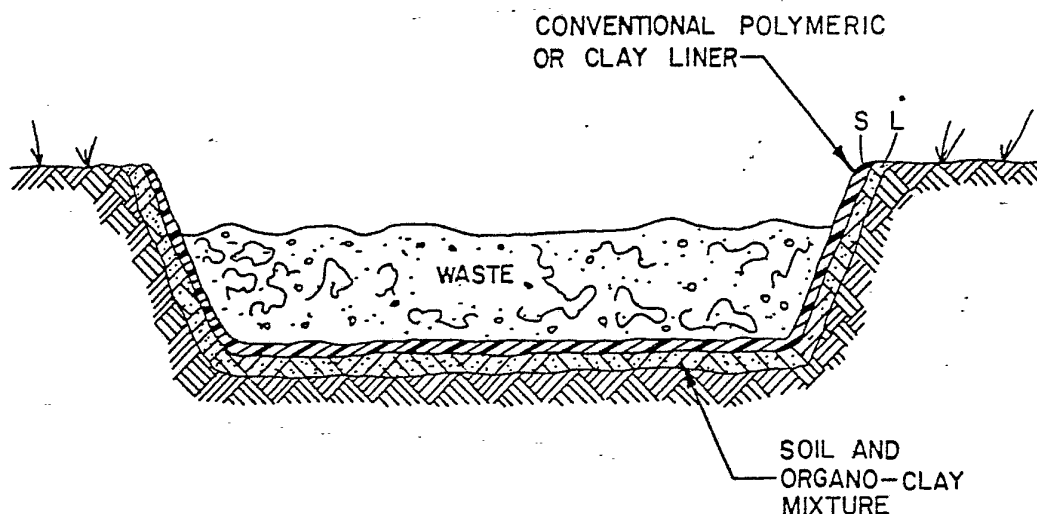


INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>3</sup> :  B01D 15/00; C02F 1/28		A1	(11) International Publication Number: WO 83/ 01204  (43) International Publication Date: 14 April 1983 (14.04.83)
(21) International Application Number: PCT/US82/01308 (22) International Filing Date: 24 September 1982 (24.09.82) (31) Priority Application Numbers: 307,300 419,302 (32) Priority Dates: 30 September 1981 (30.09.81) 20 September 1982 (20.09.82) (33) Priority Country: US (71) Applicant: RADIAN CORPORATION [US/US]; PO Box 9948, 8501 Mo-Pac Boulevard, Austin, TX 78766 (US). (72) Inventor: BEALL, Gary, W. ; 11814 Rustle Lane, Aus- tin, TX 78750 (US). (74) Agent: KLAUBER, Stefan, J.; Weingram & Klauber, East 210 Route 4, Paramus, NJ 07652 (US).			(81) Designated States: AT (European patent), AU, BE (Eu- ropean patent), CH (European patent), DE (Euro- pean patent), DK, FR (European patent), GB (Euro- pean patent), JP, LU (European patent), NL (Euro- pean patent), SE (European patent).  <b>Published</b> <i>With international search report.</i>

(54) Title: METHOD OF ORGANIC WASTE DISPOSAL



**(57) Abstract**

A method for controlling and containing organic material by sorbing it into an organoclay. Solid or liquid waste material or waste material in aqueous solution containing organic material are combined with a sufficient amount of organoclay to sorb and contain the organic material in the organoclay.

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DescriptionMethod of Organic Waste Disposal  
Related Applications

5 This application is a continuation-in-part of my  
copending application Serial No. 307,300, filed on Sep-  
tember 30, 1981, and entitled "Organoclay Waste Disposal  
Method". The entire disclosure of this parent applica-  
tion is incorporated herein by reference.

Background of Invention10 Technical Field:

This invention relates to a method for dispos-  
ing of waste fluids containing organic wastes and, more  
particularly, relates to a method for preventing escape  
of organic waste material from a waste disposal site.

15 Background Art:

One of the major problems facing cities, chem-  
ical manufacturers, and industries using various chemi-  
cals is waste disposal. More particularly, cities and  
industries are often faced with the disposal of mixtures  
20 and/or emulsions of organic contaminants. Typically,  
these are aqueous compositions, however, there exists  
waste fluids which are compositions of organic contam-  
inants and polar fluids. In many of these operations,  
the disposal of water containing the contaminant sub-  
25 stances is a problem. Regulations make it impossible to

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simply dump such waste water into streams, even if such method of disposal were desirable. Various methods have been proposed for removing such contaminants from waste water, but they have been relatively expensive or inefficient. Therefore, the removal of the contaminants from aqueous solutions, and in particular from waste water containing small amounts, is a problem which has not been completely solved.

One method in common use for organic waste disposal, utilizes waste disposal sites. Current such methods generally call for burying organic-containing waste in a lined area of containment to attempt to physically isolate the waste from any surface or ground water near the disposal site. These methods often include the use of polymer liners, bentonite liners, and bentonite-polymer liners (e.g. Vol clay) for the site. These techniques, however, suffer from two major problems. First, it is extremely difficult, if not impossible, to engineer a waste disposal site without having leaks occur in the engineered barriers either during initial placement, or with time as the engineered barriers age. In the case of polymer liners, the problem of initial placement is a major drawback since it is difficult to manufacture large sheets of synthetic liners that have no leaks, and because the sheets have finite sizes and must be sealed in the field. This sealing operation is very difficult to accomplish without leaks. One additional problem is that the presently used synthetic liners are also susceptible to puncture. A further major problem with polymers, is that after a finite period, sometimes within five to ten years, the polymer may begin to degrade badly, and to crack and rupture.

The bentonite and bentonite-polymer mixtures overcome some of the problems associated with polymeric

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liners. A problem with the clay liners is that in order to form the water impermeable layer, the swelling properties of the bentonite are of special significance. These properties, unfortunately, are a strong function of ground-water salinity and of wetting and drying cycles. Leaks in bentonite liners can be caused by ground water composition in at least two ways. If the salinity of the ground water or leachate is high, the swelling properties of the clay may be drastically altered. Secondly, if the ground water or leachate has a high content of divalent metals such as calcium or magnesium, again the swelling properties and thus the permeability of the clay may be drastically altered. Leaks can also occur through repeated cycles of wetting and drying that allow cracks to form in the liner. This will be the case in most landfills where the site is located in the unsaturated soil zone. Bentonite clay liners have also been shown to be very sensitive to some organics. It has been shown that bentonite liners undergo dehydration reactions when exposed to organics such as acetone that result in cracking of the liner.

A second major problem with all of these approaches is that they incorporate site designs that act like bathtubs. This may require some remedial action at some point to drain and treat the leachate that accumulates to ensure that leachate does not escape as overflow or breakthrough.

The following prior art is relevant to this invention:

2,367,384 to Tymstra;  
2,937,142 to Rios;  
3,487,928 to Canevari;  
3,948,770 to Goodrich et al;  
4,033,764 to Colegate et al;

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4,231,866 to Moser et al;  
4,279,756 to Weiss et al;  
9,149,968 to Kupiec;  
British 1,280,373 to Davies et al; and  
5 Japanese patent application 015979 to  
Koyo Kasei KK.

More specifically, Tymstra describes a method for removing small quantities of water-immiscible organic  
10 oily impurities from water. The method consists of contacting the oily composition with an inert solid coated with a cation surfaceactive bonding agent. The solid employed may be beach sand, mud flat deposits, silt, clay, limestone, silica, rice hulls, etc. The  
15 cationic surface-active bonding agent may be quaternary ammonium, phosphonium, arsonium, or primary, secondary, or tertiary organic amines or salts thereof.

Rios separates phenolic substances from aqueous solutions by contacting the aqueous solution with a clay  
20 absorbent. The clay is previously treated by depositing carbonaceous material thereon, and then subjecting it to combustion regeneration to burn off the carbonaceous material.

Canevari separates droplets of oil from an aqueous  
25 phase, using a mixture comprising a sodium montmorillonite clay and an organic cationic agent or glycol. The organic cationic agent is preferably an amine. The mixture is applied as a flocculating clarifying solution containing from 1 to 5% of clay to water, and an effective  
30 amount of the organic cationic agent or glycol.

Goodrich et al describes the use of an anionic polyelectrolyte and a sodium or a calcium montmorillonite clay to effectively separate water oil droplets in sea water.

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5        Colegate et al describes scavenging metal ions from solution by means of a complexing agent comprised of an inorganic substrate, such as a clay mineral, with covalent organic molecules, such as onium compounds, chemically bonded to the substrate.

Kupiec describes the use of bentonite clays and portland cement in aqueous solutions containing polluting materials, e.g. metallic ions, to form a solid mass.

10       Moser et al separates organic and aqueous phases by treatment of the emulsions with diatomaceous earth at an elevated temperature.

15       Weiss et al describes the use of a finely divide particulate mineral or clay material, the individual particles of which have been treated to produce a thin hydroxylated surface layer having a positive zeta potential at the adsorption pH.

20       Davies et al describes the separation of an oil from an emulsion. Several methods are enumerated for forming the emulsion into two layers for evaporation of the aqueous layer. One of these methods utilizes a mixture of surface-active clay and a polyelectrolyte is added to the emulsion. Bentonite is described as particularly suitable polyelectrolytes.

25       Koyo Kasei KK describes the detoxification of PCB-containing waste water by mixing the waste water with diatomaceous earth, bentonite or other clay which has been made lipophilic, and then mixing with cement, water, and aggregate. In the method less than 20% PCB waste liquor, sludges, etc., are mixed with the diatomaceous earth, bentonite, or clay minerals of inorganic fine particles previously made lipophilic by surface treatment. The PCB's are allowed to be absorbed on the mineral, and then the resulting materials are mixed with cement, water, and aggregate. Diffusing or leaching

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appears to be reduced. Activated carbons or silica gel may also be used in place of the clay.

Additionally, organoclays are well-known in the art, see for example the following U. S. patents:

- 5                   2,531,427 to Hauser;  
                  2,966,506 to Jordan;  
                  3,422,185 to Kuritzkef;  
                  3,974,125 to Oswald;  
                  4,081,496 to Finlayson; and  
10                  4,105,578 to Finlayson et al.

None of these aforementioned references teach or suggest the use of these organoclays to prevent the escape of organic waste material from a waste site.

#### Summary and Objects of the Invention

- 15               The invention includes methods for containing and preventing escape of hazardous organic waste material using organoclay material. The hazardous organic waste material which may escape from a waste disposal site is substantially contained and controlled by sorbing sub-
- 20               stantially all of the hazardous organic waste material passing from the waste disposal site in an organoclay to contain and substantially prevent escape of the hazardous organic waste material to the environment.

- It is thus an object of this invention to provide
- 25               a method for treating fluid waste, e.g. pools, streams, etc. to contain the contaminate therein in a waste disposal site. It is a further object of this invention to provide a method for treating both aqueous and polar fluid wastes containing organic contaminants.



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Brief Description of the Figures

Figure 1 is a graph showing the relationship of the logarithm of the distribution coefficients of priority organic compounds with the logarithm of their solubilities in water;

Figure 2 shows a schematic cross-sectional view of a conventional disposal site configuration incorporating the organoclay invention as liner beneath a conventional impermeable liner system;

Figure 3 shows a schematic cross-sectional view of a disposal site configuration using the organoclay invention as a filter bed treatment of waste leachate;

Figure 4 shows a schematic cross-sectional view of a proposed disposal site configuration using the organoclay invention as filtering system for waste leachate;

Figure 5 shows a schematic cross-sectional view of a proposed disposal site configuration using the organoclay invention to remove organic material from existing waste leachate;

Figure 6 shows a schematic cross-sectional view of a remedial use of the organoclay invention as a slurry trench to adsorb organic leakage from an existing waste disposal system;

Figure 7 shows a schematic cross-sectional view of a remedial use of the organoclay invention as directly injected into a waste disposal site to immobilize organic waste;

Figure 8 shows a schematic cross sectional view of application of the organoclay invention utilizing dry spraying onto the surface of a waste lagoon to form a liner upon settling and to stop waste leakage from the area;

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Figure 9 shows a schematic cross sectional view of the organoclay invention settled at the bottom of a waste lagoon forming an impermeable barrier and sorbing organic waste materials.

5        Figure 10 shows organic emissions from simulated landfarm disposal of petroleum study.

#### Disclosure of the Invention

Organoclays are well known in the art as exemplified by the aforementioned patents to Hauser, Jordan,  
10    Kuritzkey, Oswald et al, Finlayson, and Finlayson et al, the entire disclosures of which are incorporated herein by reference. In this invention, the term "organoclay" refers to various clay types, e.g. smectites, that have organo ammonium ions substituted for cations  
15    between the clay layers. The term organo ammonium ion substituted" refers to a substituted ammonium ion in which one or more hydrogen atoms are replaced by an organic group.

The organoclays are essentially solid compounds  
20    that have an inorganic and organic phase.

The preferred clay substrates for use in this invention are the smectite-type clays, particularly the smectite-type clays which have a cation exchange capacity of at least 75 millequivalents per 100 grams of clay.  
25    Useful clays for such purposes include the naturally occurring Wyoming variety of swelling bentonite and similar clays, and hectorite, which is a swelling magnesium-lithium silicate clay. The clays, are preferably converted to the sodium form if they are not already in  
30    this form. This can be effected, by a cation exchange reaction with a soluble sodium compound. These methods

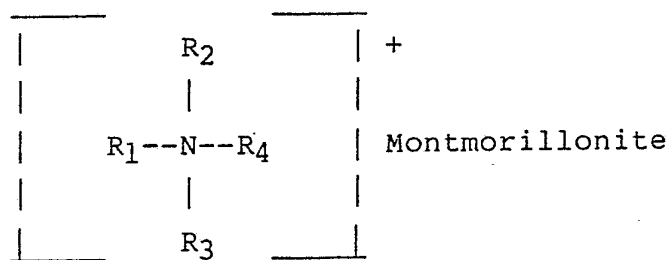
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are well-known in the art. Smectite-type clays prepared synthetically can also be utilized, such as montmorillonite, bentonite, beidelite, hectorite, saponite, and stevensite.

5       The organoclays useful in this invention include those set forth in U.S. Patent No. 2,531,427 to Hauser. These organoclays are modified clays which exhibit in organic liquids, some of those characteristics which untreated clays exhibit in water. For example, they  
10 will swell in many organic liquids and will form stable gells and colloidal dispersions.

Generally, the quaternary ammonium salt substituted onto the clay has organic groups attached to the clay which will range from aliphatic hydrocarbon of from 1 to  
15 24 carbons to aromatic organic molecules, such as benzyl groups that could have a host of groups substituted on the benzyl ring. The number of benzyl versus straight chain hydrocarbons substituted on the ammonium ion can vary from 3 to 0 (i.e. dimethyl dioctododecyl 0:2, methyl benzyl dioctododecyl 1:2, dibenzyl dioctobenzyl 1:1,  
20 tribenzyl octadecyl 3:1, methyl dibenzyl octodecyl 2:1). The amount of alkyl ammonium salt substituted on the clay can vary between 0.5% to 50%.

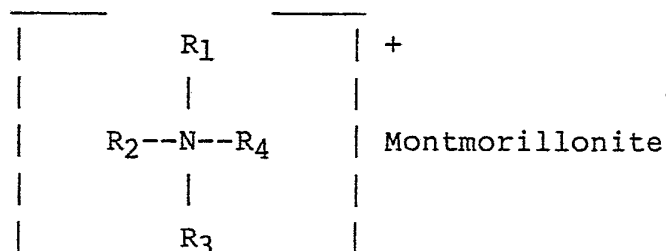
In particular, the preferred organoclay used in  
25 this invention comprises one or more of the following quaternary ammonium cation modified montmorillonite clays:



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wherein  $R_1$  is an alkyl group having at least 10 carbon atoms and up to, for example, 24 carbon atoms, and preferably having a chain length of from 12 to 18 carbon atoms;  $R_2$  is hydrogen, benzyl or an alkyl group of at least 10 carbon atoms and up to, for example, 24 carbon atoms, and preferably from 12 to 18 carbon atoms; and  $R_3$  and  $R_4$  are each hydrogen or lower alkyl groups, viz., they contain carbon chains of from 1 to 4 atoms, and preferably are methyl groups.

Other organoclays utilizable in the invention include benzyl organoclays such as dimethyl benzyl (hydrogenated tallow) ammonium bentonite; methyl benzyl di(hydrogenated tallow) ammonium bentonite; and more generally quaternary ammonium cation modified montmorillonite clays represented by the formula:



wherein  $R_1$  is  $CH_3$  or  $C_6H_5CH_2$ ;  $R_2$  is  $C_6H_5CH_2$ ; and  $R_3$  and  $R_4$  are alkyl groups containing long chain alkyl radicals having 14 to 22 carbon atoms, and most preferably wherein 20 to 35% of said long chain alkyl radicals contain 16 carbon atoms and 60% to 75% of said long chain alkyl radicals contain 18 carbon atoms.

The montmorillonite clays which may be so modified are the principal constituents of bentonite rock, and have the chemical compositions and characteristics described, for example, in Berry and Mason, "Mineralogy", 1959, pp. 508-509. Modified montmorillonite clays of this type in (i.e. organoclays) are commercially avail-

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able from Southern Clay Products, Inc., Gonzales, Texas under such trade designations as CLAYTONE 34 and 40, and are available from NL Industries, Inc., New York, New York under such trade designations as BENTONE 27, 34, and 38. The preferred organoclays utilized in this invention, are the higher dialkyl dimethyl ammonium organoclays such as dimethyl di(hydrogenated tallow) ammonium bentonite; the benzyl ammonium organoclays, such as dimethyl benzyl (hydrogenated tallow) ammonium bentonite; and ethylhydroxy ammonium organoclays such as methylbis (2-hydroxyethyl) octodecyl ammonium bentonite.

The fluid waste, which may be an aqueous waste or a waste fluid whose carrier fluid is a polar composition, e.g. aliphatic alcohol, etc. contains an amount of organic contaminant emulsified therein. Typical organic contaminants are the chlorinated organic compounds, e.g. DDT, BDD, DDE, 2, 4-dichlorophenol tetrachloroethylene, and other organics such as benzene, toluene, methylene chloride, chloroform, 1, 2 dichloroethane, 1, 1, 1-trichloroethane, trichloroethylene, tetrachloro ethylene, 2-nitrophenol, pentachlorophenol, dimethyl phthalate, Lindane, Arochlor-1254, ethyl benzene, HCP parathion, dichlorobenzene, hexachlorocyclopentadiene, ethylparathion, 2, 4-dinitrotoluene, naphthalene, pyrene, etc.

In the method of this invention, waste disposal sites are designed to use organoclays in at least two ways. The first approach as shown in Figure 2, is to line the disposal site with a mixture of soil and organoclay L. The soil should be mixed with the organoclay at a rate of between about one and ten pounds of organoclay per square foot of soil. The soil and organoclay mixture can then be covered by a conventional imperme-



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able liner system. This approach has the advantage of removing any organic compounds from the leachate that escape through the conventional synthetic or clay liner. It is understood that conventional excavating techniques, as well as conventional transporting and depositing techniques, are be used for the waste disposal system.

The approach shown in Figure 2 may, in certain circumstances, suffer from the bathtub effect. This problem can be addressed by engineering passive organoclay filtering systems. These systems use large filtering beds of organoclay constructed such that the liner system of the waste disposal system acts as a leachate collection system for these filters. The leachate flowing through these beds has the organic material removed by the organoclay and thus the leachate is released safely into the ground water. These filter beds are easily monitored to determine when and if the filtering medium needs to be changed. This controlled release of leachate has significant advantages over previous systems of waste disposal.

Figure 3 illustrates a filtering system using a filter bed of organoclay 10. The bed of organoclay 10 is surrounded by a container or tank 11 which may be formed of concrete or other suitable material. The size of the container 11 and bed 10 is sufficient to handle the amount of leachate from the waste disposal system, which depends on the size of the system and the amount of water in or added to the system. The container 11 is connected by a pipe connector or conduit 12 to a conventional impermeable liner 13 of a waste disposal system. The waste material 14 is contained by the conventional liner system which acts as a water collection system. As a leachate collects in the waste, it is flowed

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through the pipe connector 12 to the bed 10 of organo-  
clay. After sorbing of the organic molecules the fil-  
tered leachate exits through pipe 15, which conducts the  
organic-free leachate away from the waste disposal site.  
5 Suitable monitoring points or wells 16 and 17 are provi-  
ded to determine when and if the filtering medium needs  
to be changed. This can be determined by withdrawing  
samples of the organoclay for testing.

Another type of filtering system for a waste dis-  
posal is shown in Figure 4. The system includes a con-  
ventional impermeable liner system 13a for containing  
waste material 14a. A pumping system 18 (schemetically  
shown) is provided having an intake pipe 19 extending  
into the waste and an exit pipe 20 for flowing leachate  
15 into the organoclay bed 10a. The organoclay bed 10a is  
contained in a container or tank 11a. An exit pipe 15a  
is provided for the treated leachate. A monitoring  
means 16a is provided to determine when and if the fil-  
tering medium needs to be changed. The filtering system  
20 shown in Figure 4 can easily be added to conventional  
waste disposal systems. The size of the filtering sys-  
tem is proportioned to the output of the waste disposal  
system.

Another type of filtering system is shown in Figure  
25 5. In this system, a conventional liner system 13b is  
provided for containing the waste material 14b. A bed  
10b of organoclay is provided for removing organic ma-  
terial from the leachate. The bed 10b can be in the  
form of a cylindrical or rectangular channel at a drain-  
30 ing point for the waste disposal system. It may  
extend along the lower edge or a lower side of a waste  
disposal system. It is of sufficient size to trap all  
leachate from the waste disposal system. A monitoring  
well or point 16b is provided to determine when and if

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the filtering medium needs to be changed.

In accordance with the invention; organoclays can also be used in other ways with existing waste disposal sites as a remedial measure. For a landfill that is  
5 leaking and contaminating ground water, the organoclay can be applied in several ways. The first way is in the form of a slurry wall or trench. A waste disposal system incurring leakage is shown in Figure 6. The waste disposal system includes a conventional impermeable  
10 liner system 13c for containing waste material 14c. A breach of the liner system is schematically shown in the form of a hole 21 in the liner system. Escaping leachate represented by the arrows 22 and 23 migrates to the slurry wall 24 which is composed of organoclay. The  
15 slurry wall is a trench filled with the organoclay. As the leachate flows through the trench 24 filled with the organoclay, the organic materials are sorbed by the organoclay such that the leachate 25 exiting the trench 24 is treated to avoid polluting water with organic com-  
20 pounds.

Another way the organoclay can be used as a remedial measure is by directly injecting it into the waste disposal site to immobilize the organic waste. This is schematically illustrated in Figure 7 which shows a  
25 source 26 of a slurry of organoclay which is pumped through a line 27 into the waste material 14d. The waste material 14d is contained by an impermeable liner 13d.

In accordance with the invention, organoclays can  
30 also be applied to waste lagoons and on organic materials such as petroleum on water or land. This can be accomplished by spraying clay on the surface of the organic material and allowing the clay to settle or sorb the organic material. This is schematically shown in



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Figure 8 which shows a liquid waste lagoon 28 without a liner, although it could have a standard impermeable liner. A leak is schematically illustrated by the arrow 30. A spray mechanism 29 is provided for spraying the organoclay material onto the organic material or liquid waste. The organoclay will sorb the organic compounds from the aqueous phase. It will also settle to the bottom of a lagoon as shown in Fig. 9 to form an impermeable layer or liner 31 to the waste flow so that the leak is stopped.

The invention as shown in Figures 8 and 9 has certain distinct advantages. The system acts as an impermeable barrier to ground water flow because of the organoclay's swelling properties. This is very important since it can stop or retard ground water flow into the disposal area and also retard migration of the organic waste from the disposal site. The organoclay will also retard the migration of the organic waste by the partition mechanism previously described. This is an extreme improvement over current liners which only form physical barriers to waste migration.

The organoclay, upon mixing in the fluid waste, swells as the organic contaminant molecules are sorbed into and on to the organoclay. The organoclay additionally fixes the organic contaminant compounds through absorption involving partitioning of the organic molecules of the contaminant into the organoclay.

The organic molecules of the contaminant preferably partition into the organic phase of the organoclay versus the aqueous phase or polar fluid phase of the fluid. The magnitude of organic partitioning of a given organic molecule into the organoclay over, for example, the aqueous phase can be predicted qualitatively by the solubility of the organic molecule in the aqueous phase.



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That is to say, an organic molecule that is very insoluble, e.g. oil, in an aqueous phase will partition very strongly into the organoclay relative to a more soluble organic molecule. This partitioning phenomenon also follows chromatographic theory which allows precise predictions of how organic molecules will migrate through a bed of organoclay. Figure 1 shows the linear relationship of distribution coefficients for several key organic species with three forms of organoclay. The distribution coefficient equals the amount of organic adsorbed in the clay divided by the amount left in solution times the volume of the solution divided by the mass of the clay. The aqueous solution contains the organics listed in Figure 1. Generally, the amount in solution depends on solubility.

#### Example 1

In order to demonstrate the efficacy of the organoclay used in this invention, several batch sorption experiments were performed with two forms of dimethyl organoclay and compared to sorption by an unmodified montmorillonite. These were conducted with 100:1 solution to solid ratio. The following Tables 1, 2 and 3 are a summary of these studies showing results from batch equilibration sorption studies of an unmodified montmorillonite, CLAYTONE<sup>®</sup> 34 and CLAYTONE<sup>®</sup> 40 respectively. CLAYTONE<sup>®</sup> 34 and CLAYTONE<sup>®</sup> 40 are organoclays, each being a dimethyl di(hydrogenated tallow) ammonium bentonite products, available from Southern Clay Products, Inc. of Gonzales, Texas. It can be seen that extremely efficient removal occurs for all of the listed organics with the organoclays. The analyses for



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the majority of compounds in Tables 1, 2 and 3 were conducted by standard gas chromatographic techniques. The data for benzene, toluene and methylene chloride in these Tables are less accurate because the measurements were conducted by determining only the total organic carbon concentration.

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Table 1

Organic Species	Inlet Concentrations		Concentration in Blank	24 hours Batch Equilibrium Concentration		48 Hours Batch Equilibrium Concentration	
	(ppb)	(ug/l)	(ppb)	(ug/l)	(ppb)	(ug/l)	(ppb)
Amount Recovered (ppb)	Blank (ppb)	% Sorbed	Amount Recovered (ppb)	Blank (ppb)	% Sorbed	Amount Recovered (ppb)	Blank (ppb)
Spiking Level in Blank (ppb)	(ug/l)	(ug/l)	Spiking Level in Blank (ppb)	(ug/l)	(ug/l)	Spiking Level in Blank (ppb)	(ug/l)
Aroclor 1254	3.65	0	4.95	0	0	13	0
p,p'-DDT	0.88	0	0.82	0	7	0.96	0
o,p'-DDT	1.77	0	2.11	0	0	2.16	0
p,p'-DDD	0.75	0	0.75	0	0	0.88	0
o,p'-DDD	0.43	0	0.46	0	0	0.36	0
o,p'-DDE	0.17	0	0.20	0	0	0.15	0
2,4-Dichlorophenol	18,000	0	11,000	0	39	11,000	0
Tetrachloroethylene	318	0.20	278	2.10	13	331	0.70
Benzene	1.35x10 <sup>5</sup>	0	1.35x10 <sup>5</sup>	0	0		
Toluene	5.4x10 <sup>4</sup>	0	4.54x10 <sup>4</sup>	8	16		
Methylene Chloride	5.12x10 <sup>5</sup>	0	4.40x10 <sup>5</sup>	0	14		

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Table 2

Organic Species	Inlet Concentrations (ppb)(ug/l)	Concentration in Blank (ppb)(ug/l)	24 Hours Batch Equilibration Concentration		48 Hours Batch Equilibration Concentration		% Sorbed
			Amount Recovered (ppb)(ug/l)	Blank (ppb)(ug/l)	Amount Recovered (ppb)(ug/l)	Blank (ppb)(ug/l)	
Aroclor 1254	3.65	0	0	0	0	0	100
p,p'-DDT	0.88	0	0	0	0	0	100
o,p'-DDT	1.77	0	0	0	0	0	100
p,p'DDD	0.75	0	0	0	0	0	100
o,p'DDD	0.43	0	0	0	0	0	100
p,p'-DDE	0.56	0	0	0	0	0	100
o,p'-DDE	0.17	0	0	0	0	0	100
2,4-Dichloro-phenol	8,000	0	200	0	200	0	99
Tetrachloro-ethylene	318	0.20	25	0.3	24	0.2	92
Benzene	3.5 x 10 <sup>5</sup>	0	5400	0			96
Toluene	5.4 x 10 <sup>4</sup>	0	2160	0			96
Methylene Chloride	5.12 x 10 <sup>5</sup>	0	1.08 x 10 <sup>5</sup>	0			79

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Table 3

Organic Species	Inlet Concentrations (ppb)(ug/l)	Concentration in Blank (ppb)(ug/l)	24 Hours Batch Equilibrium Concentration		48 Hours Batch Equilibrium Concentration	
			Amount Recovered (ppb)	Blank (ppb)	Amount Recovered (ppb)	Blank (ppb)
			(ug/l)	(ug/l)	(ug/l)	(ug/l)
			% Sorbed	% Sorbed	% Sorbed	% Sorbed
Aroclor 1254	3.65	0	0	0	0	0
p,p'-DDT	0.88	0	0	0	0	0
o,p'-DDT	1.77	0	0	0	0	0
p,p'-DDD	0.75	0	0	0	0	0
o,p'-DDD	0.43	0	0	0	0	0
p,p'-DDE	0.56	0	0	0	0	0
o,p'-DDE	0.17	0	0	0	0	0
2,4-Dichlorophenol	18,000	0	200	0	200	0
Tetrachloroethylene	318	0.20	27	0.3	25	0.30
Benzene	1.35 x 10 <sup>5</sup>	0	3420	0		
Toluene	5.4 x 10 <sup>4</sup>	0	1620	0		
Methylene Chloride	5.12 x 10 <sup>5</sup>	0	1.13 x 10 <sup>5</sup>	0		

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Example 2

The following Table 4 gives an initial comparison of literature values of sorption capacities of activated charcoal for several organic compounds and sorption capacities from experimental data for the dimethyl di(hydrogenated tallow) form of the organoclay for these organic compounds. The data for charcoal was taken from EPA Report 600/8-80-23 and for the organoclay from data based on single experimental value per compound.

Table 4

Sorption Capacities (mg/g)

<u>Organic Compound</u>	<u>Charcoal</u>	<u>Organoclay</u>
Benzene	0.1	18
Toluene	25.0	6
Methylene Chloride	1.2	49

Example 3

The superiority of the organoclay for sorption of organics was further investigated. The sorption of three forms of organoclay at various loading rates for 12 priority organics were compared with activated charcoal in laboratory experiments and these results are shown in the following Table 5.



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Table 5

		Percentages of Sorption											
Concentration of Organic Clay Dose	Clay Type	Dimethyl Benzyl (Hydrogenated Tallow)			Dimethyl Di(hydrogenated tallow)			Methylbis (2-hydroxyethyl) Octodecyl Ammonium Bentonite			Car-bon		
		130	660	1300	130	660	1300	130	660	1300	130	660	1300
1,000	Chloroform												
1,000	1,2 Dichloroethane	64	49	56	47	55	43	42	49	51			27
1,000	1,1,1 Trichloroethane	46	36	50	48	49	42	34	29	36			40
1,000	Trichloroethylene	60	55	54	40	49	40	36	43	45			30
1,000	Tetrachlorethylene	27	24	25	12	43	9	5	13	22			86
700	2 Nitrophenols	85	46	74	47	51	74	11	39	60			92
750	Pentachlorophenol	84	87	99	27	92	87	49	84	91	95	97	85
400	Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	94	92	ND	ND	94
400	Lindane	85	ND	ND	92	94	ND	70	ND	ND	ND	ND	92
100	Arochlor 1254	99.7	93	ND	99.9	85	ND	99.9	ND	ND	ND	ND	-
15	Ethyl Benzene	40	29	90	88	95	94	88	77	98	90	98	99.7
	ND= Not Detected	29	16	22	13	24	71	8	16	-	-	-	-



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Example 4

Volatile organics emanating from landfarm disposal of petroleum sludge can be reduced by application of organoclays in accordance with the invention. Figure 14 illustrates initial emissions from an untreated landfarm waste in soil and landfarm waste which was treated in soil with a thin layer of organoclay sprinkled onto the waste burdened surface in portions A and B, respectively. The magnitude of these emissions results from physically disturbing the landfarmed waste by disking or tilling, a normal commercial practice. Figure 10, portions C and D, illustrate the volatile organic concentration results from tilling the organoclay treated surface 24 and 72 hours after treatment. It can be seen that after the first disking, the emissions were reduced essentially to background levels. For up to ten days after the initial waste implacement, this same low level quantity of emissions occurred even when the landfarm was disked repeatedly. Applications of organoclay also tends to solidify the waste-burdened surface producing a mechanically superior surface. Vehicles are able to travel over the organoclay treated area sooner after the waste was applied; currently, industrial landfarm operations are delayed about three days between waste applications to ensure that stable surface for heavy equipment are regained. It is not uncommon for the landfarm vehicles to become stuck in areas where the wastes are not percolating into the soil rapidly enough to accommodate a mechanically stable surface, and application of organoclay to these surfaces alleviates this situation.

While the present invention has been particularly set forth in terms of specific embodiments thereof, it will be understood in view of the present disclosure,



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that numerous variations upon the invention are now enabled to those skilled in the art, which variations yet reside within the scope of the present teaching. Accordingly, the invention is to be broadly construed, and

5 limited only by the scope and spirit of the claims now appended hereto.



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Claims

1. A method for preventing escape of organic contaminant material, comprising the steps of: collecting the organic waste material at a waste disposal site;  
5 substantially containing and preventing release of hazardous organic waste material from the waste disposal site; and sorbing substantially all of the hazardous organic waste material passing from the waste disposal site in an organoclay to substantially  
10 prevent escape of the hazardous organic waste material to the environment.
2. The method as set forth in claim 1 including the step of: forming a liner containing an organoclay around the waste disposal site to substantially prevent  
15 escape of any hazardous organic waste material from the site and sorb the escaping waste material.
3. The method as set forth in claim 1 including the step of: substantially containing the waste at the waste disposal site using an impermeable liner system.
- 20 4. The system as set forth in claim 1 including the steps of: flowing leachate from the waste disposal site to a filtering means containing organoclay to remove hazardous organic waste from the leachate.
- 25 5. The method as set forth in claim 1, wherein the organoclay is formed of a solid compound having an inorganic and organic phase which will sorb organic molecules.



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6. The method as set forth in claim 1, wherein the clay substrate for the organoclay is a clay type forming a suitable organic clay complex using bentonite, hectorite, or attapulgite as a clay substrate.
- 5     7. The method as set forth in claim 1, wherein the organoclay includes a quaternary ammonium salt which is substituted onto the clay.
8. The method s set forth in claim 7, wherein the quaternary ammonium salt has organic groups attached  
10     that range from aliphatic hydrocarbon chains varying from 1 to 20 carbons to aromatic organic molecules such as a benzyl group.
9. The method of claim 1, wherein the organoclay is a higher dialkyl dimethyl ammonium organoclay.
- 15     10. The method of claim 1, wherein the organoclay is a benzyl ammonium organoclay.
11. The method of claim 1, wherein the organoclay is an ethylhydroxy ammonium organoclay.
12. The method of claim 1, wherein the amount of organo-  
20     clay is at least about 1% by weight of the amount of organic contaminant.
13. The method of claim 1, wherein the amount of organo-  
clay is at least about 5% by weight of the amount of organic contaminant.
- 25     14. The method of claim 7, wherein the amount of organo-  
clay is a maximum of about 10% by weight of the

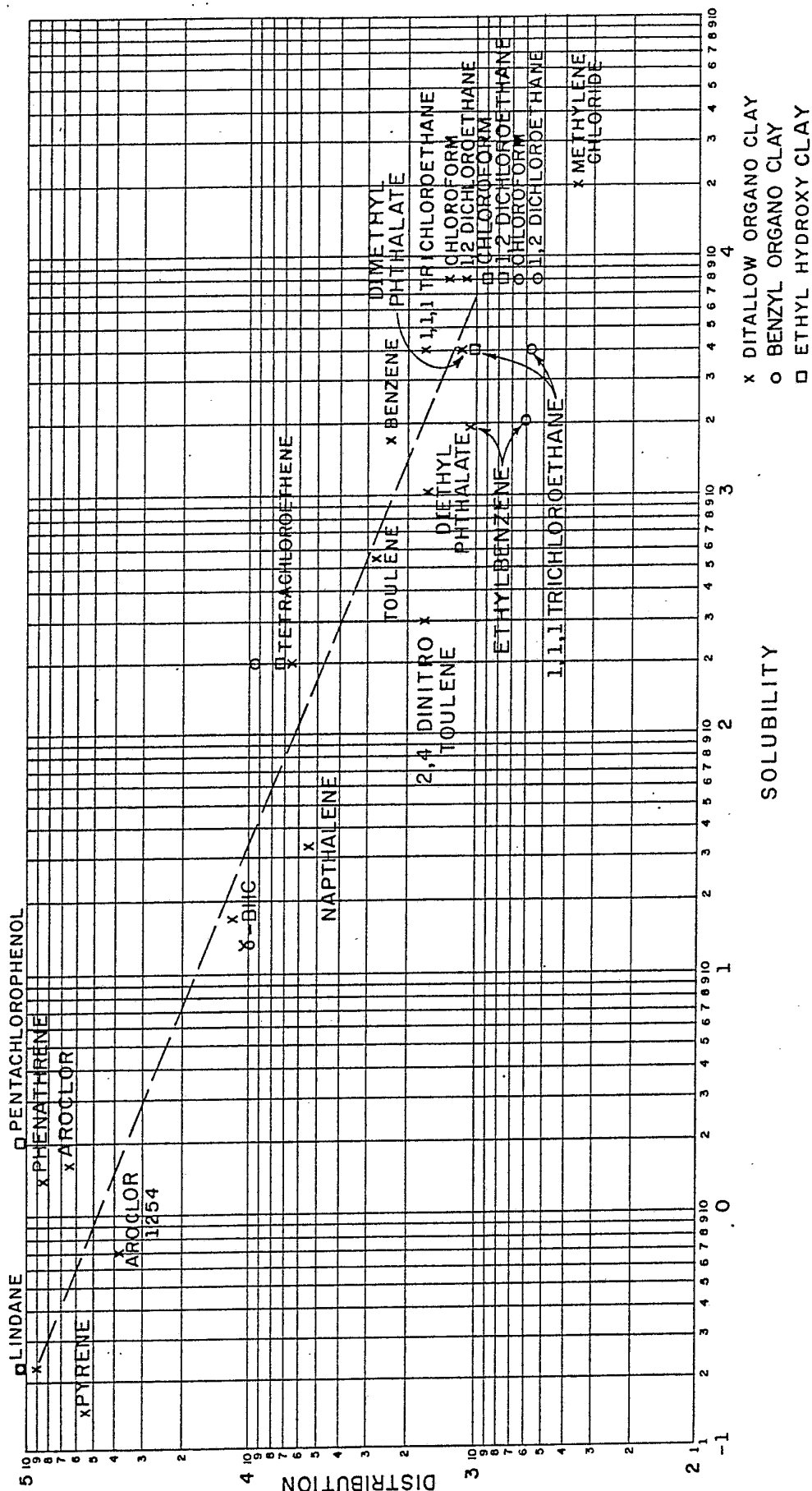


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amount of organic composition.

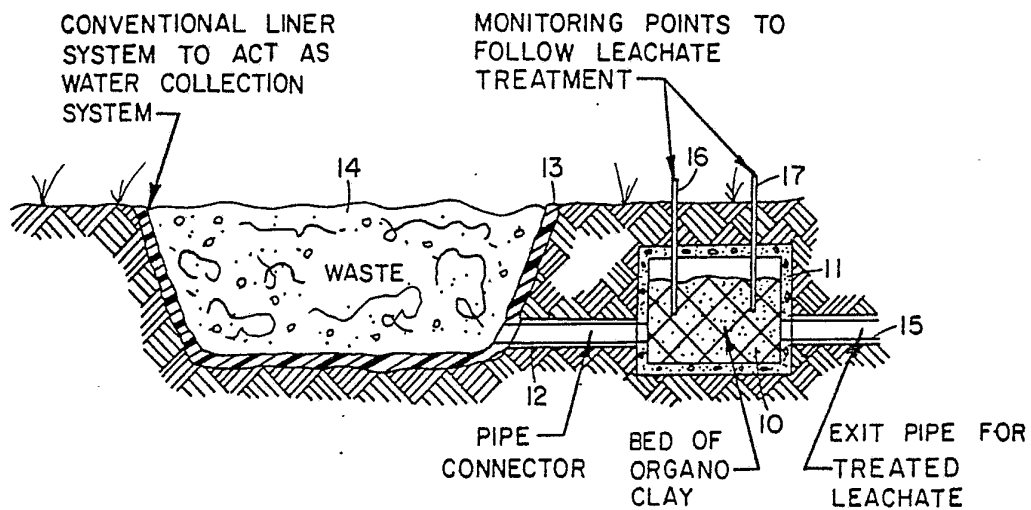
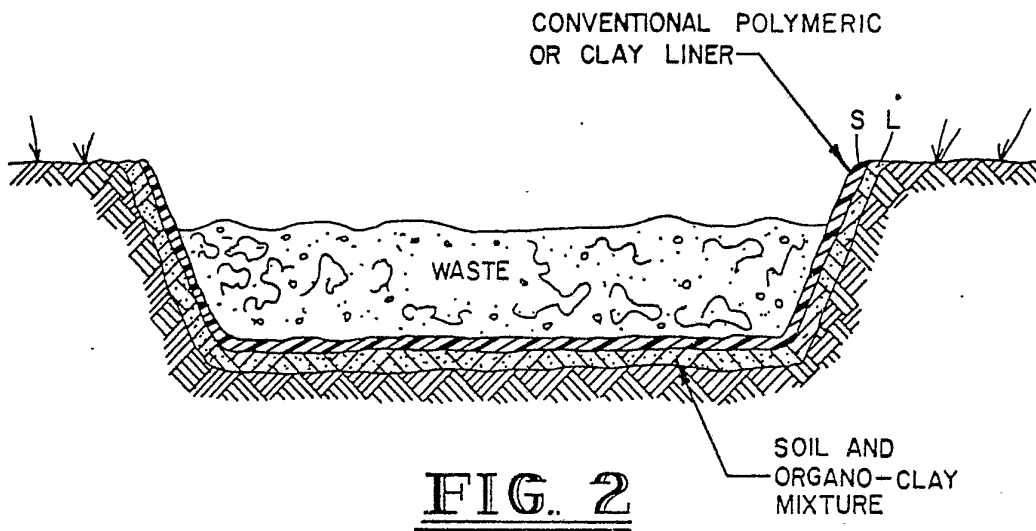
15. The method of claim 8, wherein the amount of organo-  
clay is a maximum of about 10% by weight of the  
amount of organic composition.
- 5 16. A method of controlling and limiting migrations of  
organic material into the environment, comprising the  
steps of: bringing a predetermined amount of organo-  
clay into contact with an organic material; sorbing  
the organic material into the organoclay; and con-  
10 taining the organoclay and sorbed organic material  
to control and limit migration of the organic mater-  
ial into the environment.
17. The method as set forth in claim 15, wherein the or-  
ganic material is an aqueous solution.
- 15 18. The method as set forth in claim 15, wherein a solid-  
ifying material is added to the organic material and  
organoclay to form a solid material containing the  
organic material sorbed into the organoclay.



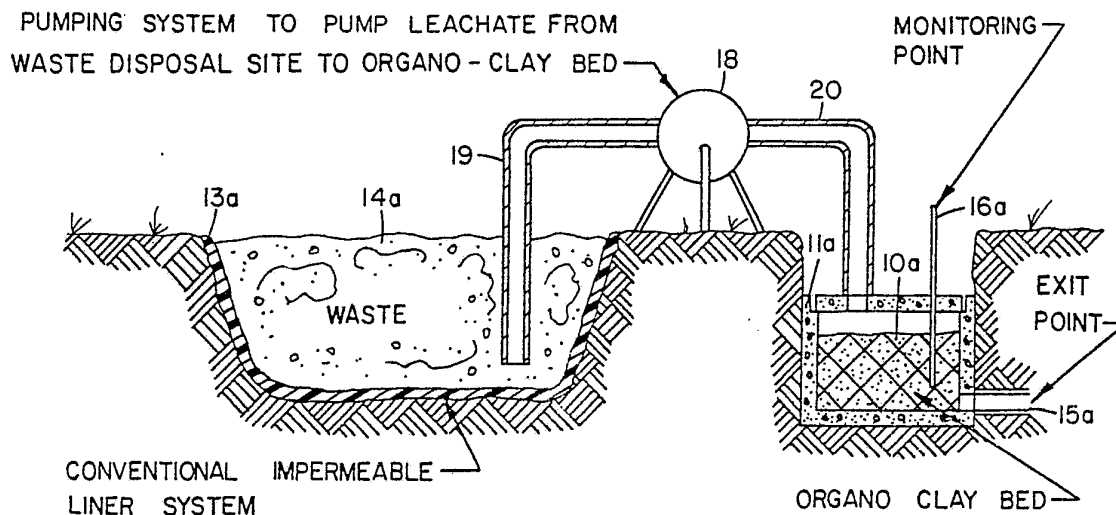
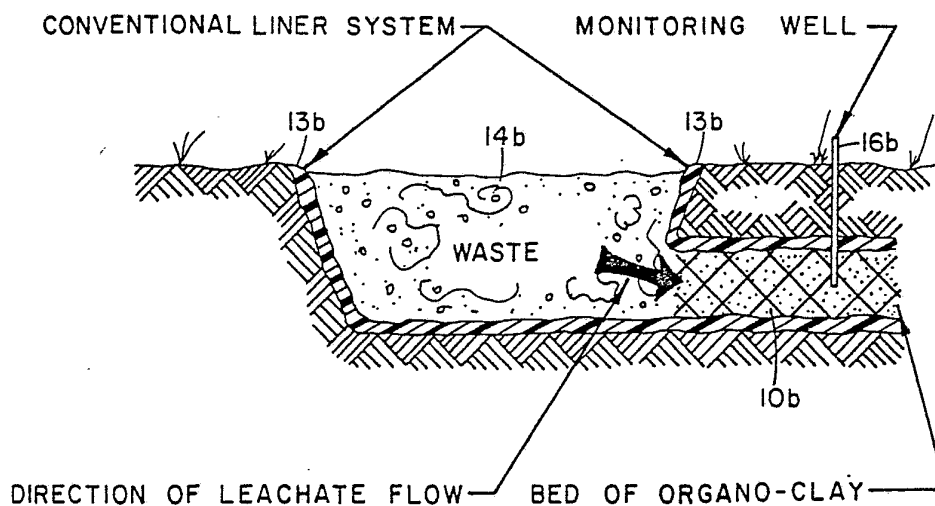


**FIG. 1**

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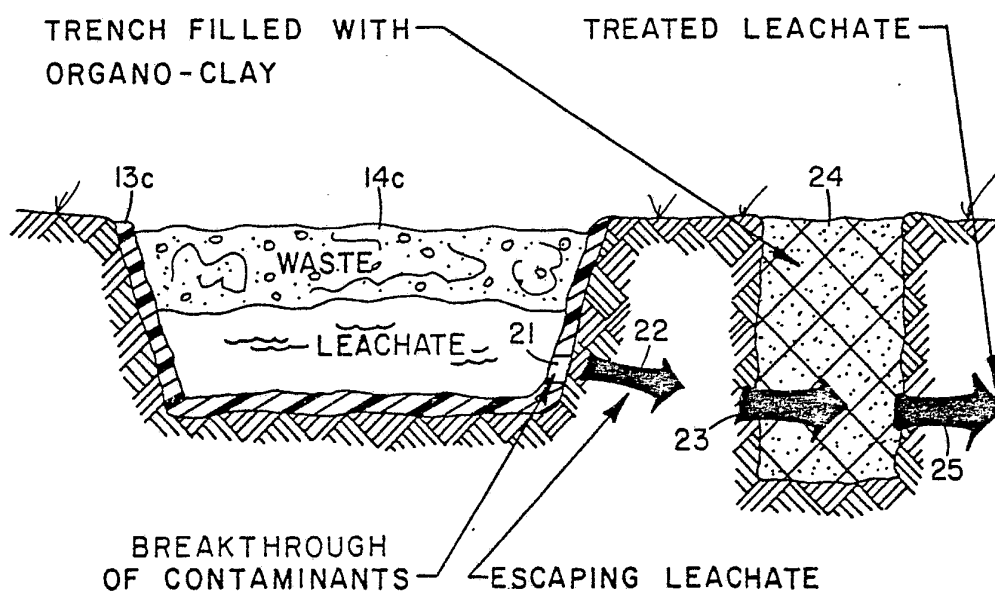
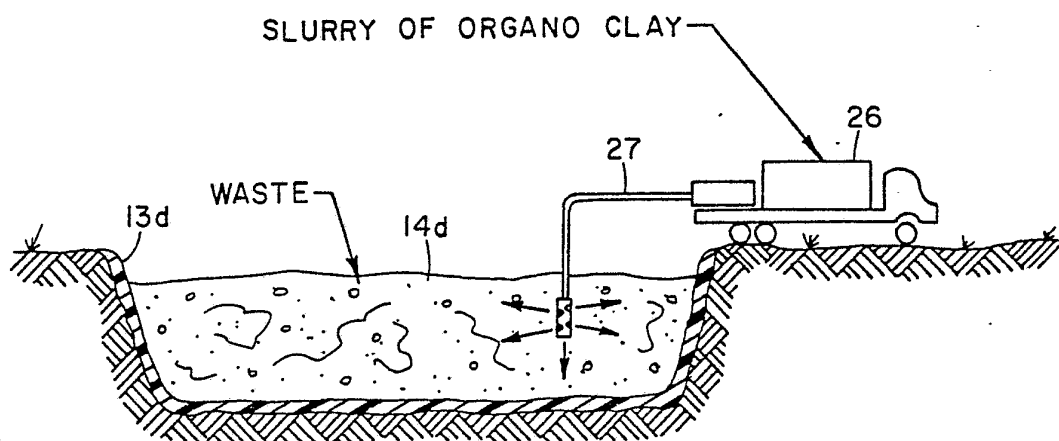
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FIG. 4FIG. 5

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FIG. 6FIG. 7

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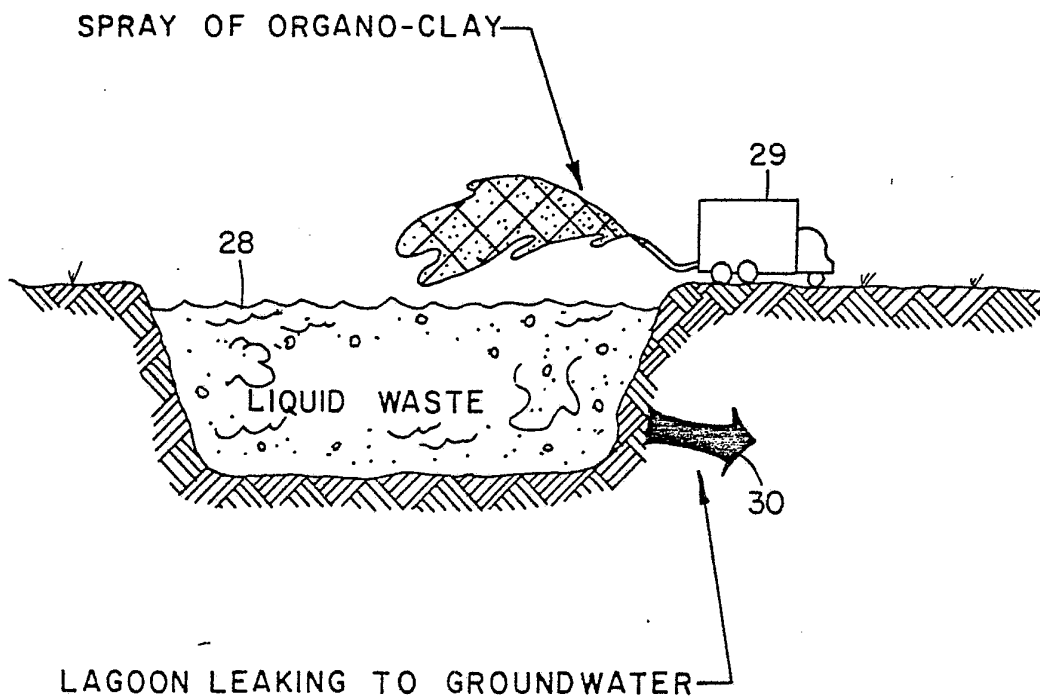


FIG. 8

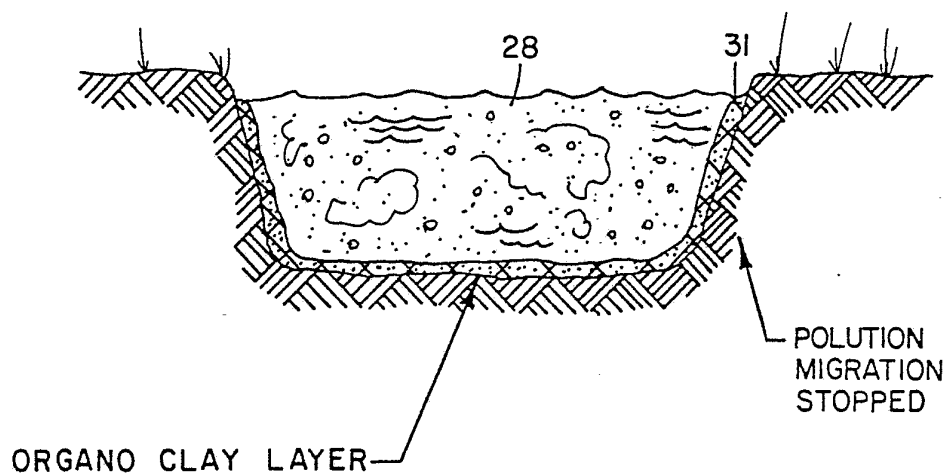


FIG. 9

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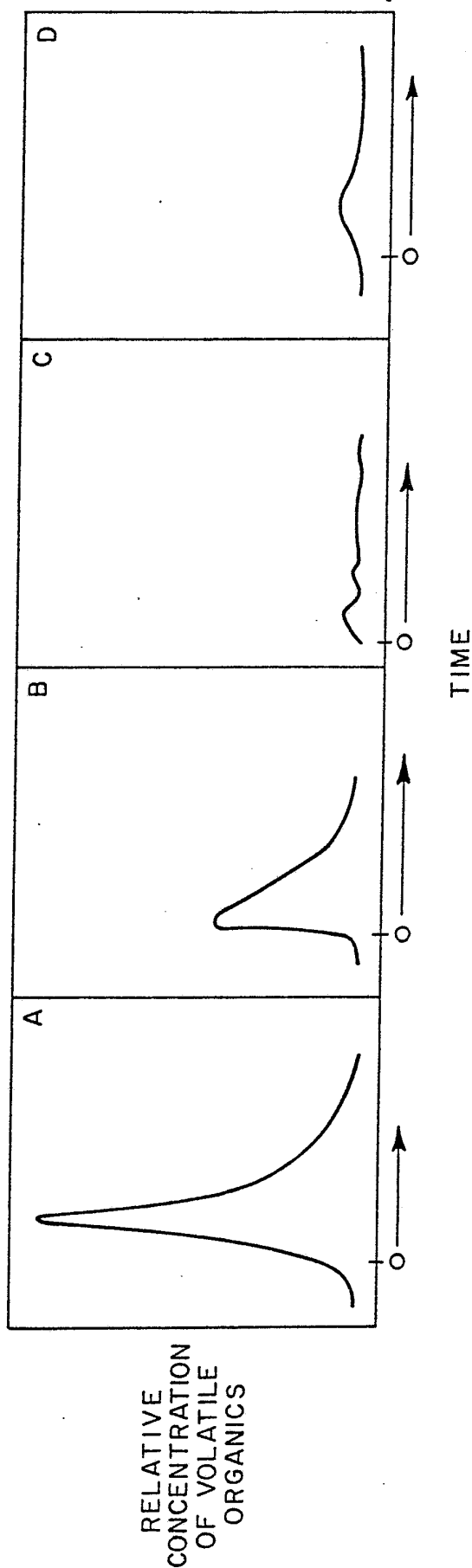


FIG. 10

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# INTERNATIONAL SEARCH REPORT

International Application No PCT/US82/01308

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)

According to International Patent Classification (IPC) or to both National Classification and IPC

INT. CL.<sup>3</sup> B01D 15/00; C02F 1/28

U.S. CL. 210/679,619,747,908

## II. FIELDS SEARCHED

Minimum Documentation Searched<sup>4</sup>

Classification System

Classification Symbols

U.S. 210/679,680,691,747,751,170,908-910,924  
252/428,430

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched<sup>5</sup>

## III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>14</sup>

Category<sup>\*</sup> Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup> Relevant to Claim No. <sup>18</sup>

A	US,A, 4,070,282 (OTTO) 24 JANUARY 1978	1-17
A	US,A, 4,149,968 (KUPIEC) 17 APRIL 1979	18
A	US,A, 4,167,481 (CREMERS) 11 SEPTEMBER 1979	1-17
A	US,A, 4,276,164 (MARTONE) 30 JUNE 1981	2,3

### \* Special categories of cited documents: <sup>15</sup>

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"Δ" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search<sup>1</sup>

Date of Mailing of this International Search Report<sup>2</sup>

14 DECEMBER 1982

23 DEC 1982

International Searching Authority<sup>3</sup>

Signature of Authorized Officer<sup>20</sup>

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