

MODULAR TANK HOUSING FOR LIQUID, GAS FILTRATION AND PERVAPORATION APPLICATIONS

TECHNICAL FIELD

[001] The invention relates to a filtration apparatus, which can be used in relation to for liquids, gases, and where pervaporation processes are required.

BACKGROUND

[002] This invention relates mainly to liquid filtration but can also be used for gas filtration and pervaporation applications.

[003] One of the greatest challenges in the water industry is providing sustainable supplies of clean water at affordable costs. Many people (especially in those rural areas) have no access to safe drinking water. According to the World Health Organisation, safe drinking water is one of the preconditions for success in the fight against poverty and hunger, to enable primary education, gender equality and women empowerment, child mortality, HIV/AIDS and malaria, and to ensure environmental sustainability and to develop global partnerships. The World Health Organisation also estimates that about 1.1 billion people have no access to any type of safe drinking water.

[004] The costs of a filtration system are largely dictated by the size and complexity of the required system. The more cleaning elements it has, or the more elements it is designed to clean, the more the system will be to construct, build and maintain. Conventionally, the tanks or housing for such filtration systems are of fixed dimensions in filtration applications such as in liquid and gas filtration, or pervaporation applications. Once constructed, the tank or housing structure cannot be altered and changes in the processing requirements (general to handle greater capacity) would necessitate replacing the tank (with one that has a bigger dimensions) or bringing in an additional tank.

[005] The conventional tank **110** is also constructed separately from the membrane module **120**. Conventional tanks have fixed dimensions and shapes (usually rectangular or round) and are designed to withstand high pressure settings. The dimensions of a tank housing are usually fixed from the start, irrespective of whether the initial installation is intended to house 10, 30 or 50 membrane modules as the case may be, in the actual project design. The membrane modules are then submerged into the tank, which is filled with an aqueous

solution. The tank housing **110** protects the membrane modules **120** and without this housing tank **110**, the membrane modules **120** cannot function properly.

[006] Expansion of system capacity in conventional tanks would usually entail adding additional tanks or membrane modules (only if there is space available). Each tank has a fixed membrane module capacity, and each tank capacity extension comes in a relatively large increment. The design and structure of conventional tanks are thus expensive, rigid, and inflexible.

[007] This invention is developed to address the need for a robust and flexible tank or housing structure, which is also inexpensive to scale up, to support the membrane modules during the liquid or gas filtration, and pervaporation applications.

[008] It is more efficient if capacity increments can be made by simply adding individual membrane module as oppose to simply adding tanks to the system.

SUMMARY OF THE INVENTION

[009] In a first embodiment, the present invention provides a filtration apparatus in combination with an efficient encasement, such that the buffer space **130** between the membrane modules and tank housing **110** is eliminated. In these conventional tanks, such buffer space **130** is required to facilitate the installation of the membrane module **120** and fixed it to the tank housing **110**, and to maintain some room for accessibility during maintenance. This buffer space **130** takes about 15% – 20% of the total tank space.

[010] Accordingly, the present invention offer advantages in term of flexibility and ease of maintenance, as well as convenience of use. This results in overall lower costs in constructing and maintaining the filtration apparatus and system. The proposed membrane to be used is made of ceramic, which has a longer life.

BRIEF DESCRIPTION OF THE DRAWINGS

[011] For the purpose of illustrating the invention, there is shown in the drawings a form that is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

[012] FIG. **1** shows a perspective view of a typical rectangular tank and the membrane modules within

[013] FIG. **2** shows a front perspective view of a typical rectangular tank and the membrane modules within

[014] FIG. **3** shows a front view of a typical rectangular tank and the membrane modules within

[015] FIG. **4** shows a top view of a typical rectangular tank and the membrane modules within

[016] FIG. **5** shows a left side view of a typical rectangular tank and the membrane modules within

[017] FIG. **6** shows a perspective view of one embodiment of the invention, being that of a single layer of the filtration apparatus in combination with the encasement

[018] FIG. 7 shows a top view of one embodiment of the invention, being that of the filtration apparatus in combination with the encasement

[019] FIG. 8 shows a bottom view of one embodiment of the invention, being that of the filtration apparatus in combination with the encasement

[020] FIG. 9 shows a front view of one embodiment of the invention, being that of a single layer of the filtration apparatus in combination with the encasement

[021] FIG. 10 shows a back view of one embodiment of the invention, being that of a single layer of the filtration apparatus in combination with the encasement

[022] FIG. 11 shows a side view of one embodiment of the invention, being that of a single layer of the filtration apparatus in combination with the encasement

[023] FIG. 12 shows a side view illustrating a membrane module within the encasement as one embodiment of the invention, being that of a single layer of the filtration apparatus in combination with the encasement

[024] FIG. 13 shows a perspective view of one embodiment of the invention, being that of three layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[025] FIG. 14 shows a front view of one embodiment of the invention, being that of three layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[026] FIG. 15 shows a back view of one embodiment of the invention, being that of three layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[027] FIG. 16 shows a side view of one embodiment of the invention, being that of three layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[028] FIG. 17 shows a side view illustrating the membrane modules within the encasements as one embodiment of the invention, being that of three layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[029] FIG. 18 shows a perspective view of one embodiment of the invention, being that of four layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[030] FIG. 19 shows a front view of one embodiment of the invention, being that of four layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[031] FIG. 20 shows a back view of one embodiment of the invention, being that of four layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[032] FIG. 21 shows a side view of one embodiment of the invention, being that of four layers of the filtration apparatus (stacked vertically atop) in combination with the encasement

[033] FIG. 22 shows a side view illustrating the membrane modules within the encasements as one embodiment of the invention, being that of four layers of the filtration apparatus (stacked vertically top) in combination with the encasement

DETAILED DESCRIPTION

[034] In the invention, the proposed encasement **210** also acts as the wall of the tank housing. Fig. 6 shows the frame of the encasement **210** that functions additionally as the wall of the tank, which thus reduces the physical footprint of the entire filtration system as the buffer space **130** between the membrane modules **120** and the tank housing **110** is eliminated.

[035] The encasement **210** is also airtight and watertight and able to withstand at least 2 bars of water or gas pressure.

[036] In this embodiment and as shown in Fig. 12, membrane modules are encased within the housing encasement **210**. The encasement **210** can be made of a durable plastic material, or some of other structurally similar material that is similarly lightweight but possesses similar structural strength.

[037] In Fig. 7, a plurality of membranes modules are arranged together in parallel and a portion of such membranes being encased within its housing encasement.

[038] In Fig. 17, the membrane modules are encased within the housing encasement together with top and bottom encasements **210**. The encasement **210** can be made of a durable plastic material, or some of other structurally similar material that is similarly lightweight but possesses similar structural strength.

[039] In this embodiment, glass reinforced plastic is preferred.

[040] In Fig. 12, the encasement **210** has a significantly thicker wall, preferably between 50 mm to 120 mm, such that there is sufficient structural strength to withstand pressure generated within and above the membrane modules to maintain the overall shape and integrity of the encasement **210**.

[041] In Fig. 12, the encasement **210** is designed so as to prevent warping from the internal and external pressures exerted onto it. The strength of the encasement **210** is enhanced by adding ribs **220** longitudinally **230** so that lesser plastic may be used in the manufacturing process, thus resulting in some cost savings whilst still maintaining the strength and structural integrity of the encasement **210**. This embodiment is also more cost-effective to manufacture.

[042] In an embodiment of the invention, the encasement **210** allows an additional encasement to be added on top. A customised gasket **250** is added between each encasement so that users can increase storage capacity by simply adding another encasement as and when required. The purpose of the gasket is explained below. This method of increasing storage capacity also enhances space efficiency.

[043] This embodiment of the invention requires at least two encasements stacked vertically atop another to function properly.

[044] In this embodiment, the male quick connect **270** joint creates a water tight seal with a female quick connect joint to channel out the filtrated water.

[045] In this embodiment and as shown in Fig. 13, the joining surfaces **240** between the modules are smooth and have sufficient contact surface area, so that the sealing by the rubber gasket **250** is airtight.

[046] Tightening rods **260** are used to secure the entire encasement **210** and to apply pressure on the gasket **250**. Such compression stretches the gasket **250** longitudinally in

order to create a water-tight sealing effect.

[047] In this embodiment of the invention and as shown in Figs. **13, 14, 15, 16, 17, 18, 19, 20, 21, 22**, the encasements **210** are also sufficiently strong and structurally adequate thus allowing the said housing encasements **210** to be stacked vertically one atop another.

[048] In this embodiment, the pipe openings for the water feed **290** are bigger, as the water capacity is larger and hence the flow of water is corresponding larger. As the water capacity is larger in multi-layered encasements, an overflow opening **300** is required.

[049] In this embodiment of the invention, an additional encasement **210** can be added on top even when the filtration apparatus is in operational mode. In a conventional tank, the entire tank has to be switched off in order for access or work to be done on the membrane modules **120**. Further, as shown in Fig. **1**, all the membrane modules **120** have to be hoisted up if physical inspection or replacement is required. The current embodiment allows the isolation of one column (by turning off the feed valve), so that cleaning and maintenance work can be carried out as and when required. Any module replacement can also be done via direct access to the affected column. This modularity offers unprecedented operational flexibility and efficiency.

[050] In this embodiment, aeration pipes **280** may be added so that air can be channelled in to promote the growth of aerobic bacteria. This is part of the water treatment process.

[051] The membrane filtration step may employ a variety of different membranes types. In water filtration systems, polymeric membranes processes are commonly used to purify water. Ceramic membranes for use in drinking water filtration have not been widespread in usage to date, despite its several advantages over polymeric membranes largely due to cost considerations. **Ceramic** membranes are more resilient to chemical cleaning agents and it is therefore easier to clean a fouled ceramic membrane. Due to their high mechanical strength, ceramic membranes are expected to have a longer life time compared to polymeric membranes. Ceramic membranes have significantly higher permeance and lower membrane resistance than polymeric membrane, thereby requiring a lower liquid pressure to produce the same volume of treated water.

CLAIMS

1. A filtration apparatus, comprising:-

a plurality of membranes modules arranged together in parallel;
a portion of such membranes being encased within its housing;
such housing encasement being structurally adequate thus allowing the said housing encasement to be stacked vertically one atop another;
such housing encasement allowing the filtration apparatus to be organised in a compact and space efficient manner.
2. The apparatus according to Claim 1, wherein the encasement is made of a durable plastic material.
3. The apparatus according to Claim 2, wherein the walls of the encasement employ a rib-like structure.
4. The apparatus according to Claim 1, wherein the membranes used are made of a ceramic material.
5. A process of filtration system comprising:-

a plurality of membranes modules arranged together in parallel;
a portion of such membranes being encased within its housing;
such housing encasement being structurally adequate thus allowing the said housing encasement to be stacked vertically one atop another;
such housing encasement allowing the filtration apparatus to be organised in a compact and space efficient manner.
6. The method according to Claim 5, wherein the encasement is made of a durable plastic material.
7. The method according to Claim 6, wherein the walls of the encasement employ a rib-like structure.
8. The method according to Claim 5, wherein the membranes used are made of a ceramic material.