A method of filtering liquid media comprises directing liquid to be filtered into a vessel 1 under pressure, the vessel including a bed 6 of filtering media (e.g. sand) and a drain arrangement 4 wherein in backwash mode liquid is forced through the filter media effecting rotating flow and fluidisation of the media, and/or in normal operation liquid 8 present in the vessel above the filter media is caused to undergo rotating flow. The drain arrangement preferably includes a plurality of radially extending arms 20 provided with apertures or slots to direct water either in a clockwise or anticlockwise manner.

FIG. 1
GB 2408001 A continuation

(72) Inventor(s):
Derek Colin Tolley
Ashley Derek Tolley

(74) Agent and/or Address for Service:
Urquhart-Dykes & Lord LLP
Three Trinity Court, 21-27 Newport Road,
CARDIFF, CF24 0AA, United Kingdom
FIG. 3a

FIG. 3b

FIG. 3c
Filtration of Liquid Media

The present invention relates to filtration of liquid media and particularly to filtration of water or the like.

Filtration apparatus is known for filtering water. Such apparatus typically comprises a vessel pressurised with water having an inlet, a bed of filter media (typically one or more layers of graded sand or other particulate material), and an outlet drain arrangement for directing off the filtered water. In order to periodically clean the filter media a cleaning backwash is forced through the drain arrangement (typically causing fluidisation of the bed of filter media) and the backwashed liquid is drawn off to waste above the level of the bed of filter media.

An improved technique and system has now been devised.

According to a first aspect, the invention provides filtration apparatus including:

- a filtration vessel;
- an inlet arrangement for inflow into the filtration vessel of liquid media to be filtered;
- a body of filter media in the filtration vessel;
- a drain arrangement to receive filtered liquid media.
for take off from the filtration vessel; wherein:

the inlet arrangement is configured to induce substantially rotating flow about the vessel of unfiltered liquid present in the vessel; and/or,

the drain arrangement is configured in backwash mode to force backwash liquid through the filter media in substantially rotating flow about the vessel; and/or

the drain arrangement includes a plurality of drain limbs inclined to the horizontal and providing for draining of filtered liquid along the inclined limbs to outlet the apparatus.

It is preferred that the inlet arrangement comprises liquid directing means arranged to direct pressurised liquid along a tangential or circumferential path with respect to an axis of the vessel. Beneficially, the liquid directing means is arranged to direct the pressurised liquid entering the vessel at an acute angle downwardly.

Beneficially, the inlet arrangement is provided closely adjacent the upper internal surface of the vessel, which upper internal surface of the vessel is beneficially inclined or concave from an upper point to lower portions proximate the periphery of the vessel. This aids in promoting the rotating flow.

Typically the unfiltered water is pressurised in the vessel
above the level of the filtration media (which is typically present as a bed laying in the vessel). The inlet arrangement is designed to induce a flow pattern within the vessel to maximise the flow length from the inlet arrangement to the liquid/filter media interface. Creating a rotation from stimulus at the inlet arrangement zone in the liquid space above the filter media provides a body or bulk rotation of the liquid media about the axis of the vessel and ensures:

1. Even flow of liquid media through the filter media bed;
2. Minimal eddy currents at higher flow rates to ensure pressure balance at water/filter media interface and inhibit tunnelling through the filter media; and
3. Retention of flocs on the surface of the filter media at high rates of flow.

In Norther Hemisphere environments the rotation is to be induced in a clockwise direction, whereas in Southern Hemisphere locations anticlockwise rotation is necessary. The reason for the different direction of rotation preferred is due to the coriolis force caused by the earth’s rotation. Taking advantage of the coriolis force leads to preferred rotation in different directions in Northern and Southern Hemispheres.

The inlet arrangement preferably comprises a plurality of radially extending duct arms, each including outlet means (typically apertures) to direct pressurised unfiltered liquid transversely to the radial direction. The duct arms
are configured to direct the outlet liquid either substantially in a clockwise sense or in an anticlockwise sense (dependant upon the geographical location of the filter vessel either in the Northern or Southern Hemisphere).

Beneficially, the radial duct arms are regularly spaced about an axis, preferably connected to a central or hub plenum inlet chamber. Beneficially the radial duct arm outlet apertures, direct the pressurised liquid at an acute angle outwardly and downwardly from the inlet arrangement within the vessel.

Beneficially the outlet apertures are guarded by filter or mesh means to inhibit filter media or other detritus passing back through the inlet arrangement during the backwash cycle.

It is preferred that the drain arrangement includes a plurality of radially extending limbs, each preferably including apertures, slots or other liquid passage means to act as backwash liquid, distribution means in backwash mode or filtered liquid collection means in normal ‘filter mode’. The backwash liquid distribution means (apertures etc) is beneficially configured to distribute backwash liquid in a direction transverse to the longitudinal direction of the respective limbs. Beneficially the backwash outlet means of limbs in the drain arrangement is configured such that in backwash mode the majority (or all) of the limbs direct water in either a clockwise sense or alternatively an anticlockwise sense (depending again upon
the geographical location of the filter vessel in either the Northern or Southern Hemisphere).

The backwash outlet means of the radial limbs of the drain arrangement also serve to collect the filtered liquid (in filter mode) having passed through the body of filter media.

The drain arrangement is preferably positioned toward the interior base of the vessel. Beneficially the interior base of the vessel is inclined, concave or dish shaped, the radial limbs of the drain arrangement extending from a lower most end at a radial central zone of the vessel to an upper end raised from the lower end and radially spaced from the centre of the vessel. The radial limbs are therefore effectively inclined, and preferably connect with a radially central drain chamber. Because the limbs are inclined, draining of the filtered liquid into the drain chamber is improved. The limbs can extend at the lowest possible point in the vessel with respect to the inclined, concave or dish shaped interior bottom surface of the vessel. Prior art arrangements have had non-radially configured limbs of a drain arrangement extending substantially horizontally.

Beneficially the apertures providing the backwash outlet or filter media inlet to the drain arrangement are provided over the majority of the length of the radial limb. Slots or the like may be provided at spaced intervals along the length of the limb to achieve this. Beneficially the apertures are provided with filter or mesh guard means to
inhibit filter media entering the drain arrangement.

In backwash mode high flow rates are used to ensure efficient backwash cycle without loss of filter media. The purpose of the backwash cycle is to attempt to remove detritus from the body of filter media, including inhibiting the risk of growth of pathogen colonies within the media. This reduces deterioration of the filter performance. This in turn aids in extending the life of the filter media. High flow rates are preferred in the backwash cycle in order to provide a short and efficient backwash cycle reducing the water volume used and further minimising running costs.

According to a further aspect, the invention provides a method of filtering liquid media, the method comprising directing liquid to be filtered into a vessel under pressure, the vessel including a bed of filter media and a drain arrangement for take-off of filtered liquid media from the filtration vessel, wherein liquid present in the vessel above the bed of filter media is caused to undergo rotating flow about the vessel and/or wherein in backwash mode liquid is forced through the filter media effecting rotating flow and fluidisation of the filter media.

The invention will now be further described in specific embodiments by way of example only with reference to the accompanying drawings in which:

Figure 1 is a schematic view of a first embodiment of filtration apparatus according to the invention;
Figure 2 is a plan view of drain arrangement of the filter apparatus of Figure 1;

Figures 3a, 3b, and 3c are plan, side and detail views of a liquid inlet arrangement in accordance with the apparatus of the invention;

Figures 4a, 4b, and 4c are section, side and detail views of an alternative embodiment of liquid inlet arrangement; and

Figure 5 is a schematic side view of a limb of the drain arrangement such as the drain arrangement shown in Figure 2.

Referring to the drawings, and initially to Figure 1, there is shown a pressure sand filter 1 comprising a filter vessel 2 having a liquid inlet arrangement 3 and a filtered liquid drain arrangement 4. Drain arrangement 4 also operates to supply backwash liquid in 'backwash mode' (as will be described hereinafter).

The vessel 2 has a concave internal bottom 5 upon which rests a bed of filter media 6 extending upwardly to approximately half the depth of the vessel 2. Filter media typically comprises a body of particulate materials such as filter sand which may be single-grade or multi-grade depending upon the precise application of the filter. Activated charcoal/carbon or other particulate material may also be utilised.
Liquid (water) to be filtered is directed under pressure into the vessel 2 via inlet arrangement 3 such that the pressurised head volume 8 of liquid is present above the surface 7 of filter media bed 6 in head space 8.

An important aspect of the invention is the ability of the inlet arrangement 3 to direct pressurised unfiltered inlet liquid such that upon entry into the head space 8 bulk rotation of liquid in head space 8 is created about the central axis of the vessel 2. Such an effect enables a situation approaching hydraulic balance to be achieved at the liquid/filter media interface providing even flow through the filter bed, minimising eddy currents and avoiding tunnelling into the filter media.

In order to achieve this the liquid inlet comprises a filter head 10 having a plurality of regularly spaced radial arms 11 extending outwardly from a central plenum 12. Central plenum 12 includes perforations permitting unfiltered liquid media to enter directly into head space 8, although a large proportion of the liquid entering is directed via arms 11 as will be described hereafter.

Arms 11 communicate with plenum 12 and are generally tubular in cross-section (as shown most clearly in Figure 3c). Respective angled slots 13 are provided for each of limbs 11, slots 13 being configured to direct jetting pressurised liquid out of arm 11 in a direction transverse to the longitudinal direction to arm 11. As can be seen from Figure 3c, the slots 13 are arranged to direct the outlet jetting liquid also at an inclined angle downwardly
into the vessel.

Figure 3c shows an alternative slot 13a. It should be noted that slots 13 and 13a are not provided in a single embodiment. Slots 13 and 13a are provided as alternatives for use in Northern and Southern Hemispheres where counter-clockwise rotation of the liquid in head space 8 is required.

Referring to Figure 3a, each limb 11 directs liquid tangentially (transversely to the longitudinal direction of respective arms 11) in the direction of arrows X. This directional jetting of inlet liquid is sufficient to initiate the required rotating flow in the body of pressurised liquid in head space 8.

Referring to Figure 4 and 4a, an alternative arrangement 103 is disclosed comprising a central plenum hub 112, and a series of curve-form vanes 111 regularly angularly spaced about hub 112 and extending outward away from the central plenum hub 112. The lower surface 120 of the inlet arrangement 103 includes a series of radially extending angularly spaced slots 113 and a welded deflection plate 115 to direct the pressurised liquid in the required inlet direction into the interior of vessel 2. Vanes 111 direct the water entering into the inlet arrangement radially outwardly some being forced through slots 113 and some exiting tangentially between outlet apertures formed between the distal ends of vanes 111 and the back of an adjacent vane.

The drain arrangement 4 (shown most clearly in Figures 1,
2 and 5) comprises a series of angularly spaced radially extending limbs 20 communicating with an axial drain chamber 21. The limbs effectively rest as closely as possible upon the concave base 5 of vessel 2, extending in inclined fashion upwardly from drain chamber 21 to their respective distal radially outermost ends. This is a departure from typical prior art arrangements in which a network of perpendicularly crossing lateral drain limbs are provided, mounted on a concrete or other solid base in horizontal fashion. The inclined orientation of the drain limbs 20 provides for draining into a central drain chamber or hub is believed to be novel and inventive per se.

Referring now to Figure 5 and Figure 2 in particular, each radial limb 20 comprises aperture means permitting filtered liquid to enter (and backwash liquid to leave) via a preferred side of the relevant limb. The preferred side is common to the majority or all of the limbs 20 in the radial arrangement. In the embodiment shown, a series of substantial regularly spaced slots 25 are provided substantially along the entire length of the relevant side of the respective limb 20. Slots 25 are covered with a fine stainless steel mesh 26 to ensure that sand filter media does not enter into the drain arrangement 4. In backwash mode, backwash water pumped back through drain arrangement 4 is forced through the apertures 25 which, being directed in a common rotational sense for all limbs 20 in drain arrangement 4, results in fluidisation of the filter media bed 6 and bulk rotation in a common sense of the body of filter material about the central axis of vessel 2. Fluidisation and rotation of the filter bed has
been found to improve the backwash effectiveness.

By mounting the drain limbs directly in sand filter media (rather than typical prior art mounting in gravel on a concrete base) the backwash fluidisation and rotation of the sand filter bed is achieved. This arrangement is believed to be novel and inventive per se.

The present invention provides improvements in relation to performance of filter apparatus by improving the inlet distribution of liquid to be filtered into a filter vessel and also the drain outlet and backwash capability and efficiency.
CLAIMS:

1. A method of filtering liquid media, the method comprising directing liquid to be filtered into a vessel under pressure, the vessel including a bed of filter media and a drain arrangement for take-off of filtered liquid media from the filtration vessel, wherein in backwash mode liquid is forced through the filter media effecting rotating flow and fluidisation of the filter media, and/or in normal operation liquid present in the vessel above the bed of filter media is caused to undergo rotating flow about the vessel.

2. A method according to claim 1, wherein in backwash mode backwash liquid is pumped through the drain arrangement into the vessel.

3. A method according to claim 2, wherein the drain arrangement includes a plurality of radially extending limbs.

4. A method according to claim 3, wherein the limbs of the drain arrangement include apertures, slots or other liquid passage means to act as backwash liquid distribution means in backwash mode or filtered liquid collection means in normal 'filter mode'.

5. A method according to any preceding claim, wherein the drain arrangement includes a plurality of radially extending limbs, backwash liquid distribution means
being configured to distribute backwash liquid in a
direction transverse to the longitudinal direction of
the respective limbs.

6. A method according to any preceding claim, wherein the
drain arrangement includes a plurality of radially
extending limbs, backwash outlet means of limbs in the
drain arrangement being configured such that in
backwash mode the majority of the limbs direct water
in either a clockwise sense or alternatively an
anticlockwise sense.

7. A method according to any preceding claim, wherein the
drain arrangement is mounted directly in sand filter
media.

8. A method according to any preceding claim, wherein in
backwash mode bulk rotation of the filter bed occurs.
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

<table>
<thead>
<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1 - 8</td>
<td>GB 1342082 A (STAGE STIRLING) see especially page 3 lines 13 - 95 and figures 3 - 8</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>US 4753726 A (SUCHANEK) see figures</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>US 3809247 A (BRETT) see figure 3</td>
</tr>
</tbody>
</table>

Categories:

<table>
<thead>
<tr>
<th>X</th>
<th>Document indicating lack of novelty or inventive step</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Document indicating lack of inventive step if combined with one or more other documents of same category &amp; Member of the same patent family</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>Document indicating technological background and/or state of the art</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Document published on or after the declared priority date but before the filing date of this invention</td>
</tr>
<tr>
<td>E</td>
<td>Patent document published on or after, but with priority date earlier than, the filing date of this application</td>
</tr>
</tbody>
</table>

Field of Search:

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

- B1D

Worldwide search of patent documents classified in the following areas of the IPC^07:

- B01D; C02F

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

- EPODOC, WPI