Evaluation of a Decision Support System for the useful application of hazardous wastes with means of immobilisation-techniques

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ABSTRACT

In the Netherlands, dumping of hazardous wastes on a landfill is discouraged. On the other hand, the Building Material Decree set standards to building materials in order to protect surface-, groundwater and soil from the leaching of hazardous components. Moreover, the government intends to minimise the use of primary materials. Therefore, new applications of hazardous wastes are needed. The most promising is Stabilisation/Solidification, sometimes called immobilisation.

Immobilisation-techniques are defined as changing the physical and chemical state of hazardous wastes in order to reduce the leaching of hazardous components. Despite financial incentives, few applications of immobilised wastes are known. Therefore, a Decision Support System (DSS) is necessary to calculate the impact of the immobilised waste on the environment. A DSS is developed and evaluated for a case with contaminated soil and residues from inorganic industry.

The first criterion of the DSS is called long term behaviour and aims at minimising the release of hazardous compounds in relation to external influences and material properties. The second criterion, environmental load focuses at consumption of (non)renewable natural resources. The third criterion is financial consequences, which calculates the overall costs and incomes during the life cycle with respect to all stakeholders.

RéSUMÉ

L’enfouissement des déchets dangereux est découragé aux Pays-Bas. Le Décret sur les déchets de construction et de démolition établit des normes destinées à protéger les eaux souterraines et de surface ainsi que le sol. Le gouvernement souhaite également minimiser l’emploi de matériaux primaires. Cette politique nécessite la mise au point de nouvelles solutions de gestion des déchets dangereux. La solution la plus prometteuse semble être la Stabilisation/Solidification, parfois appelée immobilisation.


Le premier critère du SIAD, appelé le comportement sur le long terme, est destiné à minimiser la libération des substances dangereuses sous l’effet des influences externes et des propriétés des matériaux. Le second critère, dénommé la charge environnementale, se focalise sur la consommation des ressources naturelles (non) renouvelables. Les conséquences financières constituent le troisième, et dernier critère, qui calcule pour tous les acteurs concernés l’ensemble des coûts et des revenus durant le cycle de vie.
1. INTRODUCTION

Waste is released due to several industrial and non-industrial processes. If the waste contains a high potential leaching out of hazardous components, the waste is called hazardous. In the Netherlands, Municipal Solid Waste Incineration (MSWI), soil remediation, water purification and sludge up of rivers produce approximately 500 kton hazardous waste each year [4]. A possible treatment for this waste is Stabilisation/Solidification, sometimes called immobilisation. Immobilisation-techniques change hazardous wastes, physical and chemical, such that risk of dispersal of environmental pollution through leaching, erosion and dispersion in the short and long term will decrease [1]. Both using binders, like cement, and thermal treatment may lead to a immobilised material. This material can be dumped of with less isolation and control devices. Another alternative for immobilised materials is the replacement of primary building materials such as concrete or basalt.

Although legislation was made more favourable for immobilised-materials, the technique was sufficiently tested and the materials were economically interesting in some cases, only few applications are known at this time. This is due to uncertainty about the performance of the immobilised-materials by the main stakeholders. Therefore, a decision support system (DSS) was developed. This DSS is called 'MAATSTAF' (acronym which means standard or criterion): Maatschappelijke Aspecten van het Toepassen van Afvalstoffen (Social Aspects of Using and Dumping Waste). MAATSTAF will support the evaluation of environmentally safe and effective use of immobilised-wastes in civil constructions.

In this paper the results of the first evaluation of MAATSTAF is presented. The data are obtained from a immobilised-material produced by BAG B.V., a waste treatment company in the South of the Netherlands.

2. FUNCTIONAL UNIT

MAATSTAF has been developed for those cases in which it is less clear if the immobilisation of a polluted material and subsequent usage as building material is more effective than dumping the immobilised waste or unmodified waste.

In order to accomplish a correct comparison of the different alternatives they all must satisfy the same general functional unit.

The “functional unit” which can be assessed with MAATSTAF is:

Treating \( x \) kg of waste \( y \) and using \( z \) kg of building material in a civil engineering work for a period \( t \).

The functional unit of this research is:

Treatment of 221 ton zinc slag’s, 4169 ton polluted soil and 111 ton furnace dust and using 5000 ton building material in a road foundation for a period of 120 years.

3. ALTERNATIVES

Each alternative is to be subdivided into two items: the treatment of the waste to immobilise it and the subsequent application of the immobilised material as a building material or the dumping of it.

The total period of the alternatives to be studied is the period \( t \) of the functional unit. A total period up to 500 years is taken into account for evaluating the dumping of the untreated waste and of the building material. Furthermore three phases have been defined:

- Phase k: treatment of the waste (immobilisation and/or dumping);
- Phase l: application of a building material (immobilised waste or ordinary non-polluted building material);
- Phase m: end of life span of the material (dumping or rehabilitation/upgrading).

The zinc slag’s, furnace dust and polluted soils have been immobilised in two different ways:

- A1: immobilisation of waste A (221 ton zinc slag’s with 111 ton furnace dust, 1877 ton polluted soil) and 265 ton cement plus 25 ton additive;
- B1: immobilisation of waste B (2292 ton polluted soil) with 208 ton cement.

The estimated life span of the immobilised waste is 60 years which means that after that period the material in an application must be taken out and re-immobilised again with cement. The refreshed products are called A2 and B2.

If the immobilised wastes are not used as a road foundation, the foundation will be made with a sand/cement-stabilisation. This is called alternative C1. Here also after 60 years the material must be upgraded, this is called C2. Five different alternatives are considered, see Table 1.

<table>
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<th>Table 1 - Alternatives to be studied</th>
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<td>Phase k: treatment of the waste</td>
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<td>waste A</td>
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4. DESCRIPTION OF THE THREE CRITERIA

4.1 Long term behaviour

The criterion long term behaviour (LTB) must be explored because during the life time of a material or an immobilised waste hazardous components could penetrate into the environment. The long term is set at 500 years. This means that dumping the waste is evaluated among 500 years. Dumping the building material (A1, A2, B1, B2, C1 or C2) is evaluated from end of life span till 500 years from the beginning of the application.