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MEMBRANE MANUFACTURER

Operating experiences on large seawater filtration plants equipped with the largest pressurized membrane hollow fiber UF module available on the market

Olivier Lorain, R&D Manager
o.lorain@polymem.fr
Isabelle Duchemin, Jean Michel Espenan

Polymem SA, Impasse de Palayré
31100 Toulouse France

OUTLINE

I. Introduction

II. Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market (Gigamem®)

III. Design description of large seawater filtration plants for off-shore applications

IV. Operating experiences

V. Summary

Introduction

Ultrafiltration Membrane filtration processes is now widely used in water treatment including seawater filtration thanks to :

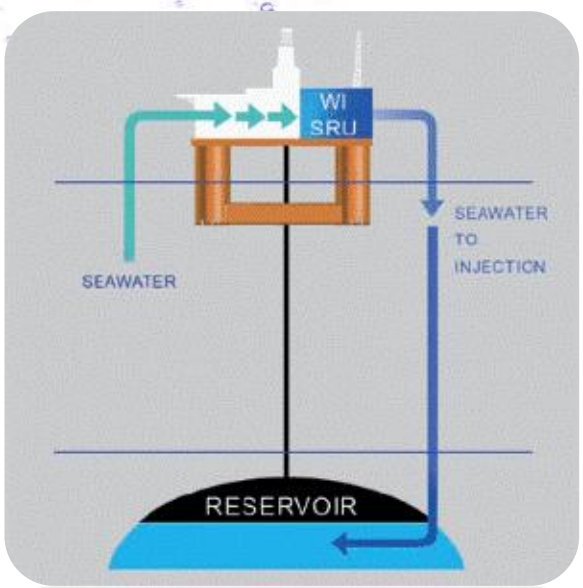
- o High rejection performances : 100% of the SS; turbidity <0.01 NTU ; SDI_{15}<<3) ; bacteria and viruses removal >4 log. Rejection of the largest fraction of the organic mater.
- o Low energy consumption 15 to 30 Wh/m^3 with head losses during operation between 0.3 and 1.5 bar
- o Simple and robust process, comparable to sand filter, fully automatic with automatic cleanings (backwash cycles, chemical cleanings)
- o Lifetime of membranes reaches 10 years
- o Today cost competitive with conventional media filters 0,10-0,15€/m^3
- o Very large plants existing on land : 300 000 m^3/d




- o Since few years, large UF applications are building on the sea as well (Offshore) for Oil and Gas Industries needs

Introduction

Oil and gas industry needs : seawater is injected in many oil fields to improve oil recovery by maintaining reservoir pressure and also displacing oil .



- UF is used instead of conventional media filtration (sand…) for weight and space saving but also for the very high quality of the ultrafiltrated seawater : no SS, turbidity < 0.01NTU, bacteria free. Also UF permeate quality is ideal (SDI reduction<<3) for Sulfate Removal Units by Nanofiltration.
- Furthermore the UF process is today robust, reliable and fully automatic with a long life time of membrane elements 5-7 years.

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Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market : The Gigamem

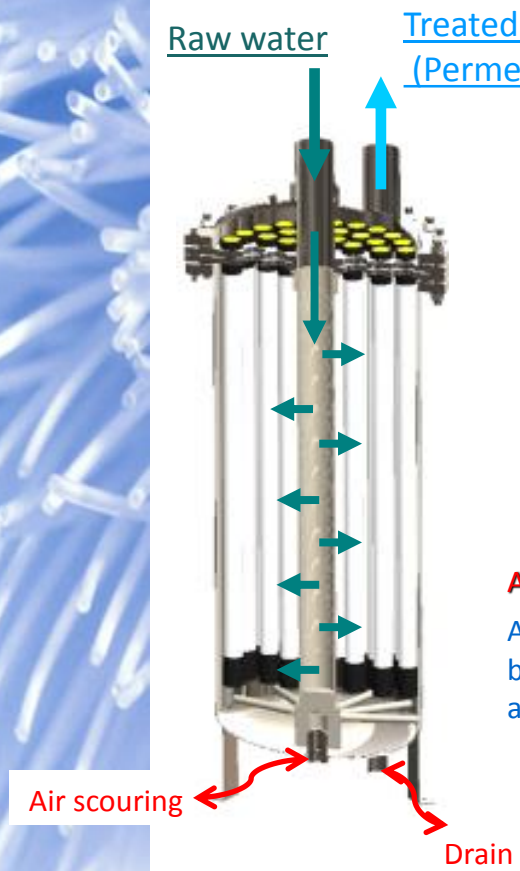
- Today, UF/MF modules sizes are relatively standardized between 8 and 12 inches with a relative small treatment capacity per modules 3-5 m^3/h. For large plants a huge number of modules is required with many associated valves, connection pipes …
- In 2009, Polymem has designed and launched a new mega module : Gigamem 540 m^2, 24 inches.

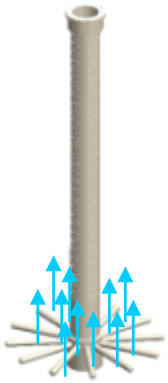
Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market : The Gigamem

- The Gigamem® module is composed of
  - a large housing (ϕ=600m; H=1.75m) designed for conventional pressure applications <3bar (plastic or stainless steel) or high operating pressures <13bar (Glass reinforced plastic, GRP)
  - 49 independent filtration elements of 11 m² (ϕ=50 mm; H=1.5m) composed of several thousands of hollow fibers.
  - Total filtration surface per Gigamem of 540 m²
  - Associated with the Polymem UF 0.72 mm OD hollow fibers (dead-end outside-in filtration) manufactured from PSF or PVDF polymers
  - A specific repartition plate in which the bundles are installed with 2 O-rings.
  - A central distribution feed pipe
  - An air scouring system at the bottom of the vessel

Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market : The Gigamem

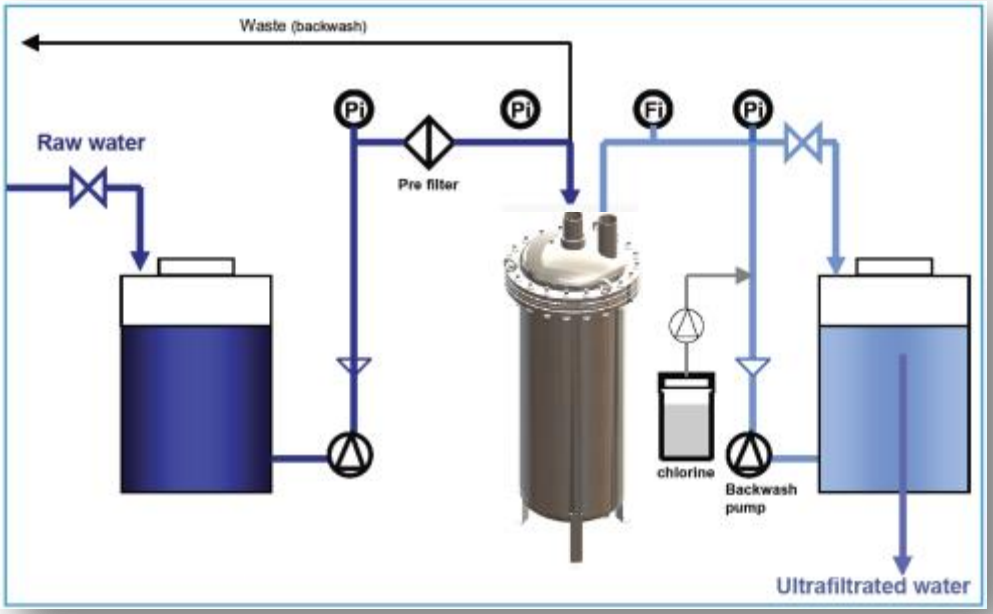
- Raw water feeds the central distribution pipe and pass through the hollow fibers (outside-in).
- The treated water (permeate)is collected at the top of the module
- Hydraulic backwashes are performed regularly to clean the membrane





Air scouring

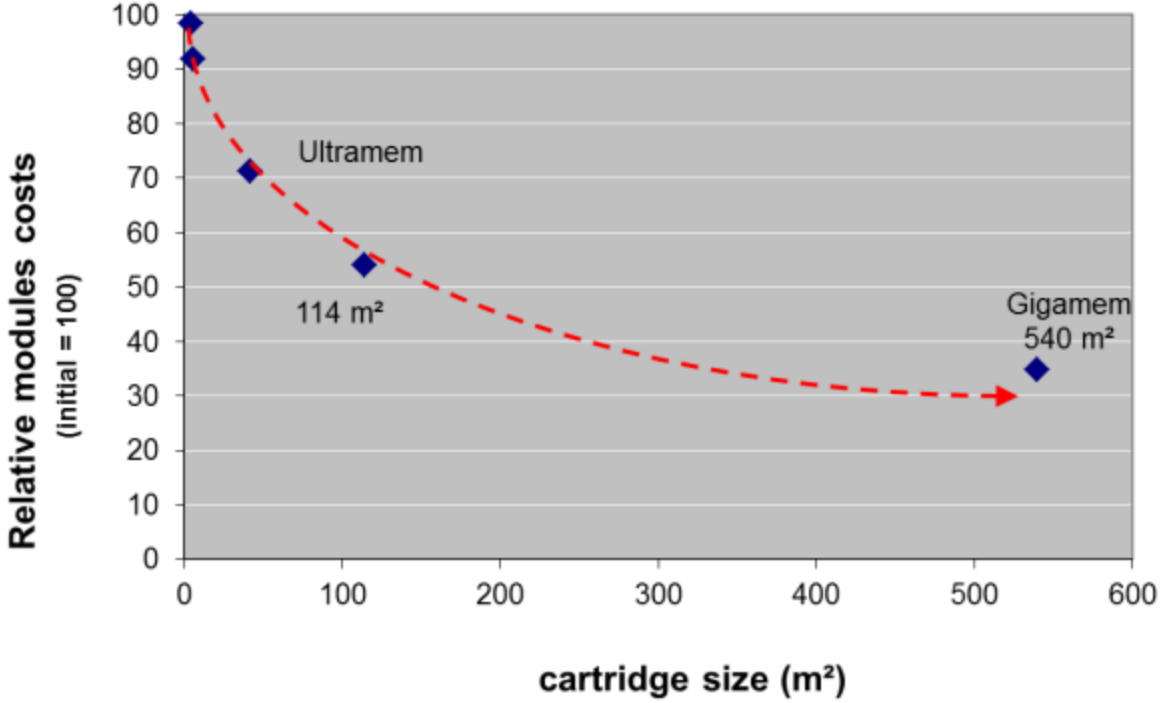
Air scouring is provided between the bundles at the bottom of the



Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market : The Gigamem

Membrane cost reduction : size effect + housing saving

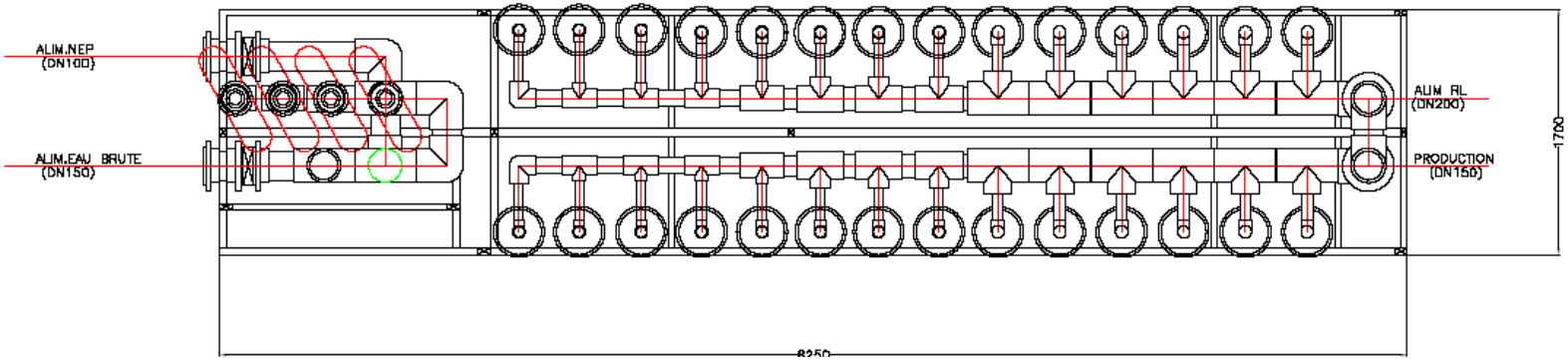
Polymem modules



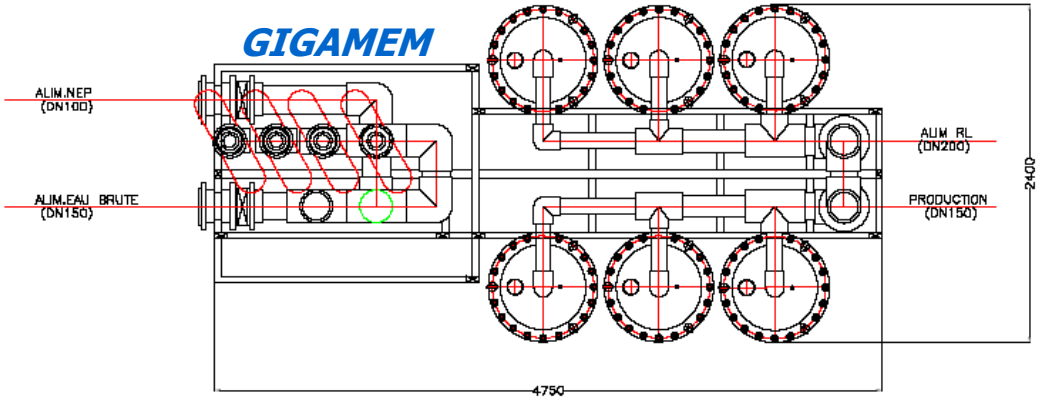
Presentation and benefits of the largest pressurized membrane hollow fiber UF module available on the market : The Gigamem

Footprint reduction

ULTRAMEM



GIGAMEM



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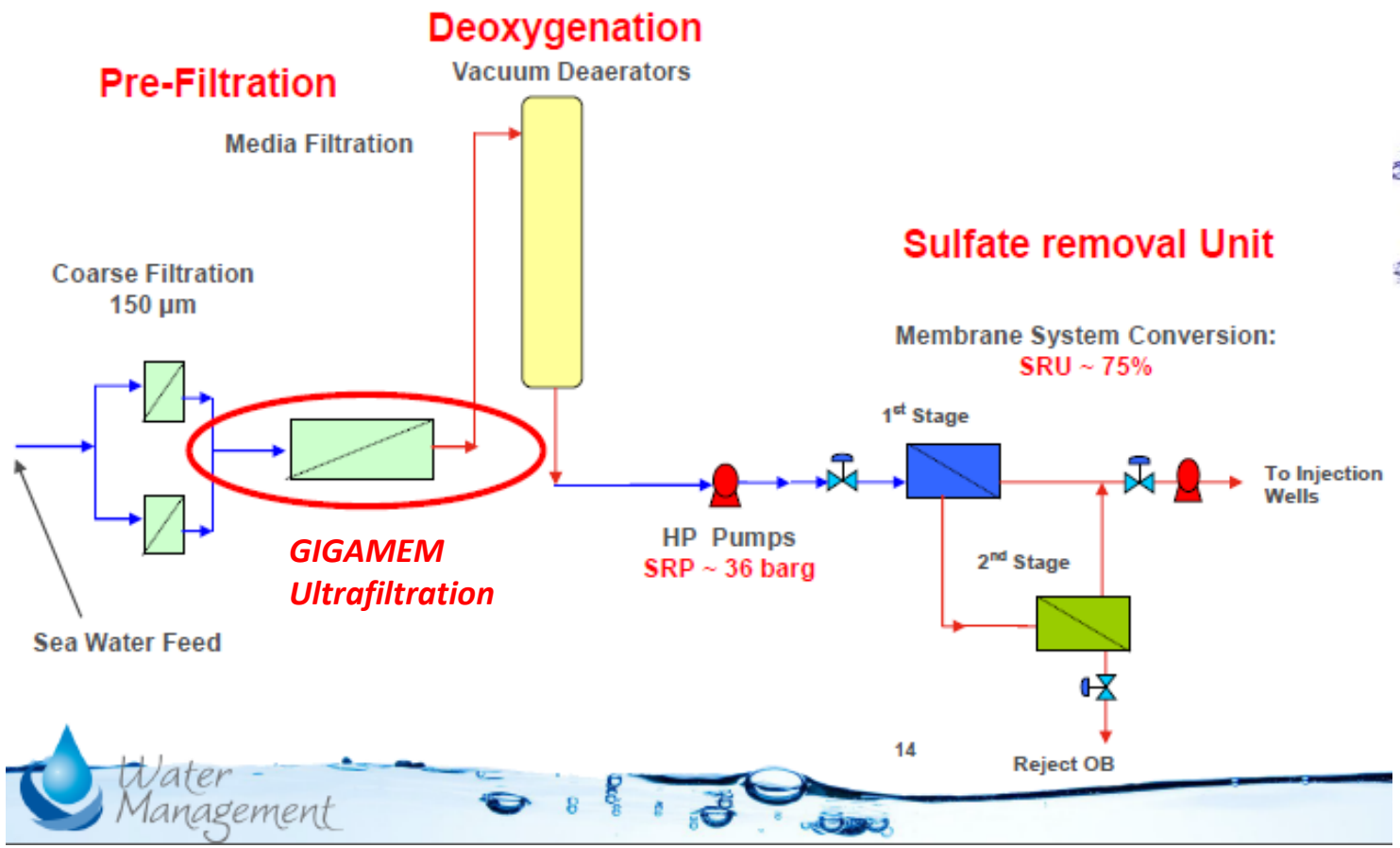


2010 Matthieu Jacob, Total Petrochimical Research Center. Roma 2010

Design description of large seawater filtration plants for offshore applications

- Design description
  - Plants references (partner Cameron) : OFON2 = 40 000 m^3/d and 30 000 m^3/d SHENZI
  - Pretreatment : strainer 150 µm is indispensable to protect UF from large debris (seawater or pipes) than can enter UF and occur mechanical damages on the membranes
  - Space savings = 30% compared to sand filtration : 1. work with no storage tank for backwash and only a slight decrease of total filtration flow during backwashes. The unit is composed of several trains of modules. By increasing temporally the operating flow of the running trains (30%), one train can be backwashed while the flow of the unit keeps constant. 2. High surface packing density in Gigamem 1500m^2/m^3
  - Weight saving : 50% compared to sand filtration
  - Flux operating : Pilot studies have been carried out at Palavas-les-flots (Mediterranean sea) since 2007. Many data have been collected allowing us to chose the appropriate design fluxes, the appropriate backwash frequencies and the appropriate forced flux for large offshore plants design
  - Chemical cleanings : backwash, maintenance and CIP frequencies have been chosen following pilot results as well. Chemical have been chosen for their efficiency but also for the facilities to be transported and stored in offshore platform.

Design description of large seawater filtration plants for offshore applications

Pilot trials on Mediterranean sea at Palavas-les-flots (France)

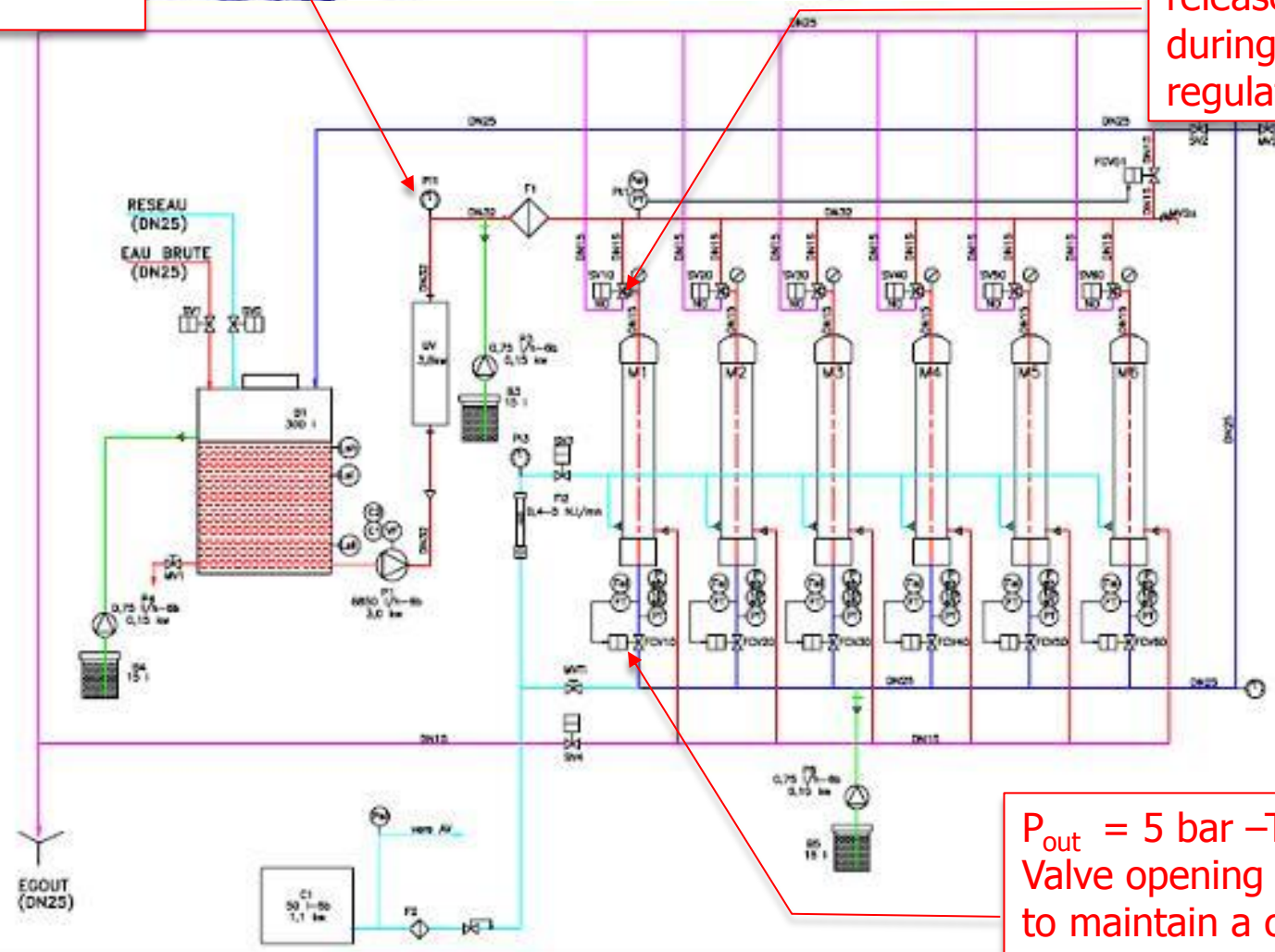
- Long term pilot trials since 2007 (5 years)
- Seawater intake : 100 m far from the costal and 3 m depth
- High SDI sea water (SDI_5 between 15 and 19)
- This in-shore seawater quality is of course worse than deep off-shore seawater (cf. table), however this allows us to accelerate and intensify the fouling phenomena within relatively short periods of time which is valuable during demonstration test

Parameters	Quality of on-shore seawater entering the demonstration plant	Typical quality of off-shore seawater
Temperature	5-25	Ambient to 40 when heated
pH	8-8.5	8.1
Salinity	37 500	38 000
SS	1-50 mg/l	1-3 mg/l
Turbidity NTU	1-10	< 5
SDI_{15}	6.0-6.7 (SDI_5=17-20)	< 5

Design description of large seawater filtration plants for offshore applications

P_{in}=5 bar

3-ways valve to release pression during BW (flow regulation)



P_{out} = 5 bar –TMP
Valve opening regulated to maintain a constant flow in the line (P_{out}> 3.5 bar)

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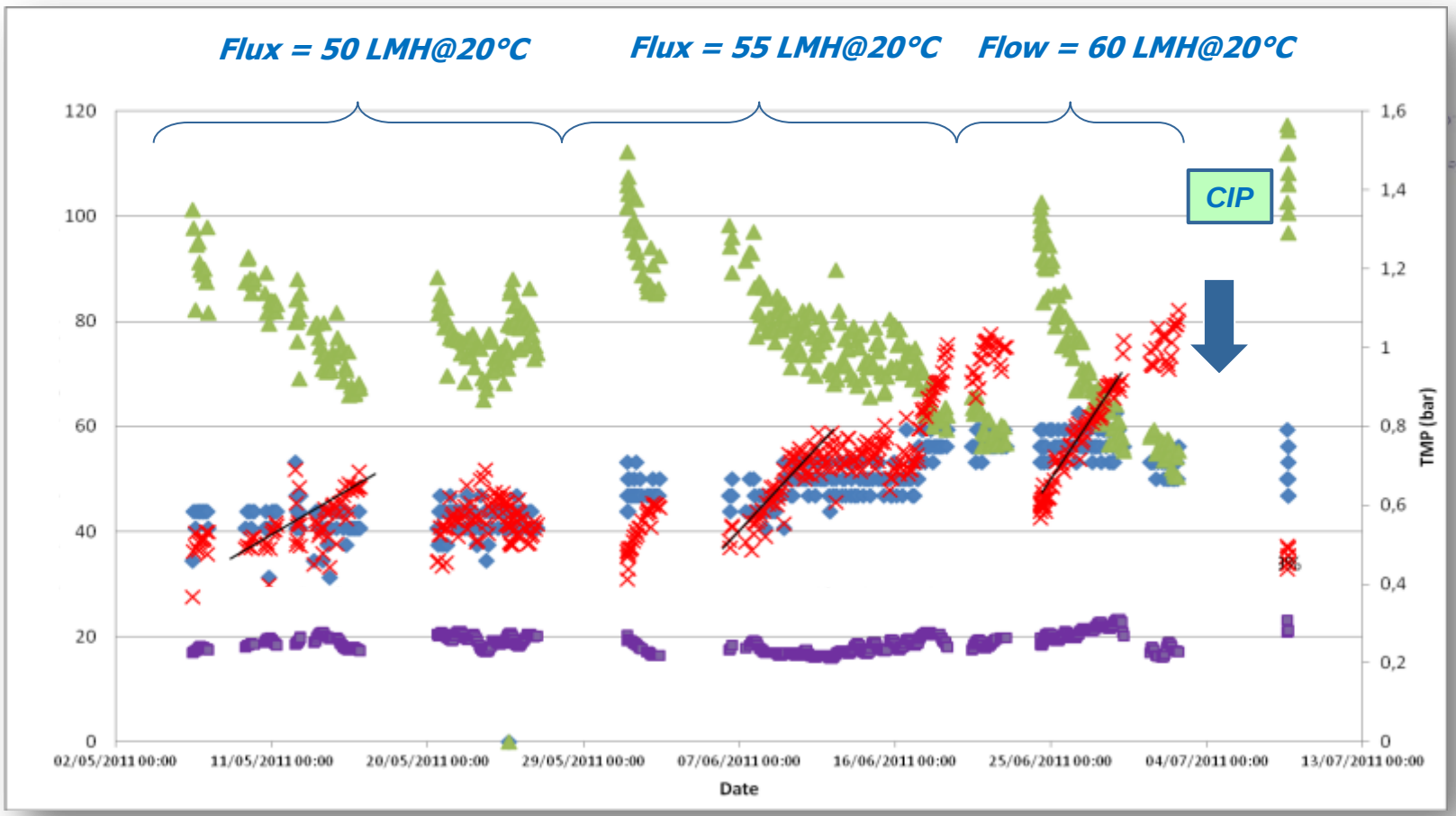

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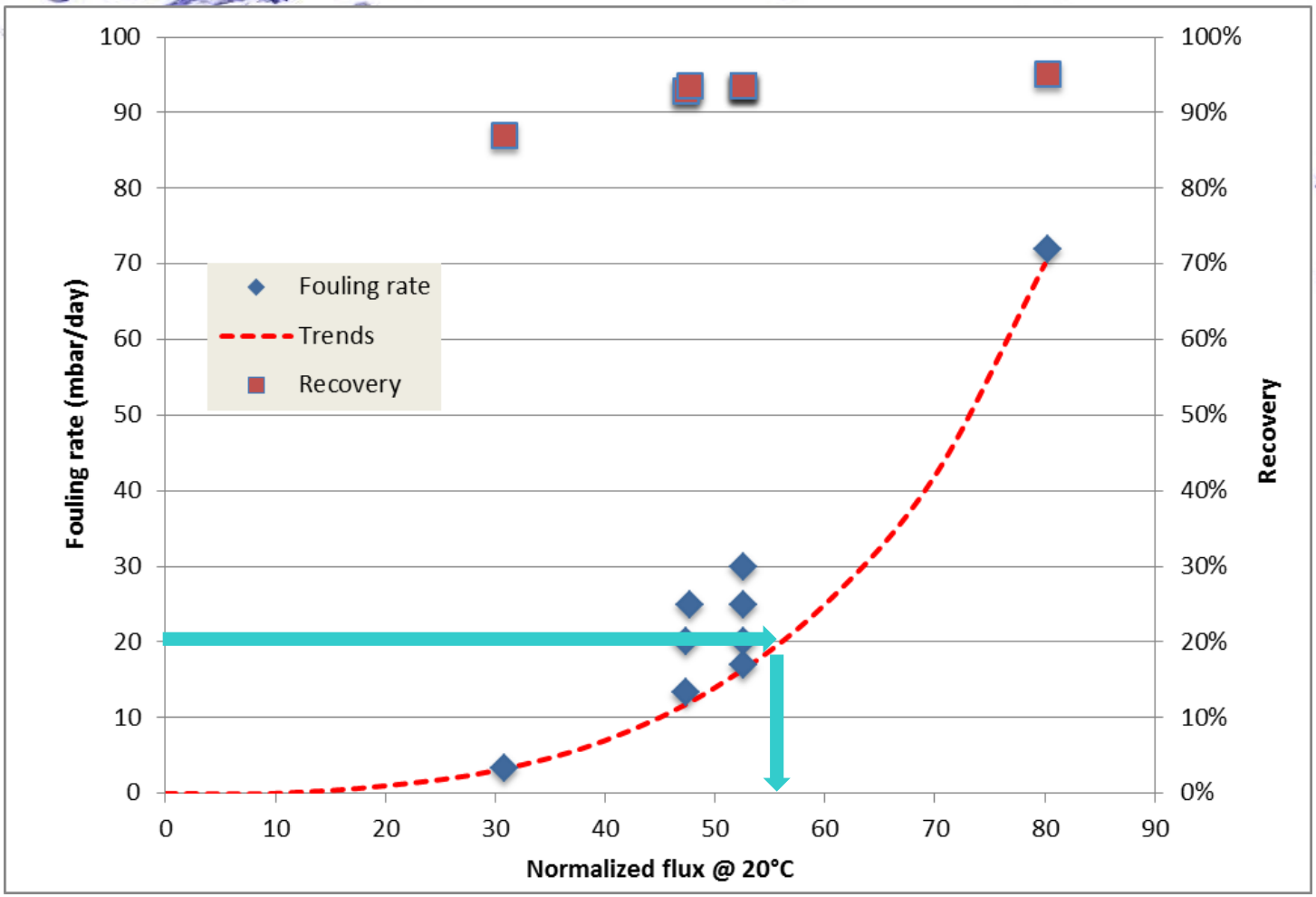

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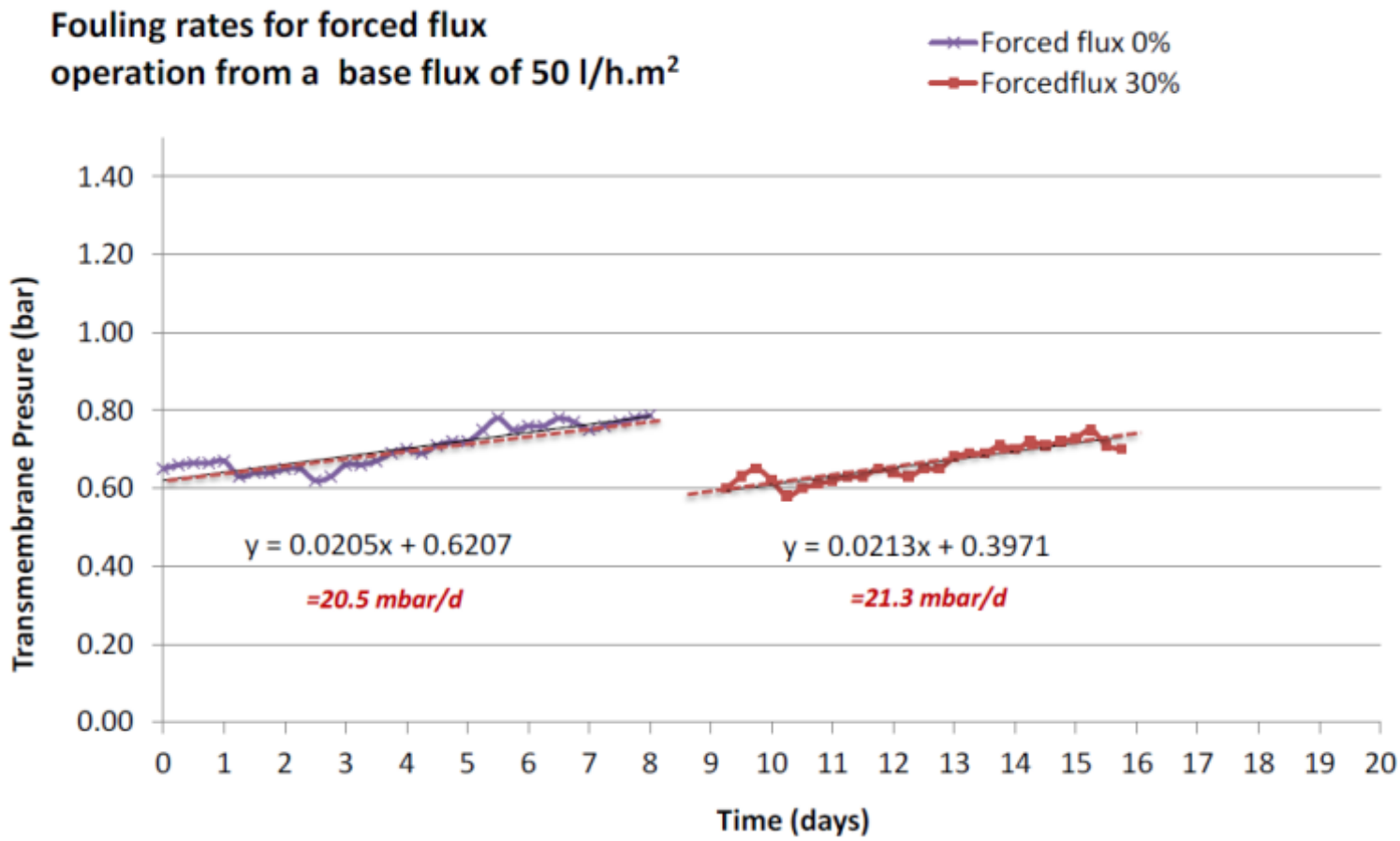

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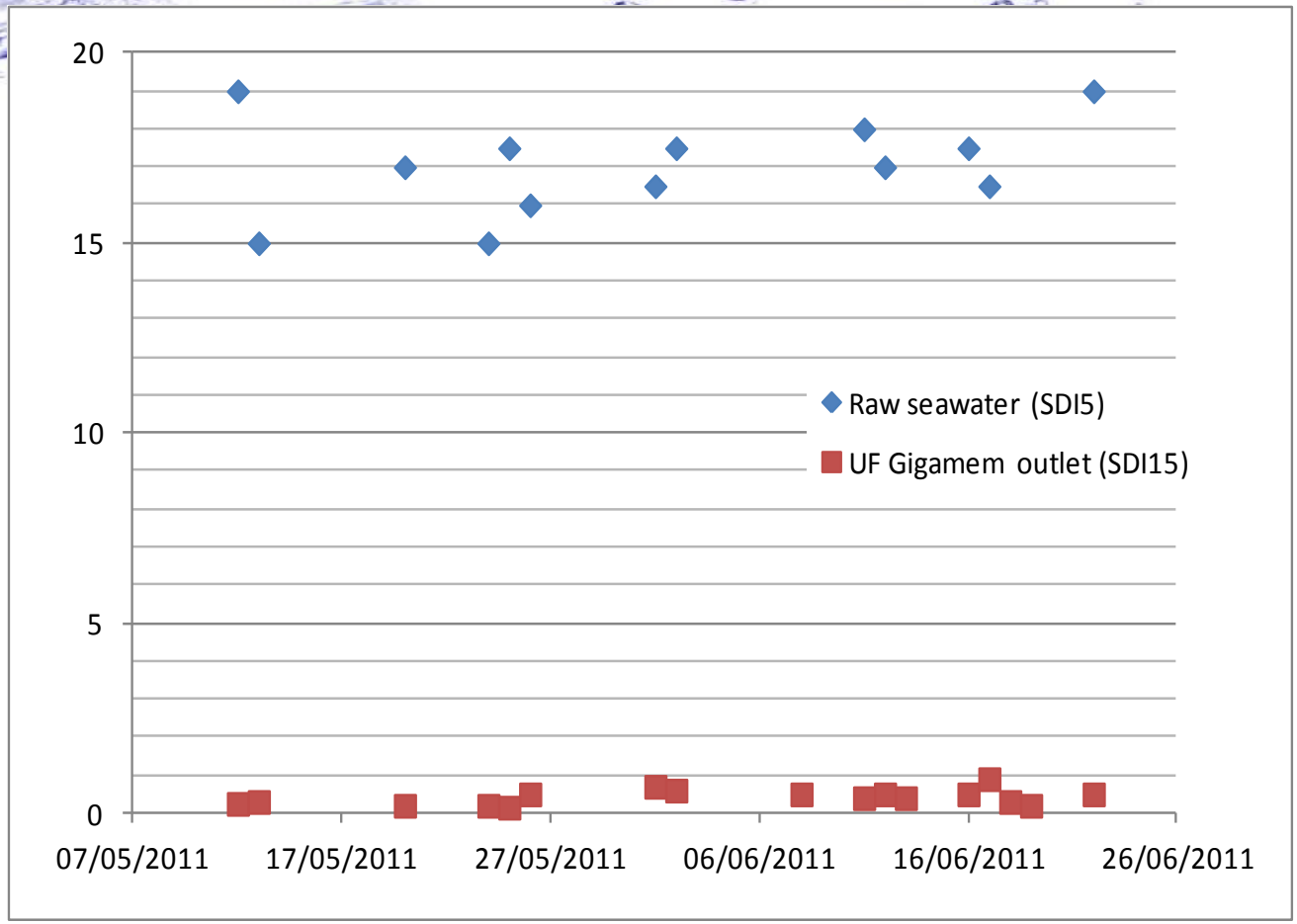

SDI_{15} of the permeate always lower than 1, whatever the high SDI_5 of the inlet seawater.

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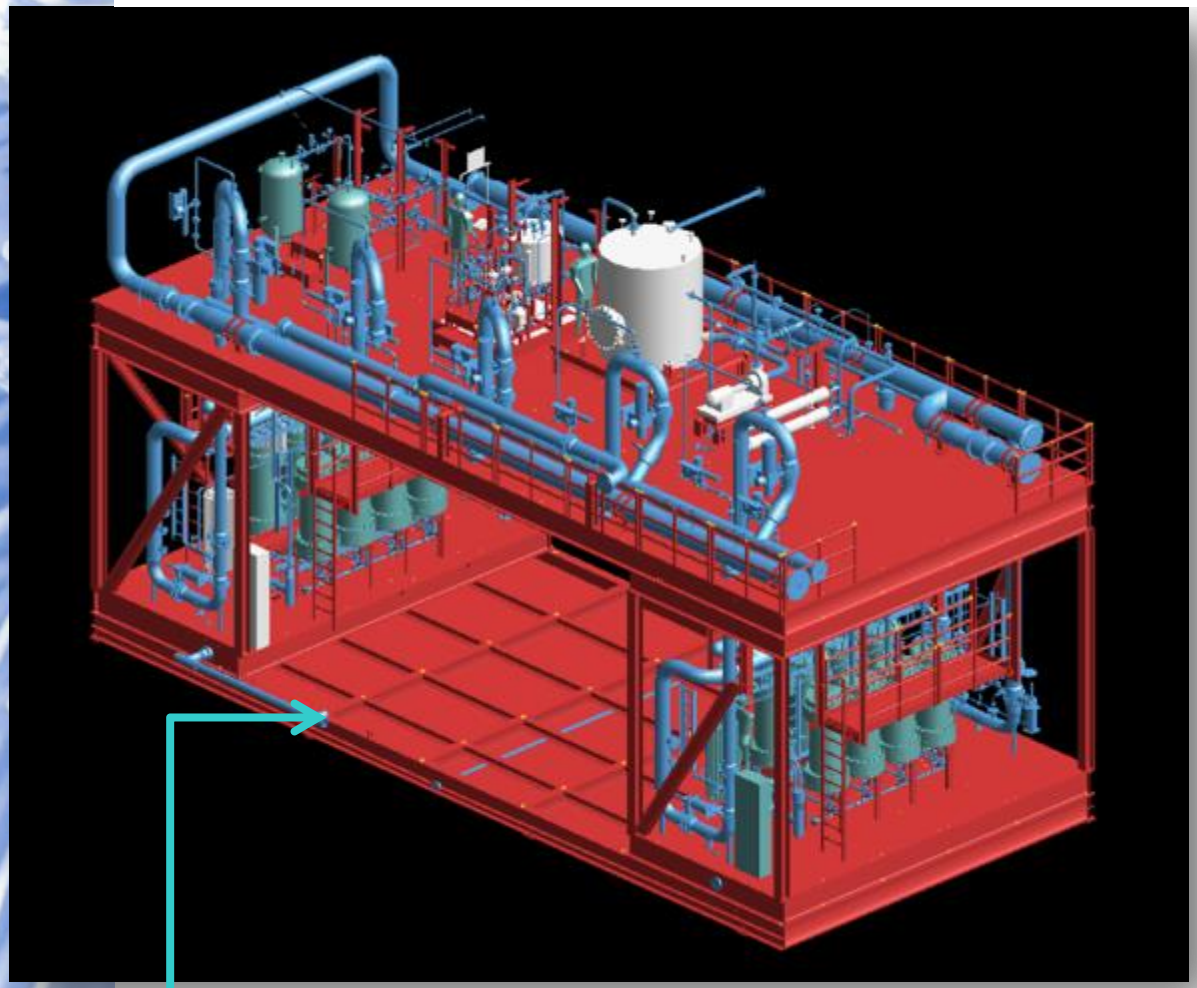
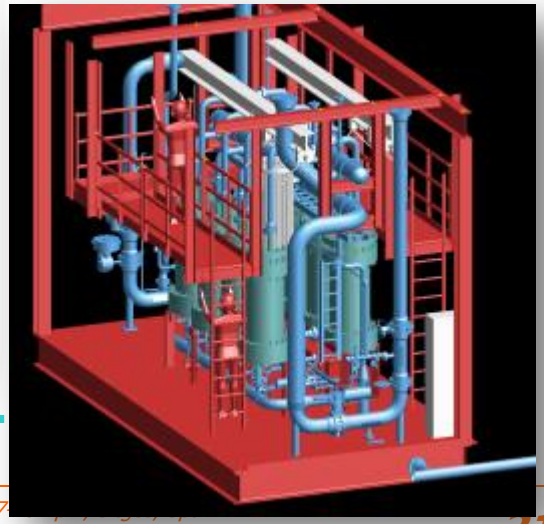
First results of operating experiences

SHENZI UF plant composed of 40 GIGAMEM : 30 000 m³/day capacity : Offshore seawater treatment plant.





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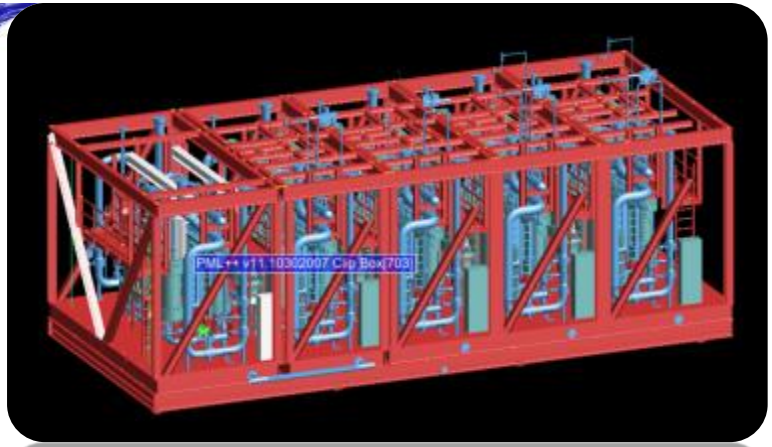

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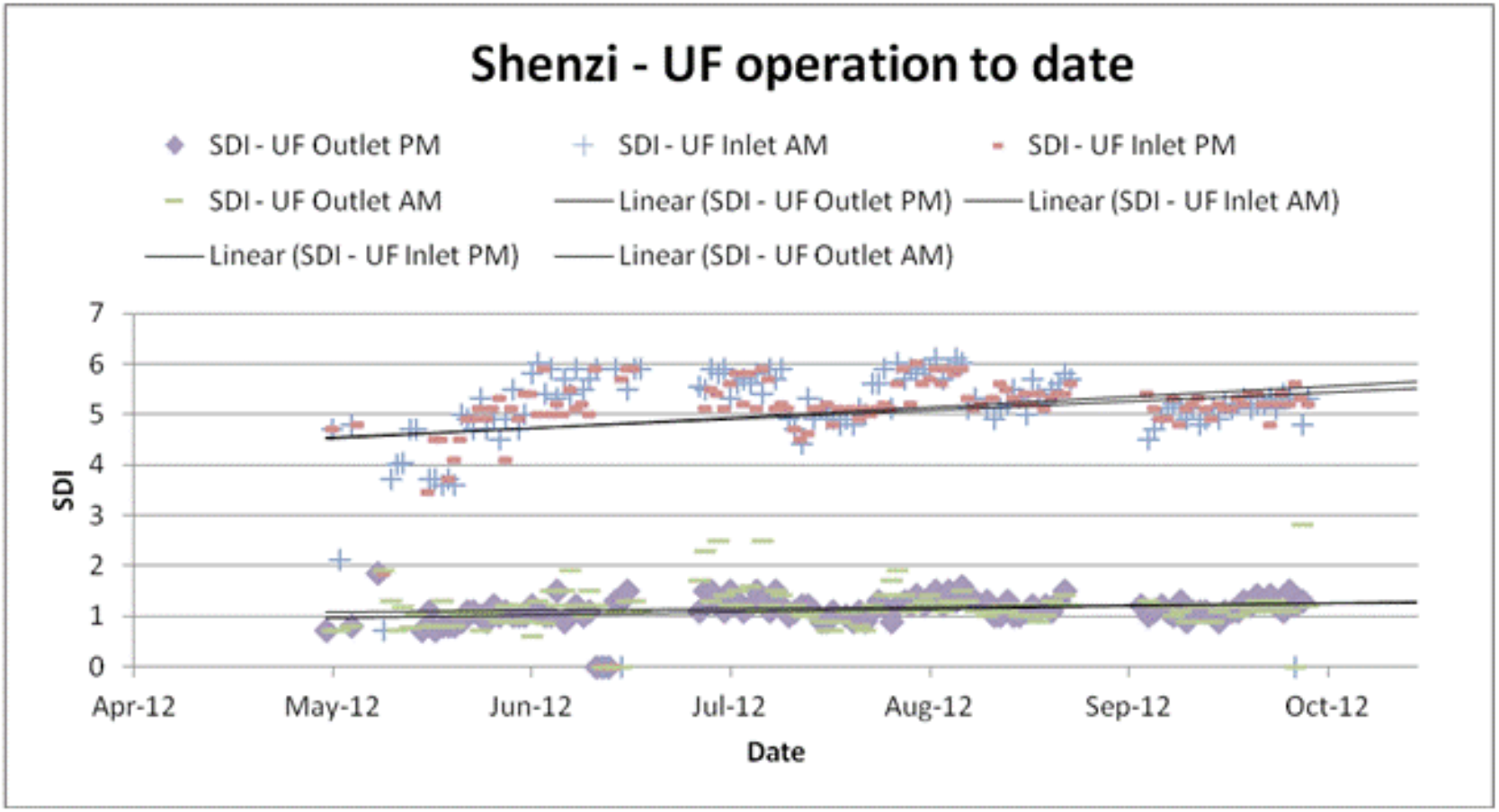

First results of operating experiences

OFON2 UF plant composed of 48 GIGAMEM : 40 000 m³/day capacity : Offshore seawater treatment plant.

Summary

- The Gigamem module concept allows to reduce drastically the weigh and the space in offshore UF applications :
  - Size enlargement of the modules
  - Allow to upgrade the plant with the most performing membrane at the moment of the replacement
  - Those benefits can be usefull for in-shore applications as well

- Several full size plants are already constructed or under construction

- The filtration performances, the constant quality of the treated water and the reliability of the UF Gigamem process are congratulated by the end-users.

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Thank you for your attention