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**APPLICATION OF CLEANING TECHNIQUES ON
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(54) **Device for the lowering of the groundwater level or for the removal of floating layers**

(57) This invention concerns a device for the drawoff of liquid, a.o. for the lowering of the groundwater level or for the removal of floating layers, characterised in that it is comprised of drawoff means consisting of a pump to which a collector (5) with bored wells (3) is connected, each of which is provided with a hanger (4) which hangs in the liquid, and is equipped at its extremity with means based on the siphon principle, the one and other such, that in combination with a certain underpressure on the collector (5), ingress of air on one or more hangers (4) is impossible, and the liquid level in each bored well (3) is positioned independently.

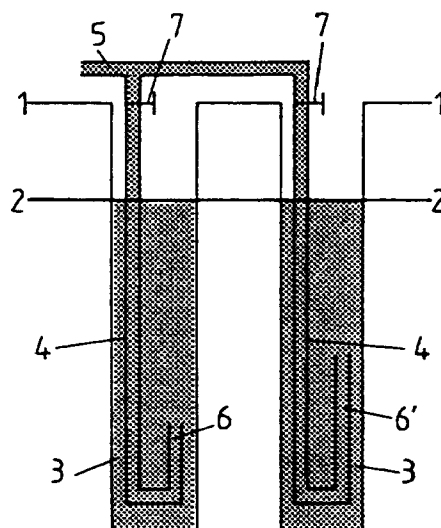


Fig. 2

EP 0 884 418 A2

Description

This invention refers to a device for the drawoff of liquid, a.o. for the lowering of the groundwater level or for the removal of floating layers.

This invention belongs to the field of well-point dewatering and drawoff of floating layers, such as those applied in soil sanitation.

When carrying out such works, a choice is made between two different principles, which may be described as follows:

a) A pump is placed in the drawoff well, in the liquid, so that the pump presses the liquid to the surface. The conveying height is defined by the maximum working pressure of the pump, and it is then no problem to press the water dozens of meters upwards;

b) A pump is placed at the surface, above ground, and the liquid is sucked in from one or more drawoff wells. In each drawoff well a hanger is placed, i.e. a blind tube which hangs in the filter tube and through which the liquid is drawn off. For this technique, the depth at which can be drawn off, is however limited.

At absolute vacuum and when losses of charge may be neglected, the theoretical maximum suction depth may be reached.

This is derived from the following law for hydrostatic pressure: $P_h = \rho \cdot g \cdot h$. ($\text{Pa} = \text{N/m}^2$)

ρ : density of liquid (kg/m^3)

g : gravitational acceleration (m/s^2)

h : height of liquid column (m)

In the case of suction, this hydrostatic pressure must be overcome to bring up the liquid. For a given liquid (ρ) this is a function of the height of the water column (h).

At atmospheric pressure (1 atm = 101,325 Pa) for water with density 1000 kg/m^3 the following applies:

$$H = 101325 / (1000 \times 9.81) \\ = 10.32$$

At absolute vacuum, theoretically thus a water column of 10.32 m high may be sucked up.

The problems which may arise with a vacuum pump, may be summarised as follows:

When drawing off with a vacuum system, the suction depth from each well is thus determined by the underpressure which is prevailing on that respective well. This underpressure is a function of the pump characteristics on the one hand, and of the pressure losses in the system on the other hand.

In the following, the atmospheric pressure (1 atm $\equiv$ 1 bar) is taken as a reference. The underpressure is then expressed in relation to the atmospheric pressure.

Highly approximating, this means that the absolute vacuum corresponds to -1.0 bar in this perspective. Per 0.1 bar of stronger underpressure, 1 m of deeper water may be sucked up.

For example:

At -0.2 bar of underpressure, 2 m of water is sucked up.

At -0.9 bar of underpressure, 9 m of water is sucked up.

That is why further pressure loss is considered as underpressure loss.

Assuming that the drawoff pump has been well chosen, the problem is reduced to minimising the underpressure losses in the system. When drawing off from one well, these are caused by:

- pipe losses
- leaks in the system.

However, when drawing off from more than one well, whereby the pump is connected with a collector system to the different wells, an additional problem arises.

As long as the mouth of the hangers is below the water level in all wells, water will be sucked up everywhere. At a certain moment, when the drawoff flow rate is larger than that of the water streaming towards the wells, the water will go down to the mouth of the hanger and air will be introduced into the system this way. This causes an underpressure loss (leak), through which the underpressure on the entire system becomes too small to further draw off water through the other hangers. This situation will be stabilised when in that one well water and air is "slobbered up", while the water in the other wells can hardly go down further.

In order to lift this problem, up to now different solutions have been devised.

In the classical dewatering of excavation, the filters are placed up to a depth of 9 to 10 m, so that the water can never go down to below the hangers (underpressure is in practice rarely stronger than -0.9 bar). In soil sanitation it is mostly not needed or desirable to lower the water level that deep.

Vacuum dewatering is applied when the water may/must not go down that deep. Thereby the ingress of air in the filter is balanced by drawing off, together with the water, a large air flow rate. This flow rate should balance the underpressure loss by ingress of air. Moreover, it is sensitive to "bad" filters or other heterogeneities which may break the vacuum.

In sanitation, in addition systems are used with several or complicated pumps which build up an independent vacuum on each well. However, this is an expensive solution.

In sanitation, it is mostly required that the water level in the wells remains constantly at a desired depth.

There to in many cases a separate level control has to be provided for each well. This control implies higher costs and a sensitive system. As it happens, the working conditions in sanitation are hampered by all kinds of dirt: sand and sludge, oil products, aggressive chemicals, etc.

In order to solve the problem defined here in accordance with the invention, taking into account the situations explained just now, the device according to the invention is comprised of drawoff means consisting of a pump to which a collector with bored wells is connected, each of which is provided with a hanger that hangs in the liquid, and is equipped at its extremity with means which are based on the siphon principle, the one and other such, that in combination with a certain underpressure on the collector, the ingress of air on one or more hangers is impossible and the liquid level on each bored well is independently positioned.

Other details and advantages of the invention will appear from the following description of a device for the lowering of the groundwater level or for the removal of floating layers, according to the invention. This description is exclusively given as an example and does not limit the invention. The reference numbers refer to the attached figures.

Figure 1 schematically shows a collector of the known type in the stage of "no draw-down".

Figure 2 shows the same situation as in figure 1, in a collector equipped with hanger according to the invention.

Figure 3 shows the collector according to figure 1 in the stage in which the water has gone down to the least deep mouth.

Figure 4 shows the same situation as in figure 3, in a collector equipped with hanger according to the invention.

Figure 5 shows the same situation as in figure 3.

Figure 6 shows a specific situation in a collector equipped with hangers according to the invention.

Figures 7 to 11 schematically illustrate a series of situations which occur when the liquid level is dropping.

In the different figures, the ground level is represented by the reference 1 and the groundwater level with the reference 2.

The device according to the invention is comprised of a series of bored wells 3 in which hangers 4 are placed which be part of a collector 5 connected to a pump not represented in figures 1-6.

In the following description the situation which prevails in bored wells equipped with classical hangers, or hangers belonging to the state of the art, will be compared to the situation which prevails in bored wells equipped with hangers according to the invention.

The figures 1, 3 and 5 illustrate the situation which prevails in different circumstances in bored wells with classical hangers. Figure 1 represents the situation in the ground mass and in the bored wells equipped with classical hangers, in the stage of "no dewatering".

Figure 2 reproduces the same situation in bored wells 3 of which the hangers 4 are provided at the bottom with siphons 6 and 6' which submerge at different levels.

Figure 3 represents the situation in the same bored wells with classical hangers. Due to dewatering, the groundwater or liquid level has gone down up to the height of the highest mouth of one of the hangers. In such a situation, vacuum loss on the entire collector arises. In figure 4 the water level is at the same height; there is no ingress of air in siphon 6, through which the underpressure on the collector remains sufficient so as to further draw off water or liquid through hanger 4 with siphon 6'.

In figure 5 a situation is represented which is identical to that shown in figure 3. Through the siphon with the highest mouth, water and air is "slobbered up" by the collector. This situation results from the use of classical hangers.

In figure 6, finally, the groundwater or liquid level in the bored well has gone down to the lowest siphon mouth. This situation, whereby the liquid level in each well may independently go down to a different depth, without air entering the system, may be sustained, provided the underpressure on the system is large enough to allow the level to go down up to the respective siphon mouths, but not sufficiently large to allow the liquid to go down to below the highest siphon neck.

A collector may connect several bored wells, and it should thus be clear that a.o. local circumstances will determine how many bored wells with their hangers will be part of a collector. Factors determining the number of bored wells are:

- capacity of the pump
- depth difference between the different mouths of the hangers
- difference in inflow rate between the different bored wells
- construction of the siphons.

For a further elucidation of the process according to the invention, referring to figures 7 to 11, the following may yet be explained.

In the different figures the vacuum pump 8 which is mounted on the collector 5, is represented, and six bored wells with references A-F are clearly visible. In the different figures each time the ground level and the groundwater level are indicated with reference 1, respectively 2.

The different hangers 4 are each provided with a siphon 6, each of which shows a mouth 9 and a neck 10. The different depths are marked in metres.

At the height of the vacuum pump 8 a certain underpressure is built up. This reference point is located here at +1 m. The six bored wells represented are not interconnected underground, and should thus be considered as autonomous. In the following, it will be

assumed that 0.1 bar is needed approximately in order to suck up 1 m of liquid column.

In the initial phase the collector 5 and all hangers are filled with liquid. In this phase (fig. 7) the liquid level is at -1 m. All siphon mouths may thus be filled up with liquid.

From -0.2 bar on, the liquid goes down in all bored wells (fig. 8). At -0.3 bar the level of the liquid has gone down everywhere to -2 m. In the bored wells A and F, this corresponds with the level of the siphon mouths in these bored wells. The liquid level cannot go down further.

At 0.4 bar (fig. 9) the liquid is at level -3 m, except in well A, where the liquid is at -2 m; in bored well F the level of the siphon mouth has been reached, so that the "water lock" is cancelled, and thus air enters the complete collector network. The operation of the whole is thus totally disturbed. For the further explanation, bored well F is then excluded. In the mean time, the lowest liquid level is reached in bored wells B and D.

When further increasing the underpressure, the liquid level further goes down to -4 m in the bored wells C and E. At 0.5 bar, ingress of air will occur in bored well D, so that the desired level in bored wells C and E cannot be reached (fig. 10). Thereto, bored well D has to be closed off, which subsequently has to be assumed.

According to the same reasoning, the liquid level in well C (-5 m) can only be reached when pumping is maximal and simultaneous in bored wells A, B and C, and as long as the underpressure is not stronger than -0.7 bar (fig. 11).

When applying the process according to the invention, the siphon height h should be at least as large, and the positioning thereof should be adjusted such, that the liquid in all wells goes down to the desired depth and the siphon neck in each well is deeper than the liquid column which is drawn up with the required underpressure. The required underpressure should be adjusted such, that it is strong enough to have the liquid go down up to the lowest siphon mouth, but not below the highest siphon neck. Pipe losses shall obviously be taken into account in this.

A device as described above may find application in circumstances where the groundwater has to go down to a well-defined level. This level needs not be the same in all bored wells. According to local circumstances, the levels in the different wells may deviate from each other. Moreover, no level control whatever is required.

The device according to the invention is therefore most suitable for the removal of a floating layer in the ground, and the depth to which the floating layer has to be pumped may be positioned very accurately in each bored well.

Claims

1. Device for the drawoff of liquid, a.o. for the lowering of the groundwater level or for the removal of float-

ing layers, characterised in that it is comprised of drawoff means consisting of a pump to which a collector (5) with bored wells (3) is connected, each of which is provided with a hanger (4) which hangs in the liquid, and is equipped at its extremity with means based on the siphon principle, the one and other such, that in combination with a certain underpressure on the collector (5), ingress of air on one or more hangers (4) is impossible, and the liquid level in each bored well (3) is positioned independently.

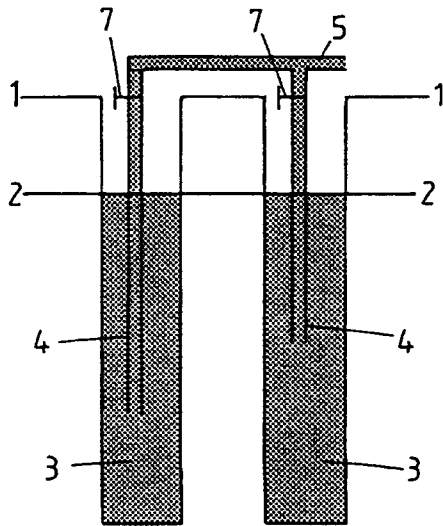


Fig. 1

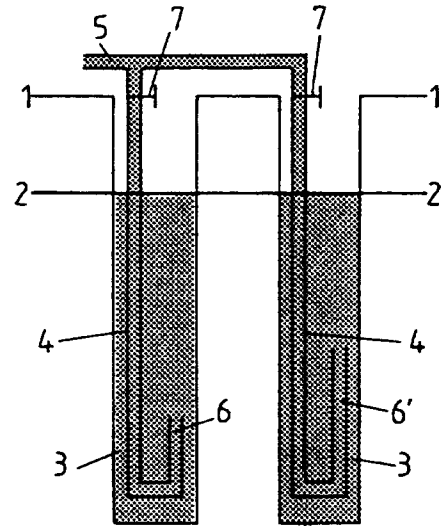


Fig. 2

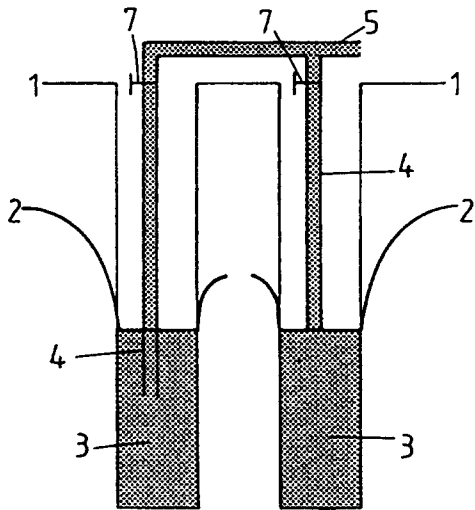


Fig. 3

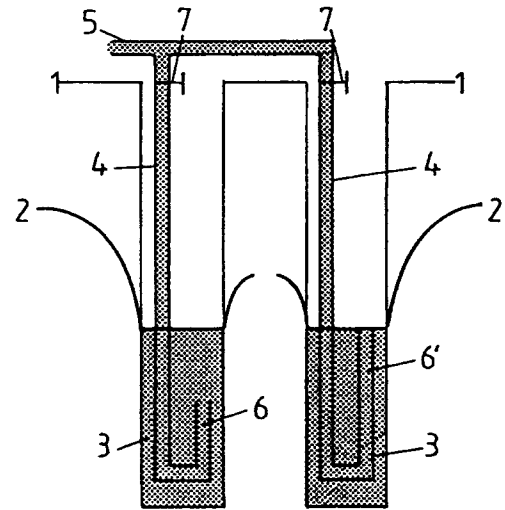


Fig. 4

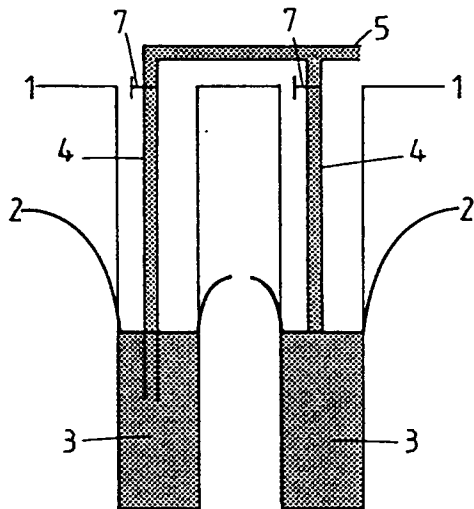


Fig. 5

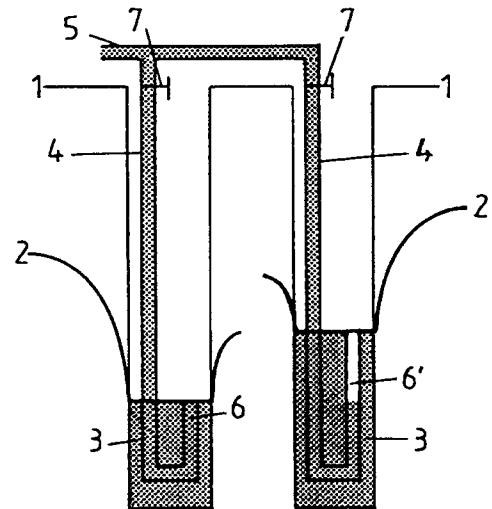


Fig. 6

