(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 059 625**
A1

(12) # EUROPEAN PATENT APPLICATION

(21) Application number: **82301004.6**

(22) Date of filing: **26.02.82**

(51) Int. Cl.³: **E 02 B 3/12**

(30) Priority: **27.02.81 US 238701**

(43) Date of publication of application:
08.09.82 Bulletin 82/36

(84) Designated Contracting States:
DE FR GB SE

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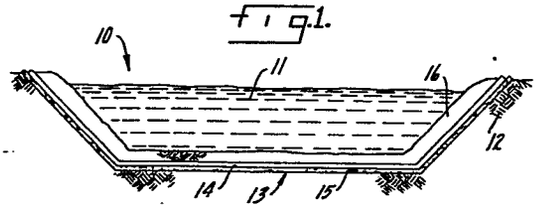
(54) **Waterproofing soil.**

(57) A method and a product providing for water-proofing soil utilizing a flexible support (15) capable of venting gas coated with water-swellable bentonite (14) and covering the soil to be waterproofed with the coated support.

Fig.1.



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WATERPROOFING SOIL

The present invention relates to a moisture impervious sheet and more particularly to a moisture impervious sheet particularly suitable for environmental pollution control as a water barrier for the building of ponds, lagoons and as a soil sealent for hazardous or nuclear waste having a flexible support capable of venting gas and coated with an adhesive and water-swellable bentonite in such a manner so as to retain its flexibility.

Various rigid panels useful in construction have been defined in prior U.S. patents 4,048,373, 4,070,839, and 4,139,588 granted to Arthur G. Clem relating to panels and utilizing bentonite to form water barriers. In another U.S. patent issued to Arthur G. Clem, 4,209,568, there is disclosed a bentonite containing gelled oil waterproofing composition which is useful for coating the walls of various constructions to provide waterproof barriers. However, the instant invention is concerned with providing waterproof barriers for ponds, lagoons and hazardous waste sites. These present particular problems in the fact that they are extremely large areas and may be subjected to extreme forces, pressures and movement. Under such conditions rigid construction materials would be too hard to work with and extremely difficult to maintain.

Some waste matter from industrial operations is noxious, hazardous or toxic. The full listing is too large to include, but some samples would be uranium tail-

ing, spent radioactive matter, acid metal salt solutions and the insoluble lime salts there of, metallic pigments, acidified sludges from crude oils, spent lubricating oils, solvents, paints, polychlor biphenyls, DDT, and similar poisons. Many of these are insoluble or sparingly soluble in water. But waste acids from some waste sources could inter-react with some insoluble metal wastes to generate a toxic metal solution leachate.

Leachate from hazardous waste must not enter the groundwater supply. If it does, large sources of drinking water may be contaminated for lengthy periods of time. For this reason, hazardous waste is sometimes stored in clay mines with three meters or more of native clay below the waste material.

More frequently, the soil at the waste disposal site may be permeable to some degree. If "clay" soil is available, it may be moved into the site, spread, disintegrated and moistened to the condition of maximum compactability, then rolled or tempted in fifteen cm to twenty cm lifts to form an impermeable surface. The surface cover may be in the sixty to one hundred cm thickness range. A simple calculation will show that this cover coat will significantly reduce storage volume, or will require extra earth excavation to maintain the original design volume.

If native clay soil is not present, or cannot be moved into the landfill site, one method of sealing

soil has been that of a plastic sheet, laid on the ground, with seams overlapped and welded or cemented. Plastic sheets or films have many problems. Some are sensitive to ultraviolet light, and must be protected by a layer of dirt. Sheets must be joined in the field and there is a potential for leakage at each seam. Many plastic films are destroyed by hydrocarbons reducing the number of waste products that can be stored. Also, leaking organic matter passing through pinholes in the plastic liner may cause gas which will cause the liner to rise. If the liner rises it will usually tear or break and destroy the seal or waterproofing of the contaminant.

Porous soils may be sealed with colloidal bentonite to store hazardous waste. The bentonite is spread over the surface intimately mixed with soil to a depth of ten cm, moistened to optimum moisture, remixed and compacted. This too has limitations. The resulting mixture must be uniform or some zones will leak while others will be highly impermeable.

It is an object of the present invention, to provide a method and product which will allow formation of a flexible sheet with waterproofing qualitites and which is suitable for use over large areas by covering the soil or other areas with the treated sheet.

According to the present invention, a flexible sheet for providing a water barrier comprises a flexible support capable of venting gas and coated with water-

swellable bentonite. The water-swellable bentonite coating is preferably between three cm and ten cm thick.

A method for forming a water impervious flexible sheet in accordance with the present invention may comprise coating a flexible support capable of venting gas at least once with a liquid adhesive, spreading a water-swellable bentonite on each coating of said liquid adhesive, and drying said thus-coated support.

In one method according to the invention, a second coating of adhesive is applied to the support, followed again by spreading water-swellable bentonite on said second coating before drying the thus double-coated support.

The invention provides a method of affixing water-swellable bentonite to a flexible support capable of venting gas in such a manner as to retain flexibility and provide a water impervious barrier.

The invention also provides a water impervious sheet which may be applied to soil so as to provide a water barrier for ponds, lagoons or hazardous waste sites.

Preferred embodiments of the present invention will now be described by way of example with reference to accompanying the drawings, in which:

Figure 1 is a side sectional view of a hazardous waste site incorporating the principles of the instant invention;

Figure 2 is a side view of one embodiment of

the instant invention;

Figure 3 is a side view of an embodiment of the instant invention showing a product in use;

Figure 4 is a side view of another embodiment of the instant invention;

Figure 5 is a perspective fragmentary view of still another embodiment of the instant invention.

Turning first to Figure 1, there is shown a hazardous waste site utilizing the products and methods of the instant invention. Hazardous waste site 10 may contain any of the contaminants and water soluble poisons enumerated previously. It may be a liquid as shown or a sludge or solid. The soil 12 is any type of porous soil or soil which one desires to protect from contamination. The hazardous waste solution 11 contacts initially a protective surface of soil 16 which is placed over a sheet 13 constructed in accordance with the instant invention. Sheet 13 includes a continuous water impermeable barrier 14 which is presented by a water-swellable bentonite used in the instant invention. Sheet 13 also includes a gas venting layer 15 which presented by a flexible support capable of venting gas described in the instant invention. Flexible support layer 15 allows built up vapors or gases which are generated by organic decay or other decomposition of materials in the soil to escape to the atmosphere above the surface of the hazardous waste site. Thus layer 15 is shown in use as extending at its edges above soil 12.

The water-swellable bentonite forms a water impermeable barrier 14 as defined more specifically later. Protective coating of soil 16 is not necessary, however it is desirable when the waste site may be filled with sharp materials or other waste that could possibly dent or puncture the barrier such as drums or other containers. If the waste material 11 is solid, it may be desirable to enclose it with another sheet constructed in accordance with the instant invention placed over the top of the waste site. In this use, the gas venting layer 15 of sheet 13 would be adjacent to the top of waste site 11 and the water impermeable barrier 14 would be above the gas venting barrier to further decrease the chances of water entering the waste site. In this top seal use, the area to be waterproofed is actually the atmosphere, since it is desired to stop precipitation such as rain, snow or the like from entering the waste material 11. This would diminish overflow from the waste site or build up of water pressure in the waste site.

Turning to Figure 2, a side view of a sheet constructed in accordance with the instant invention is shown. Sheet 20 includes a porous flexible support capable of venting gas 22 which is coated with water-swellable bentonite 21. The coating of bentonite can be affixed by most common adhesives and it is preferred to have a coating in the range of three to ten centimeters in order to provide an adequate water barrier. The ten cm thickness, for example, may be used as the base of a waste fill site

to halt leachate seepage. The thinner, three cm seal can be used as a top seal covering over a filled site to halt penetration of rain or snow into the stored waste material. In either case, the gas venting layer is under the bentonite coating water barrier. A portion of the flexible support capable of venting gas is extended beyond the edge of the coating of water-swellable bentonite at edge 23 so as to allow for installation with overlap so that a continuous layer of gas venting material can be provided. As shown in Figure 3, in common use, edge 23 of one sheet 20 is overlapped over the support 22 of another sheet 20 of the instant invention. As is shown, the bentonite coating 21 swells up to form a water impermeable barrier and forms a continuous barrier across adjacent sheets 20 and the overlapping edge 23 of one support 22 forms a continuous layer with the porous support 22 of the adjacent sheet 20. In another installation, as shown in Figure 4, a sheet 30 with a porous support 32 capable of venting gas coated with water-swellable bentonite 31 is shown lined up next to another sheet containing a porous support 32 and bentonite coating 31. Under the seam between the sheets a strip of porous support material 33 capable of venting gas is positioned so as to provide a continuous layer between adjacent sheets 30 and supports 32. The bentonite coating 31 of each sheet will swell and self seam themselves to form a continuous barrier when moistened.

In the preferred embodiment shown in Figure 5,

a sheet 40 is formed by a flexible support capable of venting gas 42 which is coated with bentonite 41 and has extending edges 43 and 44 along two sides of the roll to allow overlapping of supports 42 to provide a continuous gas venting layer. Additionally a cover mat 45 is affixed to or otherwise fastened to the top of the bentonite coating 41 so as to provide a protective retainer for retention of possible loose particles of bentonite which may be dislodged during transfer or use. A preferred width of edges 43 and 44 is in the range of two to three cm.

The bentonite utilized in the present invention is one which will hydrate in the presence of water, i.e., will swell in the presence of water. A preferred bentonite is sodium bentonite which is basically a hydratable montomorillonite clay which has sodium as its predominate exchangeable ion. However, the bentonite utilized in the present invention may also contain other cations such as magnesium and iron. The particular cation contained in the bentonite is not important. As noted above, the sodium bentonite will swell in water and is therefore the type of bentonite which is useful in the present invention.

Some physical characteristics which distinguish bentonite from other clays are its permeable texture and its extremely small grain size. The grain particles, when wetted, absorb films of water that are thicker than the films which form on other claylike materials, and after the bentonite has been wetted, the water cannot be expelled,

even at high pressures. The strong absorptive power of commercial bentonite which will absorb almost 5 times its weight of water is partially attributable to the preponderance of extremely small grains or particles, providing tremendous surface area for the exertion of absorptive powers and the film retaining capacity of these particles. Commerical bentonite swells when contacted with water as much as ten to fifteen times its dry volume. One factor which causes this swelling is the separation of the small particles by the water films absorbed thereon. Another is the distinctive nature of the particles themselves, which are composed of minute platelike structures that possess the peculiar property of allowing water molecules to penetrate their crystal lattice. The crystal structure itself is thus expanded. A third factor is the mutual repulsion of the particles due to like negative polarity. In its swollen condition, bentonite has several advantageous properties; it will carry materials in suspension; it exerts a cohesive effect; when left quiescent it forms a permanent gel, the viscosity of which increases upon aging. An important aspect of the swelling of bentonite is that it will swell only to the extent necessary to fill available space without exerting substantial pressure when confined against further swelling. A particularly preferred type of bentonite is that known as Wyoming bentonite.

The porour support of the instant invention may

be in sheet or roll form. It may be of paper capable of venting gas, fabric, fiberglass or non-woven cloth. It must be flexible and it is preferred that the support be resistant to shearing. The porous support must be capable of venting gas. This is necessary to allow various gases from the soil below the waste site to travel through the layer formed by the porous sheet to the atmosphere. A preferred material is a non-woven fabric such as one sold by Phillips Fiber Corporation under the trademark of SUPAC.

The adhesive may be a sodium silicate, animal glue, polymer suspension or latex vehicle such as those used for water based paints. One type of adhesive suitable is sold commercially under the trademark of "Elmer" glue. Other water soluble substances may be dextrine, CMC adhesive, linoleum cement. Water insoluble adhesives such as latex emulsions, rubber cement or resins dissolved in suitable solvents may be used.

In preparing the product of the instant invention, the porous support is coated with the adhesive and while the adhesive is still set, the bentonite is spread over the sticky surface. The bentonite is used in the form of a powder or granules. A layer will attach to the wet sticky surface. The support is then dried and can be processed further to allow convenience in use as a soil water barrier. Thus the porous support may be rolled or folded for transport.

What is surprising is that the dried sheet when

subjected to water will form a water impervious barrier. One might expect that when the bentonite is spread on a water based adhesive, that it would swell to such an extent that after drying and upon later contact with water, that the coating would have places where seepage or leaks would occur. The porous support can be coated with multiple applications on each side as desired.

In utilization of the treated sheets in soil sealing, the soil is preferably compacted, the sheets are spread over the soil and the edges of the sheets are overlapped. This will provide a waterproof barrier. Preferably the sheets are then covered with a protective coating of earth. This will provide protection of the sheet from puncturing and also help maintain the sheets securely in place.

Claims:

1. A flexible sheet for providing a water barrier comprising a flexible support capable of venting gas and coated with water-swellable bentonite.

2. A flexible sheet as claimed in claim 1, wherein said flexible support is a porous non-woven fabric.

3. A flexible sheet as claimed in claim 1 or 2, wherein on at least one edge of said sheet, the flexible support is not coated with said water-swellable bentonite.

4. A flexible sheet as claimed in claim 1, 2 or 3, wherein said coating of water-swellable bentonite is covered with a mat capable of retaining dislodged particles of said water-swellable bentonite coating.

5. A sheet as claimed in any one of claims 1-4, wherein said flexible support is in roll form and said coating of water-swellable bentonite does not cover two adjacent edges of said support.

6. A method for forming a water impervious flexible sheet comprising coating a flexible support capable of venting gas at least once with a liquid adhesive, spreading a water-swellable bentonite on each coating of said liquid adhesive, and drying said thus-coated support.

7. A method as claimed in claim 6, wherein, before drying said coated support, a mat is placed over the water-swellable bentonite coating.

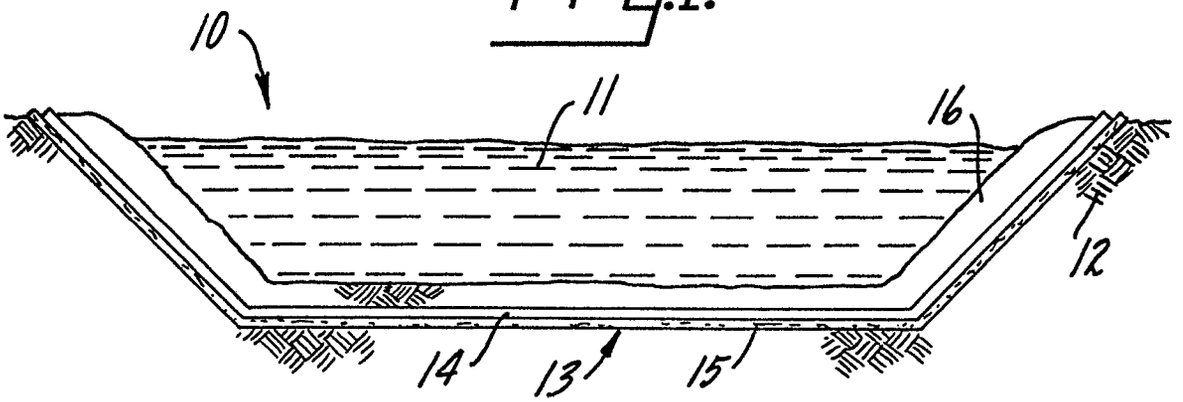
8. A method for waterproofing an area of soil

comprising coating a flexible support capable of venting gas with a water-swellable bentonite providing a barrier of water-swellable bentonite to provide coated sheets, covering the soil to be waterproofed with a plurality of said coated sheets with said coating of bentonite facing up and said support capable of venting gas facing down and aligning each sheet so that there is uninterruped contact of each of said bentonite barriers and each of said supports capable of venting gas in order to provide a continuous and uninterrupted barrier of bentonite facing the area from which water is to be barred and a continuous and uninterrupted layer of support capable of venting gas with said support capable of venting gas open at least partially to the atmosphere.

9. A method as claimed in claim 8, wherein said coated sheets are then covered with a protective layer of soil.

10. A method as claimed in claim 8 or 9, wherein said coated sheets are placed both below and above the area from which water is to be barred.

Fig.1.



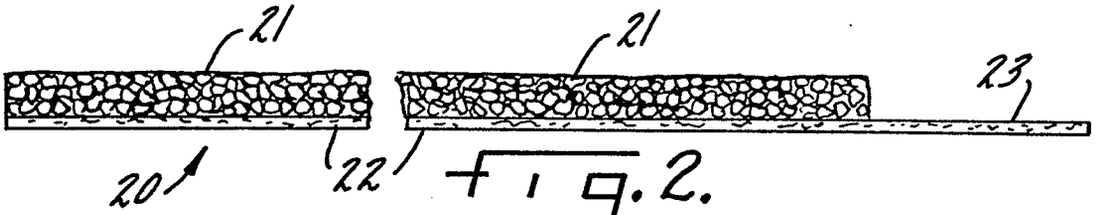


Fig.2.

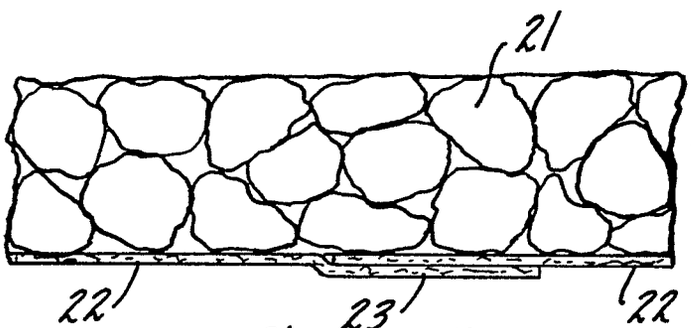


Fig.3.

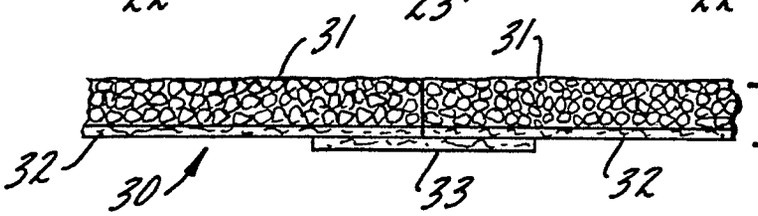
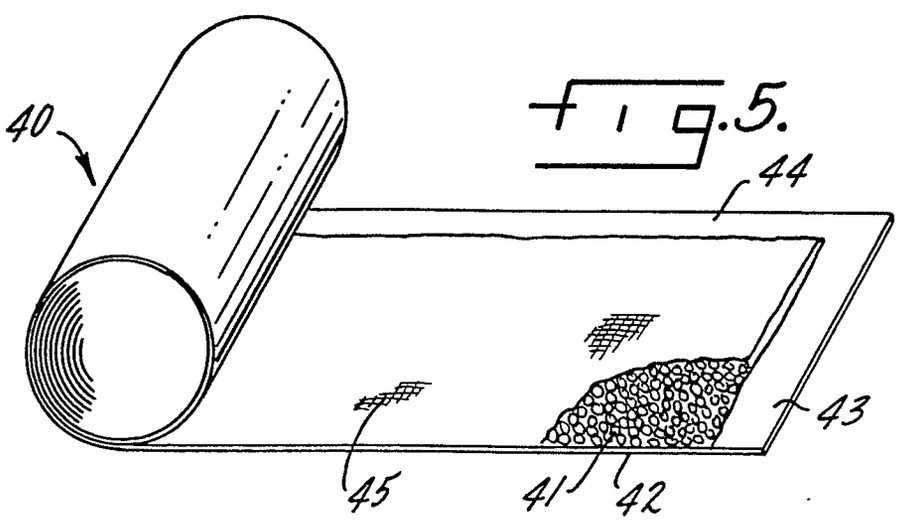


Fig.4.

Fig.5.



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EUROPEAN SEARCH REPORT

0059625
Application number

EP 82 30 1004

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A,D	US-A-4 048 373 (A.G.CLEM) *Column 2, line 67 - column 3, line 48; figure 2*	1,2,4	E 02 B 3/12
A	DE-B-1 273 433 (GELSENKIRCHENER BERG-WERKS-AG) *Column 2, line 35 - column 3, line 6; claims 1,3; figure 2*	1,8,9	
A	US-A-4 207 017 (H.K.JARRELL) *Column 1, line 56 - column 2, line 2; column 2, lines 15-19; figures 1,4*	5	
A,D	US-A-4 070 839 (A.G.CLEM)		
A,D	US-A-4 139 588 (A.G.CLEM)		TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A,D	US-A-4 209 568 (A.G.CLEM)		E 02 B E 02 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	04-06-1982	CLASING M.F.

CATEGORY OF CITED DOCUMENTS

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