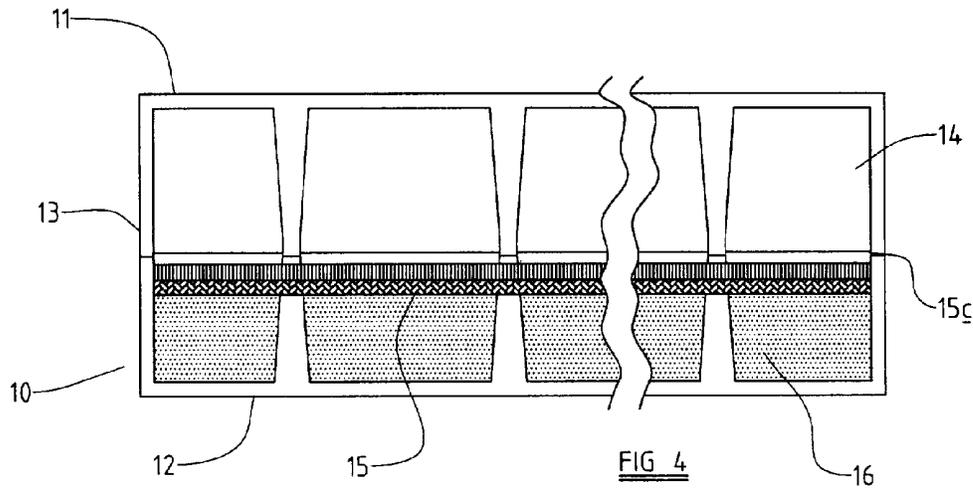


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(54) Abstract Title: **Liquid storage module containing a buoyant component**

(57) The buoyant element 15 floats on the liquid within a volume 14 defined by top 11 and bottom 12 walls of the storage module. Preferably the buoyant surface element can receive contaminant floating on the surface of the liquid. Preferably the buoyant component extends around struts, and is either fibrous or a biofilm may form on it. The modules may be joined together, to form part of a drainage system which can remove oil from water running off roads.



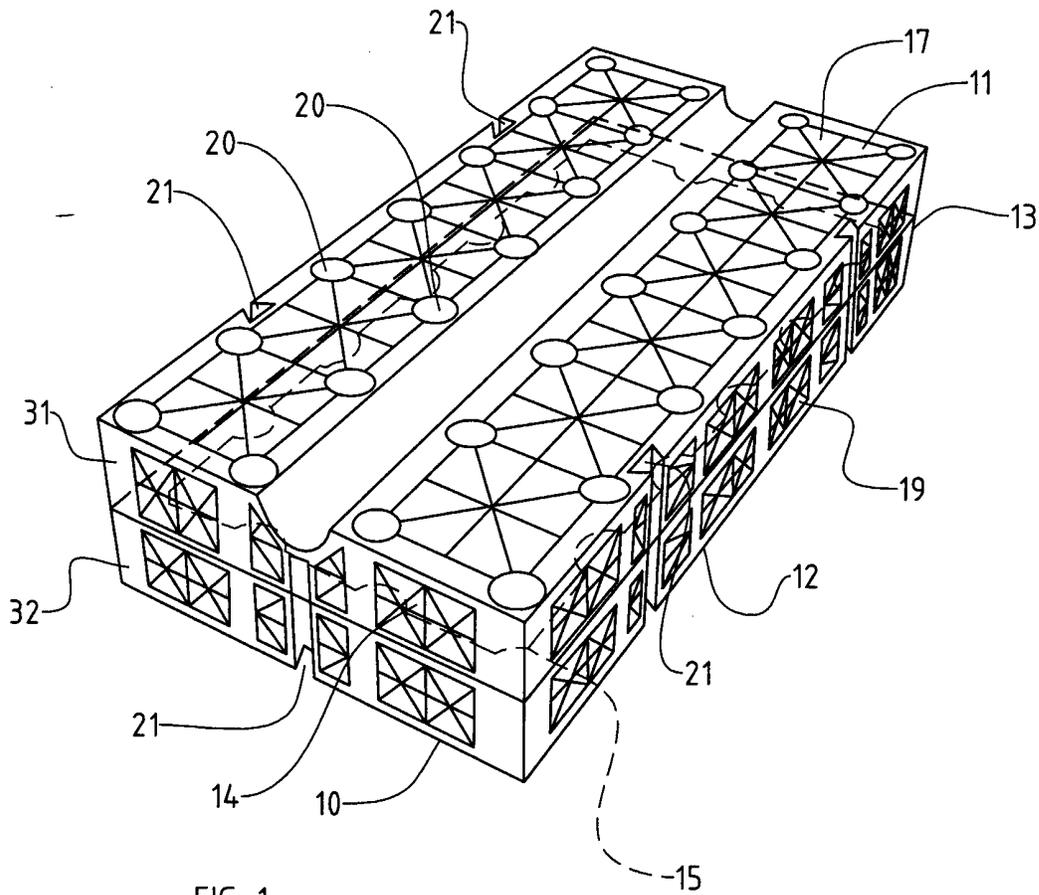
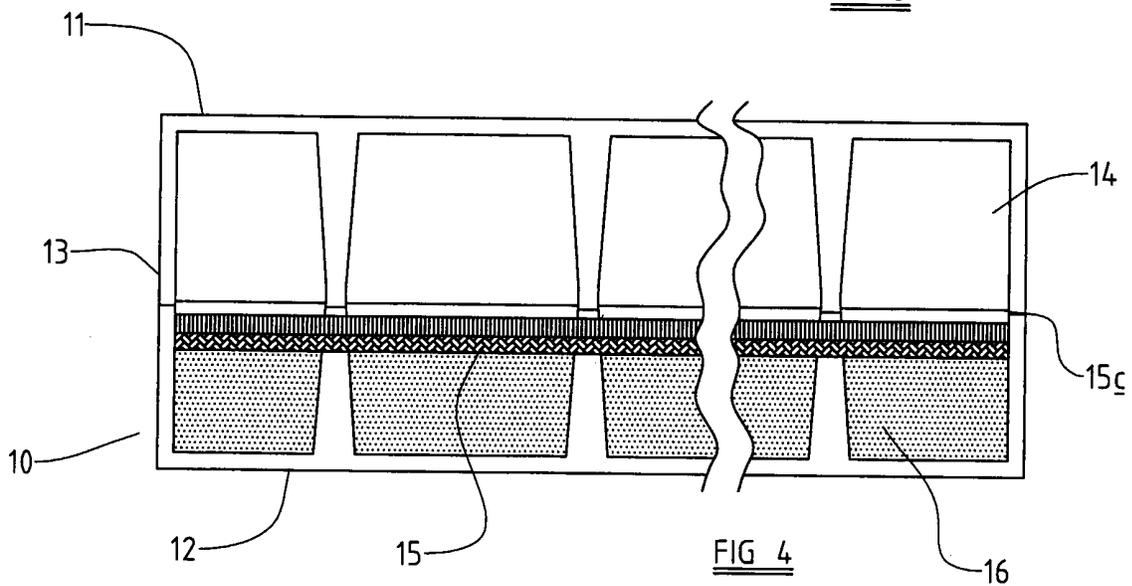
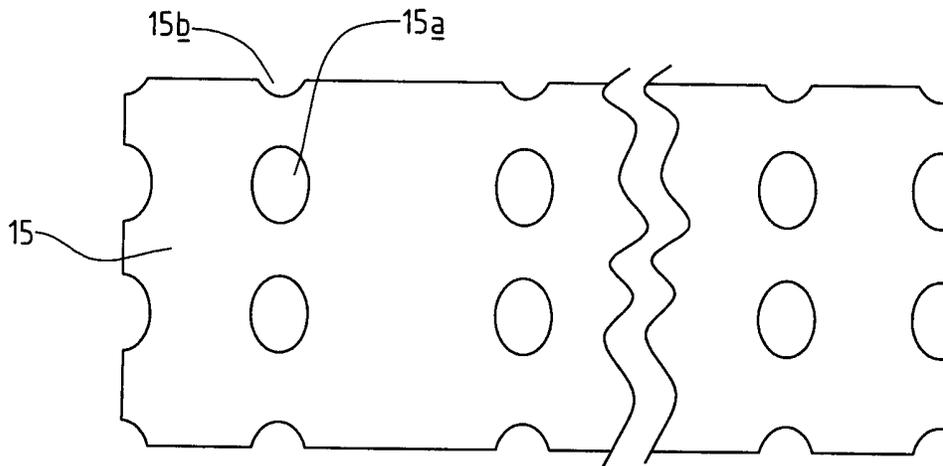
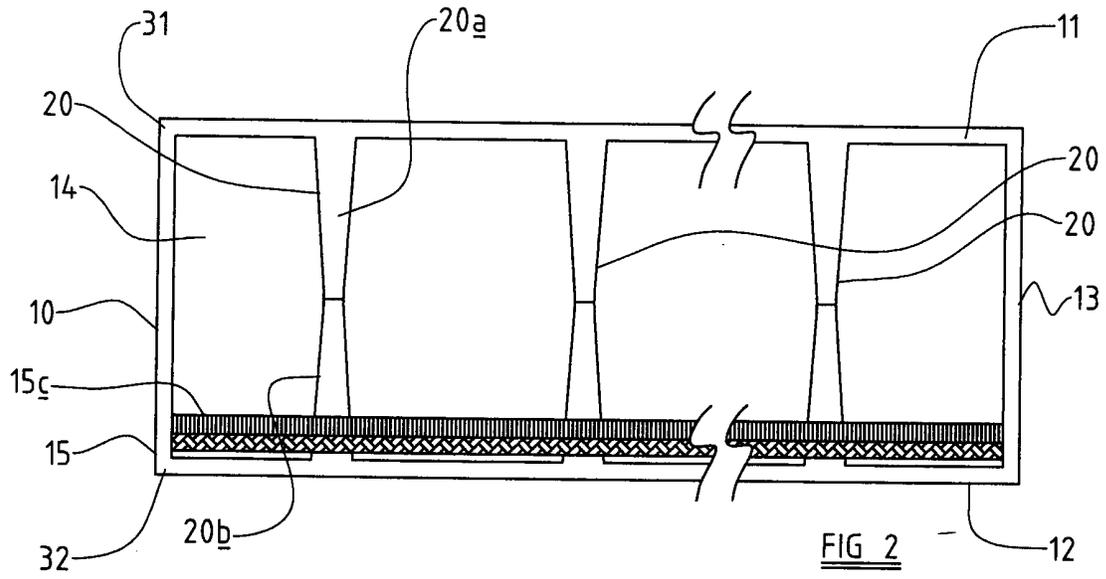
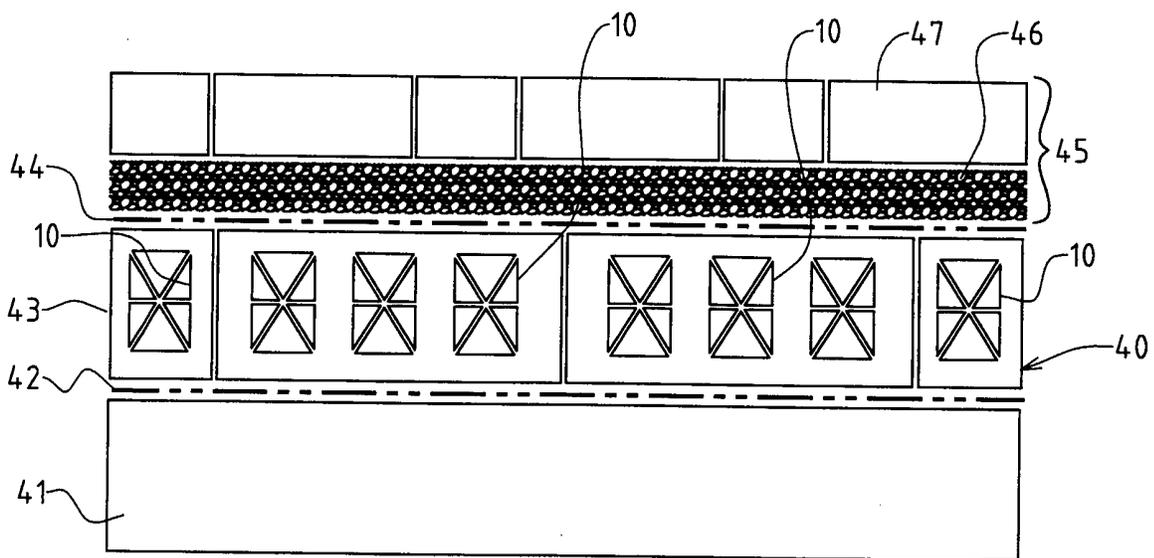
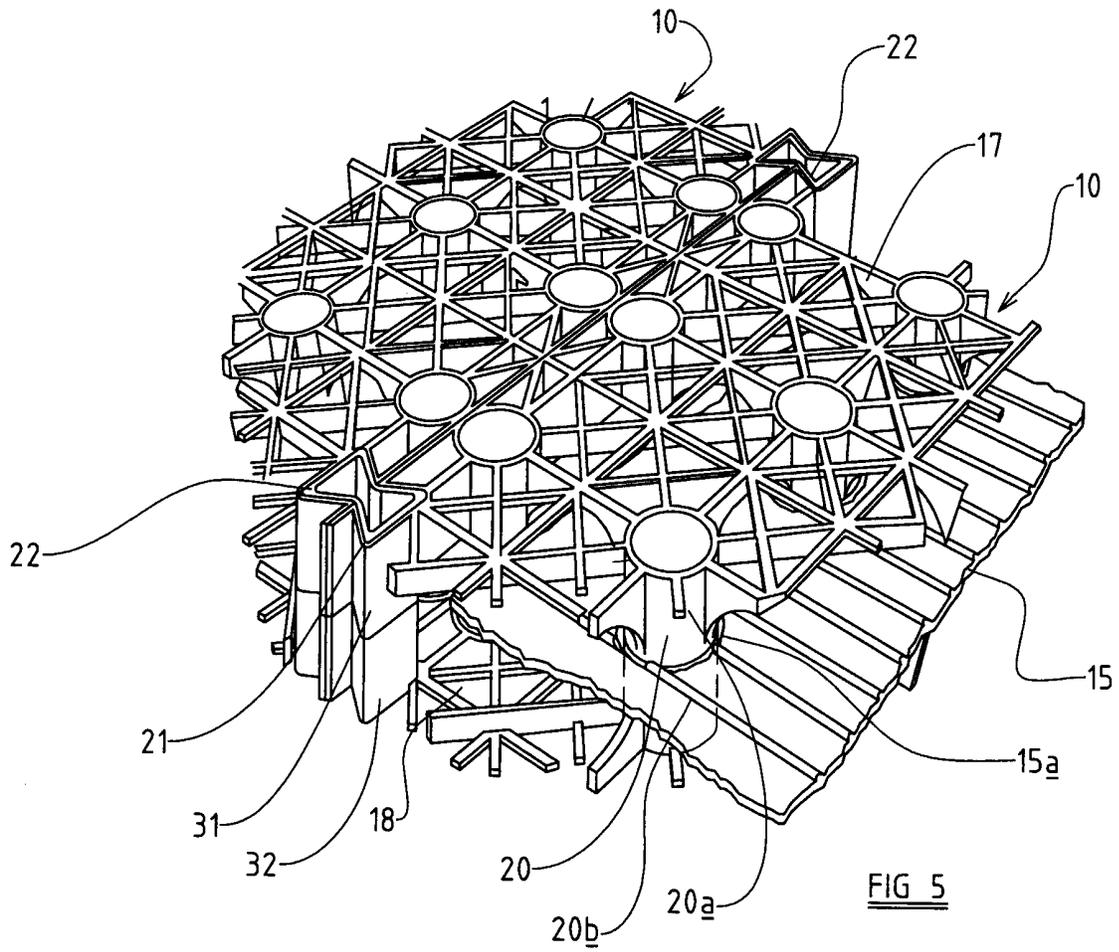


FIG 1





PATENTS ACT 1977

A10783GB

Title: Storage Module

Description of Invention

5 This invention relates to a storage module for drainage systems and a drainage system comprising a plurality of said modules.

 For construction of areas such as pedestrian areas, car parks or roads, it is desirable to provide structures which provide a surface of the sub-base layer using storage modules such as those described in WO 02/14608 providing a
10 sufficiently strong sub-base. However, in common with all drainage systems which receive surface run-off water, it is necessary to route the water away to an appropriate treatment system to remove pollutants such as oil before passing the run-off water to an appropriate outlet.

 An aim of the present invention is to reduce or overcome the above
15 problem.

 According to a first aspect of the invention, we provide a storage module for a drainage system, the module comprising a top wall and a bottom wall, the top wall and bottom wall being spaced to define a volume to receive liquid, and a buoyant surface element disposed within the volume, the buoyant surface
20 element being movable within the volume to float on liquid received within the volume.

 The storage module may further comprise a peripheral wall extending between the top and bottom wall.

 The buoyant surface element may be suitable to receive contaminant
25 floating on the surface of the liquid.

 The buoyant surface element may be suitable to provide a surface on which a biofilm may form.

 The buoyant surface element may comprise a mat of fibrous material.

The buoyant surface element may comprise one of a random mat, a mat comprising a woven material and a mat comprising a pile type fabric.

The mat may be buoyant.

The mat may be provided with buoyant floats.

5 The storage module may comprise struts extending between the top wall and the bottom wall wherein the buoyant surface element extends around said struts.

A first part and a second part may be connected together to form said storage module, wherein the buoyant surface element may be introduced into
10 said module prior to connection of the first part and second part.

Each module may be formed from a top part which may define said top wall and an upper part of the peripheral side wall and a bottom part which may define said bottom wall and a lower part of the peripheral side wall.

The top part and bottom part may each be provided with a set of half
15 struts extending within the volume towards one another, whereby the two sets of half struts engage one another to form struts extending between the top and bottom walls to resist vertical crushing of the structural module.

The top and bottom part may be substantially identical plastic moulded components which are found one inverted on top of the other.

20 At least one of the top wall, the bottom wall and the peripheral wall may be provided with apertures to allow fluid flow through said module.

The peripheral side wall of each module may be provided with a key way for receiving one half of a tie member to connect the storage module to an adjacent storage module.

25 The key way may be in the form of a female dovetail groove.

Each tie member may be an elongate member having a crosssection outline of a pair of joined trapezoids connected along the shorter of their parallel sides.

The buoyant surface element may comprise a geotextile.

According to a second aspect of the invention, we provide a drainage system comprising a plurality of storage modules according to any one of the preceding claims.

5 The invention will now be described by way of example only with reference to the accompanying drawings wherein;

Figure 1 is a perspective view of a storage module embodying the present invention.

Figure 2 is a section on line 2-2 of Figure 1,

10 Figure 3 is a plan view of the buoyant surface element of Figure 2,

Figure 4 is a view similar to that of Figure 2 where liquid is present in the storage element,

Figure 5 is a broken away perspective view on a larger scale of part of two of the storage modules of Figure 1 connected to one another and

15 Figure 6 is a section of a drainage system comprising a plurality of storage modules.

Referring now to Figures 1 to 5, a storage module is shown at 10 comprising a top wall 11, a bottom wall 12 and a peripheral wall 13 extending between the upper wall 11 and the bottom wall 12 to provide at least one side wall and in this example four side walls. The top wall 11, bottom wall 12 and peripheral wall 13 define a volume 14. Located within the volume 14 is a buoyant surface element 15. The buoyant surface element 15 is movable relative to the top wall 11, bottom wall 12 and peripheral wall 13 such that the buoyant surface element 15 is a wall to flow on any liquid 16 within the volume 20 14 as shown in Figure 4.

25 The buoyant surface element 15 in the present example comprises a mat of fibrous material, for example a random mat, a woven material or a pile type fabric. The fabric may be an appropriate geotextile of generally conventional type. The fabric may have an affinity to oil, such that oil is absorbed by or at

least held within the buoyant surface element 15. The buoyant surface element 15 also advantageously should be suitable to provide a surface on which a biofilm may form. A biofilm consists of microbial cells, in particular bacteria, and an extracellular biopolymer produced by the cells. The biofilm provides a favourable environment for the cells which form the biofilm.

Advantageously the mat may have a parallel pile, for example as shown in Figure 5, thus providing parallel ridges resistant to the flow of material across the mat.

As seen in Figures 1 and 5, the top wall 11, bottom wall 12 and peripheral wall 13 comprise a plurality of apertures 17, 18, 19 which in this example are generally triangular and defined by a plurality of struts forming the respective wall. The apertures 17, 18, 19 thus permit fluid to move in and out of the storage module 10.

Internally, in this example the storage module 10 comprises a plurality of struts 20 extending between the top wall 11 and the bottom wall 12. In the present example, the struts are generally cylindrical and hollow and are distributed in a grid arrangement across the length and width of the storage module 10. The struts 20 are sufficiently strong to resist vertical crushing of the module 10 and thus enable the module 10 to support a desired vertical load depending on the application in which the storage module 10 will be used.

To allow a plurality of modules 10 to be rigidly connected together, for example for use as a sub-base layer, the module 10 is provided with a plurality of keyways 21 located in the ends of the sides thereof. In this example, each keyway 21 is a groove of a generally female dovetail shape in plan view for slidably receiving a tie member 22. As best seen in Figure 5, the tie members 22 “bow tie” cross section, comprising a pair of trapezoids joined together along their short parallel sides to be received in the keyways 21 of adjacent modules 10 to hold them together. As will be apparent, the generally rectangular shape of the modules 10 connected to a plurality of modules 10 to

be connected together to form an extensive, substantially continuous layer of storage modules 10 of any desired area.

Advantageously, each module 10 may be formed in two parts which are connected together to form the module 10, where the buoyant surface element 15 is introduced into the module prior to connecting the two parts together. As best seen in Figure 5, advantageously the storage module 10 may comprise a top part 31 which defines the top wall and part of the peripheral side wall and a bottom part 32 defining the bottom wall and the lower part of the peripheral side wall. The top part 31 and the bottom part 32 are each provided with a set of half-struts 20a, 20b whereby the two sets of half-struts, 20a, 20b engage one another to form the struts 20 extending between the top wall 11 and bottom wall 12. Preferably the top part 31 and bottom part 32 comprise substantially identical plastic moulded components. The module 10 may be formed by connecting inverting one component and placing it on top of the other, and introducing the buoyant surface element 15 into the volume prior to joining the two parts.

As seen in Figure 3 and where the module 10 is provided with struts 20 the buoyant surface element 15 may be provided with appropriate apertures 15a and/or cut outs 15b to receive the struts 20. Such a configuration is advantageous in that the buoyant surface element 15 is able to float on the surface of the liquid and move freely in a generally vertical direction between the top wall 11 and bottom wall 12, but is constrained from substantial lateral movement by virtue of engagement of the struts 20 in the apertures 15a.

A drainage system comprising a plurality of storage modules 10 is shown at 40. The drainage system 40 comprises an appropriate base 41, such as a compacted sand bedding layer. An appropriate layer 42 is laid on the bedding layer 41, which may be impermeable, to resist passage of liquid and particularly water into the bedding layer, or may be permeable to permit water to infiltrate down through the bedding layer. At 43, a storage layer is shown

providing a plurality of storage modules 10 connected together as described above. A further geotextile layer 44 is laid on top of the storage layer 43, in this case comprising a pervious geotextile to permit water or other liquid to pass into the storage layer 43 but resisting the passage of detritus such as grit or gravel and advantageously absorbing oil. On top of the further geotextile layer 44 is an operative layer 45, in this example comprising an upper bedding layer 46 provided with a top layer 47. This may for example be the surface for a car park, a roadway, a pedestrian area or other construction, using a suitable material such as concrete block paving porous asphalt, open textured macadam or unbound granular material.

The storage modules 10 and drainage system 40 operate as follows. When rain matter or other liquid falls on the upper surface of the operative layer 45, the water will infiltrate down through the layer 45 and through the further geotextile layer 44 into the storage layer 43. Because of the apertures 17, 18, 19 the water will be able to enter the storage modules 10 and also flow between adjacent storage modules 10. The storage layer 43 provides a large volume to receive run-off liquid, thus removing the disadvantages associated with conventional drainage ducts which may backup and overflow, for example in the case of heavy rainfall.

As seen in Figure 4, when water enters the storage layer 43 it will fill the volume 14 of the storage modules 10 and the buoyant surface element 15 will float on the surface of the water 16. Contaminants, and particularly oil, which have been washed down into the storage layer 43 will float on the surface of the water 16. Any oil floating on the surface of the water 16 will be at least restricted in any lateral movement by the buoyant surface element 13, thus resisting flow of the oil out of the storage layer 43 and may even be in part absorbed by the buoyant surface element 15.

Further and advantageously, where the buoyant surface element 15 provides a suitable surface on which a biofilm 15c may form, the bacteria or

other cells in the biofilm will act on the oil to biodegrade the oil. The present invention is particularly advantageous in that the floating buoyant surface element 15 will maintain an interface between the air and the water 16 in the volume 14 providing an appropriate environment for the bacteria, in particular maintaining aerobic operation of the bacteria. Further, since the bioform is formed in the volume 14 below ground level, the temperature fluctuations within the volume 14 will be less than in other environments, encouraging the development of the bacteria in the biofilm. As any oil will be broken down by the biofilm 15c, there is no requirement to periodically remove and change the buoyant surface element 15, unlike the case where absorbent pads are used to absorb oil.

Advantageously, the buoyant surface element 15 will be colonised by bacteria such as *Pseudomonas putida* which are washed down from the upper surface 47 and which colonise the buoyant surface element 15. If necessary, the bacteria may be "fed" with a suitable slow release fertiliser to encourage the development of a biofilm.

Preferably, the volume 14 is never fully filled and may be ventilated to atmosphere, such that there is always a volume of air in the volume 14 above the buoyant surface element 15 to supply the biofilm 15c with necessary oxygen for a number of operation and does not cause an aerobic operation. The volume 14 may be vented to atmosphere by, for example, providing a vent pipe extending from the module 10.

Advantageously, the buoyant surface element 15 will be made of an appropriate material such that it floats on the water 16. Alternatively, it may be envisaged that the buoyant surface element 15 comprises a mat which is not, of itself, sufficiently buoyant. In this case, flotation devices such as hollow plastic floats or polystyrene floats or other floats as desired must be attached to the mat 15 or incorporated into its structure.

It will be apparent that any other appropriate module 10 may be provided as desired, manufactured in any other fashion. For example, one or more of the side walls or even the peripheral wall in its entirety may be omitted and the top and bottom walls held spaced by struts or otherwise.

5 In the present specification "comprises" means "includes or consists of" and "comprising" means "including or consisting of".

 The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process
10 for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A storage module for a drainage system,
the module comprising a top wall, and a bottom wall,
5 the top wall and bottom wall being spaced to define a volume to receive liquid, and a buoyant surface element disposed within the volume,
the buoyant surface element being movable within the volume to float on liquid received within the volume.
- 10 2. A storage module according to claim 1 further comprising a peripheral extending between the top and bottom wall.
3. A buoyant surface element according to claim 2 wherein the buoyant
15 surface element is suitable to receive contaminant floating on the surface of the liquid.
4. A storage module according to any one of claims 1 to 3 wherein the
buoyant surface element is suitable to provide a surface on which a biofilm may
form.
- 20 5. A storage module according to any one of the preceding claims wherein the buoyant surface element comprises a mat of fibrous material.
6. A storage module according to claim 5 wherein the buoyant surface
25 element comprises one of a random mat, a mat comprising a woven material and a mat comprising a pile type fabric.
7. A storage module according to claim 5 or claim 6 wherein the mat is buoyant.

8. A storage module according to claim 5 or claim 6 wherein the mat is provided with buoyant floats.
- 5 9. A storage module according to any one of the preceding claims comprising one or more struts extending between the top wall and the bottom wall wherein the buoyant surface element extends around said one or more struts.
- 10 10. A storage module according to any one of the preceding claims comprising a first part and a second part which are connected together to form said storage module, wherein the buoyant surface element is introduced into said module prior to connection of the first part and second part.
- 15 11. A storage module according to claim 9 wherein each module is formed from a top part which defines the top wall and an upper part of the peripheral side wall and a bottom part which defines said bottom wall and the lower part of the peripheral side wall.
- 20 12. A storage module according to claim 10 wherein the top part and bottom part are each provided with a set of half struts extending within the volume towards one another, whereby the two sets of half struts engage one another to form struts extending between the top and bottom walls.
- 25 13. A storage module according to claim 10 or claim 11 wherein the top and bottom parts are substantially identical plastic moulded components which are joined one inverted on top of the other.

14. A storage module according to any one of the preceding claims where at least one of the top wall, the bottom wall and the peripheral wall are provided with apertures to allow fluid flow through said module.
- 5 15. A storage module according to any one of the preceding claims wherein the peripheral side wall of each module is provided with a keyway for receiving one half of a tie member to connect the storage module to an adjacent storage module.
- 10 16. A storage module according to claim 15 wherein the key way is in the form of a female dovetail groove.
- 15 17. A storage module according to claim 16 wherein each tie member is elongate member having a cross section outline of a pair of joined trapezoids connected along the shorter of their parallel sides.
18. A storage module according to any one of the preceding claims wherein the buoyant surface element comprises a geotextile.
- 20 19. A storage module substantially as described herein and/or with reference to the accompanying drawings.
20. A drainage system comprising a plurality of storage modules according to any one of the preceding claims.
- 25 21. A drainage system substantially as described herein and/or with reference to the accompanying drawings.

22. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.



INVESTOR IN PEOPLE

Application No: GB 0305944.1
Claims searched: 1-21

Examiner: Robert Black
Date of search: 30 July 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-3 and 14	GB 2355211 A (SPEL) see especially the figure and abstract
X	1-3 and 14	EP 0508814 A1 (VALIANT) see especially the figures and abstract
X	1-3 and 14	US 5897773 A (RHODES) see especially the abstract, figures 2 and 7, and column 3 lines 6-16
X	1-3 and 14	DE 4031479 A (NILL) see especially WPI abstract 1991-172495 and the figures
X	1-3 and 14	DE 3137216 A (PUMPEN) see especially WPI abstract 1983-34695K and figure 1
X	1-3 and 14	FR 2449654 A (NILL) see especially WPI abstract 1980-62691C and the figures

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^v:

C1C

Worldwide search of patent documents classified in the following areas of the IPC⁷:

C02F

The following online and other databases have been used in the preparation of this search report:

EPODOC; WPI; PAJ