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Waste Materials in Construction: Putting Theory into Practice

EVOLUTION OF REGULATIONS AND STANDARDS FOR STABILIZED HAZARDOUS INDUSTRIAL FINAL WASTE MANAGEMENT IN FRANCE

Anne-France Didier (SDPD Ministère de l'Environnement) - Jacques Méhu (POLDEN -INSA LYON Développement) - Valérie Mayeux (ADEME)

1. Main principles and definitions

1.1. Definition of Hazardous Industrial Wastes

The regulatory status of HIW is defined in the decree which transposes into French law, the European list of hazardous wastes including the definition of hazardous wastes (mainly based on the 14 criteria in appendix III of the Directive 91/689. The decree establishes the relationship between what were previously called in France "wastes with harmful effects" and then "special industrial wastes".

Hazardous wastes therefore include :

- Special Industrial Wastes (which are the object of regional disposal plans, and on whose landfilling a tax is applied which contributes to finance remediation of contaminated sites),

- Dangerous Wastes (from household waste),

- Health Activity Wastes (with risk of infection).

Since the beginning of 1997, France has actively been working on the development of practical modalities of application of hazardous criteria (H1 - H14) to allow extension of the hazardous waste list to new wastes from the European Waste Catalogue. For this, Association RECORD (cooperative research network on waste) and the Ministry of Environment have launched joint research programmes concerning the application of hazardous criteria to a wide range of wastes, including stabilized wastes. The organizations in charge of the research are INERIS (H1-H3 "physical hazards"), INRS (H4 -H12 "hazards for human health) and POLDEN (H14 "environmental hazard"). The methods should be operational at the beginning of 1998.

The French Ministry of Environment also intends to publish a text concerning the general classification of all wastes (non-hazardous or municipal like, inert) based on the European Waste Catalogue. Such a comprehensive text would therefore greatly facilitate the work of local authrities and industry on site.

1.2. Treatment/disposal of SIW (Special Industrial Waste)

Annually, France produces about 150 million tons of waste including 7 million tons of SIW.

Apart from possible valorization scenarios (recycling, reuse, extraction of materials, substitution of materials, energy recovery,...) SIW can either be treated prior to disposal : physico-chemical treatments or incineration (1 558 329 tons in 48 installations (ADEME-1994)), or "disposed of" in a class I landfill, if they can be considered as "**final**" and "**stabilized**" (727 696 tons in 13 landfills (ADEME-1994)).

1.3. Notion of Final waste

The law of July 13th 1992 concerning all wastes (hazardous, municipal like, inert) determines that in 2002, only "final" wastes can be admitted for landfill. According to this law, a final waste is *"a material which can no longer be treated under present day technical and economic conditions, particularly by extraction of the valorizable fraction or reduction of its hazardous or pollutant character".*

This notion can of course evolve. Furthermore, as it is not based on quantitative criteria, it is often the object of many debates concerning its application particularly on household waste.

1.4. Notion if Stabilized Final Special Industrial Waste (SF-SIW)

The bye-laws (18/12/92) define two categories of Final SIW which must be stabilized prior to landfilling in class I.

From March 30th 1995, for category A (APC residues, steel dusts, used catalysts...)
From March 30th1998 for category B (industrial waste water treatment sludges, metallurgy slag (excluding those from salt baths-based process), waste from polluted soil treatment...)

The SF-SIW is considered as such if it satisfies a certain number of physico-chemical criteria defined by the bye-laws (18/12/92 and 18/2/94) which concern the immediately leachable fraction obtained from compliance tests (X31-210, X31-211...) in the process of standardization on a European scale (WG2 of CEN/TC 292).

Progressively, the notion of long term behaviour of wastes according to the exposure scenario will be introduced in the French regulations for landfill (it is already the case for studies in progress concerning inert waste in class III landfills. It is the object of the French standard X30-407, now awaiting standardization on the European level (WG6 of the CEN/TC 292). These new requirements will probably modify the notion of stabilized waste and therefore what can be expected from stabilization process performances.

Meanwhile, Final SIW can be considered as stabilized either as they stand, if they meet the requirements of the bye-laws (18/12/92) or after application of a stabilization process.

1.5. Stabilization processes

Three main techniques are now used or are being developed in France :

- stabilization using mineral binders (industrial stage),
- encapsulation in organic binders (pilot stage),
- vitrification (under development, first industrial unit in 1997).

Stabilization using mineral binders represents all the industrial installations to date, either near or on the class I landfill site.

9 of the 13 Final SIW French landfills have a stabilization facility for an annual capacity of about 600 000 tons.

2. Evolution of regulations and standards (Stabilized) Final Special Industrial Waste (SF-SIW) management in France

The application (first partial then total) of the new regulation concerning Final SIW landfilling has brought to light the radical increase in management costs (stabilization + landfilling).

This has led industry to reconsider waste generating processes (reduction at the source, pretreatment) in order to reduce either the quantity or the polluting character of the wastes (authorizing, for example, admission as they stand). In certain extreme cases, this has led to questioning the process itself, leading to the abandon of the considered waste.

As far as management of the "unavoidable" Final SIW is concerned, 3 fields of reflection are now open to industry :

1 Delisting of the stabilized waste (either classified as "M" assimilated to household waste, allowing landfilling in class II sites, or potentially as "I" inert, allowing landfilling in class III sites).
2 Valorization of the stabilized waste, thereby economizing the cost of landfill and even fixing a sale price for the material.
3 Valorization of the waste as it stands, thereby further economizing the cost of stabilization.

2.1. Delisting of (S)F-SIW

This alternative was first offered by the regulation within the framework of article 14 of the byelaw 25/01/91 concerning household waste incineration. A project for an application circular of this article stipulating acceptance conditions of stabilized APC from MSW incineration in class II was elaborated and discussed with industry. This perspective was at the origin of new projects for stabilization process development, a number of which had to be reconsidered due to the withdrawal of the circular.

Even today, it is clear that certain stabilization techniques are situated in the delisting perspective. This is the case for processes including an extraction. This position can be justified on the one hand by the fact that the composition (and therefore the potential pollution) of the waste is

greatly modified (by extraction of the most soluble fraction and part of the leachable metals) and on the other hand by the fact that, in certain cases, part of this salt fraction can be valorized.
This is also the case for vitrification, whose cost alone is much greater than that of stabilization by mineral binders + landfilling. A comprehensive evaluation procedure for vitrification processes is now in the validation phase. Its application could allow delisting or even banalization of vitrified materials under certain conditions and respecting certain thresholds which remain to be defined. This is apparently not the case for processes using mineral binders which are at present used in waste stabilization for class I landfilling.

It must be noted here that as stabilized wastes are not considered hazardous in the European list, the French regulations which stipulate their landfilling as hazardous waste (according to the typology of the Landfill Directive draft) could be reviewed on a case by case basis, by considering the technical and scientific aspects, in particular for wastes having undergone an extraction or a reduction of the polluting potential.

2.2. Valorization of (S)F-SIW

The possibility of valorizing certain stabilized wastes in Civil Engineering is being considered mainly for vitrified materials.

Association RECORD has funded a study on the general approach concerning banalization of materials elaborated from waste, leading to the definition of technical specifications (use criteria) and environmental specifications (present and future) to be taken into account. A certain number of conclusions can be drawn from this study :

- It is practically excluded that civil engineers envisage the use of monolithic materials elaborated by stabilization processes (blocks of solidified waste for example),

- To have a chance of being valorized, a waste must be able to substitute a material already used (sand, granulate, filler) and must respect the technical specifications like granulometry, mechanical strength and reactivity towards the other componants (e.g. problem of compatibility between hydraulic binders and vitreous matrixes, which has led several vitrifiers to orient their technique towards slow cooling which enhances crystallization),

- Furthermore, the cost must be lower than the material to be substituted and the quantitative and geographical availability must be at least equivalent,

- Environmental specifications are cruelly lacking on the French level. The development of the standard X30-407 should compensate for this in the long run (see later),

- Valorization which consists of simply diluting the waste in a construction, the waste not participating by its properties in the specifications of the construction, is to be excluded,

- The simple fact that a waste has cost too much to be stabilized for landfilling does not confer any value to it as regards valorization in civil engineering.

Valorization of stabilized waste is therefore to be studied on a case by case basis according to demand, technical and environmental specifications in a given scenario.

2.3. Valorization of waste as they stand

This is a real problem at the moment for wastes which do not follow the normal disposal routes but are stored internally on site (in-situ landfill, mining waste, metallurgy slag heaps). In most cases, a strict respect of the regulations (stabilization + landfilling) is not economically compatible with the considered industrial activity. Maintaining the activity (and the associated employment) implies research for acceptable solutions (including for the environment). It may entail modification of the site and landfilling conditions on site or the valorization scenario. A certain number of these wastes are already valorized in civil engineering locally. This is sometimes carried out "unofficially" which does not necessarily mean it is a clandestine activity, but rather on the basis of a temporary authorization while waiting for further data allowing delivery of an official authorization.

To emerge from this unsatisfactory situation, the metallurgy industry has launched research programmes with the aid of the European Commission concerning feasibility of valorization of different types of metallurgy slag in civil engineering. The most promising scenarios are in road construction. For such wastes; local use is a crucial issue given the cost of transport.

As far as valorization conditions in civil engineering are concerned, the limits are the same as those described in 2.2. The main problem is still the environmental specifications to be defined according to the scenario.

To compensate for this lack of specifications, the practically systematic reference of most promotors in civil engineering for the use of waste is the circular of May 9th 1994 concerning MSW bottom ash. The Ministry of Environment states clearly that the regulatory conditions proposed here do in no way allow appreciation of the behavioural parameters nor prediction in the long term. Even if the economical and social context for MSW Incineration has needed a short term regulatory text, its extension to all types of material, for which landfill wants to be avoided, is abusive and not relevant.

The Ministry of Environment and the Ministry of Civil Engineering are preparing a charter to propose a joint evaluation procedure. At first, this charter would apply to non hazardous waste (particularly MSW incineration bottom ash) and then would perhaps be extended to certain (S)F-SIW according to their long term behaviour and in a well-defined scenario.

3. Evolution of environmental specifications

The future of stabilization and its development towards other wastes or other scenarios is directly related to the evolution of the environmental specifications. These will be carried out on two complementary and successive levels : the verification of stabilization **performances** and the **long term behaviour** of the obtained material in the specified scenarios.

3.1. Performances

The arrival of a new regulatory context with strict constraints concerning the waste streams (theoretically covering all the F-SIW) including new wastes, relatively difficult to stabilize but for which a budget exists (APC from MSW incineration) has led to the development of more ambitious and more effective processes.

The (logical) drawback is that, taking into account the considerable extra cost of application of these techniques and their practically statutory situation on class I landfill site entrance for those managed by site managers, the demands of the authorities and producer industries are justifiably greater.

For this situation, the ADEME has initiated studies to develop "Comprehensive Evaluation Procedures of S/S processes - (CEP)", specific to the techniques used (mineral binders (POLDEN), vitrification (CEA), polymers (LNE), bitumen (forthcoming).

These comprehensive procedures, whose application would be a condition for obtaining funding for the industrial scale processes, are being implemented for mineral binders, and are in the final stages for the others.

The objective of these CEP is to establish the nature of pollutant retention by the technique considered (encapsulation, micro-encapsulation, inclusion in the porous structure, integration in the phases of the matrix, change in minerology), the mechanisms of leaching behaviour (wash-off, congruent dissolution, coupling of dissolution and diffusion, shrinking front,...) its quality (resistance to physical, chemical and biological attacks) and its durability (resistance to ageing under constraints).

Even if the objective here is process-oriented instead of material-oriented, therefore situated before the behavioural evaluation of material in specific, landfill or valorization scenarios, a certain number of experimental procedures will be the same.

3.2. Long term behaviour

The draft Landfill Directive mentioned 3 levels of waste evaluation :

level 1 : basic characterization, long term leaching behaviour
level 2 : compliance tests, verification of long term behaviour parameters
level 3 : rapid tests - control on site.

Level 2 corresponds to compliance tests which exist in most European countries for landfill acceptance (X31-210, X31-211 in France). Working Group 2 of CEN/TC292 is in charge of standardization of these tests on the European level. The stage of enquiry is now completed for the first test concerning fragmented waste.

Working Group 6 (whose French mirror is the AFNOR commission X30Y) is in charge of level 1, which is of strategic importance as it supposedly conditions the other levels.

The field of application of these studies covers much more than just the problem of (S)F-SIW landfilling. It also concerns other types of disposal (the project in progress as regards regulations for landfilling of different types of inert wastes integrates this notion), valorization in civil engineering (bottom ash in road construction for example) and in a general manner any evaluation of pollutant release from a defined source in the environment under specified conditions (mechanical, geotechnical, climatic, biological, site use, risk factors...) at a given time scale.

To prepare these evolutions, France has elaborated a methodological standard (X30-407), whose outlines, after amendment, were adopted by the participants in the European workshop. Standardization of the tests to be applied to given couples waste (or materials)/scenarios, is in progress.

One of the first priorities that the Ministry of Environment has fixed at the X30Y commission, concerns acceptance of stabilized waste in class I landfill. Logically, regulations should integrate these notions in the more or less long term, and propose rules to be respected which will probably be in the form of thresholds, but corresponding to the nature and to the objective of the tests carried out for this evaluation of long term leaching behaviour. For example, it is probable that notions of pollutant availablity according to the chemical context (pH in particular) and pollutant flux per unit surface for monolithic waste will be introduced.

We think that this will have three types of consequence on stabilization processes :

- A certain selection, which will favour the best processes, i.e. those for which a real stabilization (control of pollutant flux) will be proposed ;

- A selection within the different waste sources which can be potentially stabilized towards those which can reach a real stable state. For the others (bio-evolving, oxidizable, soluble and not retained...) pretreatments may be deemed necessary. We could therefore see S/S processes evolve towards waste streams which, due to their physico-chemical nature, logically correspond to them. We would therefore change from « a market to conquer » logic to a "treatment logic". The so-called secure landfill could then play its role to the full : protecting "unstable" stabilized waste from external attack. ;

- Justified and supported opening up of other horizons to stabilized wastes based on appropriate measures and models ; stabilization of contaminated sites, old stocks or slag heaps, "inert" wastes in class III,...Here, the waste streams, techniques and especially the environmental specifications remain to be defined.

The X30-407 (or its european equivalent) will not be sufficient. The evaluation of eco-compatibility i.e. the cross checking of pollutant flux emitted and the acceptable flux in the environment will be necessary.

It will consist of defining adapted scenarios (geotechnical, hydrodynamic, bio-physico-chemical,..) for stabilized wastes, i.e. generating flux considered as being in exchange equilibrium with the environment.

INSA Lyon is organizing an international congress in September 1998 : **"WASTE STABILIZATION AND ENVIRONMENT"** which aims to demonstrate the necessary complementarity of the three consecutive stages of evaluation :

- **control** of pollutant emission from stabilized wastes according to their intrinsic character and scenario conditions,

- **transport** and evolution of pollutants from these wastes in the environment,

- **impact** of these pollutants on man and the environment.

The final objective is of course to provide information to the regulatory and industrial organizations responsible for stabilized waste management.

Main reference works :

- Eco-compatibilité des déchets : programme de recherche pluriannuel de l'ADEME, coordonné par POLDEN
- WG 6 du CENTC 292
- Groupe de travail "Mise en décharge des déchets inertes" Ministère de l'Environnement, POLDEN
- Etudes d'application des critères de danger de la Directive 91/689 : Ministère de l'Environnement, Association RECORD, INERIS, INRS, POLDEN
- Groupe de travail, valorisation des déchets en BTP : Ministère de l'Environnement
- PEAs de PSS (liants minéraux, vitrification, polymères) : ADEME, POLDEN, CEA, LNE
- Stabilisation des DIS, Etude prospective : ADEME, ALGOE management, POLDEN