Under the High Patronage of His Majesty King Mohammed VI

International Water Resources Association
IWRA

XIX WORLD WATER CONGRESS
International Water Resources Association (IWRA)
Marrakech, Morocco| 1-5 December 2025

Kingdom of Morocco
Ministry of Equipment and Water

Green Antifoulings for Seawater Desalination: From Membrane Deposit Analysis to Laboratory Evaluation

UM6P (IWRI) / UM6P Global Hubs France : Olivier HORNER, Justin LEMARCHAND
OCP Green Water: Lamia BOUKARI, Lamia HOUSNI, Ahmed ZNIBAR
ODYSSEE Environnement : Amaury BUVIGNIER, Fabrice CHAUSSEC, Jérôme MOUGEL

4th of December 2025

UM6P GLOBAL HUBS France
IWRI INTERNATIONAL WATER RESEARCH INSTITUTE MEETING FUTURE WATER CHALLENGES
OCP GREEN WATER
ODYSSEE Environnement

Agenda

- **Context & Objectives**
- **Methodology (Autopsy & FT-IR)**
- **Key Findings**
- **Implications for RO Operations**
- **Towards Green Antifouling Solutions**
- **Conclusions**

Context

- A global context of **drought and water scarcity** in Morocco **:** development of an **ambitious desalination investment program** for water production (mining/chemical activities, drinking water supply, agriculture areas).

- OCP Green Water's ambition for 2027 **of 560 Mm3 of desalinated water** (Jorf Lasfar, Morocco)

In the field of desalinated water :

- **Membrane fouling** is a major constraint in Seawater Reverse Osmosis (SWRO) performance

- Need to understand **deposit composition** to design **greener antifouling solutions**

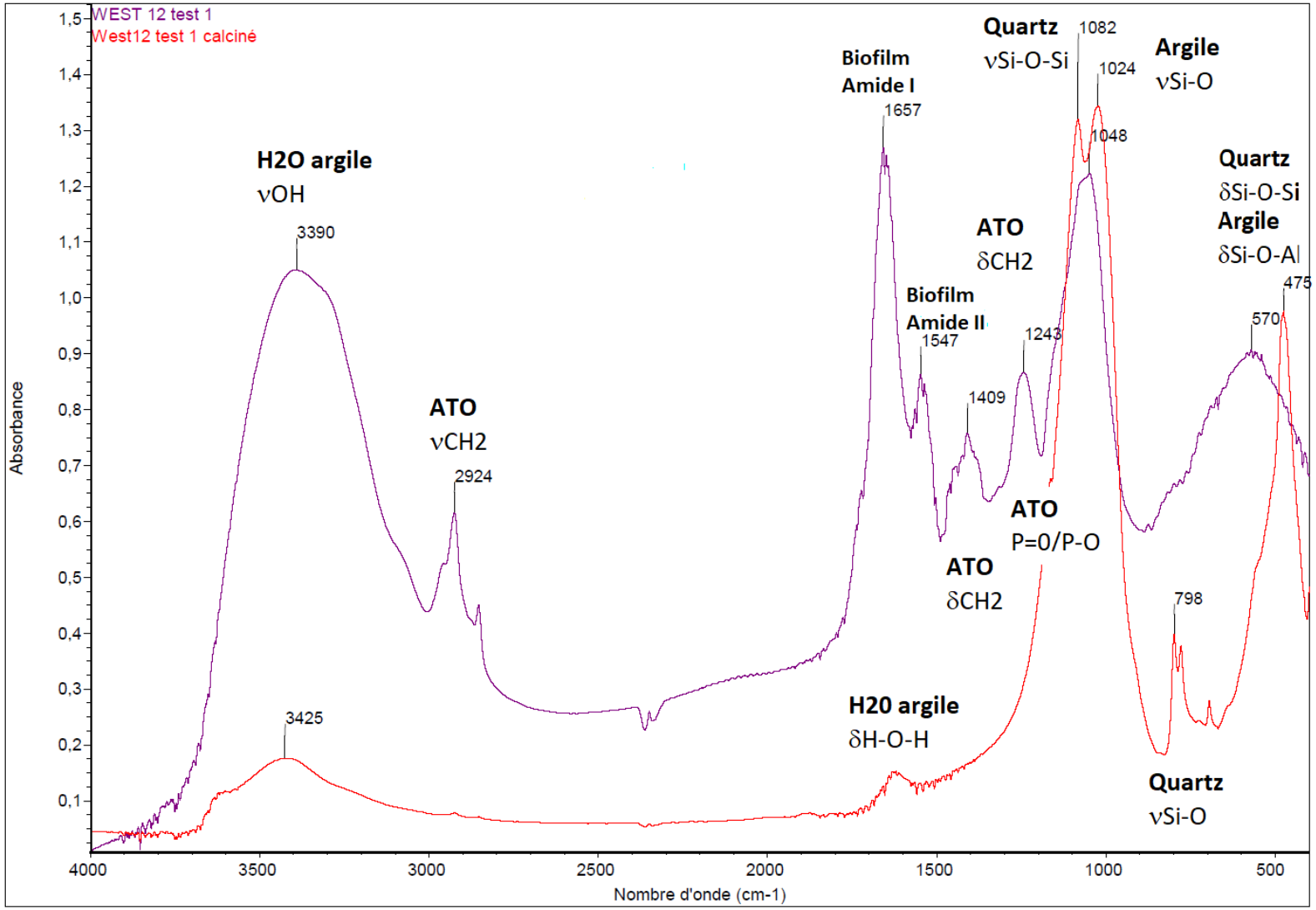
Methodology: Autopsy & FT-IR

- Sampling of **7** autopsied membranes from multiple trains
- **FT-IR spectroscopy** on raw and calcined samples
- Identification of **organic, mineral** and **biofilm** components

Anne Plottu, Béatrice Houssais, Christian Democrate, Dominique Gate, Jacques Cavard, Autopsies of membranes fouled on Mery-sur-Oise pilot units: many lessons for the behaviour of the water treatment plant, Desalination 157 (2003) 367.

Results # 1: Wave 2 West plant

- Nalco© antifouling injection (phosphonates, ~ 1 mg/L)



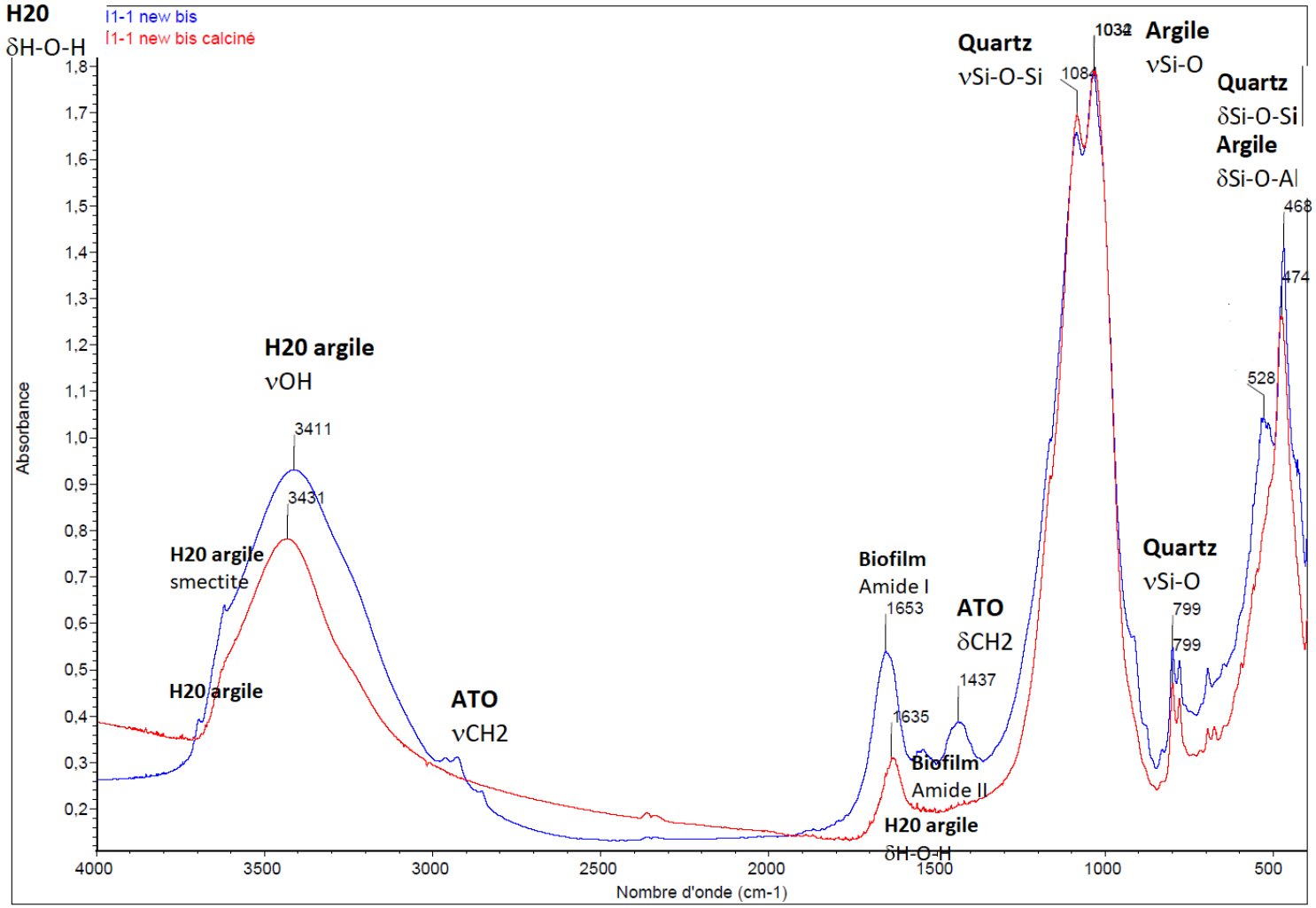
Blue : before calcination
Red : after calcination (550°C)

KBr matrix

ATO : Nalco© antifouling
Argile : amorph clays and smectites; **phosphates** not excluded (~1100 cm^{-1})

Results # 2: mobile – Ion exchange skid

- Compact skid with Nalco© antifouling injection (phosphonates)
- Low injection.



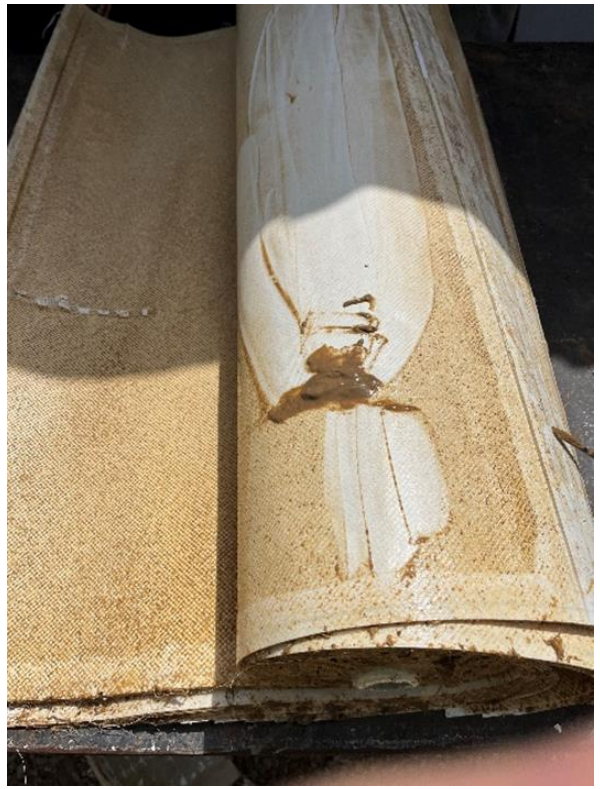
Blue : before calcination
Red : after calcination (550°C)

KBr matrix

ATO : Nalco© antifouling
Argile : amorph clays and smectites, ; **phosphates** not excluded (~1100 cm^{-1})

Key results

- High presence of **aluminosilicates** (clays, smectite), **phosphates presence** not excluded (~1100 cm^{-1})
- **Quartz** detected systematically
- **Biofilm** significant, especially in some installations Wave 2 East & West
- Low **$CaCO_3$**
- Accumulation of **phosphonates** (as an antiscalant) with membrane age



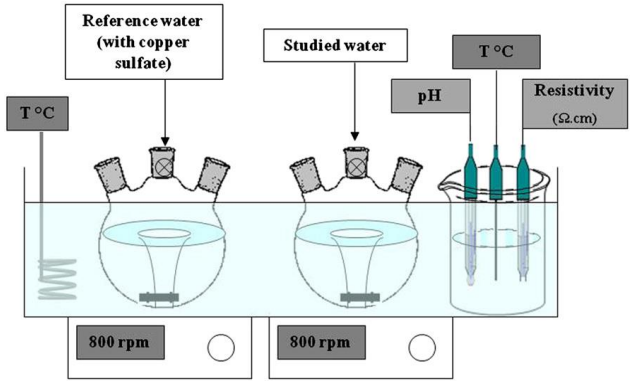
Implications for Reverse Osmosis (RO) Operations

- Fouling dominated by **clay/phosphate–biofilm** interactions
- Indicates **limits of phosphonate-based** antiscalant
- Towards alternative **green formulations** :
  - Synthesized using **safe procedures**, with **high energy efficiency**, **minimal toxicity,** and **maximal biodegradability** ;
  - No **environmentally persistent substances**
  - No contribution to **eutrophication** and **long-term ecological damage**

O. Horner, M. C. Necibi, H. Fenniri, Y. Belmabkhout, Recent progress in green scale inhibitors for industrial water systems, Desalination (2025) 119211.

Towards green antifouling solutions

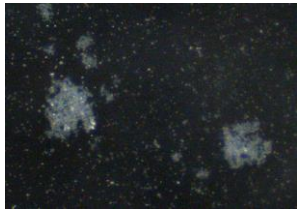
- Candidate formulations : **SOREO 3F, SOREO 6F**
- Lab tests underway: **Fast Controled Precipitation (FCP), chronoamperometry, pre-scaled tubes**
- **Goal:** reduce chemical load and improve sustainability

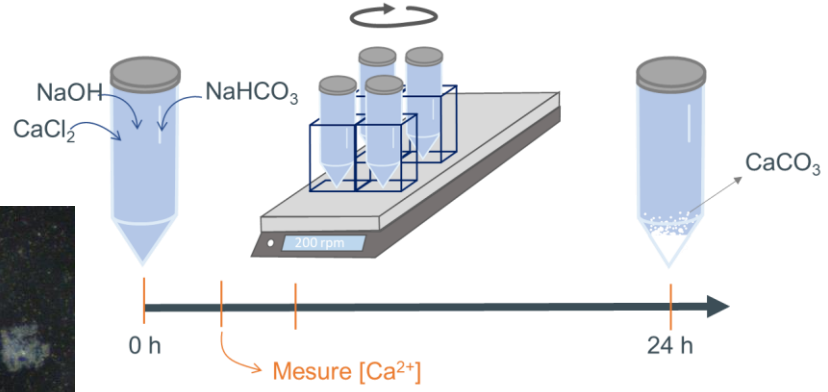


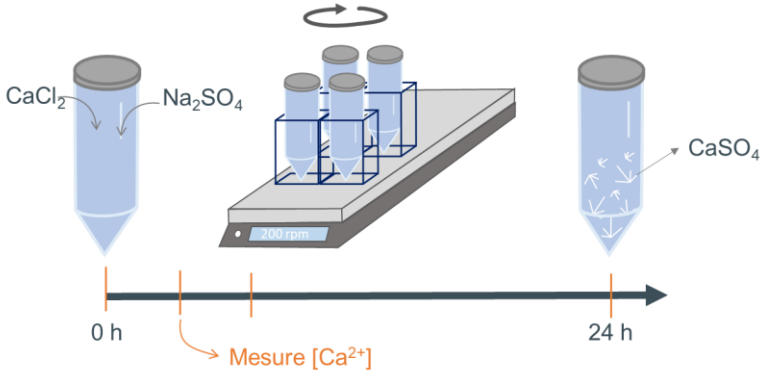
G. Gauthier, Y. Chao, O. Horner, O. Alos-Ramos, F. Hui, J. Lédion, H. Perrot, Application of the Fast Controlled Precipitation method to assess the scale-forming ability of raw river waters, Desalination 299 (2012) 89-95.

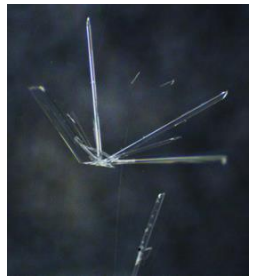
Focus on SOREO 3F & SOREO 6F

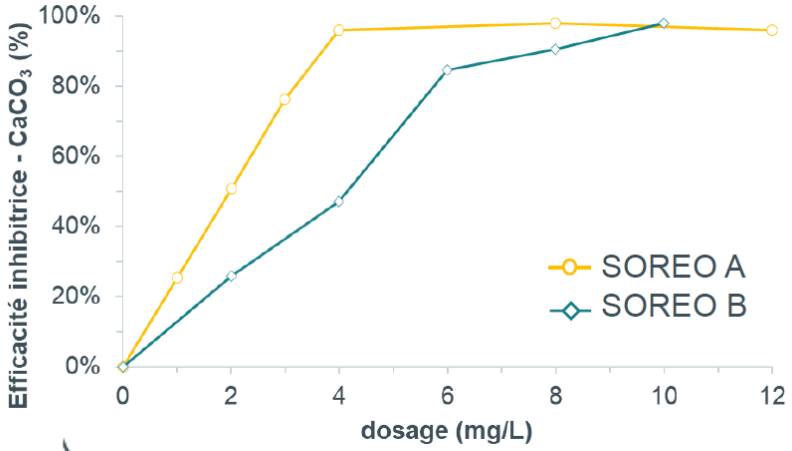
- SOREO 3F & SOREO 6F are formulations **from biomass**

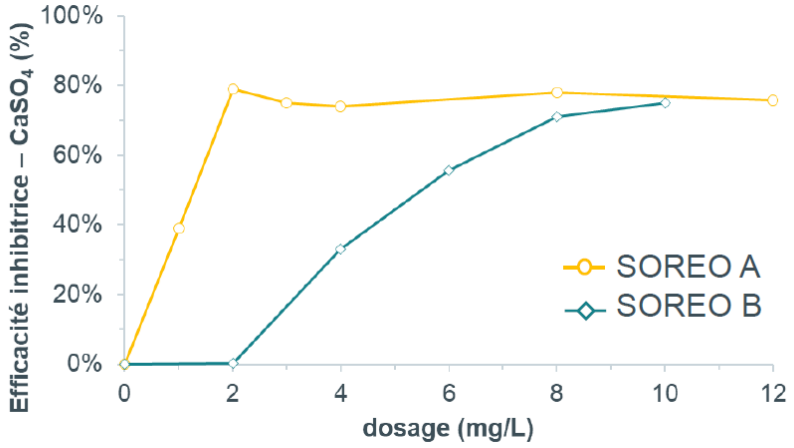












$$EI\% = 1 - \frac{[Ca^{2+}]_{t0} - [Ca^{2+}]_{t24}}{[Ca^{2+}]_{t0}ref - [Ca^{2+}]_{t24}ref}$$

Conclusions

- FT-IR reveals **mineral-organic fouling** structure
- Biofilm may trap colloidal clays
- Green antifouling formulations has **strong potential**
- Next step: **pilot-scale validation** at Jorf Lasfar

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Thank you!

olivier.horner@um6p.fr
https://um6p.fr/
https://www.instagram.com/um6p_france/

www.worldwatercongress.com