

MEMBRANE TECHNOLOGY TREATING OILY WASTEWATER FOR REUSE

Jeff Peeters, P.Eng.
ZENON Environmental Inc.

SAWEA 2005 Workshop
Al-Khobar Holiday Inn Hotel, Saudi Arabia
November 29, 2005

Presentation outline

- Why are refineries considering wastewater reuse?
- Conventional refinery wastewater treatment
- Why use membranes?
- Membrane basics
- Membrane process configurations:
 - Tertiary filtration
 - Membrane bioreactor (MBR)
- Case studies:
 - PEMEX Refinery, Mexico
 - Marathon Ashland Petroleum Marine Repair Terminal, USA
- Conclusions

Why are refineries considering wastewater reuse?

Regulatory

increasingly stringent effluent quality requirements

Supply

diminishing freshwater resources

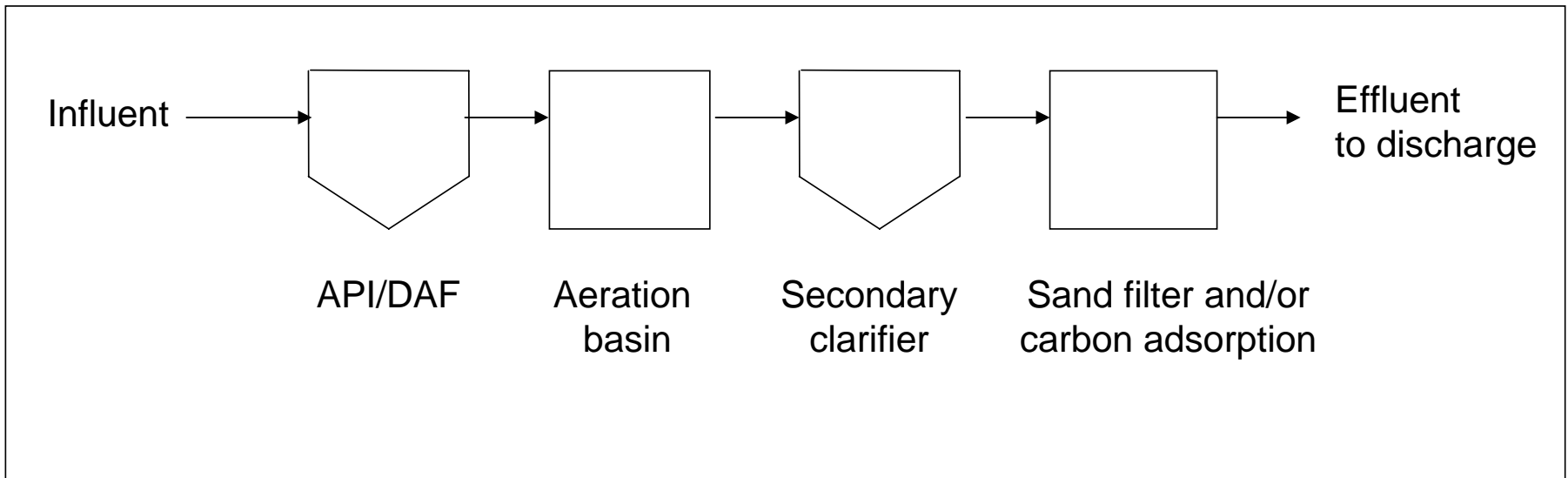
Economic

Opportunity to save on cost of process water and wastewater treatment (chemical consumption, activated carbon, sludge handling)

Technology

state-of-the-art membrane treatment meets wastewater reuse quality requirements

Conventional refinery wastewater treatment



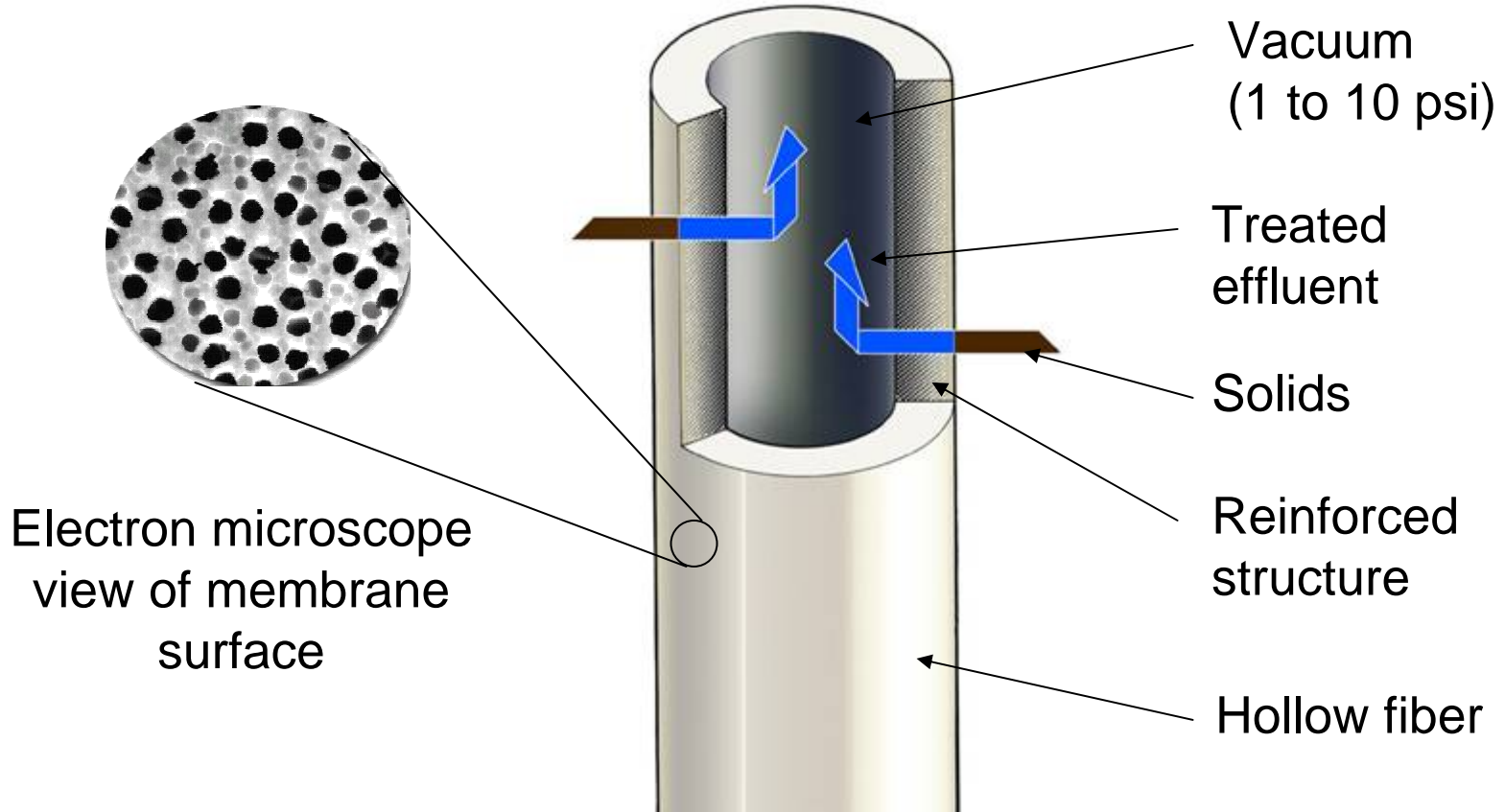
Conventional flowsheet for refinery wastewater treatment for discharge

Why use membranes?

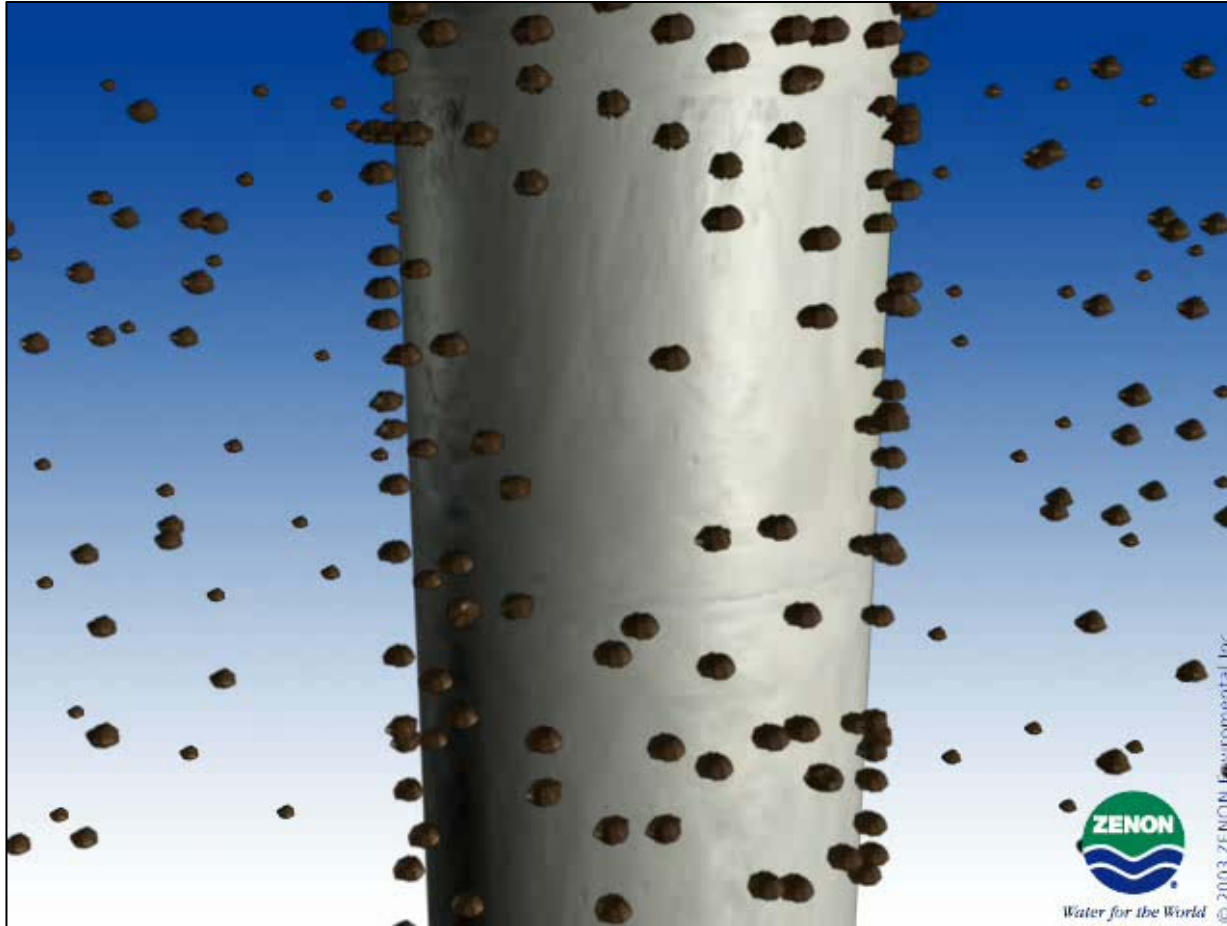
- Replace clarifiers for solid/liquid separation
- Ensure effluent is free of suspended solids
- Ensure complete removal of biologically degradable COD and TOC, including improved removal of refractory organics
- Reduce the footprint required for wastewater treatment
- Provide sufficient treatment for direct feed to RO for reuse in the refinery process
- “Absolute barrier” – not subject to process upsets

Membrane basics

Membrane basics



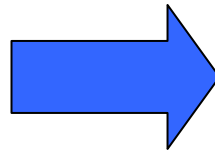
Membrane basics



Membrane basics



Membrane module

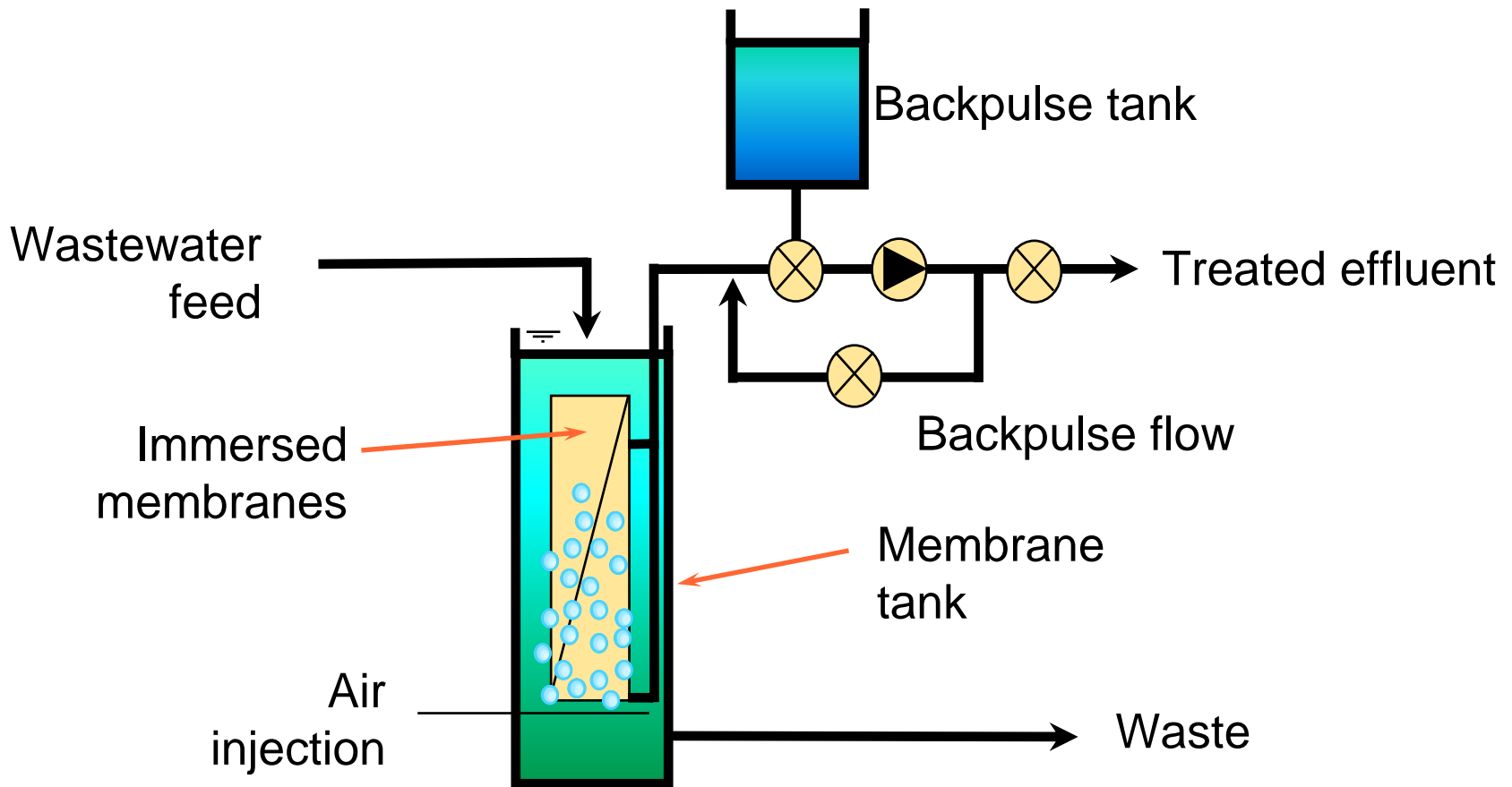


Membrane cassette

Membrane basics



Membrane basics



Membrane process configurations

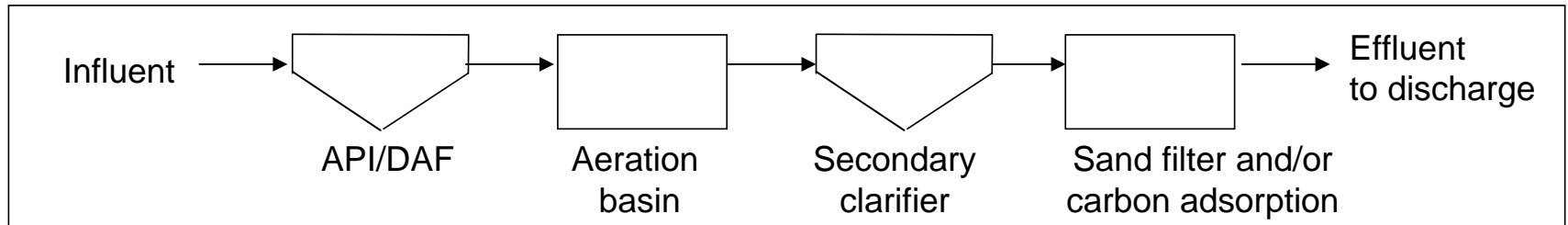


Tertiary filtration

Membrane bioreactor (MBR)

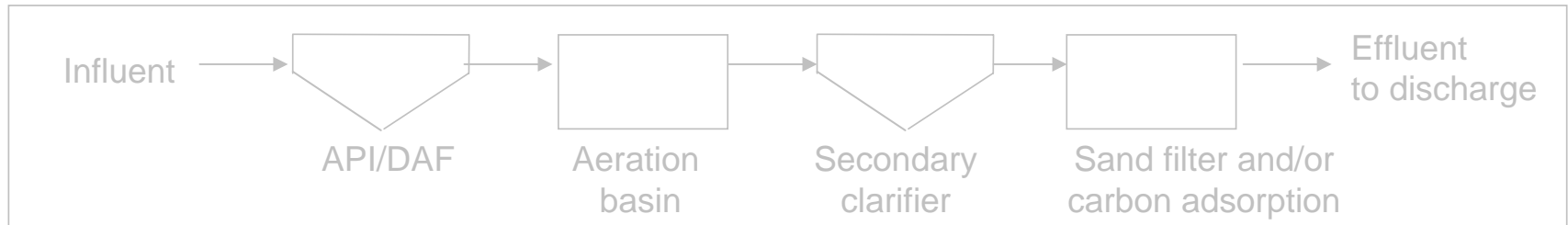
Tertiary filtration vs. MBR

Conventional

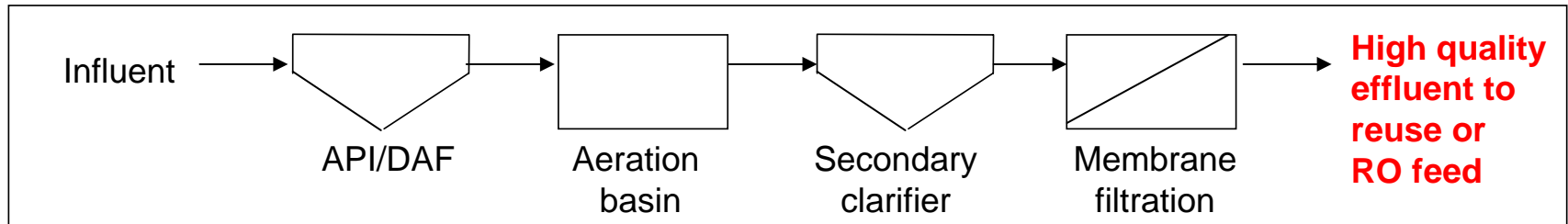


Tertiary filtration vs. MBR

Conventional

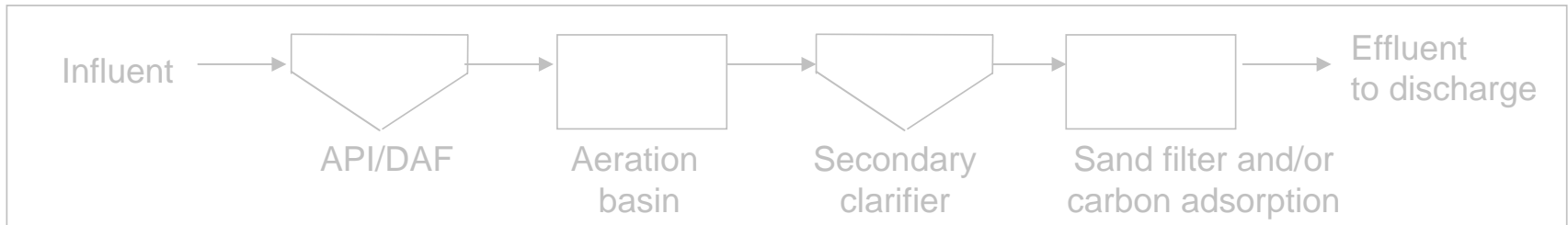


Tertiary
Filtration

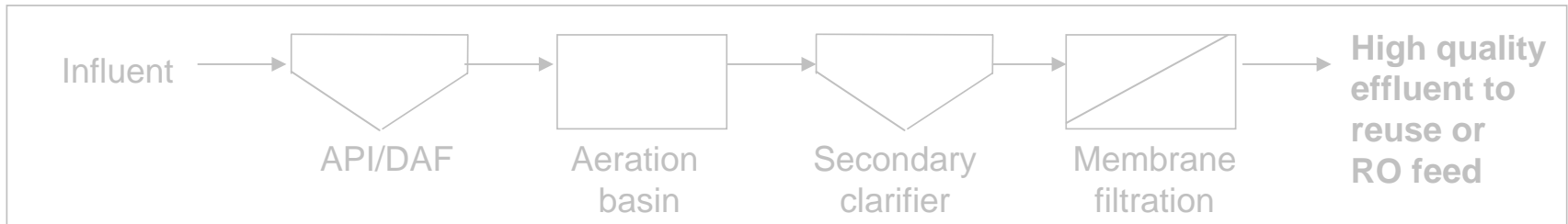


Tertiary filtration vs. MBR

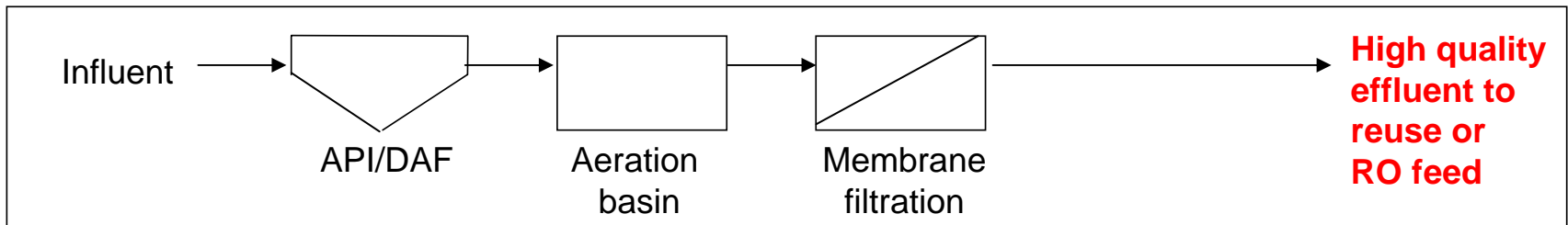
Conventional



Tertiary Filtration



Membrane Bioreactor



Tertiary filtration vs. MBR

Tertiary filtration

- Readily integrated into an existing wastewater treatment process
- Can be applied to only a portion of the wastewater flow
- Generates a reject stream that must be properly managed

Tertiary filtration vs. MBR

Tertiary filtration

- Readily integrated into an existing wastewater treatment process
- Can be applied to only a portion of the wastewater flow
- Generates a reject stream that must be properly managed

Membrane bioreactor (MBR)

- Optimized biological treatment process
 - Reduced reactor volumes
 - Improved removal of refractory organics (increased SRT)
- Integration of biological treatment and filtration
- Improved process resiliency

Case studies

PEMEX Refinery,
Mexico

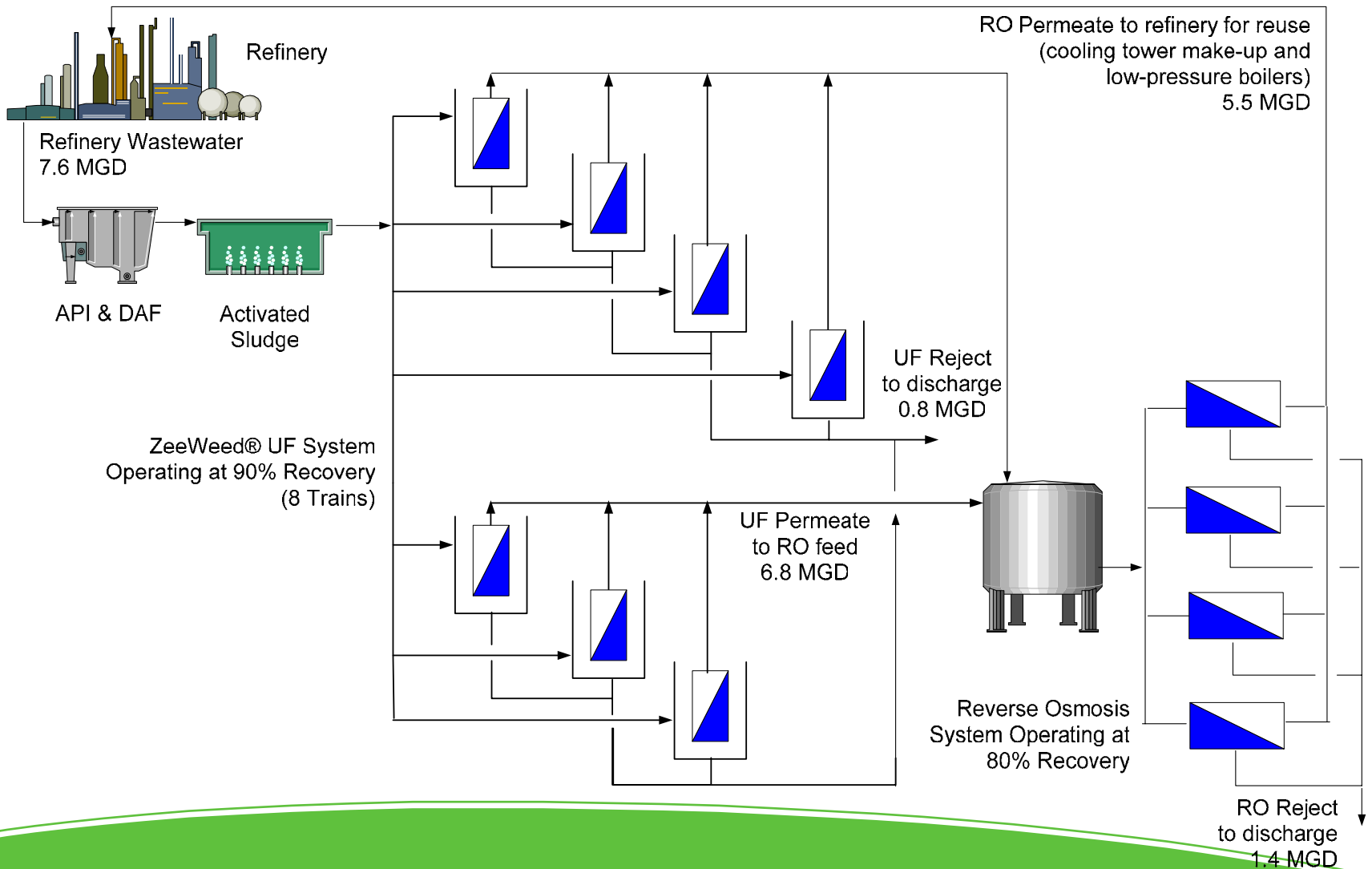


Marathon Ashland Petroleum
Marine Repair Terminal,
Kentucky

PEMEX Refinery, Mexico

- Tertiary treatment of combined refinery effluent as pretreatment for RO
- Located in Minatitlan, Mexico at one of Mexico's largest refineries (173,200 bpd)
- Wastewater treatment for reuse in the refinery – overall water recycle efficiency is 70%
- RO permeate reused for cooling tower makeup and low-pressure boiler feed
- Treatment capacity of 6.8 MGD
- Commissioned in November 2001
- Drivers – process reliability, cost savings

PEMEX Refinery, Mexico



PEMEX Refinery, Mexico



UF membrane process trains in treatment building

PEMEX Refinery, Mexico



UF membrane process trains

PEMEX Refinery, Mexico



UF membrane process equipment

PEMEX Refinery, Mexico

UF system performance data

	Secondary effluent to UF	Treated effluent, RO feed
BOD (mg/L)	50	< 5
TSS (mg/L)	200	< 1
Turbidity (NTU)	25	< 0.1
SDI (-)	N/A	< 3.0

PEMEX Refinery, Mexico

Reverse Osmosis system performance data

	UF effluent, RO feed	RO permeate
??	??	??
??	??	??
??	??	??
??	??	??

PEMEX Refinery, Mexico

- 3-1/2 years of operating experience
- Consistent effluent quality for RO pre-treatment
 - RO cleaning 2-3x per year
- Membrane recovery with cleaning following heavy free oil fouling event



Membranes recovered after cleaning

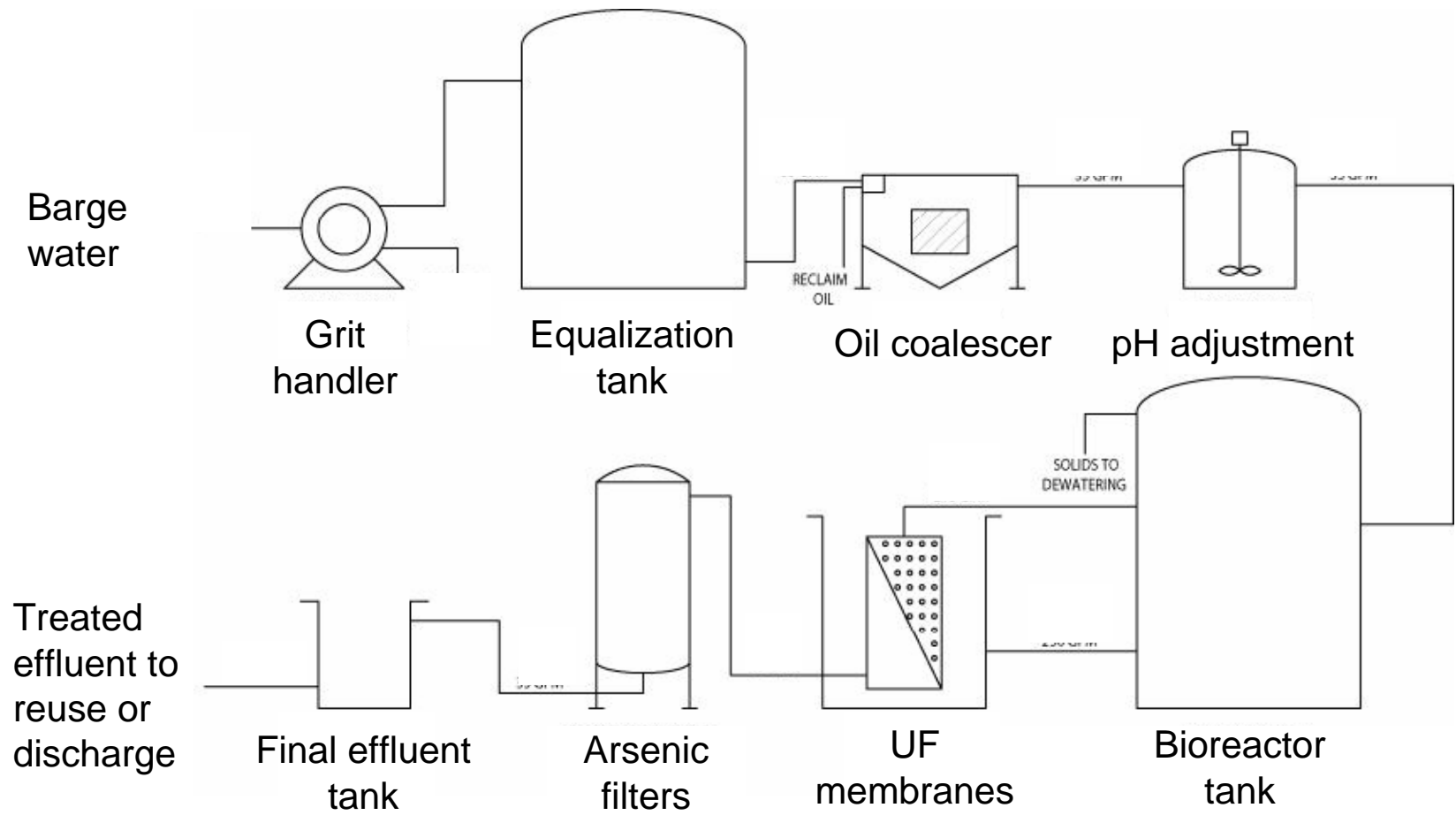
Membranes in FOG process upset condition



Marathon Ashland Petroleum Marine Repair Terminal, Kentucky

- MBR treatment of oily wastewater
- Located in Catlettsburg, Kentucky
- Treats wastewater from marine repair terminal (i.e.: oily wastewater from barge wash down)
- Treatment capacity of 50,000 gpd
- Severe variations in wastewater composition due to different crudes carried by barges
- Wastewater treated to reuse quality, however reuse infrastructure is not yet in-place
- Commissioned in July 2003

Marathon Ashland Petroleum Marine Repair Terminal, Kentucky



Marathon Ashland Petroleum Marine Repair Terminal, Kentucky



Membrane equipment building

Marathon Ashland Petroleum Marine Repair Terminal, Kentucky



Pre-treatment processes



Membrane equipment

Marathon Ashland Petroleum Marine Repair Terminal, Kentucky

	Raw wastewater	Treated effluent
BOD (mg/L)	775	< 5
COD (mg/L)	1,000	< 300
TSS (mg/L)	66	N/D
TFOG (mg/L)	165	N/D
BTEX (mg/L)	10	< 0.7

Marathon Ashland Petroleum Marine Repair Terminal, Kentucky

- 1-1/2 years of operating experience
- Membranes have not required cleaning to-date
- Membrane system able to handle severe variations in flow and wastewater composition
- > 95% removal of BTEX compounds
- Full compliance for discharge to POTW



Conclusions

Demands

exist for wastewater reuse in the petroleum industry

Immersed hollow fiber membranes fit the need
to treat refinery wastewater to the levels required for reuse

***Immersed hollow fiber membranes are the
state-of-the-art***

in the treatment of oily wastewater for reuse

***Full-scale membrane facilities treating oily
wastewater exist***

proving the technical feasibility of this technology