

## **Testmethods and criteria for the assessment of immobilized waste**

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### **Abstract**

The Dutch environmental policy is aimed at a drastic reduction of its wastes as well as the minimalisation of the use of natural raw materials. It focuses on prevention and re-use of wastes. Immobilization of (hazardous) wastes can contribute to this policy either by producing building materials from wastes or, if the former is not achievable, by producing less leachable wastes for landfilling.

A reliable set of test methods and related criteria is indispensable to apply these techniques in an environmentally safe and justified manner. Moreover, these test methods are also an expedient to further development of immobilization techniques as well as the quality assurance during full-scale application of these techniques.

### **Introduction**

The Dutch environmental policy is aimed at a drastic reduction of its wastes as well as the minimalisation of the use of natural raw materials. It focuses on prevention and re-use of wastes. Immobilization of (hazardous) wastes can contribute to this policy either by producing building materials from wastes or, if the former is not achievable, by producing less leachable wastes for landfilling.

It is important to know the effect of immobilization techniques on the leaching behaviour as well as on the durability of immobilized wastes. Test methods and related criteria to assess the characteristics of immobilized wastes have been selected and/or developed within the frame-work of CUR-committee D24. These instruments for assessment are indispensable for the development of the immobilization techniques, for proving their fitness for purpose and for quality assurance during full-scale application of these techniques.

### **Definition and aim of immobilization**

Immobilization is defined as a technological treatment in which the physical and/or chemical properties of a waste are changed in such a way that the spreading of the pollutants by leaching or erosion is reduced adequately on the short as well as on the long term.

Immobilization is a treatment on a particle size level. Storing waste in big bags or steel drums will prevent spreading of the pollutants, at least on the short term, but is not considered as immobilization.

Immobilization has two aims:

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Treatment of (hazardous) waste in such a way that it can be applied as a building material.

Producing less leachable wastes which can be landfilled under less severe isolation measures for soil protection (i.e. changing a hazardous waste into a so-called controlled leaching waste).

The first aim, application as a building material, is preferred because of much lower costs of removal of the waste, less trespassing on capacity of landfilling and the reduction in use of natural raw materials.

However, if this first aim cannot be achieved the second aim is still of importance. The costs of removal will still be lower (although not as much as for the use as a building material) and the very limited capacity of landfilling hazardous wastes in The Netherlands will be spared.

## Regulations

In The Netherlands, the Building Materials Decree sets regulations under which building materials may be applied in or on the soil or in surface water in an environmentally safe and justified manner. This decree classifies building materials according to their content of organic pollutants and to their leaching of anorganic pollutants. Depending on their classification different regulations are applied [1].

Test methods for the determination of the leaching behaviour of anorganic compounds are the so-called diffusion test for monolithic materials (Dutch Standard NEN 7345) and the so-called column test for granular materials (Dutch Standard NEN 7343), which is a percolation test. For organic compounds in building materials no suitable leaching test have yet been developed. Therefore, composition values for organic pollutants are determined instead of immission values, which undervaluates most immobilization techniques.

The Building Materials Decree requires that the building materials possesses an adequate durability. This property is not fully translated into test methods and criteria.

If a waste cannot be upgraded to a building material, in most cases it has to be dumped, according to the Dutch regulations set forth in the Disposal of Solid Waste Materials Decree. This decree classifies waste materials according to their leaching behaviour. The test method used for this classification is the above-mentioned column test, however with a lower liquid/solid ratio (1 instead of 10). The material to be investigated in the column test must be crushed to a particle size less than 4 mm according to NEN 7343. Crushed monolithic materials will therefore result in a substantial higher leaching rate than in practice because of the substantial higher specific surface due to the crushing. Immobilization techniques based on monolithic products are therefore undervaluated.

Some immobilization techniques require binders and additives. They contribute to an increase of mass and often in an increase of volume compared to the untreated waste. In the case of landfilling this is an undesired side-effect of the treatment. Dutch regulations require that such an increase in volume must be less than 25%.

Durability of immobilized waste to be landfilled is less essential than in case of use as a building material. Usually, the waste is covered by other waste or a layer of sand within a few days or weeks preventing further influence of atmospheric conditions.

## Additional test methods

In addition to the Dutch regulations described above, CUR-committee D24 has developed test methods and criteria to fully assess immobilization techniques for hazardous wastes.

With respect to environmental aspects the following properties of the immobilized wastes have

been considered:

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#### Water soluble salts

At higher contents this might lead to (partial) solution of the matrix of the immobilized waste. This will influence the leaching behaviour as well as the durability in an adverse way.

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#### Digestible organic matter

This might lead to enhanced leaching due to adsorption and complexation reactions with pollutants.

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#### Redox-conditions

Under reducing conditions leaching of some heavy metals is substantially less than in an oxidized state (e.g. lead and copper in the presence of sulphide compared to sulphate). The reducing capacity of the immobilized waste is important with respect to the leaching behaviour on the long term.

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#### Efficiency of immobilization

In order to assess the merit of immobilization techniques or to compare different techniques a diffusion test similar to NEN 7345 has been developed for untreated waste. Comparison of the leaching behaviour of the untreated and treated waste will give the environmental gain of the immobilization techniques.

The test methods developed for the above-mentioned properties together with those postulated in Dutch regulations are summarized in table 1.

The durability of immobilized wastes depends on its own structure as well as the climatic conditions it will be exposed to. In The Netherlands the most relevant mechanisms of degradation are:

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#### Wet/dry

Under alternating wet/dry conditions cohesion failure might occur due to solution and recrystallization of salts in and/or shrinkage of the immobilized waste.

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#### Freeze/thaw

Above a critical degree of saturation with water every material is susceptible to freeze/thaw conditions. This critical degree of saturation depends on the pore structure and strength of the material.

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#### Erosion

In order to prevent spreading of pollutants by wind erosion, the immobilized waste should have a certain resistance against this mechanism of degradation.

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#### Oxidation

A combined interaction of oxygen, moisture and solar radiation (activation energy) can degrade organic binders usually leading to a brittle and 'dusty' surface appearance.

Test methods for these four durability properties are shown in table 2.

## Conclusions

Immobilization of hazardous waste plays an important role in the Dutch environmental policy. It can contribute to the reduction of wastes to be landfilled, to an increasing re-use of wastes thereby saving natural raw materials. A reliable set of test methods and related criteria is indispensable to apply these techniques in an environmentally safe and justified manner. Moreover, these test methods are also an expedient to further development of immobilization techniques as well as the quality assurance during full-scale application of these techniques.

## References

1

Hendriks, Ch.F. and Raad, J.S., „Principles and background of the Building Materials Decree in the Netherlands”, Materials and Structures, vol. 30, January-February 1997, pp. 3-10.

2

CUR-report no. 183, „Guideline for the assessment of immobilized wastes”, 1995 (in Dutch, with English summary).

Table 1. 'Environmental' test methods

property	description of test method	standard
leaching	diffusion test (monolithic) column test (granular) = percolation test	NEN 7345 NEN 7343
efficiency	'granular' diffusion test	NVN* 7347
redox	redox-potential/reducing capacity	NVN* 7348
soluble salts	soluble salts at liquid/solid ratio of 10	-
organic matter	extraction with 0.1N NaOH	-

\* NVN = pre-NEN

Table 2. Durability test methods

property	description of test method	standard
wet/dry resistance	6 wet/dry cycles: 5 hours in water of 20°C + 42 hours drying at 70°C	modified ASTM D559
freeze/thaw resistance	monolithic: critical degree of saturation granular: 20 freeze/thaw cycles	RILEM 4CDC3 NEN 5924
erosion resistance	sand blasting test, originally designed for wear resistance	modified NEN 2875
oxidation resistance	Xenon-test chamber	ISO 4892