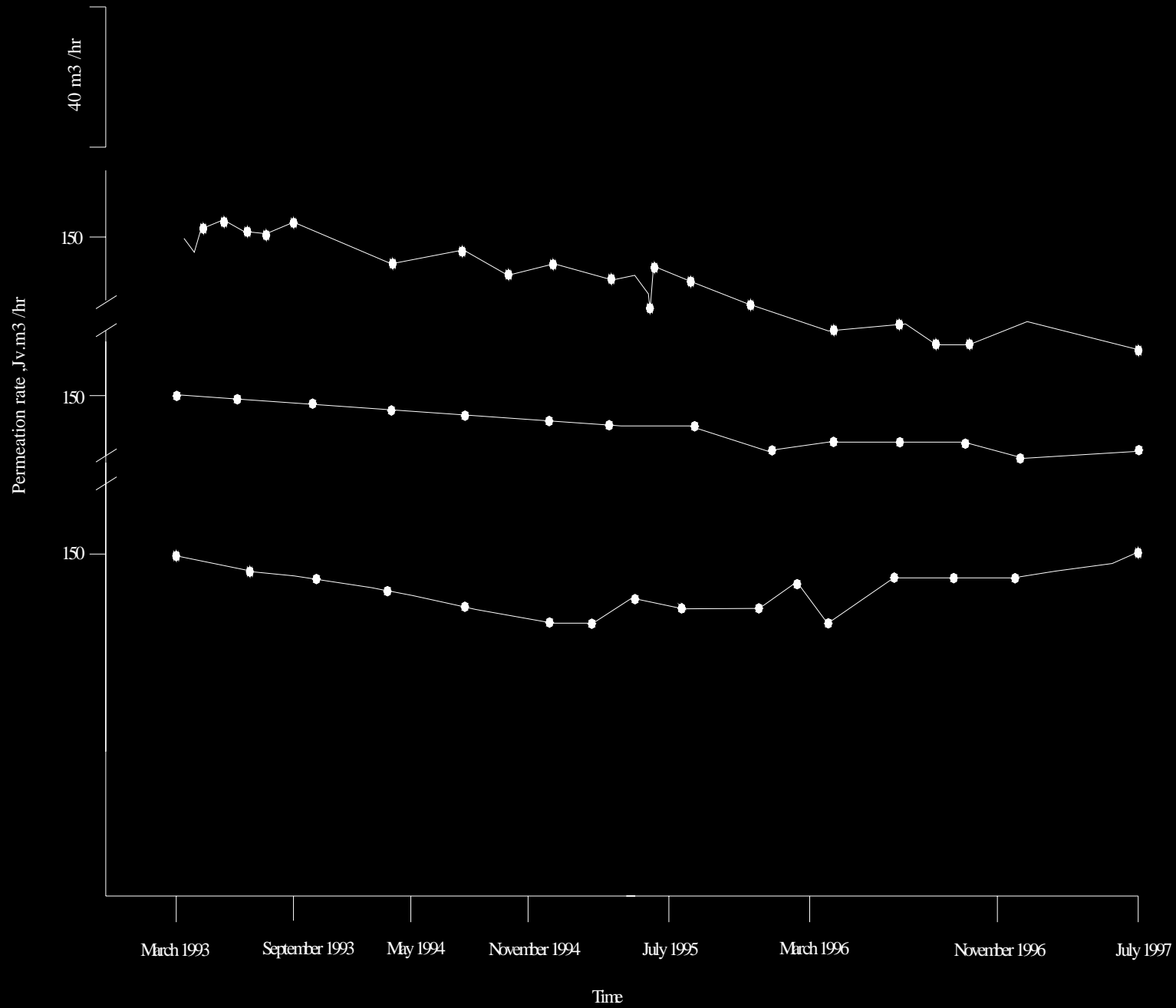
Thin Film Membrane

Product Spacer

Central Tube

# COMPARISON BETWEEN DIFFERENT TYPES OF RO MEMBRANES

	PARAMETER	THIN FILM MEMBRANE	CELLULOSE ACETATE MEMBRANE	HOLLOW FIBER MEMBRANE
1.	SALT REJECTION	97-99.5%-	94-97%	96-97%
2.	NET OPERATING PRESSURE	150-200 PSI	400 PSI	400 PSI
3.	ENERGY CONSUMPTION Kw-hr/1000 gal product	2.12 (SH) 2.55 (SG)	5.1	5.54
4.	MAXIMUM FEED TEMPERATURE	45°C	35°C	35°C
5.	OPERATING pH RANGE	4-11	5.5-6.5	4-11
6.	CLEANING pH RANGE	2-12	4-8	2-12
7.	BIODEGRADABLE	NO	YES	NO
8.	PERMITTED SDI IN FEED WATER	< 5	< 3	< 3
9.	MEMBRANE CONFIGURATION	SPIRAL WOUND	SPIRAL WOUND	HOLLOW FIBER
10.	ELEMENT DIAMETER	8" ELEMENTS 4" ELEMENTS	8" ELEMENTS 4" ELEMENTS	



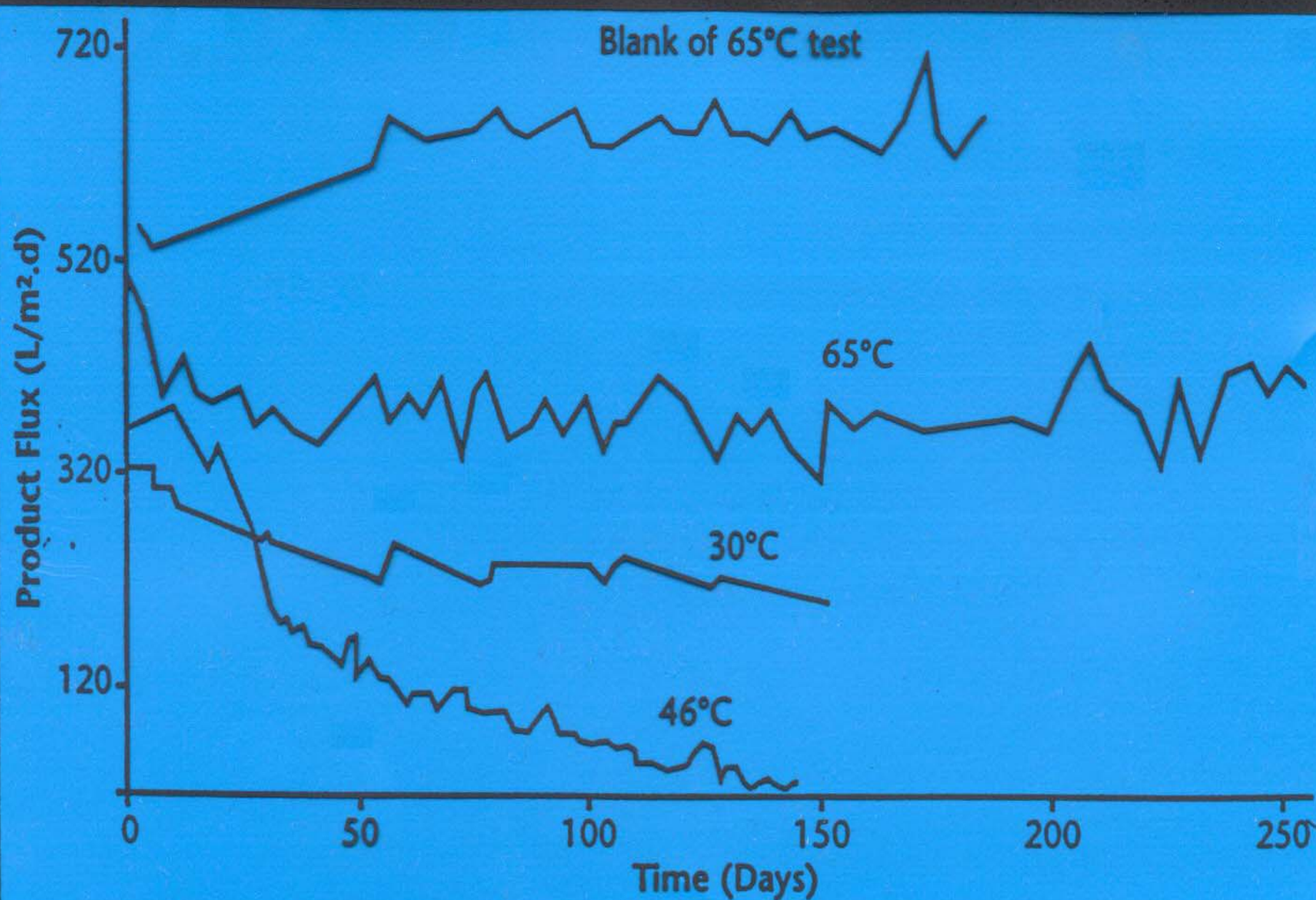
## RO Plants Retrofitted from CA Membrane to TFC, PA One

SN	Plant	Capacity
01	Buwaib	66,000 m <sup>3</sup> /day
02	Majmaah	2,000 m <sup>3</sup> /day
03	Durma	25,000 m <sup>3</sup> /day
04	KKIA	13,440 m <sup>3</sup> /day
05	Unaizah	35,000 m <sup>3</sup> /day

# **Future Trends in Development of Membrane Separation Processes**

- ❖ **Better chemical, mechanical and thermal resistance**
- ❖ **Lower energy consumption**
- ❖ **Lower water pretreatment needs**
- ❖ **Easier operation and maintenance**
- ❖ **Resistance to fouling**
- ❖ **Better control of hydrophilic / hydrophobic interactions**

**Figure 1**



# Hydrophilic vs. Hydrophobic

## A Measure Of Hydrophilicity



Membrane Material	PTFE	Poly-Propylene	PVDF	Unmodified PAN	Hydrophilic Polyethers	Cellulose	Membrane UltraChoro
Contact Angle	112°	104°	86°	46°	44°	>30°	4°

← Increasing Hydrophilicity →

### Oleophilic:

Repels Water  
Absorbs Oil  
Fouls With Free Oil  
Lower Flux Per Foot  
Difficult to Clean

### Oleophobic:

Repels Oil  
Absorbs Water  
Not Fouled By Free Oil  
Higher Flux Per Foot  
Easier to Clean

