SYNAD Special Release Plus

Concrete admixtures and leaching:

Admixtures containing concrete in contact with water

Adjuvants du béton :
C'est toute la différence

SYNAD
Syndicat National des Adjuvants pour Bétons et Mortiers

Editorial:

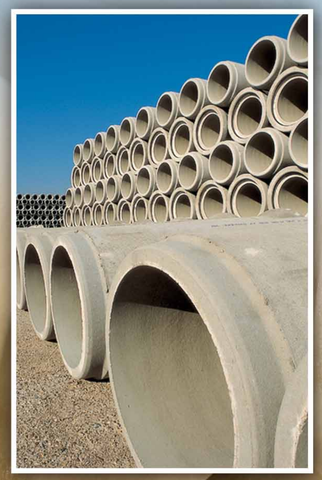
Concrete is universally recognised as a resistant, long-lasting and economical material. Due to these features, it is the world's most frequently used construction material.
Over the past two decades, admixtures have established themselves as the key component in modern concrete mix-designs. They are central to innovative products such as SCC, HPC and UHPC, as well as normal concrete, to which they provide quality, durability and ease of placement. Today, over 95% of all concrete used contains admixtures.

In addition to applications in the construction of civil engineering structures or buildings, extensive feedback has established the suitability of concrete for use in drinking water storage and transportation, or for various types of waste containment. Many technical papers have demonstrated the sequestering properties of cement materials, but no research had dealt specifically with organic molecules.

It is for this reason that SYNFAM*, ATILH* and SYNAD, through its Environment Committee, set out to broaden their understanding of the life cycle of organic molecules in concrete. These compounds are the foundation of admixtures and grinding agents.

SYNAD Plus looks into the work carried out by Cyril Guérandel for his PhD at Université Paul Verlaine in Metz. His research was dedicated to admixtures especially plasticisers and superplasticisers, which account for over two-thirds of the market.

Denis Le Cheviller
SYNAD Environment Committee Chairperson



The aim of Cyril Guérandel's research was to study the quality of the entrapment of organic substances by the cement matrix towards leaching*, where all of the detection techniques developed in previous research did not make it possible to reach the detection thresholds required by organic compounds.

Analysis methods

Cyril Guérandel in response developed an analysis method based on a mass spectrometry technique optimised to detect the core components found in superplasticisers: the active polymer and the synthesis residues. Thanks to this new method, the detection threshold was able to be lowered from 20 to 1 ppm on the synthesis residue (POE*) and detect the active polymer (PCP*) at a concentration of 10 ppm. In practice, it is now possible to identify 3 drops of water out of the 3,000,000 drops or 150 litres of water needed to produce one cubic meter of concrete.

This method was then validated on leachates of cement matrices obtained by accelerating and amplifying natural leaching phenomena, so as to achieve the most unfavourable conditions:

- Tests on pure cement paste containing an overdose of admixtures.
- On-going renewal of the leaching solution in order to prevent saturation and sustain its aggressiveness (pH = 7).
- Very high ratio between the surface in contact with the solution and the mass of the material, in order to facilitate exchange.
- Leaching solution concentrated over 150 times, to facilitate the detection of the compounds sought.

The degree of leaching applied is so severe that it begins to destroy the cement matrix.

The research findings are summarised in the following chart:

Superplasticiser leaching on pure cement paste CEM I (W/C = 0.4)

	Common dosages		Voluntary overdosage not applicable under real conditions	
% of superplasticiser	0,5%	1,2%	5%	10%
Active polymer (PCP) detection	Non-detected at concentration < 0.001%	Non-detected at concentration < 0.001 %	Non-detected at concentration < 0.001 %	Detection limit approximately 10 ppm
Synthesis residue detection (POE*)	Non-detected at concentration < 0.0001 %	Non-detected at concentration < 0.0001 %	1 to 2 ppm	8 to 10 ppm

These trials made it possible to validate the detection method.

* Refer to lexicon found on last page

Findings on Concrete

The leaching and detection methods were applied to two samples of concrete compliant with standard EN 206-1.
Both formulations were representative of the production of precast pipes and on-site basin pouring.

Concrete for precast pipes

CEM I 52.5R Cement	300 kg/m³
Limestone gravel	594 kg/m³
Sand	1308 kg/m³
Superplasticiser	3.6 kg/m³
Total water/cement	0.52
Consistence Class	S0

Ready-mix concrete for basins

CEM III A 42.5N Cement	300 kg/m³
Limestone gravel	1030 kg/m³
Sand	1308 kg/m³
Superplasticiser	3.6 kg/m³
Total water/cement	0.62
Consistence Class	S4

Results

	Concrete for Precast pipes	RMX concrete for on-site basin pouring
Detection of active compound PCP	Non-detected at concentration < 0.001%	Non-detected at concentration < 0.001%
Detection of synthesis residue POE	Non-detected at concentration < 0.0001%	Non-detected at concentration < 0.0001%

Industrial and practical consequences

Despite the drastic conditions, no trace of active polymer or synthesis residue was detected in the leachate. This clearly demonstrates that the cement matrix effectively blocks the organic compounds. The admixtures used in the concrete are thus effectively bound and cannot migrate into the surrounding areas. Consequently, concrete is a perfectly well-suited material for the transport and storage of water intended for human consumption.

For more information : ftp://ftp.scd.univ-metz.fr/pub/Theses/2009/Guerandel.Cyril.SMZ0930.pdf

Interview

Delphine Vrau
Chairperson, SNBPE Technical Committee

Patrick Peltier
Chairperson, FIB Technical Committee

How have you brought the Concrete Product – Drinking Water pair forward, these past few years?

D. Vrau: Historically, concrete has been found widely in the upstream transport of raw water to treatment stations, as well as in reservoir storage. It has proven fully suited for use in applications of this kind.

P. Peltier: The recovery and storage of water for domestic purposes is a new, developing market. It emerged as owners of individual homes, small collective or logistical and industrial facilities became aware of the sustainable development issues. In France, the regulatory framework does not make equipment of this kind mandatory, contrary to other European countries like Belgium.

The opinion on "the initial release to market of materials and objects made of cement and in contact with water intended for human consumption in water production, treatment and distribution facilities" was published on 24/02/2012: how has this impacted the use of concrete?

D. Vrau - P. Peltier: The opinion will redefine the existing regulatory framework and validate the use of concrete in new civil engineering structures.
As regards admixtures, a Positive List Compliance Plan (CLP) has been adopted. Structures that are certified under this plan will be able to prove that the admixtures used in their cement matrices in contact with drinking water are compliant with health standards.

What contributions can you see from C. Guérandel's thesis on the quality of the trapping of organic matter against leaching by the cement matrix?

P. Peltier: His thesis is representative of commonly-used concretes and comes in complement to the work carried out by the CERIB, at the request of the profession. The studies all confirm concrete's excellent properties with respect to leaching. C. Guérandel's thesis shows, once again, that organic species bind in the cement matrix:

- the discharge thresholds are below regulatory thresholds and even, in most cases, below detection thresholds. One of the major contributions from the technical standpoint is the significant decrease in detection thresholds.

Our profession is very active on the topic, both on the experimental side and in keeping abreast with developments in standards and regulations, at the national and European levels.

D. Vrau: Beyond the topic of drinking water, this research confirms concrete's ability to be in contact with all groundwater and surface water.
The study backs up many of our key messages and strengthens the concrete industry's position as a whole. It is another brick in our joint structure.
The representatives of the industry at European level also take an active part in the TC 351's research on the topic: "Construction Products – Assessing the Hazardous Substance Emissions in Air and Water".

What are your expectations with regard to our profession?

P. Peltier: The major issues today are sustainable development, the health-related aspect of materials, durability and safety, in particular with respect to fire.
The latter three topics are receiving more attention in regulations on construction materials.
Admixtures are vital to improving the performance and durability of concrete. Your profession is highly innovative and is instrumental in bringing about progress in concrete material.
It is important that SYNAD ensures that the products it offers do not interact with their environment. For this reason, SYNAD's products need to be qualified specifically on the three major themes.

D. Vrau: The industry is in step with sustainable development principles; admixtures must help us use new types of materials, and work on new even more environmentally friendly formulations. The good communication between our two industries gives us access to the information needed to protect the health of our employees, users and the environment.

Lexicon:

ATILH: French Technical Association of Industries of Hydraulic Binders.

Leaching: Action by which soluble components are removed from a material through contact with a liquid capable of dissolving them. Example: soil leaching by rainwater.

Leachate: Liquid that passes through a material and extracts solutes.

PCP: Polycarboxylate Polymer.
Family of molecules used in making new-generation superplasticisers.

POE: Polyoxyde Ethylene
One of the molecules used to synthesise PCP.

ppm: part per million.
1 ppm = 0,0001%.

Synthesis residue: molecule used in the synthesis of a polymer and subsisting in small quantities in products of the said reaction.

SYNFAM: French Confederation of Grinding Agents producers.

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