

أرامكو السعودية
Saudi Aramco



Saudi Aramco Experience with MBRs

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Wastewater Requirements (Regulations and Standards)

- Kingdom of Saudi Arabia National Policies for Water Conservation and Reuse.
- SAES-A-104, Wastewater Treatment, Reuse and Disposal.
 - PME standards,
 - Ministry of Water & Electricity (MOWE) Water Reuse Regulation
 - International California Title 22 requirements for wastewater reuse.
- Membrane Biological Reactors (MBRs) - preferred treatment technology.



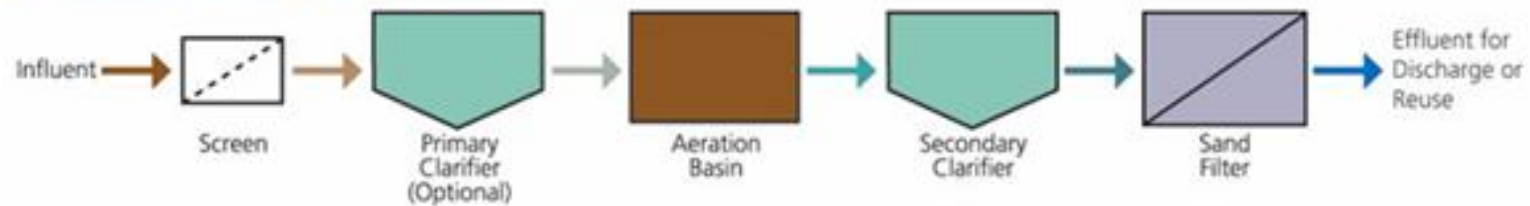
Wastewater Treatment

- Wastewater is 99% Water.
- Wastewater for water reuse shall be treated with:
 - Physical / chemical
 - Oxidization
 - Filtration
 - Disinfection

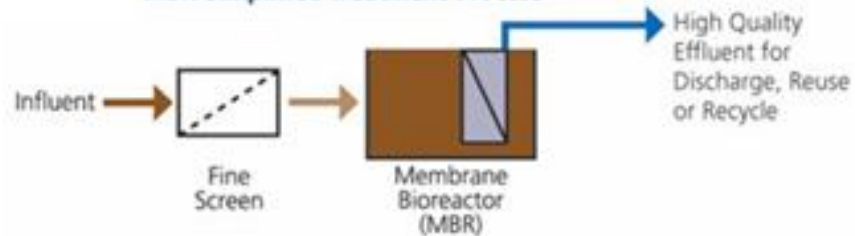


Wastewater Treatment

Conventional Multi-Step Tertiary Treatment Process



MBR Simplified Treatment Process



MBR / CAS Comparison

Parameter	MBR	Conventional
Footprint	Small	Large
High MLSS	8,000 - 16,000 mg/l	2,000 - 4,000 mg/l
High quality effluent for reuse	Excellent	Very Good
Low Nitrogen	Feasible	Difficult
Low suspended solids enables effective disinfection	Excellent	Good
Reduction in waste sludge volume	Excellent	Good



MBR / CAS Comparison Continued

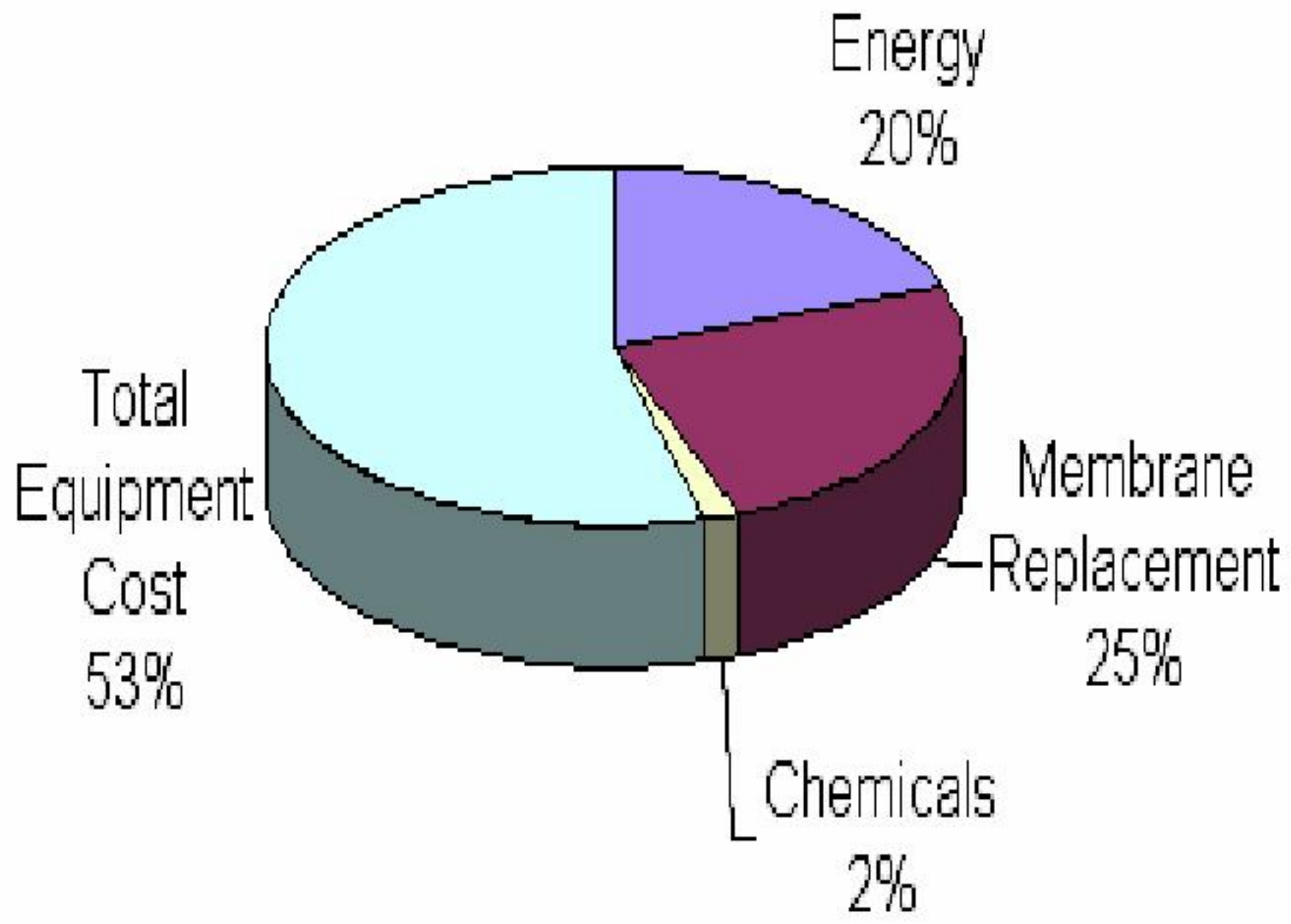
Parameter	MBR	Conventional
Operator friendly – No settling is required	Excellent	Poor
Modular construction	Fast	Slow
simplify expandability	Excellent	Good
Process is relatively easy to automate	Excellent	Poor
Reliable and proven for remote area operations	Excellent	Poor

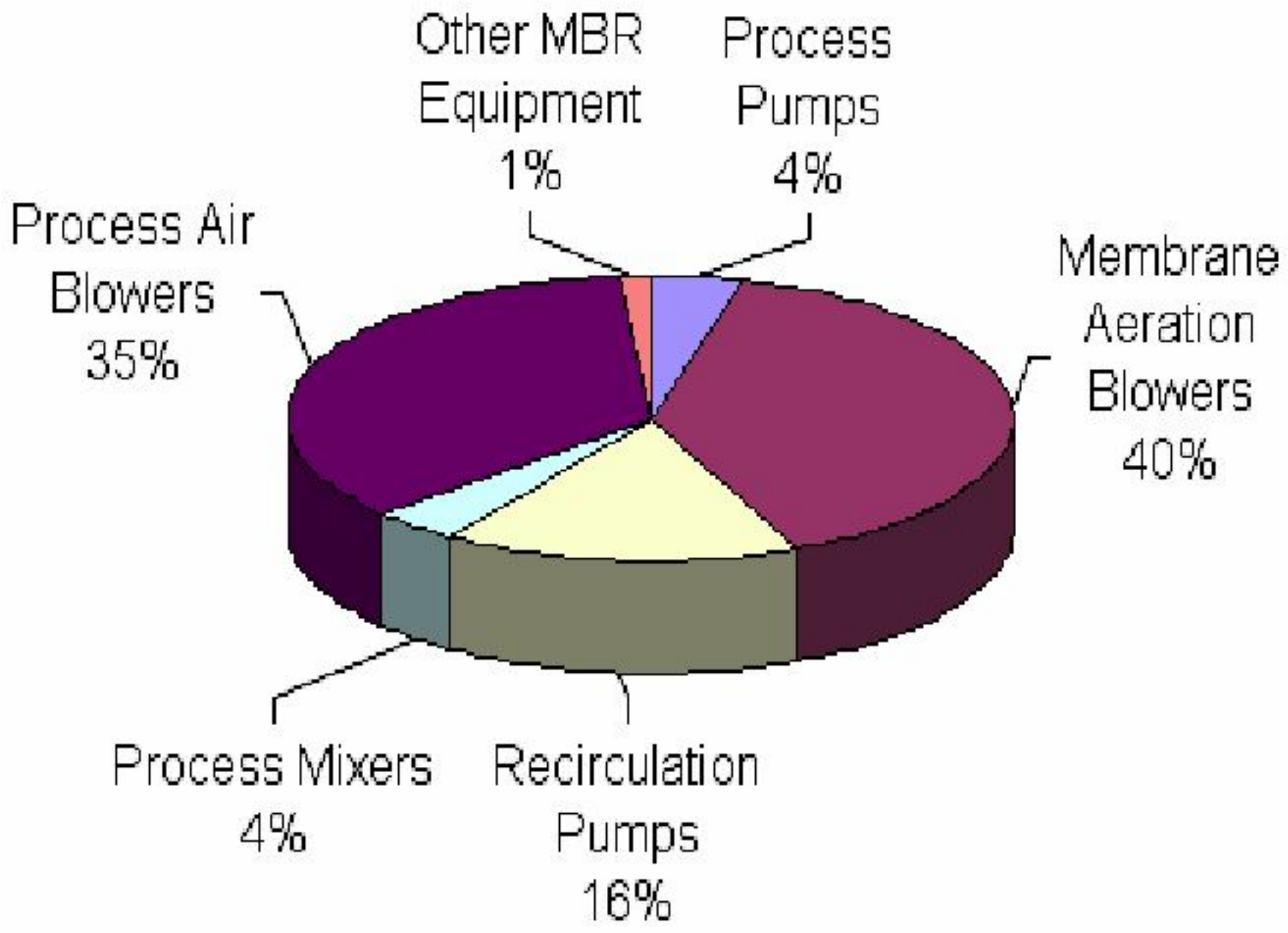
MBR / CAS Comparison

- Effluent from MBR show a lower AOC concentration than CAS.
- Reduced potential for microbial regrowth in reclaimed water distribution systems.
- MBR exhibits better removal efficiencies than CAS for Compounds of Emerging Concern (CECs).
- MBR permeate lower TOC, COD and polysaccharides concentrations, but higher color compared with the permeate from the CAS-TMF.
- MBR outperform CAS-TMF to protect downstream RO systems from organic fouling.

**REFERENCE: WEF Membranes Applications 2010 Conference,
USA**







MBR Wastewater Equipment

- MBR System is Regulated Vendor List (RVL) equipment.
- Approval from EPD Wastewater RVL Committee and Vendors Inspection
- MBR system from Manufacturers that have California Title 22 Certification for Water Reuse



MBR Plants for Wastewater Treatment in Saudi Aramco

17 MBR Plants in Different Saudi Aramco
Operating Areas:

- Pipelines Operations
- Distribution Operations
- Oil Operations
- Gas Operations
- Community Services
- New Plants in Refining Operations





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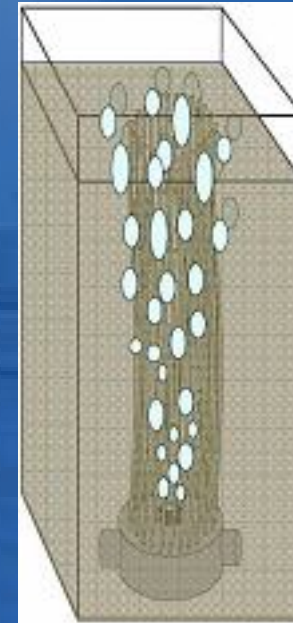


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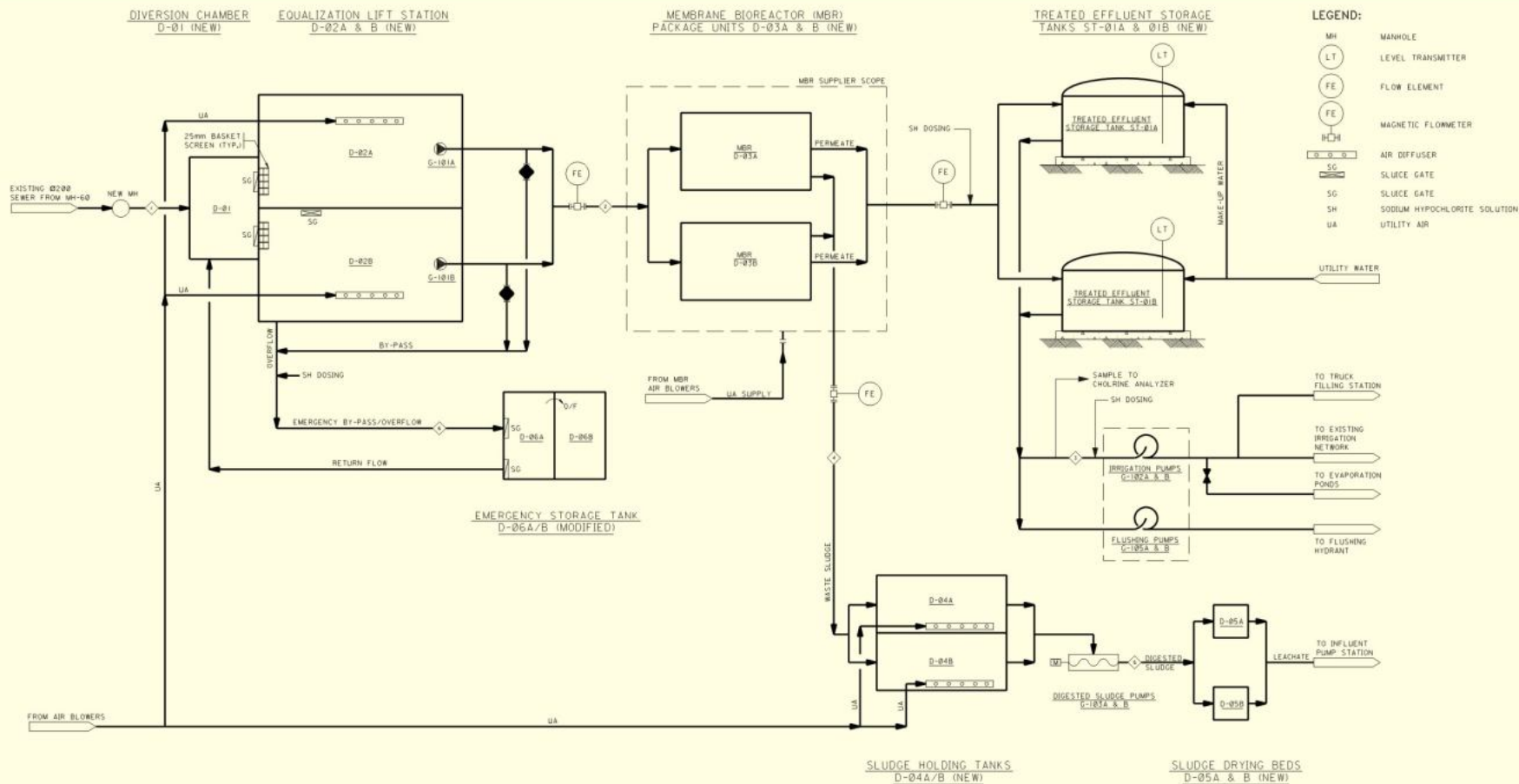
Rabigh Community MBR

- A single header construction and rugged hollow-fiber design, the PURON™ membrane modules
- A nominal pore size of 0.05μ ,
- 2000 cubic meters per day.
- Fine Bubble Aeration
- MLSS Sensor
- Rotary loop Pumps



Single header design of fiber bundles (KMS, 2007)





	NEW FACILITIES						MODIFIED
UNIT NUMBER	D-01	D-02A & B	D-03A & B	D-04A & B	D-05A & B	ST-01A & 01B	D-06A & B
UNIT NAME	DIVERSION CHAMBER	EQUALIZATION LIFT STATION	MEMBRANE BIO-REACTOR (MBR)	SLUDGE HOLDING TANK	SLUDGE DRYING BEDS	TREATED EFFLUENT STORAGE TANKS	EMERGENCY STORAGE TANK
DESIGN PARAMETERS OR FUNCTION	DIVERT INFLUENT FLOW TO PUMP STATION AND EMERGENCY TANK	-PUMP WASTEWATER TO MBR PACKAGE PLANTS -EQUALIZATION OF INFLUENT FLOW	- FINE SCREENING - DENTRIFICATION OF WASTEWATER - REMOVAL OF CARBONACEOUS ORGANIC MATTER - SOLIDS-LIQUID SEPARATION	STORAGE OF WASTE SLUDGE FOR DEWATERING	SLUDGE DEWATERING BEFORE DISPOSAL	TREATED EFFLUENT STORAGE	TEMPORARY STORAGE OF WASTE WATER
UNIT WORKING VOLUME OR CAPACITY	N/A	VOLUME: 35CM	AS PER MBR SUPPLIERS DESIGN	CAPACITY : 11CM	N/A	CAPACITY : 120CM	CAPACITY : 160CM EACH CELL
UNIT DIMENSIONS	N/A	L: 6.0M W: 2.5M D: 7.0M EACH CELL	PACKAGE PLANT SIZING BY MBR DESIGN	L: 3.2M W: 1.6M D: 3.0M EACH CELL	L: 6.0M W: 6.0M	DIA: 5.0M W: 7.0M	L: 15.0M W: 12.2M D: 2.0M EACH CELL

LINE NUMBER	1	2	3	4	5	6
FLOW AVERAGE, CMD	160	160	160	1.2	10.8	320
PEAK, CMD	640	240	240	(INTERMITTENT)	(INTERMITTENT)	(BY-PASS)
BOD	mg/L	100	100	10*	-	-
	kg/DAY	-	16	1.6	-	-
TSS	mg/L	160	100	10*	8000	8000
	kg/DAY	-	16.00	1.6	10	86

* TREATED EFFLUENT LIMITS PER SAES-A-104 TABLE 1.0 FOR UNRESTRICTED IRRIGATION



HUBER Vacuum Rotation Membrane VRM® Bioreactor

- Minimum scouring air requirement
- No periodic permeate back washing during filtration
- 3 mm Fine Screens
- Single Modules can be replaced



• HUBER Vacuum Rotation Membrane VRM® Bioreactor







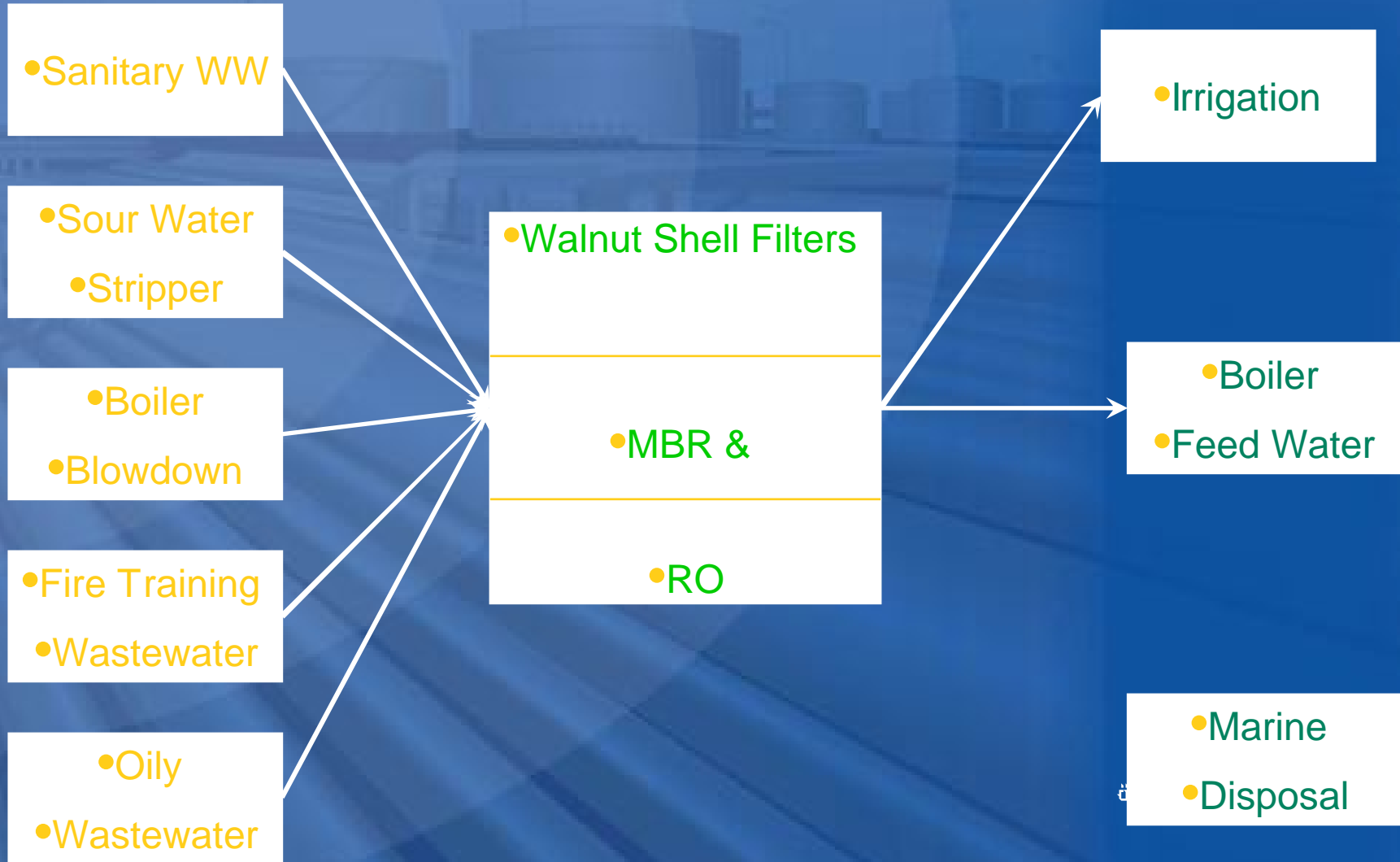
WW Reuse – New High Tech Options

JGP Industrial WW Reuse

- Combine Sanitary & Oily Wastewater
 - API & Walnut Shell Filters
 - MBR Treatment (carbon assisted)
 - Generation 2 Membranes
 - MemPulse™ Membrane Bioreactor (MBR) System
 - RO to Provide Boiler Feed Water
- Siemens Equipments



•JGP – Carbon Assisted MBR & RO



CONCLUSIONS

- Membrane Bioreactor (MBR) is the Adopted Technology for wastewater treatment and beneficial reuse in Saudi Aramco.
- MBR has Superior performance that produce high quality water and has low foot print and easy to operate compared to the Conventional Activated Sludge for wastewater treatment.
- The cost of the MBR plants compared to the CAS are + or – 10 to twenty percent.
- Continue research to provide better MBR products.
- It is feasible to retrofit and upgrade the large STPs with MBR type plants.



CONCLUSIONS Continued

- **Wastewater Can be Reused Many Ways**
- **Plans for More Water Conservation**
- **MBR systems are appropriate choice for rural areas because they require minimal supervision (Remote Monitoring).**
- **The Design selection of the MBR system shall be from approved Wastewater RVL Wastewater equipments Vendors that have California Title 22 Certification for Water Reuse.**
- **Outsourcing the Operations of the MBR Plants into Qualified MBR Vendors.**



Thank you

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