CEA/IFA Cooperation project C2-01

Development of innovative binders for the stabilization / solidification of low- and intermediate level radioactive wastes containing aluminium

IFA/IFIN-HH/Department of Radioactive Waste Management

CEA /Laboratoire de Physico-Chimie des matériaux Cimentaires (LP2C)

01.03.2012-28.02.2015

Objectives

The main purpose of the project is to design and characterize a stable cement-based matrix for conditioning radioactive waste containing **metallic aluminum** in view of storage or disposal in dedicated facilities by investigation of new **alternative cement systems**.

General work plan

2012
Literature review on alternative binders
First research coordination project (France, July)
Screening of binders

2013
Design of injection grouts based on the most promising binders
Second research coordination project (Romania, June)
Literature review on corrosion inhibitors

2014
Screening of corrosion inhibitors
Optimisation of cement recipes
Concluding meeting (France)

CEA /Laboratoire de Physico-Chimie des matériaux Cimentaires (LP2C)

Objectives (2012)

- Screening of binders to minimize the hydrogen production of aluminium rod embedded in cement:
  - Reference binder (OPC)
  - Calcium sulfoaluminate cements (CSA)
  - Blend of calcium aluminate cement and gypsum (CAC + Gypsum)
  - Magnesium phosphate cements (MKP)
  - Magnesium silicate cement (MSH)
- Compare the pH at early age by extraction of pore solution using pressure.

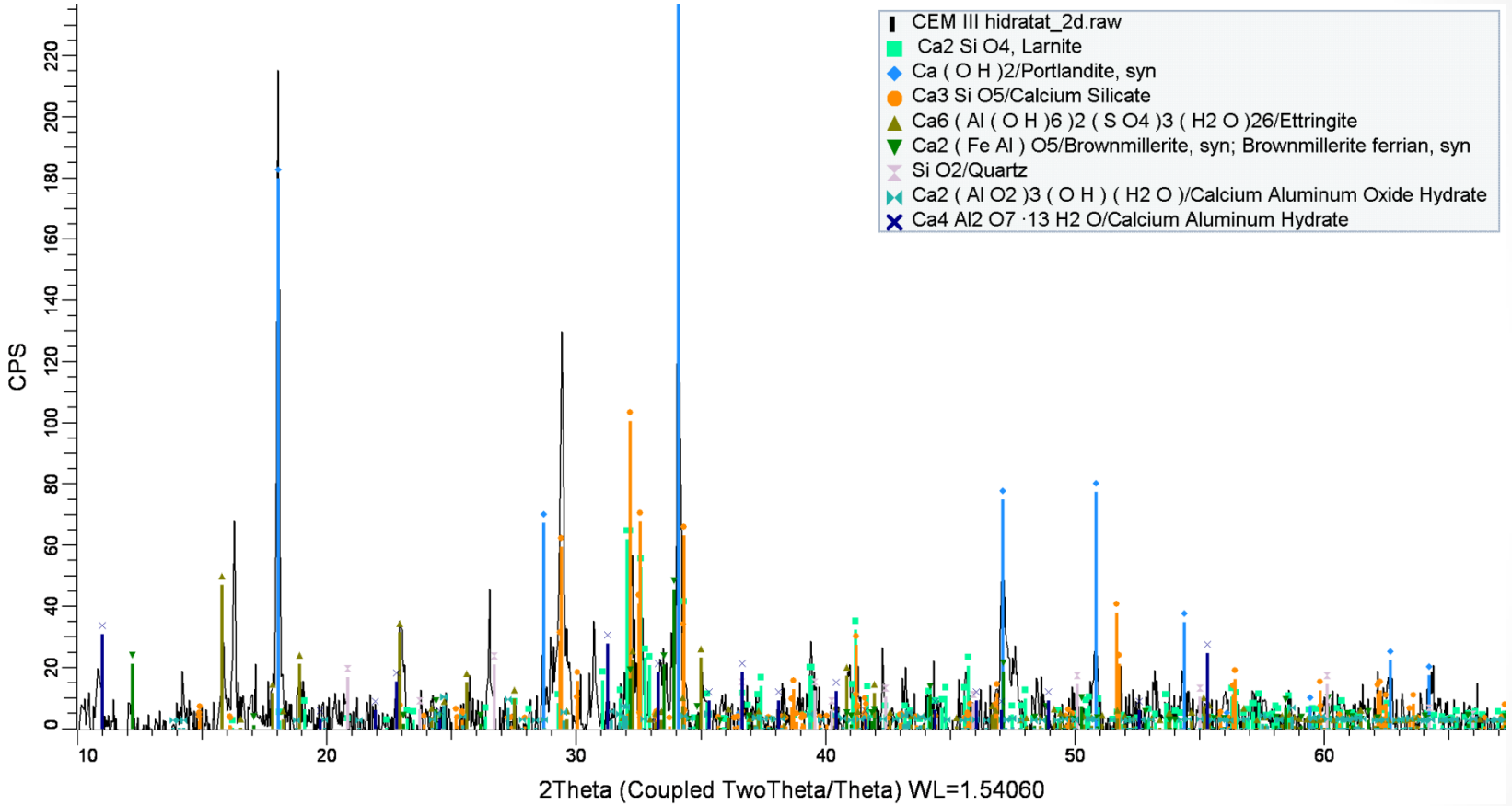
IFA/IFIN-HH/
Department of Radioactive Waste Management
Objectives (2012)

- Selection of raw materials from Romanian market; determination of composition and structure.
- Development of fast and simple determination method for measurement for pH and pozzolanic activity in $Ca(OH)_2$ and $Mg(OH)_2$ media;
- Preliminary comparison of matrix properties with and without aluminium with CEM III A 42.5N-LH and CEM V A (S-V) as reference samples.

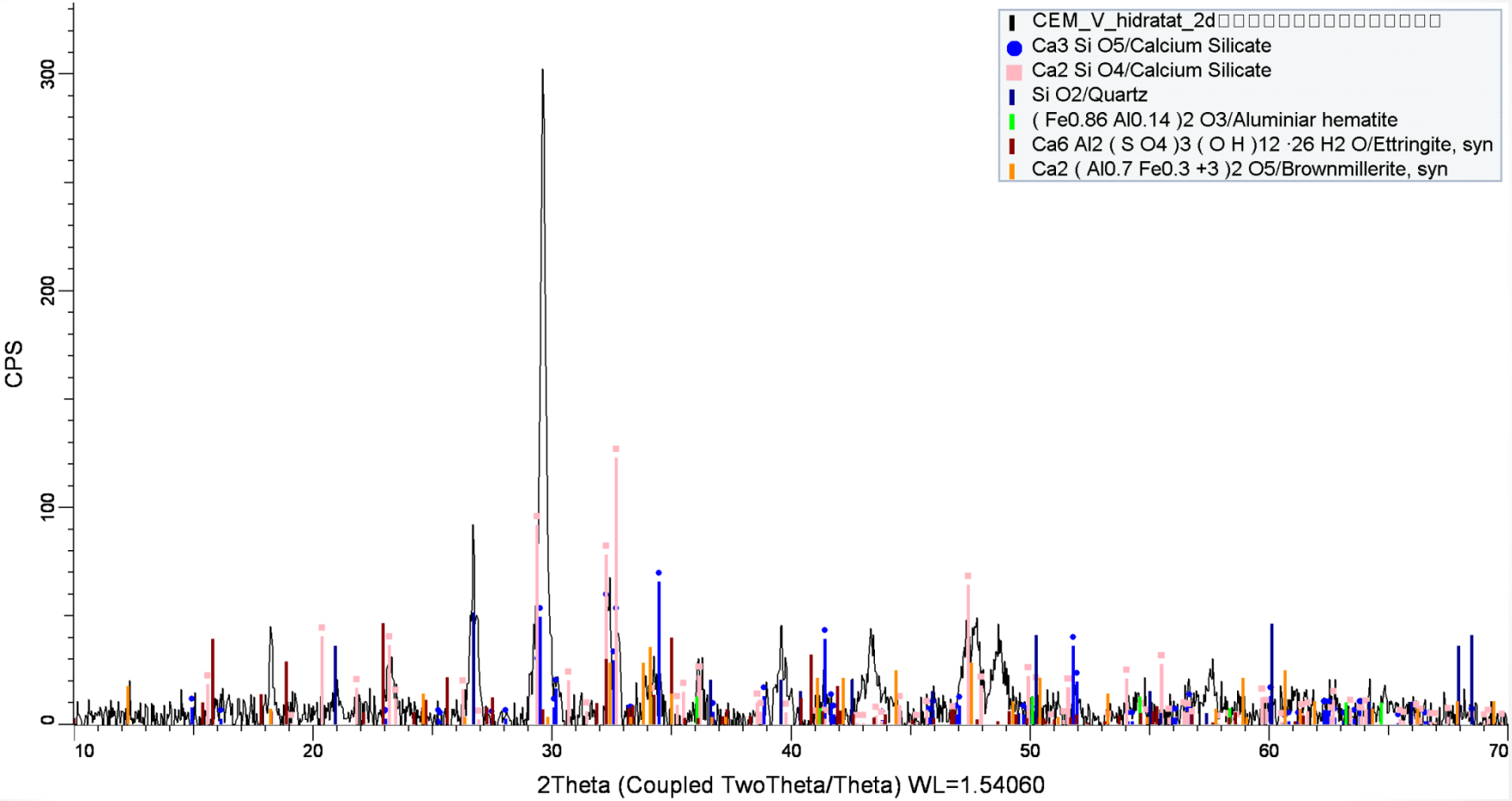
XRF analysis for CEM III-A and CEM V-A

Formula	Z	Concentration	
		CEM III	CEM V
CaO	20	61,21 %	54,65 %
SiO2	14	25,18 %	27,12 %
Al2O3	13	5,68 %	9,45 %
MgO	12	3,82 %	2,81 %
Fe2O3	26	2,37 %	4,14 %
K2O	19	0,74 %	0,96 %
Na2O	11	0,40 %	-
TiO2	22	0,32 %	0,56 %
MnO	25	0,23 %	0,22 %
SrO	38	0,05 %	0,05 %
ZnO	30	-	0,02%
ZrO2	40	-	0,01%

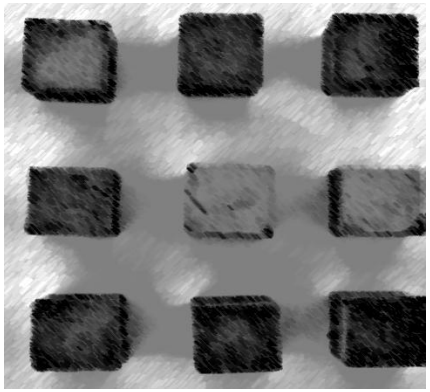
XRD Analysis for hydrated CEM III-A after 2 days



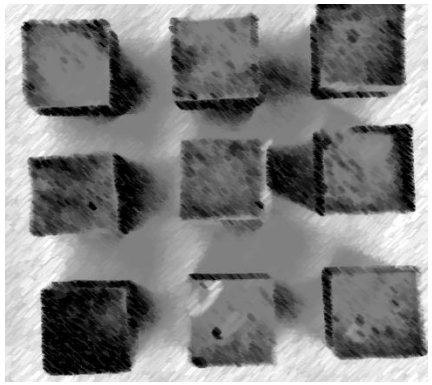
XRD Analysis for hydrated CEM V-A after 2 days



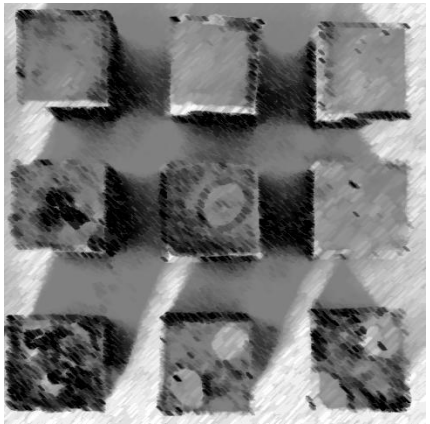
Preliminary comparison of matrix with and without aluminum



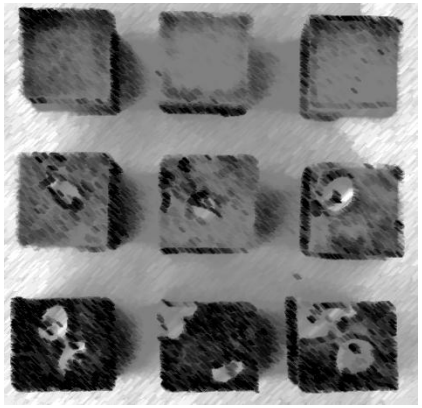
CEM III (W/C=0,4)



CEM V (W/C=0,4)

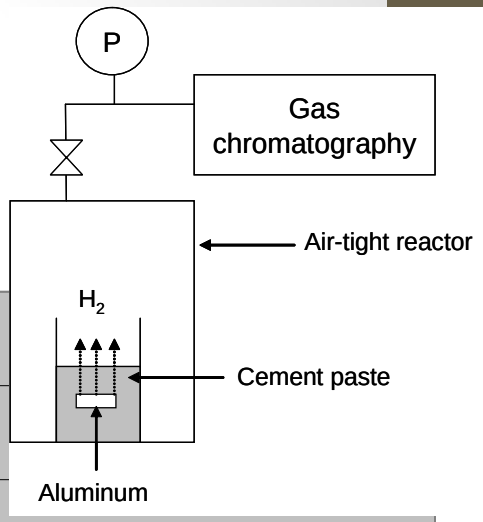


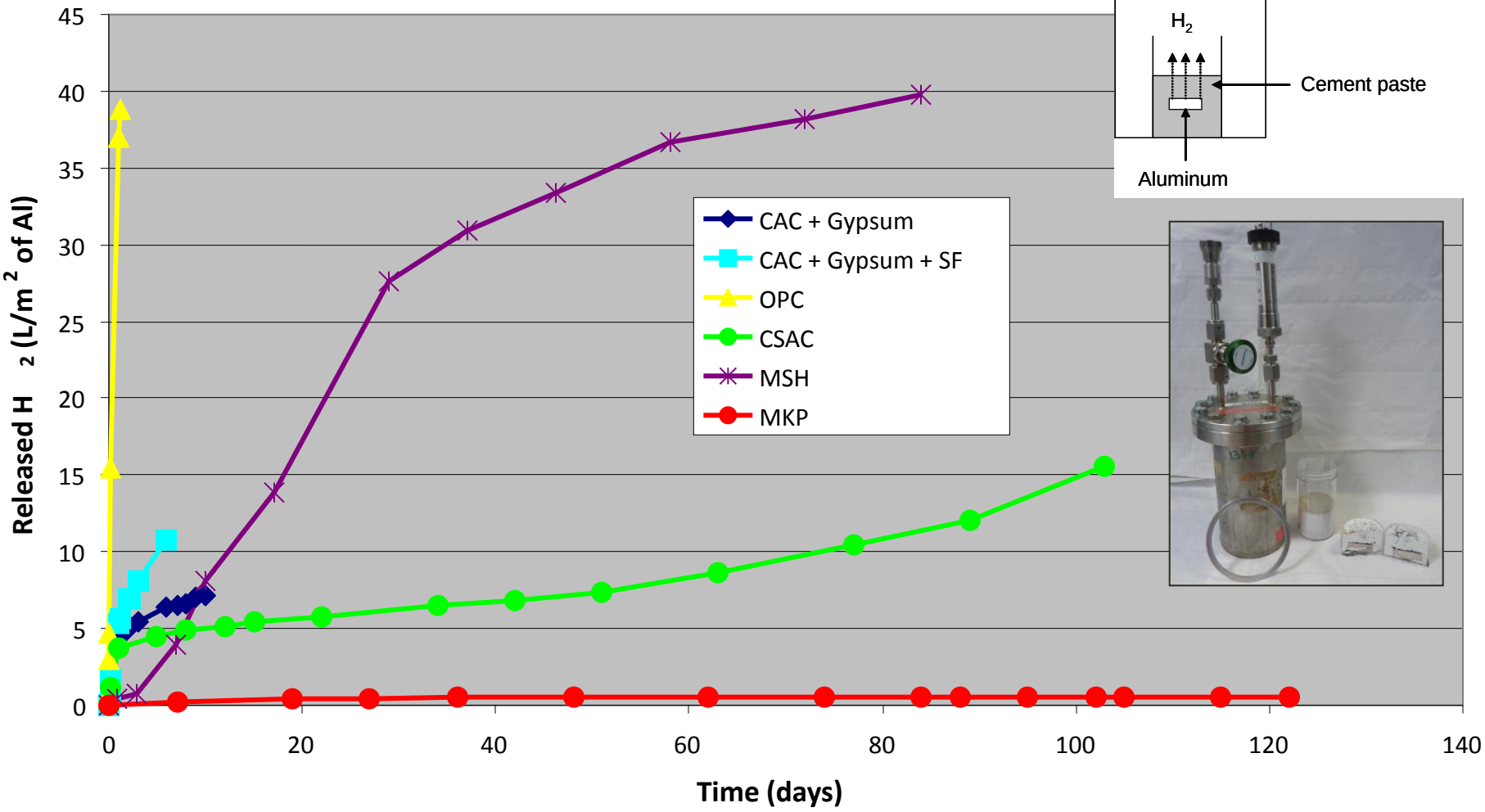
CEM III + 1% Retarder



CEM V + 1% Retarder

H_2 production





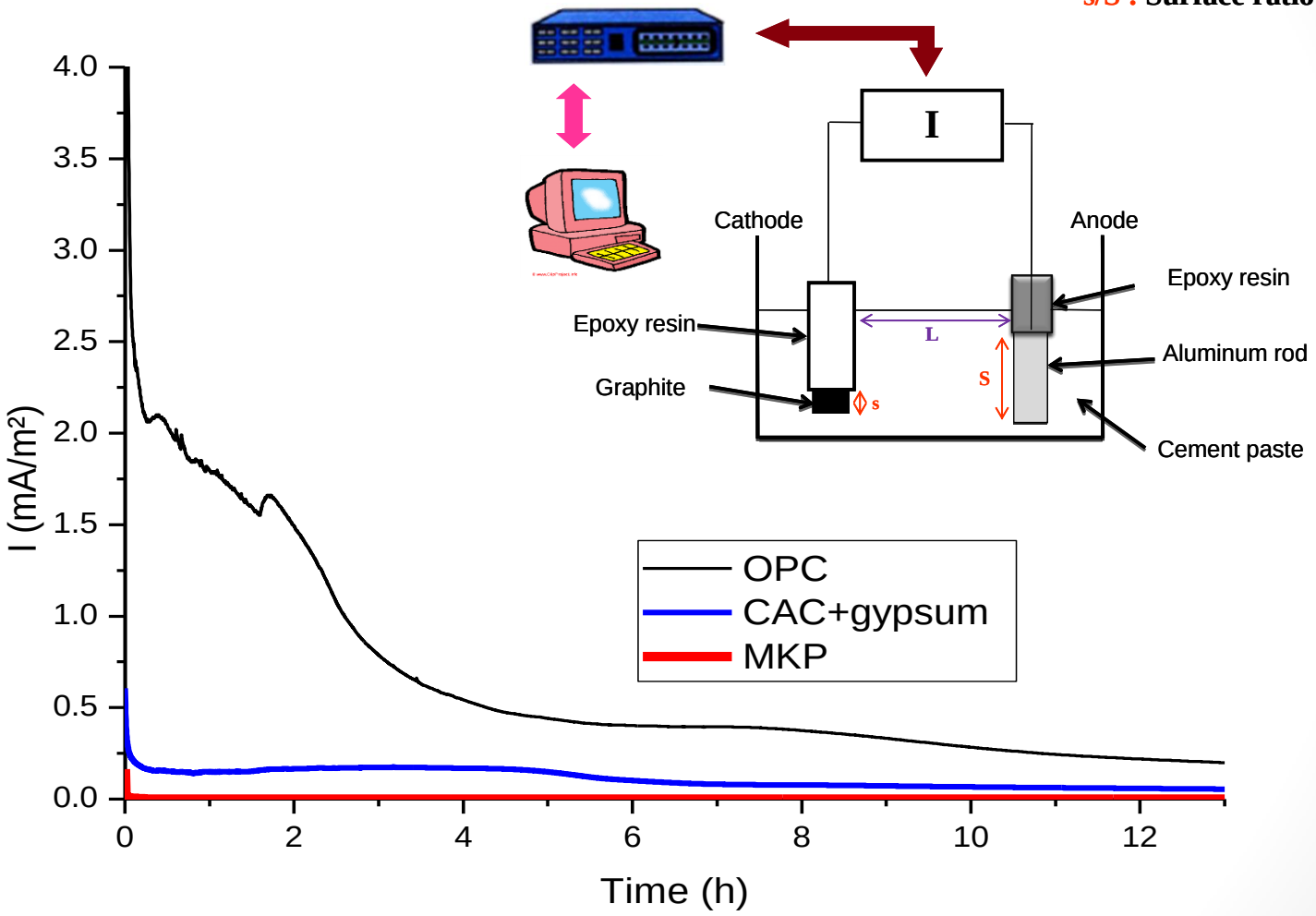
Most promising binder: magnesium phosphate binder

$MgO + KH_2PO_4 + 5\ H_2O \rightarrow MgKPO_4.6H_2O$

Galvanic corrosion with graphite

- Experimental results

L : constant for each run
s/S : Surface ratio = 10%



No galvanic corrosion with MKP binder at early age

Conclusion

- **Magnesium phosphate cement:**
  most promising binder of the screening tests

- **Main concern with this kind of binder: control of the reactivity**

(rapid and exothermic acid-base reaction)

Key parameters: specific surface area of MgO
retarding agents

Future studies

Design of a grout checking the criteria for a conditioning matrix
(setting time, heat output, workability, mechanical strength, length change)