



Durable rehabilitation of wastewater infrastructures exposed to H₂S corrosion

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▶▶ For Durable Rehabilitation, you need:

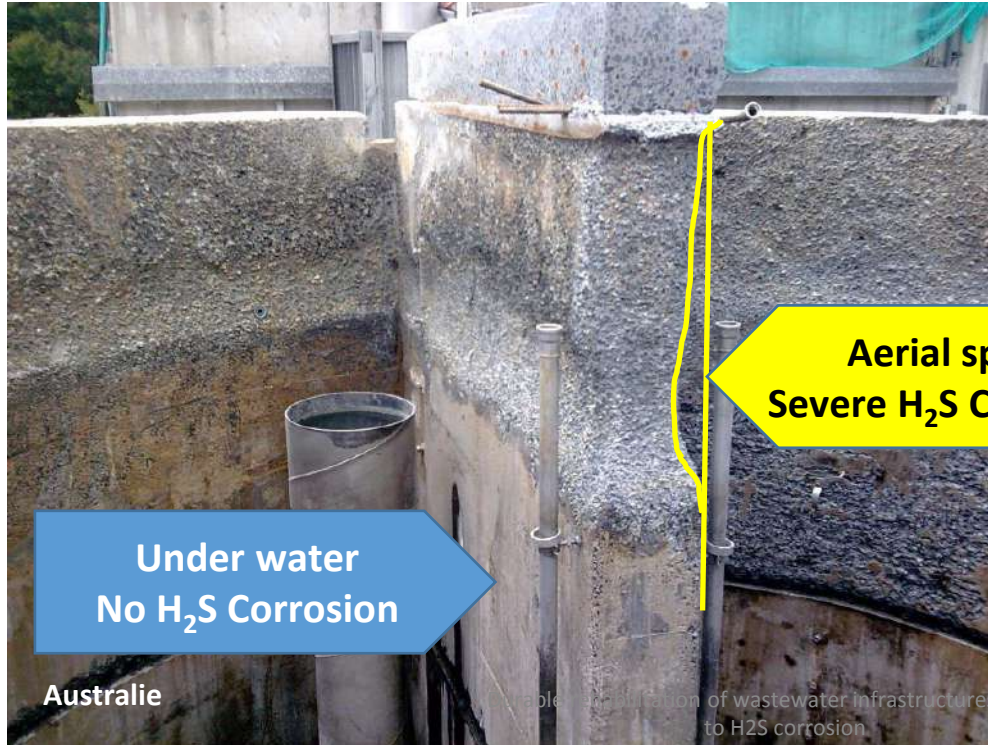
- To understand the H₂S biogenic corrosion**
- To know the resistance of calcium aluminate to H₂S biogenic corrosion
- To choose the rehabilitation method adapted to the job site
- Conclusions & Perspectives

Exemple de H₂S Corrosion on a concrete structure



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Exemple de H₂S Corrosion on a concrete structure



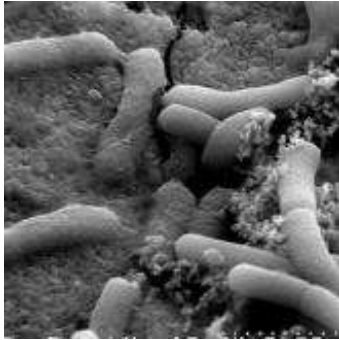
**Exemple of H₂S
Corrosion in a
WWTP chamber**

70 mm lost in 7 years

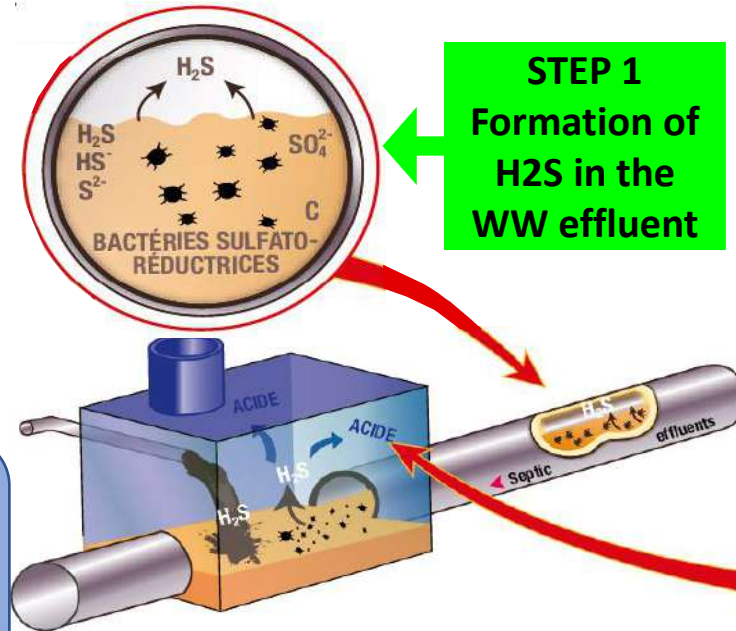
⇒ H₂S Corrosion : A Growing Issue Worldwide

- **Sanitary Sewers are more and more concentrated!**
 - ✓ Citizens are saving water!!
 - ✓ Separative sewers wherever possible; infiltration fixed to reduce fresh water intake.
- **Odor issues lead to seal the natural ventilation shafts**
 - ✓ Urban sprawl reduces the possibility for natural ventilation
- **Worldwide trend toward larger WWTP, away from city center**
 - ✓ Longer transport time, more time to form H₂S

⇒ H₂S Corrosion Principle

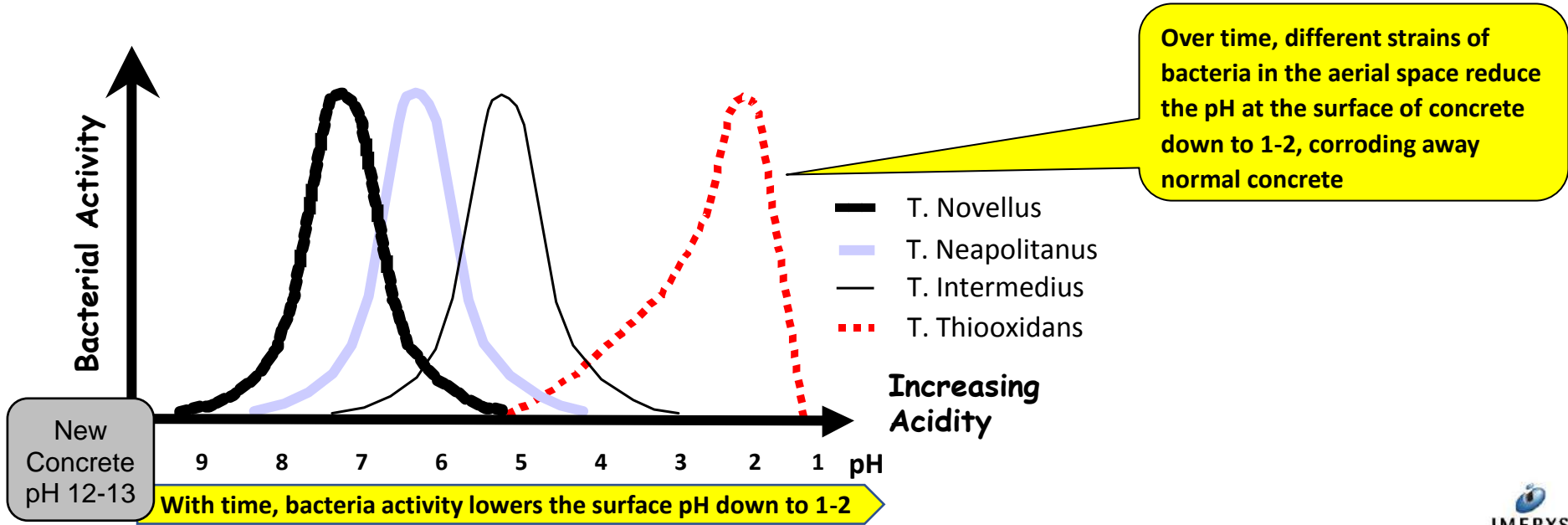


It is called **"Biogenic"** corrosion because it is bacteria that produces the sulfuric acid corroding away the **concrete**



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➤ Bacteria reducing surface pH



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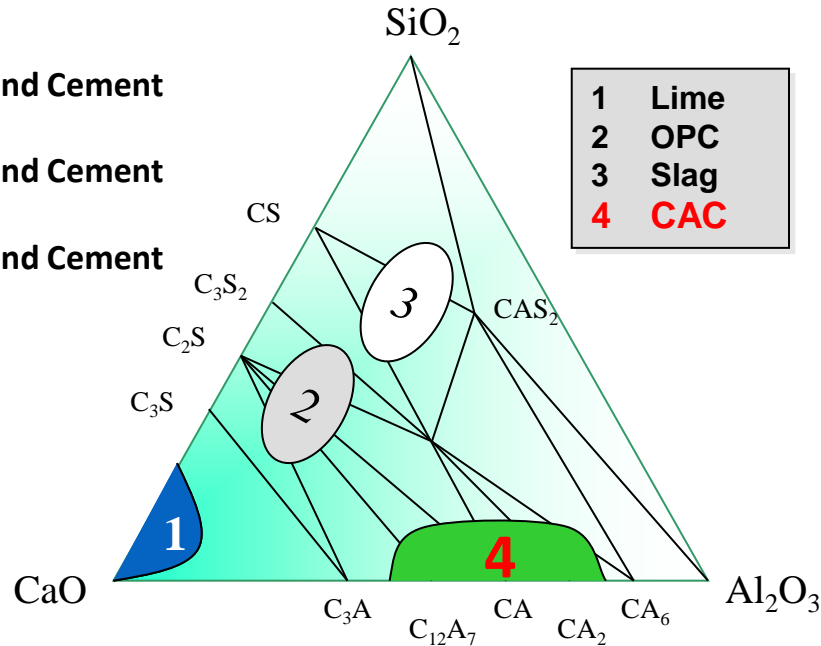
⇒ Calcium Aluminate Primer

Chemistry Different than Portland Cement

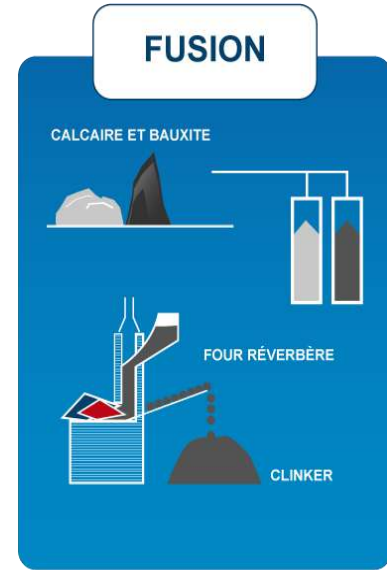
Mineralogy Different than Portland Cement

Properties Different than Portland Cement

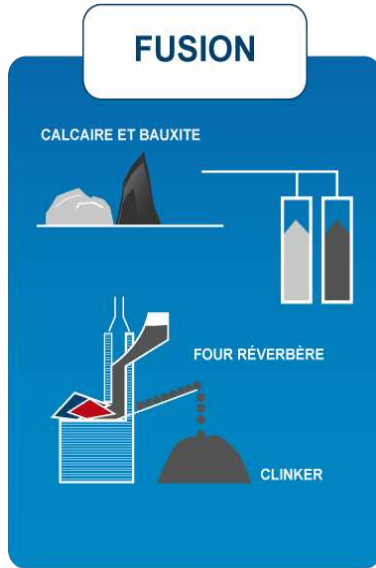
Including an excellent resistance to H₂S biogenic corrosion



Durable rehabilitation of wastewater infrastructures exposed to H₂S corrosion



⇒ 100% Calcium Aluminate Mortar



Clinker

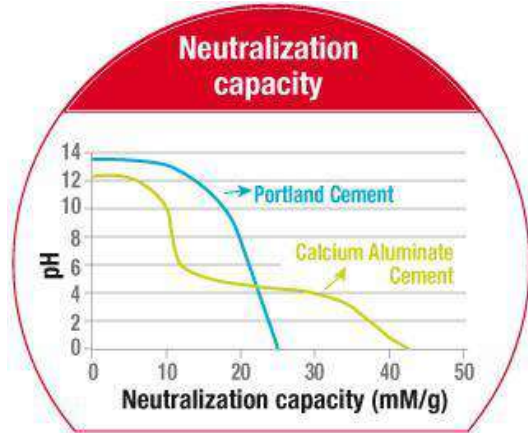
Calcium Aluminate
Aggregates

Calcium Aluminate
Cement (CAC)

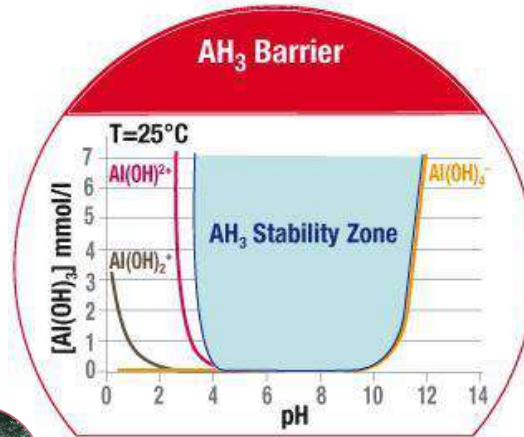
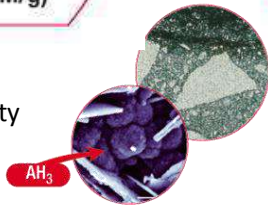
100% calcium aluminate
(CA) mortar/concrete

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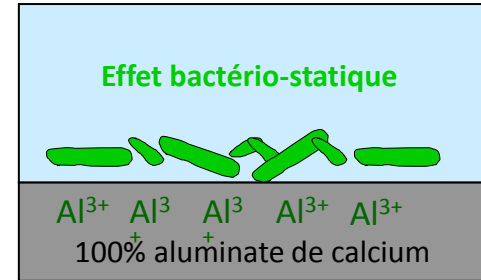
➤ Resistance to H₂S Biogenic Corrosion : 3 barriers for an outstanding durability



First Barrier:
Higher neutralization capacity



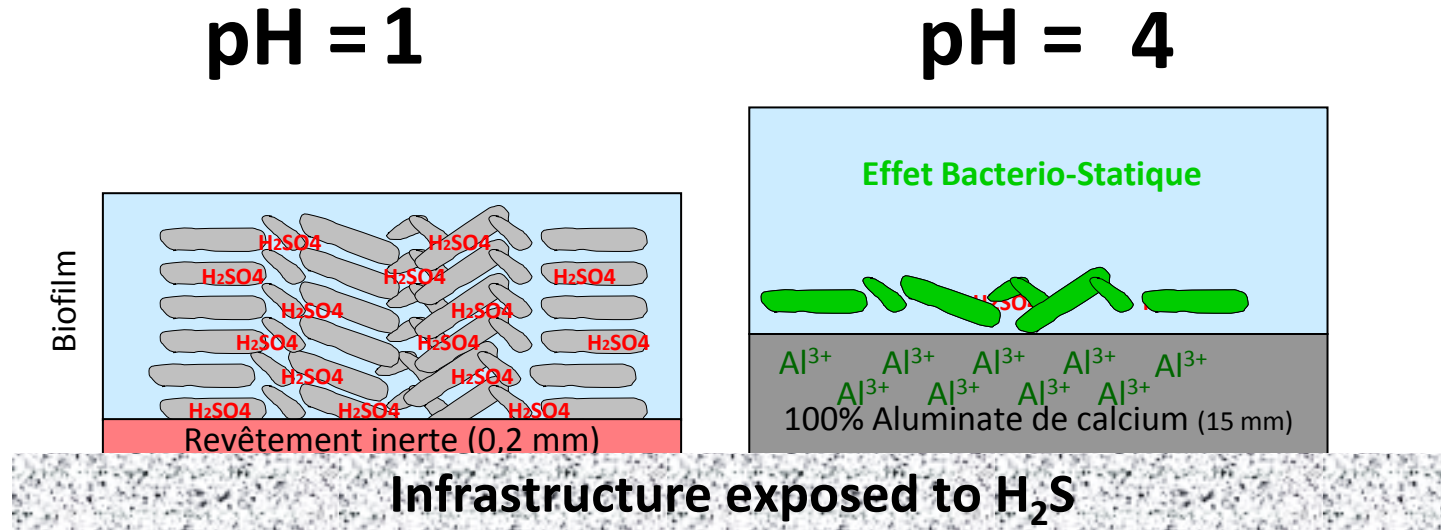
Second Barrier:
AH₃ Gel chemically stable down to a
pH 3 - 4



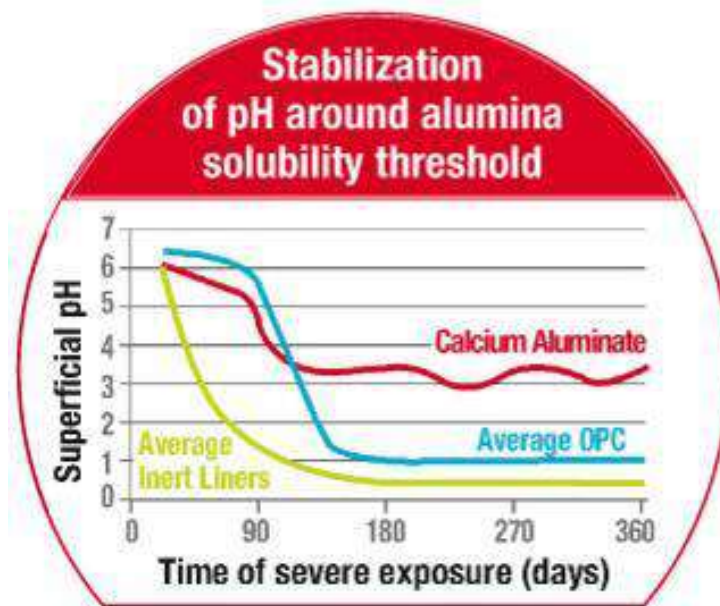
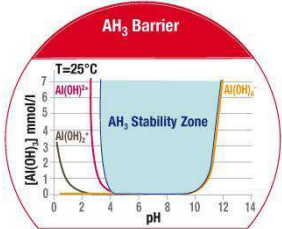
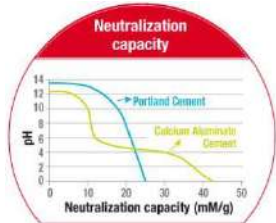
Third Barrier :
Bacterio-Static Effect

Durable rehabilitation of wastewater infrastructures exposed
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➤ Durable Rehabilitation with the Bacterio-Static Effect



Summary of Protection Mechanisms of SewperCoat®



On SewperCoat®,
stabilization of pH at 3-4,
around AH₃ solubility
threshold

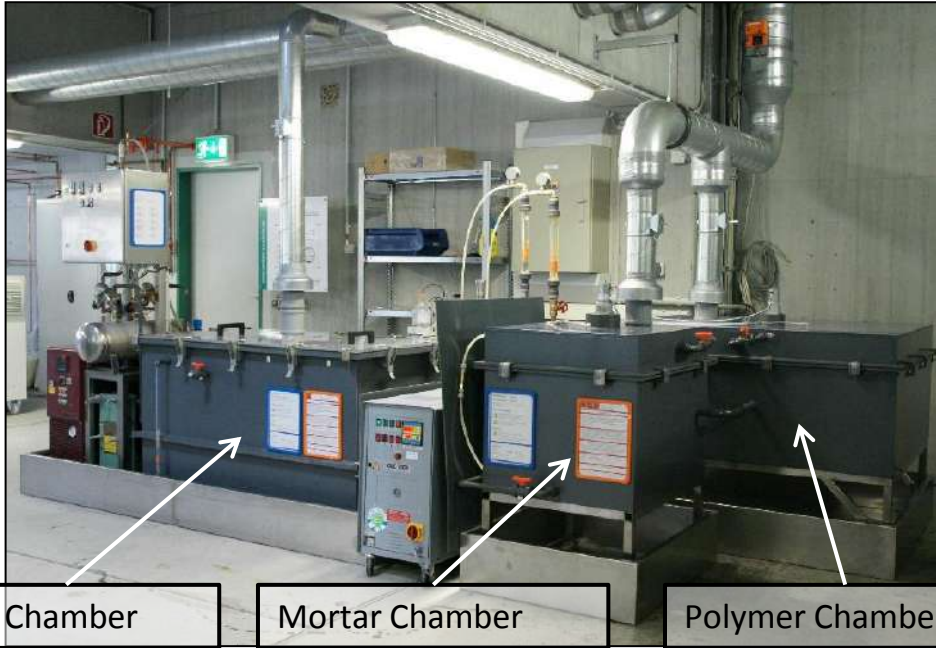
Bacterio-static effect



Al A Al Al Al⁺
100% Calcium Aluminate

Durable rehabilitation of wastewater infrastructures exposed to H₂S corrosion

➤ Durability demonstrated in lab accelerated tests



Fraunhofer UMSICHT Protocol

- Temperature 30°C
- 100% Humidité Relative
- H₂S Flow = 50 or 100 ppm

- Initial phase of 8 weeks of bacteria inoculation
- Weekly spray of nutrients to feed bacteria

According to Fraunhofer-Institute UMSICHT, the acceleration factor with this protocol is around 12

Fraunhofer Chamber – Imerys Tests 2017

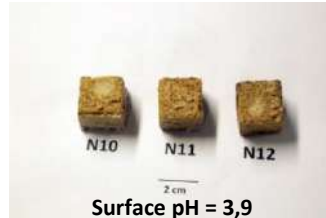


- 20 formula from 15 different products
- Follow-up :
 - Visual examination
 - Surface pH
 - Mass loss
- Duration :
 - 9 months
 - +/- 1,5 months of preparation
- Final report: 9 months

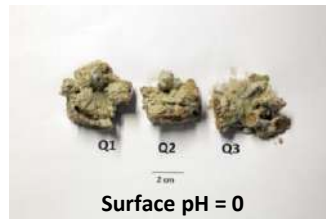
Durable rehabilitation of wastewater infrastructures exposed to H₂S corrosion

Observations after 9 month exposure

CAC Mortar
Natural Aggregates



Geopolymer
Commercial Product

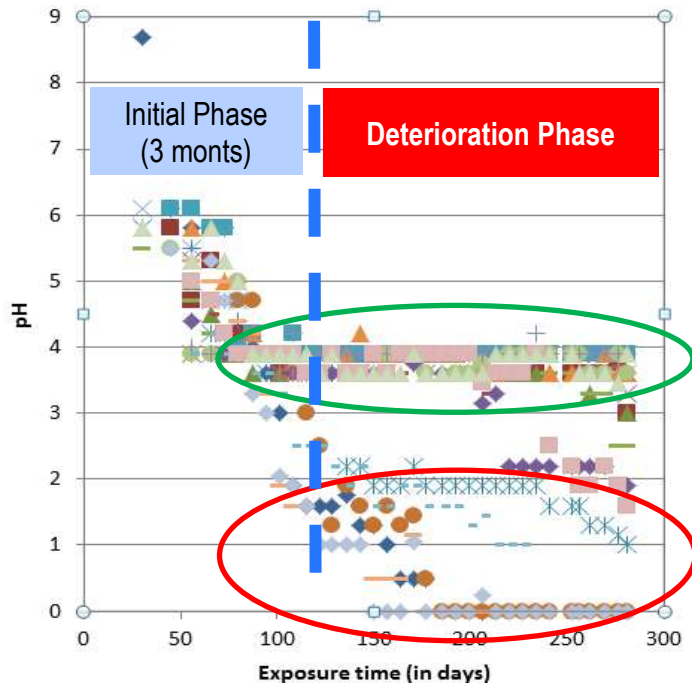


Portland Cement
Mortar
Natural Aggregates



Durable rehabilitation of wastewater infrastructures exposed
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➤ Durable Rehabilitation: Aluminates vs other solutions



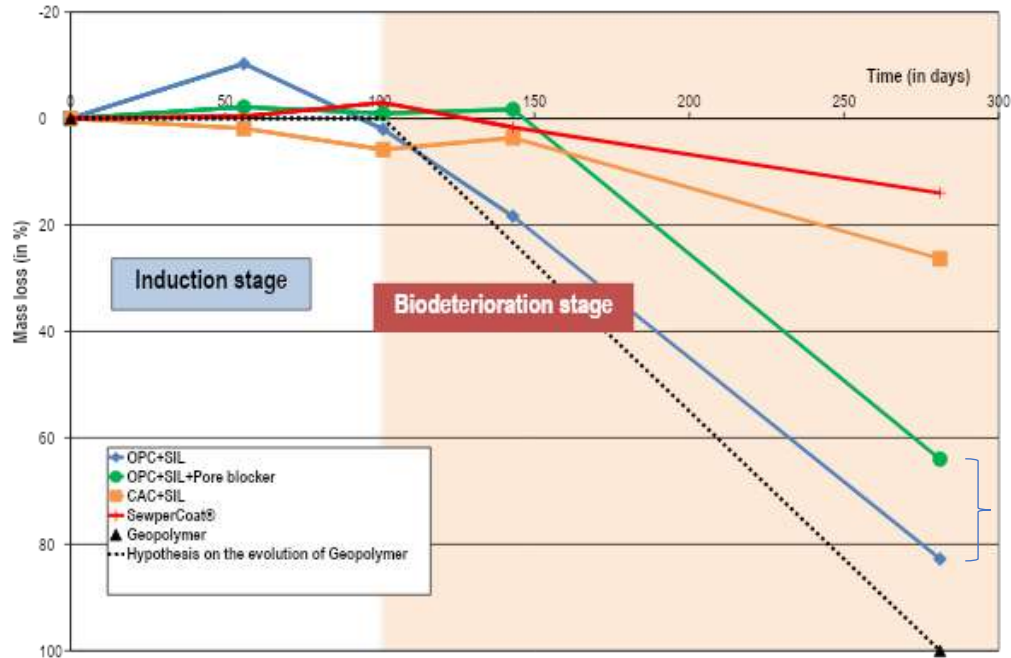
☐ Phase de préparation de 3 mois
 Tous les échantillons semblent identiques
 Même diminution de pH en surface

☐ Phase de biodétérioration active
 Rapidement, stabilisation vs chute importante de pH
 Différenciation CAC vs autres solutions (polymères, portland,..)

Aluminate based Solutions

- Portland Cement based Products
- Geopolymer

➤ Durable Rehabilitation: Aluminates vs other solutions



Fraunhofer - Mass Loss Aluminates vs other solutions

100% Aluminate de Calcium CA
(SEWPERCOAT®, FONDAG®)

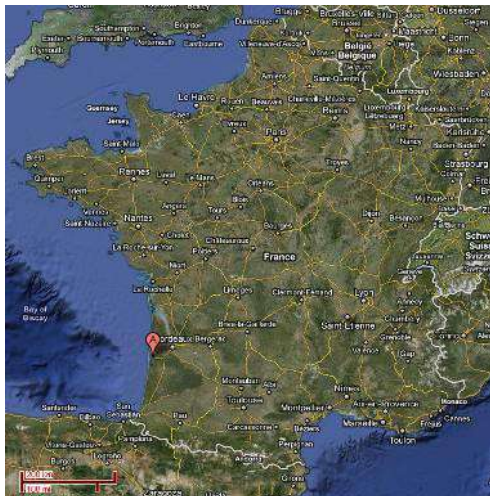
Ciment Aluminate de Calcium CAC + granulats naturels
(FONDUSTEP®, FAST&FONDU®, FONDUCRETE®)

Portland Cement

Geopolymer (commercial product)

Durable rehabilitation of wastewater infrastructures exposed
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⇒ A Durability Seen in Real Life



Université Gustave Eiffel Study
(IFFSTAR)

Arcachon : 2 exposure sites

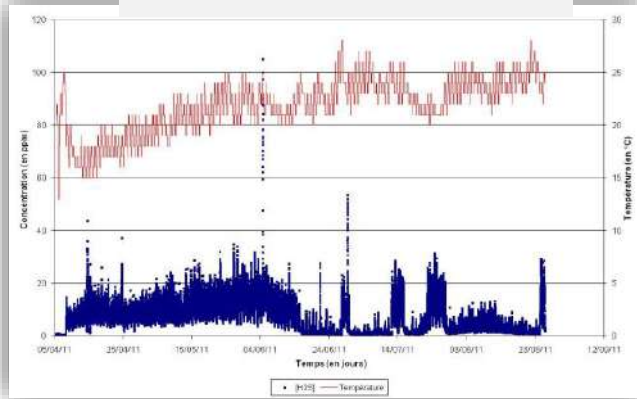
Durable rehabilitation of wastewater infrastructures exposed
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➤ A Durability Seen in Real Life Severe Exposure Conditions

Pumping Chambers

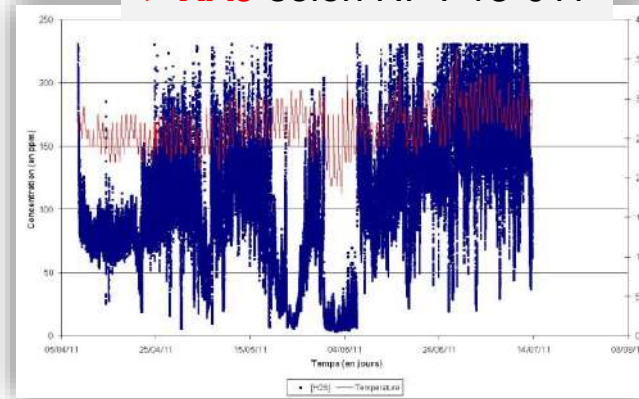
Site Malakoff

3-20 ppm / 18-25°C
XA2 selon NF P18-011



Site STEP ZI

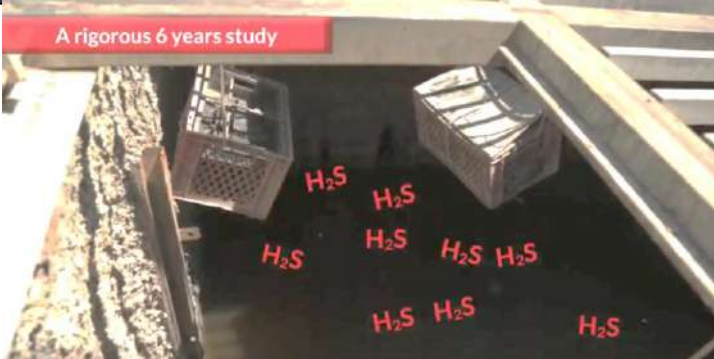
100-200 ppm / 25-30°C
> XA3 selon NF P18-011



- 2 exposure level
- Malakoff: XA2
 - STEP ZI: > XA3




Durable rehabilitation of wastewater infrastructures exposed to H2S corrosion

➤ A Durability Seen in Real Life Severe Exposure Conditions



Specimens in open boxes
suspended in aerial space

➤ A Durability Seen in Real Life After 6½ years of severe exposure condition

Mortier CEM I	Mortier CEM III	SewperCoat®
Classe maximale recommandée par NF P18_011		
Non recommandé	XA3	XA3
		

Conditions > XA3

100% Aluminate de Calcium (CA)



OPC Reference Mortar



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➤ Durable Rehabilitation with Calcium Aluminates: Monolithic protection in a single operation

Mixing



Wet Spray Projection (or dry spray)



Troweling



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➤ Durable Rehabilitation Small Assets



**Pneumatically application with
hand held sprayer**

Simple but low productivity

Durable rehabilitation of wastewater infrastructures exposed
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➤ Durable Rehabilitation Main Trunk Sewers



Durable rehabilitation of wastewater infrastructures exposed to H2S corrosion

YouTube

See more on YouTube



SewperCoat® : Rehabilitation in SIAAP Emissaire General Main Interceptor in 2016

395 views

LIKE DISLIKE SHARE SAVE ...

➤ Durable Rehabilitation Manholes

Spinning Head Application

High Productivity



Durable rehabilitation of wastewater infrastructures exposed
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➤ Durable Rehabilitation Large Assets: WWTP



Durable rehabilitation of wastewater infrastructures exposed to H₂S corrosion



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- ☑ To choose the rehabilitation method adapted to the job site
- ☑ **Conclusions & Perspectives**

⇒ Conclusions & Perspectives

1) Against H₂S corrosion, Calcium Aluminates are unique

- A complete range of mortars and ready-to-use concretes, from manholes to WWTP

2) 30 years of field track record, and R&D working on the next step...

3) A performance underlined in the next version of P18-011

- « Calcium aluminates adequate for H₂S >XA3 »

To know more, come to meet us at **Stand Imerys - Hall 6 - G14**

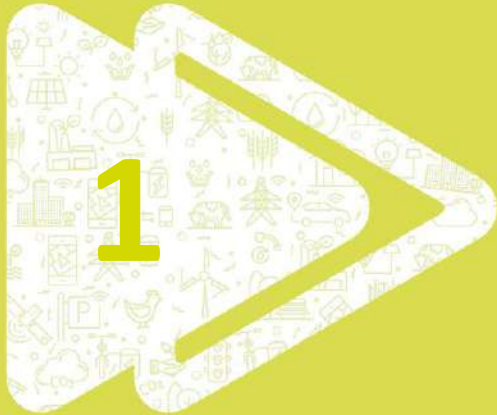
Thank you for your attention



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TITRE DU CHAPITRE

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