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A NEW UNIVERSAL SORBENT FOR HAZARDOUS SPILLS

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Summary

In this paper, the authors present information on the properties of a new, broad spectrum sorbent; a product that has the potential to render spilled liquids easily and safely collected and removed. Data on the chemical, physical, and toxicological properties are given. Methods for measuring sorption index and suppression of vapor emission are described. The sorbtion ratio of more than 70 hazardous liquids are listed. The vapor emission suppression for several volatile materials is given. A unique packaging system which makes the product convenient for field use is described.

Introduction

The use of selective sorbents for the amelioration of oil spills on water is well known, and there are several commercial materials which effectively fill this need. The same is not true in the broad category of hazardous materials.

Today, there is also a need for a non-selective, efficient, high capacity sorbent for picking up on land spills of a wide variety of hazardous liquids. Available products, such as expanded shales, perlites, vermiculites, etc. all have some disadvantages. A recently developed product called Hazorb has properties which make it applicable as a universal sorbent.

Properties

This new universal sorbent material consists of off-white, free-flowing granules with a loose bulk density of about 2 lbs/ft^3 (30 kg/m^3). It is amorphous silicate glass foam consisting of spheroid-shaped particles with numerous cells; the particles range in size from 8 mesh to 200 mesh. This product is very safe to handle, since studies show the material to have very low toxicity [1] (see Table 1).

TABLE 1

Toxicological properties of Hazorb sorbent

Acute inhalation toxicity	$LC_{50} > 2.32$ mg/l air
Acute oral toxicity	$LD_{50} > 15{,}380$ mg/kg
Eye irrigation	Mildly irritating (19.7/110.0)
Primary skin irritation	Slightly irritating (0.7/8.0)
Skin sensitization	Not a skin sensitizer

Sorption ratio

The sorption ratio is defined as the number of times its own weight of a liquid that a sorbent can pick up and hold. The method used in this work for determining the sorption ratio was a modification of Military Specification MIL-S-28600A (YD). Five-gram portions of sorbent were immersed for 15 min in the liquid to be tested. The sorbent was then removed from the liquid and allowed to drain for five minutes. The weight of liquid sorbed was measured and the sorption ratio calculated using the following equation:

$$\text{Sorption ratio} = \frac{\text{Saturated weight-Dry weight}}{\text{Dry weight}}$$

The units of the term then are mass of fluid adsorber per mass of sorbent (lbs/lb or g/g). The sorption ratios of Hazorb for 73 liquids are shown in Table 2. The lowest value was 6, while the highest was 26.

The data in Table 2 reveals the universal nature of the product. The only material tested so far for which the sorbent is not useful is hydrofluoric acid. Because Hazorb is a silicate, the acid reacts violently with it, and thus contact must be avoided.

Many of the liquids shown in Table 2 were tested for comparative purposes for sorbency by other sorbents, including polypropylene fibers (3-M sorbent);

TABLE 2

Sorption ratios of some liquids on Hazorb

Class	Product	Sorption ratio	Class	Product	Sorption ratio
Acids	Chlorosulfonic acid	19	Chlorinated solvents	Ethylene dichloride	12
	38% hydrochloric acid	14		Methylene chloride	12
	83% phosphoric acid	23		Perclene® D (Perchloroethylene)	14
	98% sulfuric acid	20		Triclene® D (Trichloroethylene)	13
	71% nitric acid	15		Chloroform	12
	Glacial acetic acid	10		Carbon tetrachloride	12
	20% chromic acid	16			
	60% chromic acid	20			

TABLE 2 (cont'd)

Alkalies	Acrylonitrile	10
	50% caustic soda	26
	10% caustic soda	15
	45% caustic potash	22
	10% caustic potash	15
	30% ammonium hydroxide	12
	25% liq. sodium methoxide in methanol	13
Salts	70% sodium bichromate	23
	40% ferric chloride	18
	47% potassium carbonate	22
	50% liquid alum	16
Silicates	Gr. 40 liq. sodium silicate	23
	Gr. 50 liq. sodium silicate	24
Hydrocarbons	# 2 fuel oil	9
	Gasoline	6
	Benzene	11
	BTX (benzene/toluene/xylene)	11
	Toluene	10
	Ethyl benzene	9
	Cyclohexane	7
	Xylene	8
	Styrene	9
	Mineral spirits	7
Amines	Diethylamine	6
	Triethanolamine	19
	Aniline	15
Ag. Chem.	Dacamine® (*N*-oleyl 1,3-propylenediamine salt of 2,4-dichlorophenoxyacetic acid, 4 lbs/gal.)	15
	Bueno® 6 (monosodium acid methanearsenate)	17
	DSMA (disodium methylarsenate)	12
Chlorinated hydrocarbons	Chlorowax LV®	18
	Chlorowax 40®	17
	Chlorowax®	18
	Chlorowax 42-170	17
	Chlorowax 50®	22
	Chlorowax 500-C	23
	Polychlorinated biphenyl	10
	Chlorobenzene	12
Alcohols and ethers	Methanol	7
	84% phenol	15
	Ethanol	7
	Ethylene glycol	14
	Isopropanol	8
	Allyl alcohol	10
	Ether	6
Ketones, aldehydes and esters	Acetone	8
	Methyl ethyl ketone	7
	37% Formaldehyde	10
	n-Butyl acetate	11
	Amyl acetate	9
	Vinyl acetate	8
	Methyl methacrylate	11
	Acetaldehyde	10
Miscellaneous	Hydrogen peroxide (30%)	10
	60% MEK peroxide in dimethyl phthalate	12
	Dow corning 561 silicone transformer liquid	12
	Cresol	13
	Tetrahydrofuran	9
	Acetic anhydride	13

treated cellulosic fibers (Conwed); vermiculite, cellulose/perlite (Fiberperl); expanded shale (Oil Dry); and polystyrene foam. The results for four different types of chemicals are shown in Fig. 1.

As can be seen, some of the other sorbents are universal; some have high sorbency; but only the Hazorb sorbent was both universal with high sorbency.

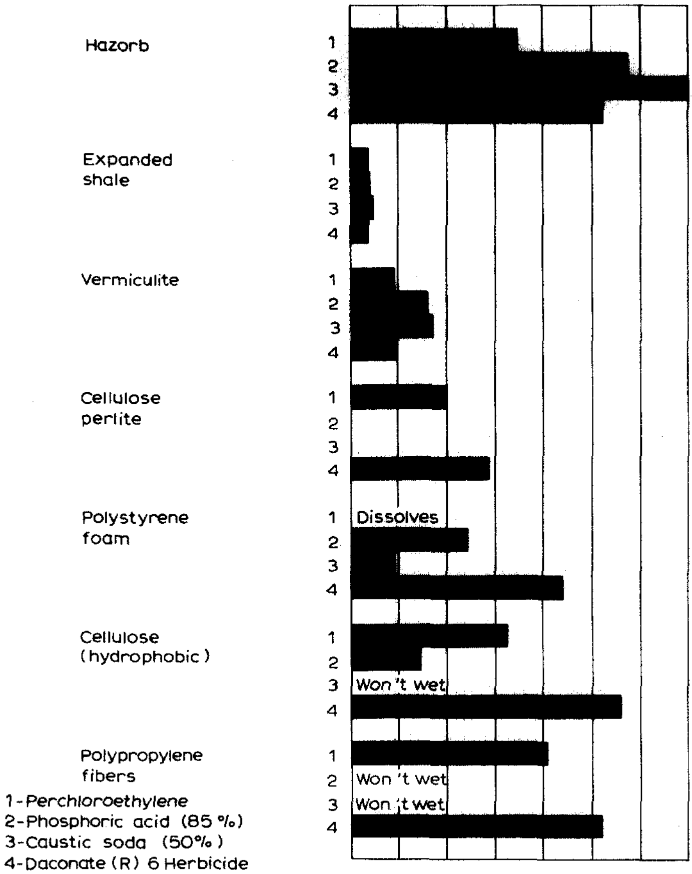

Fig.1. Comparative sorption of various sorbents.

Vapor emission control

Recently there has been a great deal of interest in suppression of vapor emissions with various types of foams, such as fire fighting foams [2—5]. Preliminary investigations have shown that the rate of evaporation for volatile liquids can be suppressed by application of the cellular silicate sorbent.

The test apparatus used to measure vaporization was very simple. It consisted of two crystallizing dishes, one nested in the other with a layer of insulation between. The equipment was placed on a digital readout balance, tared, and 200 g of the test liquid was added. Weight loss by vaporization with and without the sorbent covering layer was recorded over a two-hour period.

The weight loss in g/min cm^2 and temperature change vs. time for gasoline, ethanol, and diethyl ether respectively are shown in Tables 3, 4 and 5. The data shows that with a covering of 40 g of sorbent per 200 g of liquid, the vapor emission reduced from 50% to 90%. However, if 20 g of sorbent were used, the rate of evaporation was in some cases dramatically increased. This

TABLE 3

Vaporization rates for liquids covered by Hazorb
Weight loss and temperature data: Gasoline

Time (min)	Free evaporation		20 g Hazorb cover		40 g Hazorb cover	
	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp (°F)
0		61		65		69
5	0.0028	59	0.0028	64	0.0012	68
10	0.0018	58	0.0018	62	0.0006	67
15	0.0024	56	0.0022	61	0.0007	67
30	0.0020	55	0.0018	59	0.0009	65
45	0.0018	54	0.0015	58	0.0006	64
60	0.0018	54	0.0015	58	0.0008	63
90	0.0014	56	0.0013	58	0.0008	62
120	0.0014	58	0.0013	59	0.0008	62

TABLE 4

Vaporization rate for liquids covered by Hazorb.
Weight loss and temperature data: Acetone

Time (min)	Free evaporation		20 g Hazorb cover		40 g Hazorb cover	
	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp. (°F)
0		73		71		73
5	0.0026	69	0.0023	70	0.0008	72
10	0.0020	67	0.0024	68	0.0008	71
15	0.0019	65	0.0025	66	0.0009	71
30	0.0019	61	0.0022	63	0.0009	69
45	0.0016	59	0.0019	61	0.0012	68
60	0.0015	57	0.0023	59	0.0013	68
90	0.0016	56	0.0020	57	0.0013	65
120	0.0014	55	0.0020	55	0.0013	64

TABLE 5

Vaporization rate for liquids covered by Hazorb
Weight loss and temperature data: Diethylether

Time (min)	Free evaporation		20 g Hazorb cover		40 g Hazorb cover	
	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp. (°F)	Weight loss (g/min cm²)	Temp. (°F)
0		77		80		74
5	0.0050	68	0.0076	70	0.0017	67
10	0.0041	65	0.0067	67	0.0017	66
15	0.0038	62	0.0067	65	0.0017	65
30	0.0031	57	0.0060	57	0.0019	63
45	0.0031	54	0.0057	52	0.0018	61
60	0.0024	52	0.0050	48	0.0020	59
90	0.0022	52	0.0030	49	0.0019	56
120	0.0023	52	0.0029	50	0.0018	55

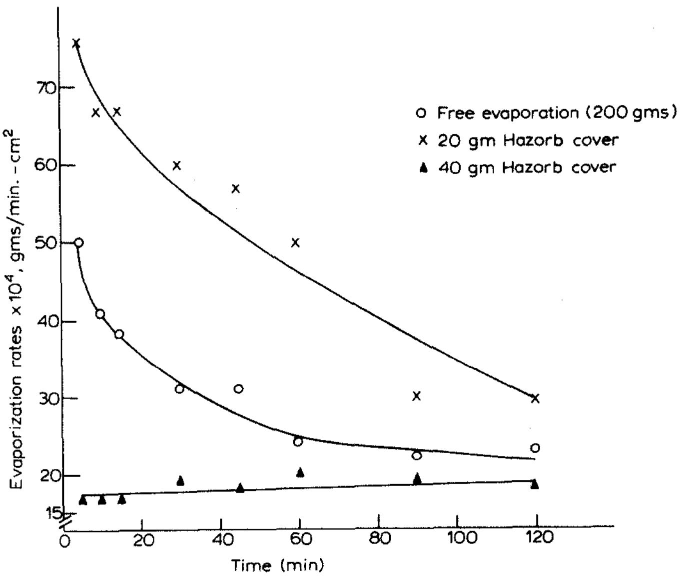

Fig.2. Diethyl ether evaporation rates.

phenomenon is shown in Fig. 2. This shows that at 60 min, the free evaporation rate is 0.0024 g/min cm^2 compared to 0.0020 g/min cm^2 with a 40-g covering of Hazorb, and 0.057 g/min cm^2 with a 20-g covering of Hazorb.

Packaging

Because of the low density of the silicate sorbent, field application is difficult. A slight breeze will make it impossible to hit a target with the loose material.

To overcome this problem, a unique packaging system has been developed. The package is a pillow of a non-woven inert fiber containing about one pound (0.5 ft^3) of sorbent. Thus, each pillow will absorb at least one gallon of any liquid.

A saturated pillow can be easily picked up by hand or machine for safe disposal.

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