A pump system especially suitable for pumping out liquids from tank enclosures. A liquid pump, preferably powered by pressurized gas such as compressed air or natural gas from a nearby well, is mounted in a tubular member frame. The rate of pressurized gas flowing to the pump, and consequently the liquid pumping rate, is controlled by a limit valve, lever arm, and float assembly. As the liquid level increases, the float rises and the lever arm opens the limit valve, permitting a higher rate of pressurized gas flow and higher pump rate. At least some components of the frame have liquid inlet openings, which permit liquids to enter the frame, and the frame serves as a conduit to carry the liquids to the intake of the pump.
PUMP SYSTEM HAVING LIQUID LEVEL SENSING SYSTEM AND MULTIPURPOSE FRAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This regular U.S. patent application claims priority to U.S. provisional patent application Ser. No. 61/560,111, filed Nov. 15, 2011, for all purposes.

BACKGROUND

[0002] Storage tanks, such as those used in connection with liquids (oil and produced water) produced from onshore oil and gas wells, are required to be surrounded by a retaining wall which confines any liquids escaping from the tanks, thereby forming a “catch basin.” As an example, the catch basin formed by the retaining wall is normally capable of holding 1½ times the volume of the largest tank within the confined area. This gives some safety measure in the event that a tank ruptures, and oil escapes into the retaining area, or in the event of carryover in the filling of a tank, etc.

[0003] Since such tank installations are in open areas, any rainfall that occurs is also captured within the retaining area. Accumulated rainfall occupies volume which could otherwise be used for oil capture—hence, there is an incentive to remove, namely pump out, accumulated water within the retaining wall, as soon as it accumulates. As noted, this is generally done by a pump positioned within the retaining wall area.

[0004] Known prior art pump systems in this application have had several drawbacks:

[0005] the pumps have frequently been manually operated—that is, they do not turn on automatically in response to accumulated liquid level, but an operator must go to the site to turn the pump on, whether it is in the middle of the night or any other inconvenient time;

[0006] the pumps, once turned on, pump at maximum capacity; that is, the pumps go from zero to 100% capacity, with pump rate not proportional to the level of fluid within the enclosure;

[0007] fluid inlet to the pump has usually been a hose simply laid out in the bottom of the enclosure, giving rise to plugging issues and problems in establishing and maintaining a consistent feed to the pump; and

[0008] pumps are not mounted in a strong yet lightweight frame, for ease in moving to a desired position by a worker, etc.

[0009] These and other limitations in the prior art have given rise to an incentive to improve the design of pump systems, specifically those used in catch basin applications.

SUMMARY OF THE INVENTION

[0010] The present invention comprises a liquid pump mounted in a frame, and a means for controlling the liquid pumping rate of the pump, responsive to a level of the liquid being pumped. Preferably, the pump is powered by pressurized gas, and a limit valve, lever arm, and float allow an increasing pressurized gas flow rate to the pump, and consequently higher liquid pumping rate, with an increasing liquid level. Preferably, the frame is of hollow tubular members, providing a conduit for liquid to flow to the liquid intake of the pump.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a front view of the pump system embodying the principles of the present invention.

[0012] FIG. 2 is another, simplified front view of the pump system, with the float in the lowermost position and the pump off.

[0013] FIG. 3 is another simplified front view of the pump system, with the float in a raised position and the pump running.

[0014] FIG. 4 is a view in the direction of the section line shown in FIG. 3, along a leg base, which illustrates the liquid inlet openings in the frame, particularly the bottom portion of the leg bases, through which liquids enter and flow to the pump.

DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENT(S)

[0015] With reference to the photographs and drawings, some of the presently preferred embodiments can now be described.

[0016] Broadly, the pump system embodying the principles of the present invention comprises a pump, a frame in which the pump is mounted, and a means for controlling the rate at which the pump pumps liquids, the means for controlling being responsive to a level of a liquid being pumped, namely the higher the level of liquid, the higher the liquid pump rate.

[0017] As can be seen in FIGS. 1 and 2, pump system 10 comprises a pump 20 capable of pumping liquids, such as water and oil. Pump 20 is preferably driven by a pressurized gas, whether compressed air or pressurized natural gas, such as lease gas (natural gas) produced from a nearby oil and gas well, eliminating the need for electricity. For purposes of this application, the pressurized gas, whether compressed air or pressurized natural gas, will be referred to as “inlet air.”

[0018] While various types of pumps may be suitable for use, double pickup, air operated double diaphragm pumps are particularly suitable in this application. One suitable pump is manufactured by Graco Harshy model 1050 (1")- however, it is understood that other models of pumps, and other manufacturers, may be used.

[0019] Pressurized inlet air enters the system from a suitable source, and first flows through inlet valve 30, which can be used to permit air flow or completely stop air flow to the pump. Preferably, an inlet air particulate filter 40 is placed in the air flow line, to remove contaminants from the air stream (liquids or solids). Air filters of this type are well known in the art.

[0020] The pressurized inlet air next flows through an air/gas pressure regulator 50, to drop the pressure from the source pressure to a pressure suitable for use by the controller or limit valve 60, and pump 20. Pressure regulators of this type are well known in the art; a suitable range for this application is zero to 100 psi.

[0021] The pressurized inlet air next flows to a means for controlling the rate of inlet air flow to pump 20. It is understood that the rate at which inlet air flows to pump 20 increases with an increase in the level of liquid being pumped, and the rate at which pump 20 pumps liquid increases with increasing rate of inlet flow air. In a preferred embodiment, the means for controlling the rate of inlet air flow to pump 20 comprises limit valve 60, a lever arm 70 attached to limit valve 60, and a float 80 attached to lever arm 70. Limit valve 60 is responsive to movement of the float arm assembly,
readily seen in FIGS. 1-3. Limit valve 60 has a rotating shaft, which controls (via internal valving moved by the shaft) the rate of air flowing through the limit valve, and hence to pump 20. As can be seen in FIG. 1, a lever arm 70 is attached to a rotating shaft 62, lever arm 70 having a float 80 attached to the distal end, forming a float arm assembly. The float arm assembly size and geometry is adjusted so as to place float 80 near the surface on which pump system 10 is resting, in a first position (see FIG. 2); in this position, limit valve 60 is closed, hence pump 20 is not operating. As can be readily understood, and as explained in further detail herein, as a liquid level rises around pump system 10, float 80 rises, moving lever arm 70 and causing rotating shaft 62 to rotate. This opens limit valve 60 and permits pressurized inlet air to flow to pump 20, thereby turning pump 20 on. As previously noted, a key feature of limit valve 60 is that as float 80 rises and rotates rotating shaft 62, more and more inlet air is permitted to flow through limit valve 60 and hence to pump 20, increasing the speed of pump 20 and the rate at which it pumps and removes liquid from the enclosure. Fluid discharge from the pump is through a discharge conduit 90.

While various limit valves may be suitable, one known and suitable limit valve is a Numatrol air controller, Model L.R3-0206, manufactured by Numatics, Inc. in Highland, Mich.

Downstream of limit valve 60, an automatic oil lubricator is preferably installed in the line, in order to permit automatic oiling of pump 20. Oilers of this type are well known in the art.

The pressurized inlet air flows through and actuates diaphragm pump 20, and exhausts from pump 20, preferably through exhaust vent 110.

As can be seen in FIGS. 1 and 2, pump 20 is mounted in a frame 120, which at least partially encloses and holds pump 20 and the other components. While the frame can take various forms, depending upon the particular setting and type of pump, etc. used, the illustrated frame configuration is an acceptable one. Key components are a control stabilizer or support 122 which holds pressure regulator 50; vertical members 124 which give structural stability to the frame and enclose pump 20; stabilizer feet 126 which provide support and vertical spacing as needed. At least some of the members of frame 120 are hollow tubular members, preferably 1" schedule 80 PVC pipe, although metal pipe could be used as well.

A novel aspect of pump system 10 is that at least some of the hollow tubular members of frame 120 connect to the liquid intake 22 of pump 20, and comprise one or more liquid inlet openings 130, through which liquid flows into the hollow tubular members and then to the liquid intake 22 of pump 20. One embodiment of this aspect of frame 120, and one which provides a unique element of pump system 10, are base legs 128, forming the bottommost parts of frame 120. Base legs 128, which as noted above are hollow, have a number of liquid inlet openings 130 (holes or perforations) in them, preferably along a bottom surface, through which liquid enters, and ultimately flows through the hollow frame members to the liquid intake 22 of pump 20, as can be readily seen in FIG. 1. This novel placement permits base legs 128 and other hollow tubular members of frame 120 to serve not only as structural members of frame 120, but also to serve as an efficient conduit to carry liquids to the pump inlet. As can be readily understood, the liquid inlet openings 130 (see FIG. 4, a view from the bottom of the frame assembly) in the base legs 128 are always in the lowest position (e.g. against the ground or other surface which pump system 10 rests on), and avoids the issues of prior art pumps with a hose-type inlet simply laid out on the ground. In addition, depending upon the size of liquid inlet openings 130 in base legs 128, some degree of filtering of solids from the liquids to be pumped takes place. It is to be understood that liquid inlet openings may be in different or additional locations on the hollow tubular members, and may vary in number (one or more), size, or shape.

The frame 120, for example of light but strong PVC, permits a small, light and portable pump unit, which one man can move and setup without the need for additional personnel.

FIG. 2 is a somewhat simplified view of pump system 10, as shown in FIG. 1. Directional arrows show the direction of flow of inlet air, and the location and direction of liquid flow to pump 20, and liquid discharge from pump 20.

Operation of the Pump System

Operation of the pump system is straightforward. As is well known, pump system 10 is placed on the ground, on a concrete or other hard surface, etc. within a tank enclosure. Preferably, pump system 10 is placed at a low elevation. Preferably the lowest point within the enclosed area, so that any liquid within the area will flow naturally to pump system 10.

The pressurized inlet air source is connected to the pump system, as previously noted, and valve 30 is opened so as to permit air flow to limit valve 60. Since the float assembly (float 80 and lever arm 70) is initially fully lowered, as in FIGS. 1 and 2, limit valve 60 is closed and prevents air from flowing to and operating pump 20.

Referring to FIG. 3, when liquid accumulates in the enclosure and at the pump location, float 80 starts to rise in the liquid, rotating the float arm assembly and rotating shaft 62 in limit valve 60 and opening same so as to permit air flow to pump 20. This position of the float is shown in FIG. 3. Inlet air flow rate increases as the level of the liquid, and hence float level, increases. Liquid feeds to the pump intake by flowing through the inlet openings 130 in base legs 128, through the hollow tubular members and to pump 20. The pump rate is proportional to the air flow rate, so that the higher the liquid rises, the more limit valve 60 is opened, the greater the inlet air flow rate to pump 20 and the faster pump 20 pumps. FIG. 3 shows the direction of inlet air and discharge thereof, and also shows the direction and location of liquid inflow through inlet openings 130.}

CONCLUSION

While the preceding description contains many specifics, it is to be understood that same are presented only to describe some of the presently preferred embodiments of the invention, and not by way of limitation. Changes can be made to various aspects of the invention, without departing from the scope thereof. For example, different brands and manufacturers of the various components may be used; sizes and capacities may be changed to suit particular applications; the pump system may be used to pump water, oil, water/oil mixtures; the pump system may be placed within protective berms around oil and water storage tanks, may be used in plant and refinery settings, etc.
Therefore, the scope of the invention is to be determined not by the illustrative examples set forth above, but by the claims of a future regular patent application and their legal equivalents.

1 claim:

1. A pump system, comprising:
   a) a pump adapted to pump liquids;
   b) a means for controlling the liquid pumping rate of said pump, said means responsive to a level of a body of liquid to be pumped by said pump; and
   c) a frame in which said pump is mounted, said frame comprising hollow tubular members, at least some of said hollow tubular members comprising liquid inlet openings therein, said hollow tubular members forming a fluid flowpath from said liquid inlet openings to a liquid intake of said pump.

2. The pump system of claim 1, wherein said liquid inlet openings are disposed in one or more hollow tubular members which rest upon a support surface for said pump system.

3. The pump system of claim 1, wherein:
   said pump is powered by pressurized gas; and
   said means for controlling the liquid pumping rate of said pump comprises a valve controlling said pressurized gas flow to said pump, said valve permitting an increasing pressurized gas flow rate to said pump with an increasing level of a body of liquid to be pumped by said pump, whereby said pump has an increasing liquid pumping rate in response to said increasing pressurized gas flow rate.

4. The pump system of claim 2, wherein:
   said pump is powered by pressurized gas; and
   said means for controlling the liquid pumping rate of said pump comprises a valve controlling said pressurized gas flow to said pump, said valve permitting an increasing pressurized gas flow rate to said pump with an increasing level of a body of liquid to be pumped by said pump, whereby said pump has an increasing liquid pumping rate in response to said increasing pressurized gas flow rate.

5. A portable, pressurized gas powered pump system, comprising:
   a) a diaphragm pump powered by said pressurized gas, said diaphragm pump having an increasing liquid pumping rate in response to an increased rate of pressurized gas flowing to said diaphragm pump;
   b) a frame in which said pump is mounted, said frame comprising hollow tubular members, at least some of said hollow tubular members fluidly connected to a liquid intake on said diaphragm pump, at least some of said hollow tubular members comprising liquid inlet openings, whereby when a liquid level rises around said frame, said liquid flows through said liquid inlet openings and through said hollow tubular members to a liquid intake on said pump; and
   c) a means for controlling said rate of pressurized gas flowing to said diaphragm pump, responsive to said liquid level, said means for controlling said rate of pressurized gas permitting an increased flow rate of pressurized gas with an increased level of liquid.

6. The pump system of claim 5, wherein said frame further comprises one or more vertical members forming carrying handles.

7. The pump system of claim 6, wherein said means for controlling said rate of pressurized gas flowing to said diaphragm pump comprises a limit valve, a lever arm attached to said limit valve, and a float attached to said lever arm, wherein when said level of liquid increases, said float rises and moves said lever arm, said movement of said lever arm rotating a shaft in said limit valve which permits an increased rate of pressurized gas to flow through said limit valve and to said pump.

8. The pump system of claim 5, wherein said means for controlling said rate of pressurized gas flowing to said diaphragm pump comprises a limit valve, a lever arm attached to said limit valve, and a float attached to said lever arm, wherein when said level of liquid increases, said float rises and moves said lever arm, said movement of said lever arm rotating a shaft in said limit valve which permits an increased rate of pressurized gas to flow through said limit valve and to said pump.

9. A portable, pressurized gas powered pump system, comprising:
   a) a diaphragm pump powered by said pressurized gas, said diaphragm pump having an increased liquid pumping rate in response to an increased rate of pressurized gas flowing to said diaphragm pump; and
   b) a means for controlling said rate of pressurized gas flowing to said diaphragm pump, responsive to said liquid level, said means for controlling said rate of pressurized gas permitting an increased flow rate of pressurized gas with an increased level of liquid, comprising a limit valve, a lever arm attached to said limit valve, and a float attached to said lever arm, wherein when said level of liquid increases, said float rises and moves said lever arm, said movement of said lever arm rotating a shaft in said limit valve which permits an increased rate of pressurized gas to flow through said limit valve and to said pump.

10. The pump system of claim 9, further comprising a frame in which said pump is mounted, said frame comprising hollow tubular members, at least some of said hollow tubular members fluidly connected to a liquid intake on said diaphragm pump, at least some of said hollow tubular members comprising liquid inlet openings, whereby when a liquid level rises around said frame, said liquid flows through said liquid inlet openings and through said hollow tubular members to a liquid intake on said pump.

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