A PORTABLE WASTE LIQUID TREATMENT CONTAINER

The invention describes a portable waste container (54) containing a soil matrix (64) which uses reed bed technology to treat contaminated liquids. The container (54) has an inlet pipe (56) which accesses an inlet buffer bed through a hole (58) formed in a side wall (60). A gravel inlet buffer trench (66) extends from the inlet pipe (56) to the base. The container (54) and the gravel inlet buffer also has an intrusive layer (70) which extends further underneath the soil matrix (64). The inlet construction induces Artesian flow which causes the waste liquid to rise up through the soil matrix (64) thereby being treated by the reed bed before passing down to an outlet (68) under gravity where it exits the container.
A PORTABLE WASTE LIQUID TREATMENT CONTAINER

The present invention relates to a portable waste liquid treatment container and, in particular, a waste liquid treatment container that utilises reed bed technology.

Reed beds are a natural wastewater system utilising the bacterial and mineral treatment capabilities also harnessed in part by the more common 'constructed wetlands'. However, the reed bed is a more highly engineered construction, usually completely isolated from the natural water system and allowing the treatment of highly contaminated effluents.

The most common type of reed planted for water treatment is *Phragmites australis* (the common reed). This is a robust species and grows rapidly being able to tolerate a range of climatic conditions and many types of waste water. Reed beds are simple to operate and cheap to maintain but a significant disadvantage is the time lag between the planting of the reed bed and its ability to effectively treat wastewater. Immature systems can suffer from low porosity, but in due course, the reeds become established and simultaneously, re-establish a root structure, which reintroduces porosity into the substrate. Typically, this process may take two to three years to fully develop.

Furthermore, although reed beds have been successful in many applications they are usually prepared on a large site which is initially dug out of the surrounding environment and lined with, typically, a low density
polyethylene liner to isolate the system from their surrounding environment.

The system suffers from the drawback of requiring an adjacent site of sufficient size to develop the reed bed system. However, there are many potential applications which are not close to such sites and which may benefit from reed bed technology.

For instance, interceptors, which are found on petrol station forecourts and oil tanker loading bays, collect contaminated run off, but, hitherto, the possibility of achieving treatment on-site has been limited.

Preferably, such interceptors allow the contaminating hydrocarbons to settle out, and then the interceptors are periodically cleaned out and the waste taken to landfill. There is a recurrent cost for the operational life of the store (25 years), and the present option of depositing into landfill goes against government policy and the principles of Agenda 21. A small-scale, low-cost, and on-site system requiring low maintenance and low energy input is an ideal solution. Reed bed technology can provide such a solution if adapted in novel ways, and the "green" profile of the product is also advantageous.

A problem arises in that a standard reed bed is a permanent feature, requiring excavation and engineering for its instalment. The necessary disruptive works are not appropriate in many situations, including most actively running petrol stations. In addition, the system requires up to three years to achieve full treatment capability. This period is required for the soil
hydrology and rhizosphere bacterial population to develop. Until the system is mature, soil porosity is not yet optimal and hence treatment capacity is also not yet optimal. To use reed beds in such a situation requires a completely new approach and application of the technology.

In relation to petrol interceptor waste, there are a number of problems. Interceptors receive an intermittent flow of effluent of a 2-phase nature. The phases are generally, but not always, aqueous and hydrocarbon based. Standard reed bed inlet design allows the immiscible oily waste to remain at the system surface. This immiscible waste then tends to flow over the top of the reed bed, where it will receive only minimal treatment. Furthermore, a system is required which deals with the intermittent flows likely to be received in such environments.

According to a first aspect of the present invention there is provided a portable waste liquid treatment container comprising an open topped container, aquatic plants growing in a soil based medium, the permeability of the medium to liquid being maintained by a root structure provided by the aquatic plants, means to deliver waste liquid to be treated to the medium and means to collect the treated liquid after it has flowed through the medium.

Preferably, the soil based medium has a liquid delivery region for the delivery of the liquid to the soil medium. Preferably an inlet buffering medium is located adjacent to the delivery region. Preferably, the buffering medium comprises a gravel bed. Preferably, the liquid to be treated is delivered to the inlet buffering medium. Preferably, the buffering medium has a porous structure to
allow the liquid to percolate therethrough to access the delivery region of the soil based medium.

An inlet aperture may be provided in the container wall for the delivery of waste liquid to the inlet buffering medium.

After the liquid has flowed through the soil based medium, it is, preferably, directed into an outlet buffering medium which is, again, located adjacent to the soil based medium but on the outlet side. An outlet aperture may be formed in the container wall adjacent to the distal side of the buffering medium.

Preferably, the delivery region is the surface of the soil medium adjacent or abutting the buffering medium.

Preferably, the means to collect the treated liquid comprise an outlet buffering medium and an outlet aperture in the container. Preferably, the inlet aperture and outlet aperture are located in the walls of opposite sides, or the base and a side of the container.

Preferably, the outlet aperture is formed in the region of the base of the wall of the container.

Preferably, the inlet/outlet buffering medium is a gravel inlet/outlet trench provided between the soil medium and the inlet delivery means and between the soil medium and the outlet collection means respectively.

Preferably, the aquatic plants comprise one or more wetland species, preferably, reed species, more
preferably, the species comprises one or more of *Phragmites australis*, *Typha latifolia*, *T. angustifolia* or *Schoenoplectus lacustris*.

Preferably, the soil medium comprises a sandy clay loam. 

Preferably, composted materials and/or sand are added to the soil medium in amounts dependent both on the exact soil type and also the type of wastewater for treatment.

The combination of wetland species growing within a soil matrix provides biological processes in the soil and the rhizosphere of the wetland species which provides the system with aerobic and anaerobic matrices necessary for product treatment to occur.

According to a second aspect of the present invention, there is provided a portable liquid treatment container comprising aquatic plants growing in a soil based medium, the permeability of the medium to liquid being at least partially maintained by a mature root structure provided by the aquatic plants, a delivery region of the soil medium for the delivery of waste liquid to be treated to the medium and means to collect the treated liquid after it has flowed through the medium, wherein the liquid to soil delivery region is at least partially located directly beneath at least a proportion of the soil medium

Preferably, the root structure is a mature root structure.

By locating the soil delivery region at least partially directly beneath a proportion of the soil medium, any less dense water-immiscible components are forced to rise through the soil medium and are thus able to contact the
root mass supporting the bacteria. This avoids the problem of less dense water-immiscible components remaining at the surface of the water-saturated soil matrix and thus failing to be treated by the system. Furthermore, clogging of the system by the accumulation of untreated waste is avoided.

Preferably, to facilitate the delivery region being below at least a proportion of the soil medium, an outlet buffer medium extends at least partially beneath the at least a proportion of the soil medium. An inlet aperture in the container for delivery of liquid to the inlet buffer may be located below the surface level of the soil medium for delivery of liquid to the inlet buffer medium located below the at least a proportion of the soil medium.

Preferably, at least a proportion of the delivery region is located on an underside surface of the soil medium.

A further advantage of such a system is that the location of the delivery region directly beneath the surface soil induces Artesian flow characteristics into the bed. Generation of Artesian flow dynamics through the bed has the effect of:-

a) optimising the flow through the system;

b) taking full advantage of the available treatment matrix; and

c) allowing similar throughput as a larger static system with a 2% bottom slope.

Furthermore, despite its small size, the system is able to treat larger flows than usual immediately upon installation.
Preferably, in systems according to any of the aspects of the present invention, it is important to achieve sufficient porosity and sustainable structure into the matrix. Organic matter in soil tends to degrade over a period of years and this itself leads to a reduction in porosity and hence treatment capacity. Preferably, the soil is a biologically active soil. Preferably, the biologically active soil is artificially structured by addition of composted or other organic matter to produce sufficient porosity in accordance with effluent character. Preferably, the biologically active soil is artificially structured by the addition of various aggregates to produce sufficient porosity in accordance with effluent character. The level of porosity required will depend upon the effluent character and the volume of the effluent which is to be treated. Preferably, the soil matrix is structured so as to be sustainable over a given time period. Preferably, the soil matrix is structured to enhance the root growth over time. By building in a sustainable structure and enhancing root growth in relation to conventional soils, a resultant rapid development of total root structure is provided and this gives long term stability to the system.

Preferably, in some embodiments, the wastewater is delivered to the base of the container and, in such cases, a buffering medium inlet is located between the base of the container and at least a proportion of the base of the soil medium so that the at least a proportion of the base of the soil medium is the delivery region. In a few of the embodiments, there is preferably a holding tank to provide sufficient head to generate hydraulic pressure to cause the waste liquid to well up through the soil matrix.
from a base delivery region under pressure. Alternatively, a pump can be provided for the same purpose.

In an alternative to the Artesian flow design, the inlet may still comprise a buffering medium such as a gravel trench along one upright wall of the bed but the buffering medium gravel extends partially into the soil medium under the surface thereof preferably, at the inlet buffering medium base, so that the waste liquid travels through the buffering medium and under the soil medium to thereafter induce Artesian flow characteristics from the delivery region. By inducing Artesian flow, the waste liquid is forced up through the initial phase of the bed and subsequently adopts more conventional gravity flow to the outlet buffering medium which is typically located at the base of the opposite side of the container. However, when the inlet aperture is located in the base of the container so that the liquid is directed upwardly through the soil it is possible that the outlet aperture and buffering medium could be located higher in the walls of the container as the liquid will be treated by the time it percolates through the soil surface.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Figure 1 shows a container design in accordance with the present invention;

Figure 2 shows a container design with an aperture and buffering medium at the base in accordance with the present invention;
Figure 3 shows a container in accordance with the present invention with a subsoil inlet aperture and Figure 4 shows a container in accordance with the present invention with a conventional inlet pipe and buffering medium modified to artesian flow characteristics.

Referring to figure 1, a sectional view of a container 2 having a base 4 and side walls 6, 8 is shown. The side walls 6, 8 extend vertically upward from the base 4 and may be illustrative of a container with a circular base or a container with a square or rectangular base in accordance with requirements. A waste liquid inlet pipe 10 is angled downwardly over the rim 12 of the side wall 6 of the container 2 and extends as far as the surface 18 of a gravel buffer bed 20 which extends downwardly to the base 4 of the container 2 and also abuts against the side wall 6 of the container. On its opposite side, the gravel inlet buffer 20 abuts against the delivery region for the soil matrix 16 which occupies the greater volume of the container 2. The surface level 14 of the soil matrix 16 is co-planar with the surface level 18 of the gravel inlet buffer 20. On the opposite side of the container to the gravel buffer bed 20 and below the surface of the soil matrix 16 is a gravel outlet buffer 22 which extends partially along the base 4 of the container and partially up the side 8 thereof. The gravel outlet buffer 22 has a generally angled mating interface with the outlet region of the soil matrix 16 below the surface of the latter. An outlet pipe 24 extends outwardly from an opening formed in the base of the side wall 8 and which is immediately adjacent to the opposite side of the gravel buffer 22.
The soil matrix 16 may comprise a sandy clay loam, either with or without composted materials and/or sand.

A typical example of a soil matrix and its components is

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy clayey loam</td>
<td>60-100%</td>
</tr>
<tr>
<td>Mineral Structural (Sands etc)</td>
<td>0-40%*</td>
</tr>
<tr>
<td>Organic Structural (Compost etc)</td>
<td>0-40%*</td>
</tr>
</tbody>
</table>

*Singularly or in combination

In use, incoming waste liquid undergoes gravity flow from the inlet and downwardly across the soil bed to the outlet 22. The system is portable and is sufficiently small to be delivered using standard haulage vehicles. The aquatic plants and soil structure and materials may be selected from those previously described.

Referring to figure 2, an alternative container is shown which utilises the principles of upflow and hydraulic pressure. The container 30 is of a similar type to that previously described with respect to figure 1 except the inlet pipe 42 is located in a hole 40 centrally disposed in the base 32 of the container (there may be a number of inlet pipes to distribute the wastewater throughout the gravel inlet buffer). In addition, there is no outlet at the base of either of the side walls 34, 36. A holding tank 38 is designed to hold waste liquid at a greater height than the soil surface, to give sufficient head to generate the necessary hydraulic pressure for the water to rise through the soil from the inlet aperture 40 at the base 32 of the container 30. A suitable pipe 42 connects the holding tank 38 to the inlet 40 to transfer the waste liquid from the holding tank into the treatment container 30. Gravel buffer bed (not shown) is located along the
inside of the base of the container 30 and the soil matrix (not shown) is located above this gravel inlet buffer bed so that incoming waste liquid fills the gravel inlet (as this material offers less resistance than the soil) and percolates under hydraulic pressure up through the soil matrix to be collected from the soil matrix surface.

Referring to figure 4, a container 44 is formed having the same structure as container 4 previously described with respect to figure 1. However, in this case, the gravel inlet buffer 46 extends partially along the base of the container and beneath the soil matrix 50. The intrusive layer 52 of gravel induces Artesian flow through the soil matrix 50 which improves flow characteristics. After rising up through the bed the waste liquid then travels under gravity towards the outlet in the normal manner.

Referring to figure 3, a container 54 similar to those previously described with respect to figure 1 and figure 4 has a modified inlet pipe 56 which accesses the inlet buffer bed through a hole 58 formed in the side wall 60 of the container 54. The inlet aperture 58 is located below the surface level 62 of the soil matrix 64. The gravel inlet buffer trench 66 extends from the inlet pipe to the base 68 of the container 54. The gravel inlet buffer also has an intrusive layer 70 similar to that previously described and depicted in figure 4 which extends further underneath the soil matrix 64. Again, such an inlet construction induces Artesian flow characteristics which causes the waste liquid to rise up through the soil matrix before passing down to the outlet 68 under gravity.

As has been illustrated by the soil matrix and gravel inlet buffer interface in relation to figure 1, the
delivery region between the incoming waste liquid and the soil matrix is along the vertical face 100 of the soil bed 16. However, to prevent accumulation of water-immiscible waste at the gravel inlet buffer surface and soil surface, and to induce Artesian flow characteristics, it is preferred to allow the incoming waste liquid to contact the soil mass from underneath. Advantageously, by providing a containerised reed bed the system may be delivered to any potential treatment site. Furthermore, by providing a sufficiently developed root structure in the container, the system is fully functional from the day of installation. The development of the root structure is partially due to off-site maturation and also due to the use of specialised soil mixes within the systems, which encourage more rapid root development.

The portable system of the invention may usefully be used for effluent treatment in a variety of applications including:-

petrol/service station waste waters (eg. station interceptor waste, forecourt run off), car wash waste water, hydrocarbon contaminated ground water; small scale agricultural wastes such as sheep dip, silo seepage and yard run off; small scale chemical and industrial wastes such as chemical manufacturing waste, industrial cleaning waste, laundry waste and textile manufacturing waste; domestic sewage, contaminated ground water; oil spillages; and heavy metal contaminated waste water.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this
specification, and the contents of all such papers and
documents are incorporated herein by reference.

All of the features disclosed in this specification
(including any accompanying claims, abstract and
drawings), and/or all of the steps of any method or
process so disclosed, may be combined in any combination,
except combinations where at least some of such features
and/or steps are mutually exclusive.

Each feature disclosed in this specification (including
any accompanying claims, abstract and drawings), may be
replaced by alternative features serving the same,
equivalent or similar purpose, unless expressly stated
otherwise. Thus, unless expressly stated otherwise, each
feature disclosed is one example only of a generic series
of equivalent or similar features.

The invention is not restricted to the details of the
foregoing embodiment(s). The invention extend to any novel
one, or any novel combination, of the features disclosed
in this specification (including any accompanying claims,
abstract and drawings), or to any novel one, or any novel
combination, of the steps of any method or process so
disclosed.
Claims

1. A portable waste liquid treatment container comprising an open topped container, aquatic plants growing in a soil based medium, the permeability of the medium to liquid being maintained by a root structure provided by the aquatic plants, means to deliver waste liquid to be treated to the medium and means to collect the treated liquid after it has flowed through the medium.

2. A portable waste liquid treatment container according to claim 1, wherein the soil based medium has a liquid delivery region for the delivery of the liquid to the soil medium.

3. A portable waste liquid treatment container according to claim 2, wherein an inlet buffering medium is located adjacent to the delivery region.

4. A portable waste liquid treatment container according to claim 3, wherein the buffering medium comprises a gravel trench.

5. A portable waste liquid treatment container according to either of claims 3 or 4, wherein the liquid to be treated is delivered to the inlet buffering medium.

6. A portable waste liquid treatment container according to any of claims 3 to 5, wherein the buffering medium has a porous structure to allow the liquid to percolate therethrough to access the delivery region of the soil based medium.
7. A portable waste liquid treatment container according to any of claims 3 to 6, wherein an inlet aperture is provided in the container wall for the delivery of waste liquid to the inlet buffering medium.

8. A portable waste liquid treatment container according to any preceding claim, wherein after the liquid has flowed through the soil based medium it is directed into an outlet buffering medium which is located adjacent to the soil based medium but on the outlet side.

9. A portable waste liquid treatment container according to claim 9, wherein an outlet aperture is formed in the container wall adjacent to the distal side of the buffering medium.

10. A portable waste liquid treatment container according to any of claims 3 to 9, wherein the delivery region is the surface of the soil medium adjacent or abutting the buffering medium.

11. A portable waste liquid treatment container according to any preceding claim, wherein the means to collect the treated liquid comprise an outlet buffering medium and an outlet aperture in the container.

12. A portable waste liquid treatment container according to any of claims 9 to 11, wherein the inlet aperture and outlet aperture are located in the walls of opposite sides, or the base and a side of the container.
13. A portable waste liquid treatment container according to any of claims 9 to 12, wherein the outlet aperture is formed in the region of the base of the wall of the container.

14. A portable waste liquid treatment container according to any of claims 11 to 13, wherein the inlet/outlet buffering medium is a gravel inlet/outlet trench provided between the soil medium and the inlet delivery means and between the soil medium and the outlet collection means respectively.

15. A portable waste liquid treatment container according to any preceding claim, wherein the aquatic plants comprise one or more wetland species.

16. A portable liquid treatment container comprising aquatic plants growing in a soil based medium, the permeability of the medium to liquid being at least partially maintained by a mature root structure provided by the aquatic plants, a delivery region of the soil medium for the delivery of waste liquid to be treated to the medium and means to collect the treated liquid after it has flowed through the medium, wherein the liquid to soil delivery region is at least partially located directly beneath at least a proportion of the soil medium.

17. A portable liquid treatment container according to claim 16, wherein to facilitate the delivery region being below at least a proportion of the soil medium,
an outlet buffer medium extends at least partially beneath at least a proportion of the soil medium.

18. A portable liquid treatment container according to either of claims 16 or 17, wherein an inlet aperture in the container for delivery of liquid to the inlet buffer is located below the surface level of the soil medium for delivery of liquid to the inlet buffer medium located below at least a proportion of the soil medium.

19. A portable liquid treatment container according to any of claims 16 to 18, wherein at least a proportion of the delivery region is located on an underside surface of the soil medium.

20. A portable liquid treatment container according to any of claims 16 to 19, wherein the location of the delivery region directly beneath the surface soil induces Artesian flow characteristics into the bed.

21. A portable liquid treatment container according to any of claims 16 to 20, wherein the soil is a biologically active soil.

22. A portable liquid treatment container according to claim 21, wherein the biologically active soil is artificially structured by addition of various aggregates to produce sufficient porosity in accordance with effluent character.

23. A portable liquid treatment container according to any preceding claim, wherein the wastewater is delivered
to the base of the container and a buffering medium
inlet is located between the base of the container and
at least a proportion of the base of the soil medium
so that the at least a proportion of the base of the
soil medium is the delivery region.

24. A portable liquid treatment container according to any
preceding claim, wherein there is a holding tank to
provide sufficient head to generate hydraulic pressure
to cause the waste liquid to well up through the soil
matrix from a base delivery region under pressure.

25. A portable liquid treatment container according to any
preceding claim, wherein the inlet comprises a
buffering medium such as a gravel trench along one
upright wall of the bed but the buffering medium
gravel extends partially into the soil medium under
the surface thereof preferably, at the inlet buffering
medium base, so that the waste liquid travels through
the buffering medium and under the soil medium to
thereafter induce Artesian flow characteristics from
the delivery region.

petrol/gasoline forecourt comprising the steps of:-
locating the portable waste liquid treatment container
according to claim 1 in a position to receive the said
run-off.

27. A portable waste liquid treatment container
substantially as herein described with reference to
and as illustrated by the accompanying drawings.
28. A method substantially as herein described with reference to and as illustrated by the accompanying drawings.