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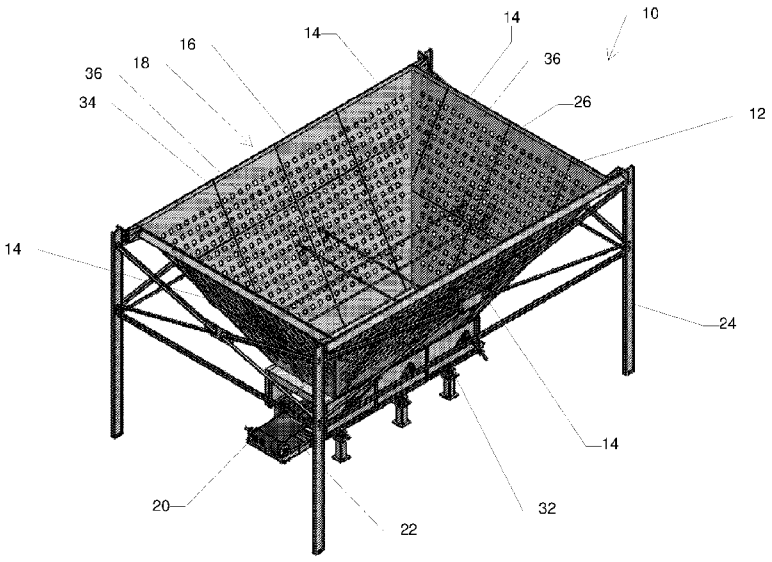


FIGURE 1

(57) Abstract: A hopper comprising: a hopper body having an internal surface; and a porous liner covering at least a portion of the internal surface of the hopper body, wherein one or more perforations are provided through at least a portion of the hopper body.

WO 2020/154768 A1

[Continued on next page]

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Desiccation Hopper

TECHNICAL FIELD

[0001] The present invention relates to a desiccation hopper. More specifically, the desiccation hopper of the present invention is adapted to prevent sticking and hanging up of wet feedstocks inside the hopper.

BACKGROUND ART

[0002] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0003] Hoppers, variously referred to as storage bins, ore bins, silos, grain stores, draw points and feed hoppers, are all containers used for the temporary storage of a feedstock comprising loose particulate solids, and/or to assist in moving such material from one receptacle to another. In such apparatus, the feedstock is typically loaded into the top of the apparatus, with a discharge being provided at the lower end.

[0004] Conventional hoppers are not ideally suited for the storage and throughput of wet or sticky feedstocks. In conventional hoppers, wet stored feedstock materials will stick to the sides and base of the structure causing blockages and "hang-ups". This problem is caused when wet material comes into contact with the typical smooth side or base surfaces of the hopper. The wet feedstock in contact with the surfaces will "sweat", generally increasing the moisture content of this material compared to the surrounding feedstock. This leads to the adherence of this material to the structure surface. This adhesion can last for many months, if not years, and can eventually result in cementing of these materials to the inside of the hopper through crystallisation or rusting of the structure surface.

[0005] When materials adhere to the wall of a hopper, the live volume of the hopper is reduced. Continued use of the hopper will increase the amount of material that is adhered to the sides. If this material is not cleared, the passage through which new material may pass becomes increasingly narrow, this is commonly referred to in the art

as a "rat-hole". Eventually, the build-up will lead to a total blockage of that portion of the silo or hopper.

[0006] Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0007] Throughout this specification, unless the context requires otherwise, the word "hopper", will be understood to refer to a temporary storage container adapted to receive, temporarily store, and discharge materials. Typically, such apparatus will comprise vertical and tapered sides to funnel and direct the material.

SUMMARY OF INVENTION

[0008] In accordance with the present invention there is provided a hopper, said hopper comprising:

a hopper body having an internal surface; and

a porous liner covering at least a portion of the internal surface of the hopper body,

wherein one or more perforations are provided through at least a portion of the hopper body.

[0009] Preferably, the hopper is adapted to remove water and/or other liquids from at least a portion of a wet feedstock, particularly at the point of contact between the wet feedstock and the hopper body. The inventors have found that the removal of liquids at the point of contact between the wet feedstock and the hopper body will lead to a reduction in the amount of material that sticks to the internal surface of the hopper. This leads to an increase in the flow dynamics of the feedstock through the hopper.

[0010] Throughout this specification, unless the context requires otherwise, the term "porous liner" or variations, will be understood to refer to a material that comprises a plurality of pores or interstices that admit the passage or diffusion of gas and liquid therethrough.

[0011] The inventors have found that by lining at least a portion of the internal of the hopper body with a porous liner, a portion of any liquids in the feedstock will be removed from the feedstock. In particular, the removal of liquid from the feedstock is localised primarily in the areas where the feedstock is in contact with the porous liner at the interface between the feedstock and the hopper body. It is understood by the inventors, that when the porous liner is brought into contact with liquid in the feedstock, the porous liner will "wick" or absorb liquid or moisture due to capillary forces. The capillary force generates suction that absorbs water from the feedstock through the porous liner. The perforations provide a pathway through which liquids absorbed by the porous liner may exit the hopper, through drainage or evaporation.

[0012] It has also been found that as liquids are removed from the particles adjacent to the lining, these drier particles will in turn draw liquid from the surrounding wet particles by way of capillary transmission. This will lead to a reduction in liquid levels inside the hopper.

[0013] The reduced liquid content has been found to reduce the adhesion of the feedstock to the internal surface of the hopper body, improving flow rates of wet materials. The use of the porous liner has also been found to be particularly useful for handling feedstocks that contain sticky, or tacky, materials.

[0014] The perforations will provide areas in which the porous liner is exposed to the exterior of the hopper body. It is envisaged that the perforations provide locations for air and liquids to exit the interior of the hopper body. In a preferred embodiment of the present invention, the perforations are in communication with the pores of the porous liner, thereby allowing evaporation of volatile liquids, particularly water, from the porous liner to the exterior of the hopper body, whilst still retaining the feedstock within the hopper body.

[0015] In one embodiment, the hopper body defines a transfer section, the transfer section having an entrance section and a discharge section in communication. As would be understood by a person skilled in the art, the transfer section is adapted to provide a pathway along which the feedstock can flow from the entrance section to the discharge section. Preferably, the feedstock flows from the entrance section to the discharge section under the influence of gravity. The particular geometry of the

entrance section, transfer section and discharge section can be adapted to suit the particular application of the hopper.

[0016] In one form of the present invention, the hopper is suitable for the mechanical guiding of bulk materials.

[0017] In one form of the present invention, the hopper body is fixed in a stationary position.

[0018] In one form of the present invention, the hopper body is elongate in the vertical axis. Alternatively, the hopper body is elongate in the horizontal axis.

[0019] In one form of the present invention, the hopper body tapers inwardly towards the discharge section.

[0020] In one form of the present invention, the hopper body is defined by one or more side structures.

[0021] In one form of the present invention, a portion of the hopper body is a frustum. In one embodiment a portion of the hopper body is frusto-conical in shape. In an alternative embodiment, a portion of the hopper body is frustro-polyhedron. In a preferred embodiment, the hopper body is a quadrilateral frustum. As would be appreciated by a person skilled in the art, a number of different hopper geometries are used in various industries. The geometry of the hopper of the present invention can be adjusted to suit the particular application.

[0022] In one form of the present invention, the hopper body comprises three or more opposed side structures. Preferably, the side structures are plate-like panels. Preferably, the hopper body comprises four opposed side structures.

[0023] In one embodiment, each side structure has an upper edge that defines the entrance section. In one embodiment each side structure has a lower edge that defines the discharge section.

[0024] In one embodiment, the lower ends of the side structures taper inwardly toward the discharge section.

[0025] In one embodiment, where the side structures taper inwardly towards the discharge section, at least one of the side structures is provided at an incline to the vertical.

[0026] In one embodiment, the hopper body further comprises an upper section. In one embodiment, the upper section comprises substantially vertical walls. It should be appreciated that the upper section may similarly be lined with a porous liner.

[0027] In one form of the present invention, the porous liner is constructed from a material selected from the group comprising porous textiles, porous fabrics, porous rubbers, porous plastics, porous ceramics, porous wood, porous cement, porous concrete, porous brick and porous metals. Preferably, the porous liner is a woven or non-woven textile. More preferably, the porous liner is a geosynthetic textile.

[0028] As would be appreciated by a person skilled in the art, geosynthetic textiles are textiles that consist of synthetic fibres. These synthetic fibres are typically made into flexible, porous fabrics by standard weaving machinery or are matted together in a random non-woven manner. Geosynthetic textiles are porous to liquid flow across their manufactured plane and also within their thickness. Such fabrics are designed to have an increased surface area to generate large capillary forces. The capillary force can generate suction that absorbs water from the feedstock through the fibre channels.

[0029] Preferably, the porous liner is constructed from synthetic fibres. Preferably, the synthetic fibres are constructed from a polymeric material. More preferably the synthetic fibres are constructed from one or more of polypropylene, polyester, polyethylene and high density polyethylene (HDPE). In an alternative form of the present invention, the porous liner is constructed from metal wires. The metal wires can be fine or coarse, or a combination of both, to allow egress of liquids whilst providing additional mechanical strength.

[0030] Preferably, a number of perforations are provided around the circumference of the hopper body.

[0031] Preferably, a number of perforations are provided along the longitudinal length of the hopper body.

[0032] In one form of the present invention, the perforations are regularly disposed about the hopper body.

[0033] In one form of the present invention, the liner is made up of one or more layers.

[0034] In a preferred form of the invention, the porous liner covers at least 50% and up to 100% of the internal surface of the hopper body.

[0035] In one embodiment of the present invention, a protective layer comprising a number of apertures is provided over the porous liner. In applications where the feedstock comprises abrasive particles, the protective layer is used to prevent or inhibit the abrasive particles from damaging the porous liner, whilst still permitting the egress of water, vapours or fumes through to the porous liner. Preferably, the protective layer is constructed from an abrasion resistant material. More preferably, the abrasion resistant material is selected from the group comprising rubber, plastics, neoprene, ceramics or metals.

[0036] Preferably, the apertures of the protective layer are between 10 mm and 50 mm.

[0037] In one form of the present invention, the hopper further comprises a means for generating an airflow into the hopper body. Preferably, the direction of the airflow is substantially parallel to the vertical axis of the hopper. More preferably, the direction of the airflow is substantially parallel to the vertical axis of one or more of the side structures. In one form of the present invention, the means for generating airflow into the hopper body is a fan or air blower. Preferably, where a fan or air blower is used, the direction of the airflow is along the side structures of the hopper body. In one form of the present invention, multiple fans or blowers may be used to generate the airflow into the hopper body. In a preferred form of the present invention, separate fans or blowers are positioned to generate an airflow substantially parallel to each of the side structures.

[0038] The inventors have found that the airflow generated through the hopper body will enhance the rate of evaporation of the water and other volatile liquids from the wet feedstock. Without wishing to be bound by theory, the inventors believe that as liquids evaporate into the atmosphere of the hopper as a vapour, the airflow will continually direct the vapour out of the hopper. This is understood to increase the rate of evaporation of liquid from the wet feedstock whilst also preventing the recondensation of vapour onto the walls of the hopper. Furthermore, at least some of the air will pass

through the porous liner and out through the perforations, especially where portions of the porous liner are exposed. This will assist with carrying liquids through the porous liner, drying the porous liner.

[0039] In one form of the present invention, the hopper further comprises a means for generating an airflow onto or about the exterior of the hopper body. As discussed above, liquids that have been absorbed by the porous liner will evaporate from the porous liner at the perforations. Without wishing to be bound by theory, the inventors believe that as the liquid evaporates into the atmosphere as vapour, the airflow will continually direct the vapour away from the exterior of the hopper, thereby increasing the rate of further evaporation.

[0040] Preferably, the direction of the airflow is substantially parallel to the elongate axis of the hopper. The inventors have found that the most efficient way to remove liquid vapour is to direct the airflow in a direction that is generally along the side structures. The direction will therefore be dependent on the particular geometry of the hopper body. In one form of the present invention, the means for generating airflow onto or about the exterior of the hopper body is a fan or air blower. Furthermore, the inventors have determined that the means for generating an airflow onto or about the exterior of the hopper body can be focused at critical sections of the hopper body where blockages or choke points are problematic. In one form of the present invention, multiple fans or blowers may be used to generate the airflow onto or about the hopper body from different directions.

[0041] In accordance with a further aspect of the present invention, there is provided a method for temporary storage of a feedstock comprising a liquid, the method comprising:

> introducing the feedstock into a hopper, the hopper being defined by a hopper body having an internal surface, wherein one or more perforations are provided through at least a portion of the hopper body and at least a portion of the internal surface is covered by a porous liner; and
>
> discharging the feedstock from the hopper.

[0042] As discussed above, the inventors have found that excess liquids in the feedstock can diffuse through the porous liner, reducing the moisture content of the

feedstock at the interface of the feedstock and the porous liner. This has been found to prevent the feedstock from adhering to the side of the hopper and generally reducing the liquid content of the feedstock. As the feedstock travels downward through the hopper, the density will increase due to moisture loss. Advantageously, the use of the hopper of the present invention avoids the need to heat the feedstock to remove the liquids, resulting reduced operating costs.

[0043] In one form of the present invention, the feedstock is selected from the group comprising pellets, powders, seeds, biomass matter, muds, sludges, lumps, slurry, suspensions, ores, aggregates, dusts, cement, sands, concentrates and agglomerates. Preferably, the feedstock contains crushed rock, pellets, agglomerates and/or granules.

[0044] In one form of the present invention, an airflow is generated into the hopper body. In one form of the present invention, the airflow into the hopper body is generated by a fan or air blower. Preferably, where a fan or air blower is used, the direction of the airflow is substantially parallel to the vertical axis of the hopper body.

[0045] In one form of the present invention, an airflow is directed onto or about the exterior of the hopper body. In one form of the present invention, airflow is directed onto or about the exterior of the hopper body by a fan or air blower. Preferably, where a fan or air blower is used, the direction of the airflow is substantially parallel to the elongate axis of the hopper body.

[0046] In a preferred form, the volume of air passed through the hopper body is between 10,000 to 100,000 m^3/hr.

[0047] In one form of the present invention the hopper is continuously operated.

[0048] In an alternative form of the present invention, the hopper is batch operated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0049] Further features of the present invention are more fully described in the following description of several non-limiting embodiments thereof. This description is included solely for the purposes of exemplifying the present invention. It should not be understood as a restriction on the broad summary, disclosure or description of the

invention as set out above. The description will be made with reference to the accompanying drawings in which:

Figure 1 shows an upper perspective view of a hopper in accordance with the present invention; and

Figure 2 shows an exploded upper perspective view of a hopper in accordance with the present invention.

DESCRIPTION OF EMBODIMENTS

[0050] As discussed above, the present invention relates to a hopper, said hopper comprising: a hopper body having an internal surface; and a porous liner covering at least a portion of the internal surface of the hopper body, wherein one or more perforations are provided through at least a portion of the hopper body.

[0051] In one embodiment, the hopper body defines a transfer section, the transfer section having an entrance section and a discharge section in communication. As would be understood by a person skilled in the art, the transfer section is adapted to provide a pathway along which the feedstock can flow from the entrance section to the discharge section. Preferably, the feedstock flows from the entrance section to the discharge section under the influence of gravity.

Hopper Body

[0052] In one form of the present invention, the hopper body is elongate in the vertical axis. Alternatively, the hopper body is elongate in the horizontal axis.

[0053] In one form of the present invention, the ratio of diameter of the hopper body at the entrance section and the height of the hopper body is between 1:0.5 and 1:15.

[0054] In one form of the present invention, the ratio of the diameter of the hopper body at the discharge section and the height of the hopper body is between 1:0.5 and 1:15.

[0055] Preferably, the ratio of the half height diameter of the hopper body to the height of the hopper body is between 1:0.5 and 1:15

[0056] In one embodiment, the height of the hopper body is at least 3 metres. In one embodiment, the height of the hopper body is at least 4 metres. In one embodiment,

the height of the hopper body is at least 5 metres. In one embodiment, the height of the hopper body is at least 6 metres. In one embodiment, the height of the hopper body is at least 7 metres. In one embodiment, the height of the hopper body is at least 8 metres. In one embodiment, the height of the hopper body is at least 9 metres. In one embodiment, the height of the hopper body is at least 10 metres. In one embodiment, the height of the hopper body is at least 11 metres. In one embodiment, the height of the hopper body is at least 12 metres. In one embodiment, the height of the hopper body is at least 13 metres. In one embodiment, the height of the hopper body is at least 14 metres. In one embodiment, the height of the hopper body is at least 15 metres. In one embodiment, the height of the hopper body is at least 16 metres. In one embodiment, the height of the hopper body is at least 17 metres. In one embodiment, the height of the hopper body is at least 18 metres. In one embodiment, the height of the hopper body is at least 19 metres. In one embodiment, the height of the hopper body is at least 20 metres. In one embodiment, the height of the hopper body is at least 21 metres. In one embodiment, the height of the hopper body is at least 22 metres. In one embodiment, the height of the hopper body is at least 23 metres. In one embodiment, the height of the hopper body is at least 24 metres. In one embodiment, the height of the hopper body is at least 25 metres. In one embodiment, the height of the hopper body is at least 26 metres. In one embodiment, the height of the hopper body is at least 27 metres. In one embodiment, the height of the hopper body is at least 19 metres. In one embodiment, the height of the hopper body is at least 28 metres. In one embodiment, the height of the hopper body is at least 29 metres. In one embodiment, the height of the hopper body is at least 30 metres. In one embodiment, the height of the hopper body is at least 31 metres. In one embodiment, the height of the hopper body is at least 32 metres. In one embodiment, the height of the hopper body is at least 33 metres. In one embodiment, the height of the hopper body is at least 34 metres. In one embodiment, the height of the hopper body is at least 35 metres.

[0057] In one embodiment, the diameter of the entrance section is at least 0.5 meters. Throughout this specification, the term “diameter of the entrance section” will be understood to refer to the width of the entrance section at it widest point. In one embodiment, the diameter of the entrance section is at least 1 meters. In one embodiment, the diameter of the entrance section is at least 1.5 meters. In one embodiment, the diameter of the entrance section is at least 2 meters. In one embodiment, the diameter of the entrance section is at least 3 meters. In one

embodiment, the diameter of the entrance section is at least 4 meters. In one embodiment, the diameter of the entrance section is at least 5 meters. In one embodiment, the diameter of the entrance section is at least 6 meters. In one embodiment, the diameter of the entrance section is at least 7 meters. In one embodiment, the diameter of the entrance section is at least 8 meters. In one embodiment, the diameter of the entrance section is at least 9 meters. In one embodiment, the diameter of the entrance section is at least 10 meters. In one embodiment, the diameter of the entrance section is at least 11 meters. In one embodiment, the diameter of the entrance section is at least 12 meters. In one embodiment, the diameter of the entrance section is at least 13 meters. In one embodiment, the diameter of the entrance section is at least 14 meters. In one embodiment, the diameter of the entrance section is at least 15 meters. In one embodiment, the diameter of the entrance section is at least 16 meters. In one embodiment, the diameter of the entrance section is at least 17 meters. In one embodiment, the diameter of the entrance section is at least 18 meters. In one embodiment, the diameter of the entrance section is at least 19 meters. In one embodiment, the diameter of the entrance section is at least 20 meters. In one embodiment, the diameter of the entrance section is at least 21 meters. In one embodiment, the diameter of the entrance section is at least 22 meters. In one embodiment, the diameter of the entrance section is at least 23 meters. In one embodiment, the diameter of the entrance section is at least 24 meters. In one embodiment, the diameter of the entrance section is at least 25 meters. In one embodiment, the diameter of the entrance section is at least 26 meters. In one embodiment, the diameter of the entrance section is at least 27 meters. In one embodiment, the diameter of the entrance section is at least 28 meters. In one embodiment, the diameter of the entrance section is at least 29 meters. In one embodiment, the diameter of the entrance section is at least 30 meters.

[0058] In one embodiment, the diameter of the discharge section is at least 0.5 meters. Throughout this specification, the term “diameter of the discharge section” will be understood to refer to the width of the discharge section at it widest point. In one embodiment, the diameter of the discharge section is at least 1 meters. In one embodiment, the diameter of the discharge section is at least 1.5 meters. In one embodiment, the diameter of the discharge section is at least 2 meters. In one embodiment, the diameter of the discharge section is at least 2.5 meters. In one

embodiment, the diameter of the discharge section is at least 3 meters. In one embodiment, the diameter of the discharge section is at least 3.5 meters. In one embodiment, the diameter of the discharge section is at least 4 meters. In one embodiment, the diameter of the discharge section is at least 4.5 meters. In one embodiment, the diameter of the discharge section is at least 5 meters.

[0059] As discussed above, the side structures taper inwardly toward the discharge section. To provide this taper, it is envisaged that at least one of the side structures is provided at an incline to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 10° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 15° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 20° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 25° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 30° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 35° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 40° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 45° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 50° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 55° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 60° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 65° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 75° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 80° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 85° to the vertical. In one embodiment, at least one of the side structures is provided at an incline of at least 90° to the vertical.

[0060] It is envisaged that the vertical incline of the side structures will depend on the water content of the feedstock. Generally, the inventors have found that wetter feeds will require a steeper angle of the side structures to maintain flow. The height of the hopper body and the diameters of each of the entrance section and the discharge section may be tailored to accommodate the required angles of the side structures.

[0061] In one form of the present invention, the ratio between the area of the entrance section and the discharge section is between 1:2.5 and 1:15.

[0062] In a preferred form, each of the side structures are provided at the same inclination to the vertical.

Porous Liner

[0063] The inventors have found that a liner that is constructed from a porous material is particularly useful in the removal of water from the feedstock. As would be appreciated by a person skilled in the art, porous materials absorb water through a mechanism known as capillary action, also known as wicking. In this mechanism, the intermolecular forces between the liquid and surrounding solid surfaces cause water to be drawn into the pores of the porous material. It is envisaged that the porous liner can be constructed from any material that can be adapted to absorb water. Examples include a wide range of woven and non-woven fabrics, rubber, plastic, ceramic, wood, cement, concrete/brick liners and metals. A particularly useful material used to construct the porous liner is a geosynthetic textile. Such materials comprise a woven or non-woven textile constructed from synthetic fibres. Materials that have been found to be particularly useful by the inventors include Texcel™, Bidim™, Mirafi™ and Megaflow™ (GEOFABRICS AUSTRALASIA PTY LTD).

[0064] In one embodiment, the liner covers at least 50 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 55 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 60 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 65 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 70 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 75 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 80 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 85 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 90 % of the internal surface of the hopper body. In one embodiment, the liner covers at least 95 % of the internal surface of the hopper body.

[0065] In one embodiment, the size of the pores is between 1 microns and 100 microns. In one embodiment, the size of the pores is between 1 microns and 90 microns In one

embodiment, the size of the pores is between 1 microns and 80 microns In one embodiment, the size of the pores is between 1 microns and 70 microns In one embodiment, the size of the pores is between 1 microns and 60 microns In one embodiment, the size of the pores is between 1 microns and 50 microns In one embodiment, the size of the pores is between 1 microns and 40 microns In one embodiment, the size of the pores is between 1 microns and 30 microns In one embodiment, the size of the pores is between 1 microns and 25 microns In one embodiment, the size of the pores is between 1 microns and 20 microns. In one embodiment, the size of the pores is between 1 microns and 15 microns. In one embodiment, the size of the pores is between 1 microns and 10 microns. As would be appreciated by a person skilled in the art, the pores need to be sized to provide the required capillarity or surface tension to retain liquid in the pores of the porous layer for subsequent evaporation.

[0066] In one embodiment, the thickness of the liner is between 1 mm and 100 mm. It is envisaged by the inventors that the type of material used in the porous liner will dictate the thickness of the porous liner. It is understood by the inventors than non-textile liners will typically need to be thicker than textile liners. In one embodiment, the thickness of the liner is between 1 mm and 90 mm. In one embodiment, the thickness of the liner is between 1 mm and 80 mm. In one embodiment, the thickness of the liner is between 1 mm and 70 mm. In one embodiment, the thickness of the liner is between 1 mm and 60 mm. In one embodiment, the thickness of the liner is between 1 mm and 50 mm. In one embodiment, the thickness of the liner is between 1 mm and 40 mm. In one embodiment, the thickness of the liner is between 1 mm and 30 mm. In one embodiment, the thickness of the liner is between 1 mm and 20 mm.

[0067] In one embodiment, the thickness of the liner is between 1 mm and 10 mm. In one embodiment, the thickness of the liner is between 2 mm and 9 mm. In one embodiment, the thickness of the liner is between 3 mm and 8 mm. In one embodiment, the thickness of the liner is between 3 mm and 7 mm. In one embodiment, the thickness of the liner is between 2 mm and 8 mm. It is understood by the inventors that if the thickness of the liner is too thin, the liner is susceptible to damage from abrasive materials in the feedstock or tearing due to sliding forces.

[0068] In one embodiment, the porous liner is made up of two or more layers. In one embodiment, where each layer is made up of two or more layers, the thickness of each

layer is between 1 mm and 100 mm. In one embodiment, the thickness of each layer is between 1 mm and 90 mm. In one embodiment, the thickness of each layer is between 1 mm and 80 mm. In one embodiment, the thickness of each layer is between 1 mm and 70 mm. In one embodiment, the thickness of each layer is between 1 mm and 60 mm. In one embodiment, the thickness of each layer is between1 mm and 50 mm. In one embodiment, the thickness of each layer is between 1 mm and 40 mm. In one embodiment, the thickness of each layer is between 1 mm and 30 mm. In one embodiment, the thickness of each layer is between 1 mm and 20 mm. In one embodiment, the thickness of each layer is between 1 mm and 10 mm. In one embodiment, the thickness of each layer is between 2 mm and 9 mm. In one embodiment, the thickness of each layer is between 3 mm and 8 mm. In one embodiment, the thickness of each layer is between 3 mm and 7 mm. In one embodiment, the thickness of each layer is between 2 mm and 8 mm

Perforations

[0069] In one form of the present invention, the perforations in the body of the hopper have a diameter of from about 1 mm to about 150 mm. In a preferred form of the present invention, the perforations have a diameter of from about 50 mm to 100 mm. It is understood by the inventors that the size of the perforation should be large enough to provide the porous liner with sufficient contact area with the exterior atmosphere. The size is however limited by reduced support the larger perforations provide the porous liner and the engineering strength of the hopper or silo structure.

[0070] In one embodiment, the perforations occupy at least 10% of the hopper body. In a preferred form of the present invention, the perforations occupy between 10 % and 80 % of the hopper body. In a preferred form, the perforations occupy between 20 % and 70 % of the hopper body. In a preferred form, the perforations occupy between 30 % and 60 % of the hopper body. In a preferred form, the perforations occupy about 40 % of the hopper body. As would be appreciated by a person skilled in the art, the coverage of the perforations is limited by the structural integrity of the hopper body, the density of the feedstock and the strength of the hopper construction materials.

Airflow into Hopper

[0071] In one embodiment, the apparatus further comprises a means to generate an airflow into the hopper body.

[0072] In one form of the present invention the airflow is at atmospheric temperature. In an alternative form of the present invention, the airflow is heated. In an alternative form of the present invention, the airflow is cooled.

[0073] In one embodiment, the temperature of the airflow is less than 100 °C. In one embodiment, the temperature of the airflow is less than 90 °C. In one embodiment, the temperature of the airflow is less than 80 °C. In one embodiment, the temperature of the airflow is less than 70 °C. In one embodiment, the temperature of the airflow is less than 60 °C. In one embodiment, the temperature of the airflow is less than 50 °C. In one embodiment, the temperature of the airflow is less than 40 °C. In one embodiment, the temperature of the airflow is less than 30 °C. In one embodiment, the temperature of the airflow is less than 25 °C.

[0074] In one embodiment, the temperature of the airflow is less than 0 °C.

[0075] In one form of the present invention the speed of the airflow is at least 2 km/hr. In one embodiment, the airflow is at least 3 km/hr. In one embodiment, the airflow is at least 4 km/hr. In one embodiment, the airflow is at least 5 km/hr. In one embodiment, the airflow is at least 6 km/hr. In one embodiment, the airflow is at least 7 km/hr. In one embodiment, the airflow is at least 8 km/hr. In one embodiment, the airflow is at least 9 km/hr. In one embodiment, the airflow is at least 10 km/hr.

[0076] In one embodiment, the airflow is between 2 km/hr and 50 km/hr. In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 35 km/hr. In one embodiment, the airflow is between 6 km/hr and 30 km/hr. In one embodiment, the airflow is between 8 km/hr and 25 km/hr. In one embodiment, the airflow is between 10 km/hr and 20 km/hr.

[0077] In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 40 km/hr. In one embodiment, the airflow is between 6 km/hr and 40 km/hr. In one embodiment, the airflow is between 8 km/hr and 40 km/hr. In one embodiment, the airflow is between 10 km/hr and 40 km/hr.

[0078] As would be appreciated by a person skilled in the art, the rate of evaporation increases with increased airflow. However, the rate of evaporation has been found to reach a limit due to the limiting rate of liquids being expelled from the porous liner and the feedstock.

[0079] In one embodiment, the airflow is directed into the hopper body at a rate of at least 2.5 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 3 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 4 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 5 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 6 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 7 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 8 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 9 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 10 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 11 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 12 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 13 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 14 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 15 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 16 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 17 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 18 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 19 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 20 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 21 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 22 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 23 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 24 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 25 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 26 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 27 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 28 m^3/s.

In one embodiment, the airflow is directed into the hopper body at a rate of at least 29 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 30 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 40 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 50 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 60 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 70 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 80 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 90 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 100 m^3/s.

Airflow Onto or About the Exterior Surface

[0080] In one embodiment, the apparatus further comprises a means to generate an airflow onto or about the exterior surface of the hopper body.

[0081] In one form of the present invention the airflow is at atmospheric temperature. In an alternative form of the present invention, the airflow is heated. In an alternative form of the present invention, the airflow is cooled.

[0082] In one embodiment, the temperature of the airflow is less than 100 °C. In one embodiment, the temperature of the airflow is less than 90 °C. In one embodiment, the temperature of the airflow is less than 80 °C. In one embodiment, the temperature of the airflow is less than 70 °C. In one embodiment, the temperature of the airflow is less than 60 °C. In one embodiment, the temperature of the airflow is less than 50 °C. In one embodiment, the temperature of the airflow is less than 40 °C. In one embodiment, the temperature of the airflow is less than 30 °C. In one embodiment, the temperature of the airflow is less than 25 °C.

[0083] In one embodiment, the temperature of the airflow is less than 0 °C.

[0084] In one form of the present invention the speed of the airflow is at least 2 km/hr. In one embodiment, the airflow is at least 3 km/hr. In one embodiment, the airflow is at least 4 km/hr. In one embodiment, the airflow is at least 5 km/hr. In one embodiment, the airflow is at least 6 km/hr. In one embodiment, the airflow is at least 7 km/hr. In one embodiment, the airflow is at least 8 km/hr. In one embodiment, the airflow is at least 9 km/hr. In one embodiment, the airflow is at least 10 km/hr.

[0085] In one embodiment, the airflow is between 2 km/hr and 50 km/hr. In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 35 km/hr. In one embodiment, the airflow is between 6 km/hr and 30 km/hr. In one embodiment, the airflow is between 8 km/hr and 25 km/hr. In one embodiment, the airflow is between 10 km/hr and 20 km/hr.

[0086] In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 40 km/hr. In one embodiment, the airflow is between 6 km/hr and 40 km/hr. In one embodiment, the airflow is between 8 km/hr and 40 km/hr. In one embodiment, the airflow is between 10 km/hr and 40 km/hr.

[0087] As would be appreciated by a person skilled in the art, the rate of evaporation increases with increased airflow. However, the rate of evaporation does reach a limit due to the limiting rate of water being expelled from the pellets.

[0088] In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 2.5 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 3 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 4 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 5 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 6 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 7 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 8 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 9 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 10 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 11 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 12 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 13 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 14 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 15 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 16 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 17 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 18 m^3/s. In one embodiment, the airflow is directed

onto or about the hopper body at a rate of at least 19 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 20 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 21 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 22 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 23 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 24 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 25 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 26 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 27 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 28 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 29 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 30 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 40 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 50 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 60 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 70 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 80 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 90 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 100 m^3/s.

[0089] In accordance with a further aspect of the present invention, there is provided a method for temporary storage of a feedstock comprising liquids, the method comprising:

introducing the feedstock into a hopper, the hopper being defined by a hopper body having an internal surface, wherein one or more perforations are provided through at least a portion of the hopper body and at least a portion of the internal surface is covered by a porous liner; and

discharging the feedstock from the hopper.

[0090] In one form of the present invention the feedstock is selected from the group comprising pellets, powders, seeds, biomass matter, waste materials, muds mine

tailings, sludges, lumps, slurry, suspensions, aggregates, dusts, cement, sand, ores, concentrates and agglomerates. Preferably, the feedstock contains pellets.

[0091] In one form of the present invention, the moisture content of the discharged feedstock is less than the water content of the initial feedstock.

[0092] In one embodiment, the feedstock has a solids content of at least 1 %. In one embodiment, the feedstock has a solids content of at least 2 %. In one embodiment, the feedstock has a solids content of at least 4 %. In one embodiment, the feedstock has a solids content of at least 6 %. In one embodiment, the feedstock has a solids content of at least 8 %. In one embodiment, the feedstock has a solids content of at least 10 %. In one embodiment, the feedstock has a solids content of at least 12 %. In one embodiment, the feedstock has a solids content of at least 14 %. In one embodiment, the feedstock has a solids content of at least 16 %. In one embodiment, the feedstock has a solids content of at least 18 %. In one embodiment, the feedstock has a solids content of at least 20%.

Airflow into Hopper

[0093] In one embodiment, the method further comprises the step of directing an airflow into the hopper body.

[0094] In one form of the present invention the airflow is at atmospheric temperature. In an alternative form of the present invention, the airflow is heated. In an alternative form of the present invention, the airflow is cooled.

[0095] In one embodiment, the temperature of the airflow is less than 100 °C. In one embodiment, the temperature of the airflow is less than 90 °C. In one embodiment, the temperature of the airflow is less than 80 °C. In one embodiment, the temperature of the airflow is less than 70 °C. In one embodiment, the temperature of the airflow is less than 60 °C. In one embodiment, the temperature of the airflow is less than 50 °C. In one embodiment, the temperature of the airflow is less than 40 °C. In one embodiment, the temperature of the airflow is less than 30 °C. In one embodiment, the temperature of the airflow is less than 25 °C.

[0096] In one embodiment, the temperature of the airflow is less than 0 °C.

[0097] In one form of the present invention the speed of the airflow is at least 2 km/hr. In one embodiment, the airflow is at least 3 km/hr. In one embodiment, the airflow is at least 4 km/hr. In one embodiment, the airflow is at least 5 km/hr. In one embodiment, the airflow is at least 6 km/hr. In one embodiment, the airflow is at least 7 km/hr. In one embodiment, the airflow is at least 8 km/hr. In one embodiment, the airflow is at least 9 km/hr. In one embodiment, the airflow is at least 10 km/hr.

[0098] In one embodiment, the airflow is between 2 km/hr and 50 km/hr. In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 35 km/hr. In one embodiment, the airflow is between 6 km/hr and 30 km/hr. In one embodiment, the airflow is between 8 km/hr and 25 km/hr. In one embodiment, the airflow is between 10 km/hr and 20 km/hr.

[0099] In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 40 km/hr. In one embodiment, the airflow is between 6 km/hr and 40 km/hr. In one embodiment, the airflow is between 8 km/hr and 40 km/hr. In one embodiment, the airflow is between 10 km/hr and 40 km/hr.

[00100] As would be appreciated by a person skilled in the art, the rate of evaporation increases with increased airflow. However, the rate of evaporation does reach a limit due to the limiting rate of water being expelled from the pellets.

[00101] In one embodiment, the airflow is directed into the hopper body at a rate of at least 2.5 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 3 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 4 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 5 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 6 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 7 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 8 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 9 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 10 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 11 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 12 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 13 m^3/s. In one embodiment, the airflow is directed into the hopper

body at a rate of at least 14 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 15 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 16 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 17 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 18 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 19 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 20 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 21 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 22 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 23 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 24 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 25 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 26 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 27 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 28 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 29 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 30 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 40 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 50 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 60 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 70 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 80 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 90 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 100 m^3/s.

Airflow onto or about Exterior Surface

[00102] In one embodiment, the method further comprises the step of directing an airflow onto or about the exterior surface of the hopper body.

[00103] In one form of the present invention the airflow is at atmospheric temperature. In an alternative form of the present invention, the airflow is heated. In an alternative form of the present invention, the airflow is cooled.

[00104] In one embodiment, the temperature of the airflow is less than 100 °C. In one embodiment, the temperature of the airflow is less than 90 °C. In one embodiment, the temperature of the airflow is less than 80 °C. In one embodiment, the temperature of the airflow is less than 70 °C. In one embodiment, the temperature of the airflow is less than 60 °C. In one embodiment, the temperature of the airflow is less than 50 °C. In one embodiment, the temperature of the airflow is less than 40 °C. In one embodiment, the temperature of the airflow is less than 30 °C. In one embodiment, the temperature of the airflow is less than 25 °C.

[00105] In one embodiment, the temperature of the airflow is less than 0 °C.

[00106] In one form of the present invention the speed of the airflow is at least 2 km/hr. In one embodiment, the airflow is at least 3 km/hr. In one embodiment, the airflow is at least 4 km/hr. In one embodiment, the airflow is at least 5 km/hr. In one embodiment, the airflow is at least 6 km/hr. In one embodiment, the airflow is at least 7 km/hr. In one embodiment, the airflow is at least 8 km/hr. In one embodiment, the airflow is at least 9 km/hr. In one embodiment, the airflow is at least 10 km/hr.

[00107] In one embodiment, the airflow is between 2 km/hr and 50 km/hr. In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 35 km/hr. In one embodiment, the airflow is between 6 km/hr and 30 km/hr. In one embodiment, the airflow is between 8 km/hr and 25 km/hr. In one embodiment, the airflow is between 10 km/hr and 20 km/hr.

[00108] In one embodiment, the airflow is between 2 km/hr and 40 km/hr. In one embodiment, the airflow is between 4 km/hr and 40 km/hr. In one embodiment, the airflow is between 6 km/hr and 40 km/hr. In one embodiment, the airflow is between 8 km/hr and 40 km/hr. In one embodiment, the airflow is between 10 km/hr and 40 km/hr.

[00109] As would be appreciated by a person skilled in the art, the rate of evaporation increases with increased airflow. However, the rate of evaporation has been found to reach a limit due to the limiting rate of water being expelled from the porous liner and the feedstock.

[00110] In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 2.5 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 3 m^3/s. In one embodiment, the airflow is directed

onto or about the hopper body at a rate of at least 4 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 5 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 6 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 7 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 8 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 9 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 10 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 11 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 12 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 13 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 14 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 15 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 16 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 17 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 18 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 19 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 20 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 21 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 22 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 23 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 24 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 25 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 26 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 27 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 28 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 29 m^3/s. In one embodiment, the airflow is directed onto or about the hopper body at a rate of at least 30 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 40 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 50

m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 60 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 70 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 80 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 90 m^3/s. In one embodiment, the airflow is directed into the hopper body at a rate of at least 100 m^3/s.

[00111] In Figures 1 and 2 there is shown a generalised drawing of a hopper 10 for the temporary storage of a feedstock. The hopper 10 comprises a hopper body 12 having four generally opposed side structures 14 that define the hopper body 12.

[00112] The side structures 14 are arranged to define a transfer section 16. The transfer section 16 has an entrance section 18 and a discharge section 20 in communication. The hopper body 12 can be any desired shape with a hollow interior to permit the passage of the bulk material therethrough. Whilst a rectangular configuration is shown in the Figures, it is envisaged that other polygonal or circular configurations could be used and extended in length, width and height. Whilst not shown in the Figures, it is envisaged the hopper body may further comprises an upper section defined by substantially vertical side structures. The upper section may also comprises a number of perforations and be lined with a porous liner.

[00113] As would be understood by a person skilled in the art, hoppers similar to that described in the present invention are typically used to transfer bulk materials to a conveyor 22 or direct discharge into a train, truck or tank etc. The entrance section 18 of the hopper 10 is adapted for receiving the bulk materials from a source or in-feed (not shown). The source will typically be an in-feed belt or chute, but could also be the outlet of a bunker, ore pass, silo, pipe or hopper. From the entrance section 18, the bulk materials flow into and along the transfer section 16 towards the discharge section 20. The flow of the bulk materials is driven by the influence of gravity. The transfer section 16 of the hopper serves to stabilise the bulk material flow and guide it towards the discharge section 20. The bulk material exits the hopper through the discharge section 20 and typically onto the conveyor 22, although this can be directly discharged by gravity into a train, truck, hopper, silo or bin etc.

[00114] The lower portions of each side structure 14 taper inwardly towards the discharge section 20. In the embodiment shown in the Figures, the diameter of the

entrance section 18 is much wider than the diameter of the discharge section 20. This allows the hopper 10 to capture bulk material from a number of sources and funnel it towards the narrow discharge section 20 suitable for deposition onto a narrow conveyor 22. As would be appreciated by a person skilled in the art, the diameter of the entrance section 18 may not necessarily be wider than the discharge section 20. The hopper sides have vertical or inclined surfaces dependent upon the natural angle of repose of the feedstock being processed and designed into the structure. In some designs the walls of the hopper can be adjustable to suit various angles of repose of the feedstock.

[00115] The hopper 10 is positioned over the conveyor 22 by a support structure 24. In the embodiment shown in the Figures, the support structure 24 comprises a series of cross beams and uprights.

[00116] As best seen in Figure 2, each side structure 14 is constructed from a plate-like panel having a top edge 26, a bottom edge 28 and side edges 30. The panels are secured together at their side edges 30 to form the hopper body 12. The top edges 26 define the entrance section 18 and the bottom edges 28 define the discharge section 20. Whilst the embodiment shown in the Figures shows a hopper body 12 constructed from separate panels, it is envisaged a continuous hopper body 12 may be alternatively used. The size and configurations of the structures may be changed to suit the particular purpose of the hopper. As would be understood by a person skilled in the art, it is typically advantageous to have transfer section 16 that has a cross-sectional area that decreases as the transfer section 16 extends downwardly from the entrance section 18 to the discharge section 20.

[00117] The side structures may be constructed from a flexible material to enhance flow of the material through the hopper 10. The side structures may be flexed using cables or by hydraulic means

[00118] A gate 32 may be provided at the discharge section 20 to temporary block passage of the material through the hopper 12. When the gate 32 is in a closed position, the material will build up in the hopper 12, permitting temporary storage. To discharge material from the hopper 12, the gate 32 is moved to an open positon, to permit the material to flow out the hopper body. It is envisaged that the material may be directed to a conveying means (not shown), such as a belt type or other suitable conveyor system 22, or into a train, truck, bin, stockpile or other moveable container for

transport to a different area. Alternatively, when a belt type or other conveyor is used, a gate 32 need not be provided, and flow through the discharge section 20 may be initiated by turning on the conveyor 22 and thereby removing material blocking the discharge opening.

[00119] At least a portion of the internal surface 34 of the hopper body 12 is covered with a porous liner (not shown). In a preferred embodiment, the porous liner 34 is constructed from a porous material. By lining the internal surface 34 of the hopper body 14 with a porous liner, the material within the hopper 10 will come into intimate contact with the porous liner. During this contact, the porous liner will absorb water from the feedstock whilst rejecting solids. The inventors have found that a porous liner that is constructed from a porous material is particularly useful in the removal of water and other liquids from the feedstock. As would be appreciated by a person skilled in the art, porous materials absorb water through a mechanism known as capillary action, also known as wicking. In this mechanism, the intermolecular forces between the liquid and surrounding solid surfaces cause water to be drawn into the pores of the porous material and then evaporated on the outside of the hopper structure, allowing more liquid to be drawn into the porous liner. It is envisaged that the porous liner can be constructed from any material that can be adapted to absorb or transfer liquids. Examples include a wide range of woven and non-woven fabrics, rubber, sponge, plastic, ceramic, wood, cement, metal, concrete or brick liners. A particularly useful material used to construct the porous liner is a geosynthetic textile. Such materials comprise a woven or non-woven textile constructed from synthetic fibres. Materials that have been found to be particularly useful by the inventors include Texcel™, Bidim™, Mirafi™ and Megaflow™ GT500 and GT 750 supplied by Tecate™ and GEOFABRICS AUSTRALASIA PTY LTD.

[00120] In order to ensure efficient removal of the water from the feedstock, it is recommended to maximise throughput that at least 50% of the internal surface of the hopper body 14 should be lined with a porous liner.

[00121] The pore size of the porous liner is between 1 microns and 100 microns. As would be appreciated by a person skilled in the art, the size of the pores needs to be sized to provide the required capillarity or surface tension to retain the water in the pores of the porous layer, before wicking to the opposite surface for evaporation.

[00122] The thickness of the porous liner is usually 1 mm to 30 mm thick but preferably 3mm to 6mm in thickness depending upon the type of material is used to construct the porous liner. Generally, a thicker porous liner is required when the porous liner is constructed from a material that is susceptible to being damaged by the solids in the feedstock or when the feedstock has a very high liquid content.

[00123] In one embodiment, a protective layer (not shown) comprising a number of apertures is provided on the surface of the porous liner. In some applications where the feedstock comprises abrasive particles, the protective layer is used to prevent or inhibit the abrasive particles from damaging the liner, whilst still permitting the egress of water, vapours or fumes to the liner. Preferably, the protective layer is constructed from an abrasion resistant material. More preferably, the abrasion resistant material is selected from the group comprising rubbers, ceramics, neoprene or metals. The coverage and size of the apertures needs to be balanced between the size of the abrasive particles and ensuring that sufficient porous liner is exposed to the feedstock to allow moisture to be transferred to the air outside the hopper. Typically, the apertures of the protective layer are between 10 mm and 50 mm.

[00124] In the embodiment shown in Figure 1, each side structure 14 is provided with a number of perforations 36. The perforations 36 are provided at regular intervals around the edges or circumference of the hopper body 12 and at regular intervals along the length or circumference of the hopper body 12. The perforations 36 permit communication between the interior of the hopper body 12 and the exterior. Whilst not shown in Figure 1 for sake of clarity, it is preferred that the porous liner lines the surface of any portion of the hopper body 12 that has perforations 36. The perforations 36 provide a means by which water and other liquids absorbed by the porous liner may be removed from the porous liner, by drainage, wicking and or evaporation. The porous liner will also prevent the material from exiting the interior of the hopper body 12 through the perforations 36.

[00125] The apparatus further comprises a means to generate an airflow into the hopper body 12. The required airflow direction is down into the interior of the hopper body 12 and onto the surface of the material in the hopper 10. The inventors have found that the airflow generated through the hopper will enhance the rate of evaporation of the water from the feedstock and help dry out any lining material that is wet. Without wishing to be bound by theory, the inventors believe that as water evaporates into the atmosphere

as water vapour, the airflow will continually direct the water vapour out of the hopper. This is understood to increase the rate of evaporation of water from the feedstock whilst also preventing the recondensation of water vapour. Furthermore, the airflow generated into the hopper body may pass through the pores of the porous liner and out the perforations 36. As it passes through the porous liner, the airflow carries with it the removed water, thereby evaporating it from the porous material and drying the lining.

[00126] The apparatus further comprises a means to generate an airflow onto or about the exterior surface of the hopper body 12. The airflow on the exterior of the hopper body 12 which has also been found to assist in the evaporation of water from the wet or damp porous liner. As discussed above, the inventors believe that as water evaporates from the porous liner into the atmosphere outside the hopper as water vapour, the airflow will continually direct the water vapour away from the hopper 10. This is understood to increase the rate of evaporation of water from the feedstock whilst also preventing the recondensation of water vapour.

[00127] The hopper further comprise a drainage means (not shown) provided underneath the hopper body 12. The drainage means is shaped so as to catch any liquids expelled by the hopper body 12 and direct them to an appropriate recycle, storage or disposal means. One or more filters may be associated with the drainage means.

[00128] In operation, the hopper 10 is initially filled with the bulk material to be stored. As the material contacts the porous liner, liquids in the bulk material will be wicked away from the bulk material by the porous liner. The perforations 36 provide a communication between the exterior of the hopper body 12, the porous liner and the feedstock in contact with the liner, providing a pathway for water to be removed from the porous liner by either drainage or evaporation. The airflow generated on the exterior surface of the hopper body 12 will carry away any evaporated water vapour, increasing the evaporation from the porous liner and stimulating wicking of moisture from the wet feedstock. The airflow generated into the hopper will also increase evaporation of liquids from the bulk material, drying the surface of the material and drying the porous liner by surface airflow and air moving through the porous liner.

[00129] When it is desired to discharge material from the hopper, the gate 32 may be moved to an open position and conveyor 22 is turned on to remove material blocking

the discharge section 20. Material then flows out of the hopper body 12 through the discharge section 20 under the influence of gravity, and is carried away by conveyor 22. Material will continue to flow out of the hopper through the discharge section 20 by gravity until the angle of repose for the particular material in the hopper is reached, or nearly reached, and a discharge cavity is created over the discharge section 20. At the angle of repose, the inner face of free flowing material assumes an inverted cone shape with its apex at the discharge section 20. The inventors have found that the removal of moisture from sides, base and surface of hopper reduces angle of repose of wet loose feedstock materials at the edge of the hopper enhancing flow dynamics of the feedstock through the chutes.

[00130] It is envisaged that the hopper may be adapted to operate in either a batch configuration or a continuous configuration. In a batch operation, a finite amount of feedstock is loaded into the hopper body 12 and the gate 32 is moved to a closed position. Once the feedstock has been sufficiently cured, the gate 32 is opened and the material is discharged thorough the discharge section 20.

[00131] In continuous configuration, the feedstock is continuously fed into the hopper with the gate 32 moved to an open position. In operation, it is envisaged that the feedstock will need to be fed into the hopper body at a controlled rate or removed from the discharge section 20 at a controlled rate, to allow sufficient time contact between the feedstock and the porous liner. It is envisaged that the length and pitch of the side structures may also be configured to increase contact time between the feedstock and the porous liner.

[00132] It is envisaged that two or more hoppers 10 may be used in parallel or series. It is envisaged that series operation may operate in a multiple pass type arrangement to allow recycling of drying feedstock with different process conditions for each subsequent hopper 10. It is envisaged that parallel operation will allow a higher throughput of feedstock processing.

[00133] The inventors envisage that the hopper is suitable to treat feedstocks selected from pellets, powders, seeds, biomass materials, waste materials, mine tailings, muds, sludges, lumps, mashes, aggregates, slurry, suspensions and agglomerates.

[00134] The hopper is adapted to treat feedstocks with a solids content of at least 1% but preferably a minimum of 12% solids and above, although many other materials may be stored using this invention with solids content up to or greater than 95%.

[00135] It is envisaged that additional products can be added separately into the hopper body 12 to aid with the overall process such as dry solids, powders, liquids, chemicals or adsorbents.

Example 1

[00136] A number of tests were conducted to simulate the removal of moisture from a numbers of feedstocks containing a liquid that is held within a hopper in accordance with the present invention. In order to simulate the hopper, the feedstock was poured into a solid container with a single opening. The container has a capacity of 20L. The opening was covered by a steel mesh that was lined with a woven geotextile fabric constructed from polyethylene fibres. The mesh had an aperture size of 5mm. The porous liner was a R600 geotextile sourced from Australian Geotextiles Pty Ltd. Moisture probes were drilled into the container at various locations. The container was overturned and allowed to stand for 72 hrs. During this time a fan was used to direct an airflow under the steel mesh. Samples of the feedstock were collected at various distances from the steel mesh and the liquid content of these samples was measured. The results of these tests are shown in Tables 1 -3.

Test 1: Agglomerated Sewage Sludge (liquid content 82%)

Table 1: Liquid Content Tests

Distance from fabric	Moisture %
150mm	82%
130mm	80%
105mm	75%
85mm	62%
60mm	57%
50mm	48%
30mm	39%

Test 2: Cattle Paunch (liquid content 65%)

Table 2: Liquid Content Tests

Distance from fabric	Moisture %
170mm	65%
162mm	61%
150mm	56%
129mm	51%
108mm	46%
91mm	42%
80mm	36%
69mm	30%

Test 3: Sugar Mill Mud (liquid content 60%)

Table 3: Liquid Content Tests

Distance from fabric	Moisture %
1810mm	60%
171mm	54%
152mm	50%
131mm	46%
120mm	41%
103mm	38%
80mm	32%
62mm	28%

[00137] The results show that the water content of the feedstock at and around the point of contact with the hopper surface was significantly reduced compared to the starting moisture content. As would be appreciated by a person skilled in the art, the dry material is less likely to adhere to the surface of the liner. This will reduce the likelihood of blockages within the hopper.

Example 2

[00138] A number of tests were undertaken to determine the effect that the porous liner had on the angle of repose of different feedstocks. In order to conduct the test, the sample was placed on a steel mesh plate that was lined with a woven geotextile fabric. The mesh had an aperture size of 5mm. The porous liner was a R600 geotextile

sourced from Australian Geotextiles Pty Ltd. The steel mesh plate was rotated relative to the horizontal until the samples slid down the plate. The angle of the plate is used to represent the angle of repose of the feedstock. Three different feedstocks with varying moisture contents were tested and the results are shown in Tables 4-6 below.

Test 1: Agglomerated Sewage Sludge

Table 4: Liquid Content Tests

Moisture %	Angle of Rolling (Deg)
85%	75
80%	70
75%	65
70%	62
65%	60
60%	60
55%	58
50%	55
45%	52
40%	50

Test 2: Cattle Paunch

Table 5: Liquid Content Tests

Moisture %	Angle of Rolling (Deg)
65%	65
60%	63
55%	59
50%	57
45%	50
40%	44
35%	40

Test 3: Sugar Mill Mud

Table 6: Liquid Content Tests

Moisture %	Angle of Rolling (Deg)
60%	60
55%	54
50%	49
45%	41
40%	39
35%	39

[00139] The results show that as the moisture content of the feedstock decreased, so did the angle of repose. As would be understood by a person skilled in the art, the angle of repose is representative of the flow dynamics of the wet material through the chute. The result indicate that the removal of the moisture from the feedstock significantly decreases the angle of repose, thereby indicating improved flow dynamics. When taken together with the results of Example 1, it is clear that the hopper of the present invention will reduce the liquid content of the feedstock held in the hopper, particularly at and around the hopper walls. Furthermore, the reduced liquid content will improve to flow dynamics of the feedstock through the hopper. This is achieved without the need to subject the wet feedstock to an energy intensive drying step.

[00140] Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. The invention includes all such variation and modifications. The invention also includes all of the steps, features, formulations and compounds referred to or indicated in the specification, individually or collectively and any and all combinations or any two or more of the steps or features.

CLAIMS

1. A hopper, said hopper comprising:

   a hopper body having an internal surface; and

   a porous liner covering at least a portion of the internal surface of the hopper body,

   wherein one or more perforations are provided through at least a portion of the hopper body.

2. A hopper according to claim 1, wherein the hopper body defines a transfer section, the transfer section having an entrance section and a discharge section in communication.

3. A hopper according to claim 2, wherein the hopper body tapers inwardly towards the discharge section.

4. A hopper according to any one of the preceding claims, wherein hopper is suitable for the mechanical guiding of bulk materials.

5. A hopper according to any one of the preceding claims, wherein the hopper body is defined by one or more side structures.

6. A hopper according to claim 5, wherein the hopper body comprises three or more opposed side structures.

7. A hopper according to claim 5, wherein the hopper body comprises four or more opposed side structures.

8. A hopper according to any one of claims 5 to 7, wherein side structures are plate-like panels.

9. A hopper according to any one of the preceding claims, wherein the porous liner is constructed from a material selected from the group comprising porous textiles, porous fabrics, porous rubbers, porous plastics, porous ceramics, porous wood, porous cement, porous concrete, porous brick or metal mesh.

10. A hopper according to any one of the preceding claims, wherein the porous liner is a woven or non-woven textile.

11. A hopper according to claim 10, wherein the porous liner is a geosynthetic textile.

12. A hopper according to any one of the preceding claims, wherein the porous liner is constructed from synthetic fibres.

13. A hopper according to any one of the preceding claims, wherein the porous liner covers at least 50 % and up to 100% of the internal surface of the hopper body.

14. A hopper according to any one of the preceding claims, wherein the hopper further comprises a means for generating an airflow into the hopper body.

15. A hopper according to any one of the preceding claims, wherein the hopper further comprises a means for generating an airflow onto or about the exterior of the hopper body.

16. A method for the temporary storage of a feedstock comprising a liquid, the method comprising:

    introducing the feedstock into a hopper, the hopper being defined by a hopper body having an internal surface, wherein one or more perforations are provided through at least a portion of the hopper body and at least a portion of the internal surface is covered by a porous liner; and

    discharging the feedstock from the hopper.

17. A method according to claim 16, wherein the feedstock is selected from the group comprising pellets, powders, seeds, biomass matter, muds, sludges, lumps, slurry, suspensions, ores, aggregates, dusts, cement, sands, concentrates and agglomerates.

18. A method according to claim 16 or 17, wherein an airflow is generated into the hopper body.

19. A method according to claim 18, the volume of air passed through the hopper body is between 10,000 to 100,000 m3/hr

20. A method according to any one of claims 16 to 19, wherein an airflow is directed onto or about the exterior of the hopper body

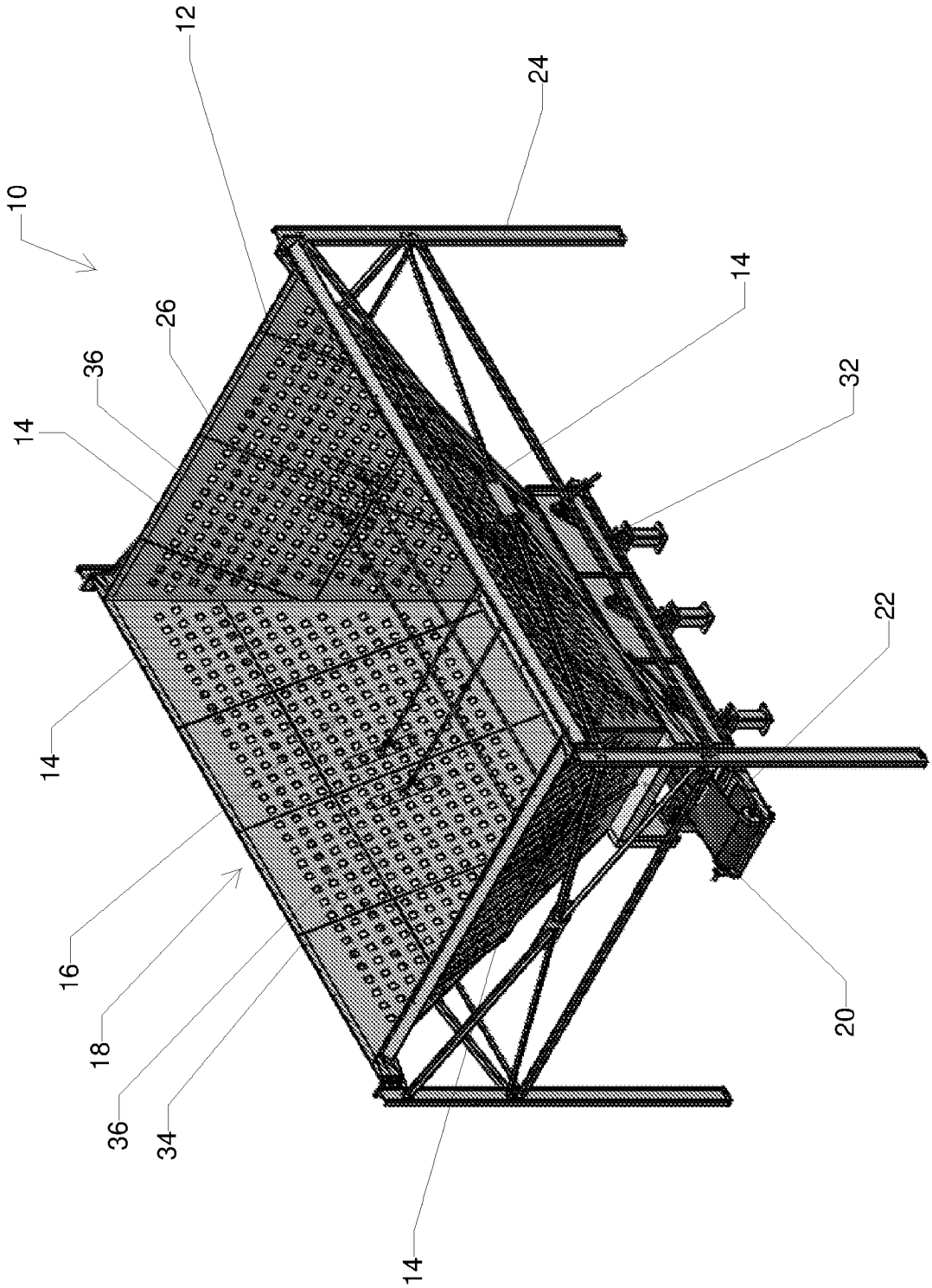


FIGURE 1

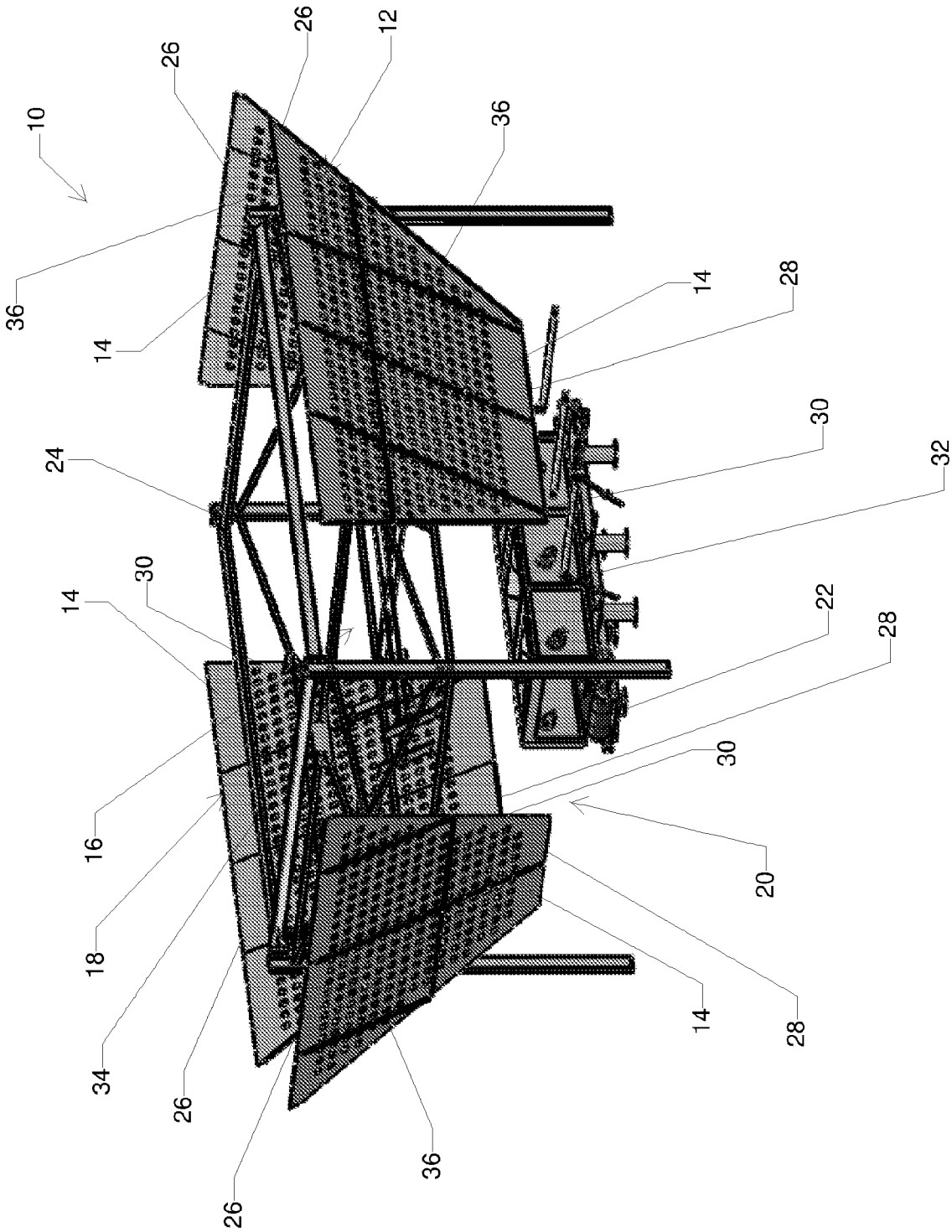


FIGURE 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2020/050060

A. CLASSIFICATION OF SUBJECT MATTER

B65D 88/72 (2006.01) B65D 88/26 (2006.01) F26B 17/12 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW, WPI, EPODOC, EPOQUE INTERNAL IPC, CPC B01D1/12, B01J8/0015, B01J8/003, B32B2305/188, B32B2307/724, B32B3/266, B32B5/024, B65D88/26, B65G11/16, B65G11/166, B65G53/18, F26B, F26B1, F26B17/103, F26B17/12, F26B17/122, F26B17/14, F26B25/12, F26B5/16 & Keywords (liquid, absorb, water, lining, fabric, aperture, opening, hopper, woven) and like terms.

AUSPAT PELLETON GLOBAL RENEWABLES [applicant] John Webster [inventor] and (hopper or liner or lining)
ESPACENET PELLETON GLOBAL RENEWABLES [applicant] John Webster [inventor] and (hopper or liner or lining)
Cited/citing search conducted on citations
Applicant/inventor search conducted in IP Australia internal databases

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 March 2020	23 March 2020

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/0054639 A1 (BONERB) 16 March 2006 Abstract, paragraphs [0002], [0028]-[0034], [0036]-[0038] and [0040], claims 1 and 5, figures 1-12	1-20
X	EP 0348007 A1 (SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V.) 27 December 1989 Abstract, column 1 lines 1-11, column 3 lines 45-56, column 4 lines 44-50, column 5 lines 8-13, figures 2-3	1-9, 13-14 and 16-19
X	US 4086706 A (LESK ET AL.) 02 May 1978 Abstract, column 1 lines 23-28, column 3 line 34 to column 5 line 18, claim 1, figures 1-6	1-14 and 16-19

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2020/050060**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
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		US 4094078 A	13 Jun 1978

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.