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SOME INDEPENDENT ASSESSMENTS OF THE SEALOSAFE/STABLEX METHOD FOR TOXIC WASTE TREATMENT

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Summary

SEALOSAFE is a method of toxic waste treatment involving a solidification process. This SEALOSAFE process is also operated under the name of STABLEX. The operators claim that the process effectively isolates heavy metals and other pollutants from the environment and claim that natural agencies cannot release them. Independent research work undertaken in the United Kingdom and abroad is presented as an impartial assessment of these claims. Data is reproduced from the reports prepared by the independent researchers and it is demonstrated that these investigations do indeed substantiate the operators' claims for the process.

Introduction

SEALOSAFE has been operated commercially in the U.K. since August 1974 and there are now three plants in this country: two are located at Brownhills in the Midlands operated by Polymeric Treatments Ltd. and the third at West Thurrock, Essex, operated by Stablex Ltd. The process operators claim to be able to treat a large range of industrial toxic and hazardous wastes in any physical form and to convert them into an environmentally inert polymer or synthetic rock termed STABLEX. Pollutants are said to be held in the lattice structure or matrix of the STABLEX by "crystal capture" mechanisms and these mechanisms are presently being studied using X-ray crystallography and other techniques.

In spite of nearly five years' operating experience at full-scale plant, the process operators have, naturally, met with requests for independent assessments of the technology, especially when looking at opportunities for export. Consequently, a number of Bodies have been involved in investigating the claims made for SEALOSAFE/STABLEX and these independent reports form the basis of this present discussion.

The SEALOSAFE process

Toxic wastes in solid, sludge or liquid form can be accomodated by SEALOSAFE and the first stage in the process is to blend, homogenise and pretreat a variety of wastes available from storage on the plant. In this way, the interactions between various wastes can be beneficially employed to bring the waste mix to the desired state prior to polymerisation. For example, simple neutralisation of acids using waste caustic and reduction of Cr^{VI} using waste sulphuric pickle acids is commonly undertaken at the plant and this reduces treatment costs substantially as well as making the wastes suitable for treatment.

From the pre-mixing and pre-treatment stage the homogenised waste mix is weigh-batched through the polymerisation plant. Here, two or more reagents are added in automatically programmed and controlled proportions and the whole thoroughly mixed before discharge from the plant. The STABLEX thus formed is initially a slurry having the consistency of porridge and, in this state, can be pumped or tankered away to a final destination. The primary use of STABLEX has been land reclamation although other uses have been explored for the material.

The STABLEX slurry sets to a hard, rock-like material in about three days and is described as environmentally inert.

The claims for the process

The operators claim that STABLEX has the following characteristics:

Permeability
Measured by a falling head device to be 1.0—2.0 $\times$ 10^{-6} cm/s which is less than that of clays or concrete.

Leaching
Toxic heavy metals are said to be typically less than 1 p.p.m. total in the leachate produced by an Equilibrium Leaching Test (ELT) as described later.

Structural integrity
A measured compressive strength of 200—800 p.s.i.

Environmental factors
Non-flammable, non-odourous, non-putrescible, unattractive to vectors.

The leaching characteristics are, perhaps, the most significant in terms of waste treatment and disposal and these are primarily what have been studied in depth by independent laboratories. The leaching test developed by the operators themselves, and recommended for general use, is described as the Equilibrium Leaching Test (ELT). It was devised as a rigorous test to simulate the worst possible conditions that could occur naturally. A sample of STA-

BLEX is taken, ground to a fine powder and mixed with ten times its weight of distilled water that has been equilibrated with atmospheric carbon dioxide to pH 4.5—6.0 and at 20°C. The whole is magnetically stirred for one hour and then filtered through a Whatman 541 filter. The filtrate is then analysed for metals and other significant parameters [1].

This ELT procedure increases the surface area of the STABLEX sample by up to 5,000 times and, since leaching can be considered directly proportional to exposed area, represents an extremely rigorous test. The claims of less than 1 p.p.m. leachable toxic metals are, therefore, extremely significant environmentally. Additionally, the low permeability of STABLEX offers increased environmental safeguards and guarantees.

However, the question most often asked is: "Can the claims be substantiated by independent organisations?". Outlined below are results reproduced from the test reports conducted by such independent bodies.

Japan — Environmental Protection Agency

Five samples of industrial wastes produced in Japan were submitted for SEALOSAFE treatment.

Table 1 shows their chemical analysis [2]. These wastes were then processed and an authorised laboratory in Tokyo conducted leaching tests in accordance with Standard Method Article 3 of Cabinet Order 5, 1973 of the Environmental Protection Agency Notice No. 13. Briefly, the test involved grinding to a particle size of between 0.5 and 5 mm diameter, leaching with ten times weight of distilled water at pH 5.8—6.3 and 20°C for six hours, filtration through a type 5C paper and centrifugation at 5,000 r.p.m. for 20 min with subsequent chemical analysis. Table 2 presents the results [2]. Comparison of the two tables shows the effectiveness of the SEALOSAFE process.

TABLE 1

Analysis of industrial wastes (Japan)

	Electro-plating waste	Humus sludge	Paint sludge	Latex sludge	Acid tar
Total solid matter (%)	44.7	1.5	3.7	55.0	93.3
Ash on ignition (%)	46.5	0.3	2.4	0.1	1.3
pH	< 1	6.1	9.0	8.1	< 1
Cyanide (p.p.m.)	0	0	0	0	0
Cadmium ”	5	<1	1	< 1	< 1
Chromium ”	120,000	3	1,000	13	18
Copper ”	11,600	25	20	40	146
Iron ”	—	340	7,200	24	600
Lead ”	220	19	32	50	4,080
Nickel ”	2,200	1	220	5	12
Zinc ”	3,200	300	2,200	11	2,400

TABLE 2

Analysis of STABLEX leachate (Japan) (p.p.m.)

	Electro-plating waste	Humus sludge	Paint sludge	Latex sludge	Acid tar
Cyanide	<0.007	—	—	—	<0.007
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.02
Chromium	<0.01	—	<0.01	<0.01	<0.01
Copper	<0.3	<0.3	<0.3	<0.3	<0.3
Lead	<0.3	<0.3	<0.3	<0.3	0.37
Nickel	<0.1	—	<0.1	<0.1	0.15
Mercury	—	<0.0005	<0.0005	<0.0005	—
Organic phosphorus	—	<0.02	—	—	—
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001

America — National Sanitation Foundation (NSF)

A potential site for a SEALOSAFE plant has been located in Michigan and plans are well advanced for its construction. The Michigan Department of National Resources requested an independent assessment of the claims made for STABLEX and the NSF were nominated to conduct the programme.

A major automobile manufacturer collected five wastes from his plant and handed these over to NSF staff. The wastes were three different plating wastes, a paint priming waste and a waste treatment plant sludge. The NSF observed the processing of the wastes and took the STABLEX samples back for their testing. ELT testing was undertaken on all samples and also the American Society for Testing and Materials (ASTM) shake test performed on the STABLEX sample made from the zinc phosphate priming waste. Tests were conducted from 1 to 28 day immersion periods.

Table 3 presents the data on the raw wastes. Table 4 reproduces the results obtained in the one-day ELT tests on all of the STABLEX samples and the two-day ASTM test performed on the paint priming waste and its STABLEX [3].

Again, a comparison of the results between the raw waste data and the leaching tests on the STABLEX confirms that heavy metals are effectively held within the STABLEX.

The NSF also compared the results of their tests with the U.S. Environmental Protection Agency's (EPA) National Interim Primary Drinking Water Regulations and reports that the comparison is "impressive". In addition, the EPA's Proposed Guidelines and Regulations and Proposal on Identification and Listing of Hazardous Wastes is cited wherein a waste is defined as "hazardous" if it contains levels of any contaminants in excess of ten times the EPA drinking water standards. For arsenic, cadmium, chromium, lead, mercury, selenium and nitrate and using the rigorous ELT test, each sample of

TABLE 3

Raw wastes analysis (America) (p.p.m.)

	Nickel-plating waste	Chrome-plating waste	Copper-plating waste	Paint priming waste	Treatment plant sludge
Cadmium	0.008	0.005	0.01	1.9	0.9
Chromium	1.5	1,750	7.3	26	136
Copper	220	7.5	7,500	3.9	39.6
Iron	14.2	0.5	75	3,250	565
Lead	0.4	0.4	4.0	23.4	79
Nickel	2,900	40	27	1,040	814
Zinc	15.5	100	17.5	27,625	10,735
T.O.C.	110	45	520	28,000	163,700
C.O.D.	397	103	2,000	261,000	313,000
Cyanide	9.1	<0.003	5.8	1.6	129

TABLE 4

One-day ELT and two-day ASTM leaching data (America) (p.p.m.)

	1-day ELT on STABLEX					2-day ASTM	
	Ni-waste	Cr-waste	Cu-waste	Zn-waste	Sludge	Raw Zn-waste	STA-BLEX
Cadmium	—	—	—	<0.0005	—	0.04	<0.001
Chromium	—	0.09	—	0.3	0.07	0.08	0.06
Copper	<0.002	—	0.02	—	—	—	—
Iron	—	—	—	0.01	0.005	10.1	<0.005
Lead	—	—	—	<0.005	0.01	0.05	0.03
Nickel	<0.05	<0.005	—	<0.005	—	50	<0.005
Zinc	—	<0.005	—	<0.005	<0.005	226	<0.005
T.O.C.	<1.0	<1.0	3.0	2.9	78	4.4	8.2
C.O.D.	<25	<25	<25	97	806	47	67
Cyanide	0.03	—	0.04	—	0.03	—	—

STABLEX was, without exception, classified as non-hazardous. Moreover, in 36 of the 40 leachate results quoted, the level of contaminant was actually less than that required for drinking water itself.

U.K. — Northumbrian Water Authority

During September and October 1975, a core was drilled out of the STABLEX bed deposited at the Empire site and sections submitted to the Northumbrian Water Authority for leaching and analysis. The procedure adopted was to grind 150 g of STABLEX and leach in 1,500 ml of distilled water for

TABLE 5

Leachate data on core samples (U.K.) (p.p.m.)

	7 days	14 days	21 days
Ammoniacal nitrogen	0.02	0.12	0.70
Total oxygen demand	107	111	140
Cyanide	<0.01	0.03	0.10
Thiocyanate	<0.01	0.09	0.10
Phenols	0.3	0.3	0.3
Cadmium	<0.001	<0.001	<0.001
Chromium	0.06	<0.02	0.15
Copper	0.10	0.34	0.14
Lead	<0.01	<0.01	0.40
Mercury	<0.001	—	—
Nickel	0.06	0.25	0.02
Zinc	0.02	1.85	0.02

seven days with a few minutes agitation each day. A sample of the aqueous phase was taken for analysis. The procedure was continued for a further seven days and an aqueous phase sample analysed, and continued for another seven days, with inclusion of eight-hour continuous agitation for the last two days, and a further aqueous phase sample analysed. The results are presented in Table 5 [2].

Again, the effectiveness of the SEALOSAFE process in isolating pollutants from the environment is demonstrated.

U.K. — Portsmouth Polytechnic

Four different sewage sludges were processed using SEALOSAFE methods and the resulting STABLEX material used as a basal medium for tomato growth

TABLE 6

Analysis of tomato fruit (U.K.) (duplicates, in mg/kg)

		Zinc	Manganese	Iron	Chromium	Copper	Nickel	Lead	Cadmium
Sludge A	1.	24.1	10.4	13.8	<1.2	4.1	<3.0	N/D	<5.0
	2.	19.4	9.1	9.3	<1.2	6.0	7.6	N/D	<5.0
Sludge B	1.	28.6	11.4	55.3	<1.2	6.9	3.3	N/D	<5.0
	2.	31.7	14.8	53.1	<1.2	11.7	<3.0	N/D	<5.0
Sludge C	1.	23.1	14.1	32.2	<1.2	7.9	<3.0	N/D	<5.0
	2.	20.5	9.8	49.7	<1.2	7.9	<3.0	N/D	<5.0
Sludge D	1.	24.3	8.9	16.5	<1.2	10.7	<3.0	N/D	<5.0
	2.	23.4	7.7	13.3	<1.2	7.8	<3.0	N/D	<5.0
Typical peat or compost		37	20	40	12	10	3	7	<5.0

trials. The fruit were harvested and digested using hydrogen peroxide, sulphuric and nitric acid until cleared. The digestion and subsequent analysis were undertaken in duplicate and the results are presented in Table 6 [4].

From the comparison with the typical levels expected from tomatoes grown in peat or compost, it can be seen that the metal uptake from the STABLEX prepared from sewage sludges is significantly less. This is an important result since studies at Portsmouth have already established that metal levels in tomato fruit are quite independent of the metal levels in the growth medium. Thus, the property of isolating metals from the environment is again demonstrated for the SEALOSAFE process.

Conclusions

The research data presented in this paper offer considerable independent evidence to substantiate the claims of the SEALOSAFE operators as far as leaching characteristics and environmental isolation of metals are concerned.

References

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