

SPECIFICATION



FILTER SAND WASHING METHOD AND ITS SYSTEM

159159

Technical Field

The present invention relates to a method of cleansing filtration sand, of a filtration reservoir used to filter water, and to a system therefor. More specifically, the present invention relates to a method of cleansing a portion of filtration media which is removed from a high speed filtration reservoir, and to a system used therefor.

Background Technology

Water purification processes at water treatment plants involve adding chemicals to untreated water drawn from rivers, lakes, ponds, or wells to consolidate the suspended matter therein to a size that causes said consolidated matter to deposit on the bottom. The supernatant water is skimmed and sent to a filtration reservoir, where it is passed through a layer of sand (filtration sand) to remove the finer suspended matter. This water is then disinfected with chlorine. At high speed filtration reservoirs, regular cleansing of filtration media is performed at intervals of 24~72 hours. As methods of cleansing the filtration media, there are: surface cleansing, in which water is sprayed from a nozzle to strike the surface of the sand layer; and backwash cleansing, in which purified water is forced into the filtration reservoir from a lower pressure chamber to cause the sand particles



to rub against each other, to remove contamination.

Even if surface cleansing and backwash cleansing are regularly performed, pollutants in the water (contaminants such as sludge, hereinafter referred to as contaminants) attach to the surfaces of the filtration sand, if used for a long period of time. Problems arise from repeated use over a period of time such as: the reduction of space among the filtration media due to the progressive thickening of particle size from contaminant accumulation thereon, clogging due to the separation of materials that had been attached to the filtration media, and the leaking of the contaminants themselves. Conventionally these problems were dealt with by, for example, increasing the frequency of the backwash process. However, if the backwash process is repeated over a long period of time, the water pressure thereof influences even the gravel layer which supports the filtration media, creating areas of different thickness in said layer, which is optimally flat and of an even thickness. When the gravel layer becomes uneven, the sand layer is thin at portions where the gravel layer is thick, and insufficient filtration occurs at these portions. The filtration function is reduced, the filtration reservoir does not function properly, and the supply of safe water becomes impossible.

In order to restore proper filtration function, it is necessary to perform a regeneration process, which involves:

ceasing the total operation of the filtration reservoir, removing the filtration media, cleansing and sieving the removed filtration media, inspecting and correcting the interior of the filtration reservoir, replacing the filtration media with the filtration media which has been cleansed. However, the regeneration process is extremely costly, and as during said process the filtration reservoir is not operating, it leads to a decrease in water treatment efficiency. Therefore, there is a strong demand on the part of the water treatment plant to space the intervals between regeneration processes as long as possible.

There are cases in which the filtration sand which is replaced in the course of the regeneration process is new sand. However, stringent standards are set so that the percentage of collected sand that is acceptable as filtration sand is only 10~20% in reality. In addition, costs are increased in the case that new sand is utilized. Therefore, filtration sand is regenerated by cleansing and the like. The inventors of the present invention have proposed a sand cleansing apparatus which enables cleansing of filtration sand to a degree of contamination less than or equal to 30, which is a state of cleanliness close to that of new sand (Japanese Unexamined Patent Publications No. H10(1998)-109051 and H11(1999)-057526), by employing a revolutionary method called a scrubbing cleansing process. By use of this apparatus, filtration function similar to that of a filtration reservoir that

employs new sand is capable of being realized, even if new filtration sand is not replaced in the filtration reservoir during the regeneration process.

However, the quality of water to be filtered for use is rapidly deteriorating in recent years. This is due to: pollution of rivers, lakes, and the ocean by city waste water, industrial waste water, and agricultural waste water; acid rain that includes nitrous oxides and sulfur oxides due to atmospheric pollution; and the like. Due to the deterioration in the quality of water to be filtered, contamination of the filtration sand has advanced as shown in Table 1. Filtration reservoirs which were capable of being utilized for a period of 7~10 years under normal operating conditions must now quicken the pace of regeneration processes.

[Table 1]

Reservoir/Year		Contamination (degree)	Post Cleansing Weight (g)	Dry Weight of Contaminants (mg) (mg/g)		Hydrochloric Acid Solubility (%)	Post Cleansing Contamination (degree)
A	1985	4340	48.96	1150	23.963	1.60	172
	1994	6830	48.03	2260	47.054	3.40	394
B	1986	3940	49.29	658	13.350	2.10	140
	1993	6340	48.59	1320	27.166	2.80	320
C	1987	4760	48.67	839	17.238	2.20	169
	1995	8380	48.57	1948	40.107	2.40	560

Meanwhile, maintenance operations of filtration sand performed at filtration reservoirs are performed to determine the time frame of the next regeneration process, and mainly involve

measurement of the unevenness of the gravel layer, measurement of particle diameters, and the like. Maintenance operations to preserve the function of the sand which has regained its filtration function by the regeneration process are limited to regular cleansing processes of surface cleansing and backwash cleansing.

The Ministry of Health and Welfare has issued guidelines for the degree of contamination of water, which has passed through filtration reservoirs, to be less than or equal to 0.1 degree, as the result of cryptosporidium provisional measures which were established in 1996. To comply with these guidelines, water treatment plants are increasing the frequency of the surface cleansing and backwash cleansing which have been described above. However, during these cleansing operations, water cannot be treated, and the amount of obtainable water is decreased. Consequently, the water treatment efficiency is reduced. In addition, fine sand flows out every time that cleansing is performed. Further, if the frequency of backwash cleansing is increased, the formation of uneven thickness in the gravel layer is hastened. As a result, there are cases in which a regeneration process must be performed sooner. Therefore, it is thought that there are limits to the extent which conventional surface cleansing and backwash cleansing can deal with the contamination of filtration media.

The present invention has been developed in view of the

above circumstances, and it is the object of the present invention to provide a method and apparatus for cleansing filtration sand that enables extension of the time period between regeneration processes by regenerating the filtration function of sand by a method other than by surface cleansing or backwash cleansing, without ceasing operation of the filtration reservoir.

Disclosure of the Invention

The method for cleansing filtration sand of the present invention comprises the steps of:

extracting a predetermined amount of filtration sand from a high speed filtration reservoir, that performs purification of water using filtration sand, during a backwash cleansing operation;

supplying the extracted filtration sand to a sand cleansing apparatus;

cleansing the filtration sand to remove contaminants therefrom with the sand cleansing apparatus;

returning the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir, during the back wash cleansing operation; and

repeating the above extracting, supplying, cleansing, and returning operations to cleanse the filtration sand of the high speed filtration reservoir.

The filtration sand cleansing system of the present invention comprises:

a high speed filtration reservoir;

an extracting means for extracting filtration sand from the high speed filtration reservoir;

a sand cleansing apparatus for cleansing the extracted filtration sand;

a returning means for returning the sand, from which contaminants have been removed, to the high speed filtration reservoir from the sand cleansing apparatus. The filtration sand cleansing system may perform the processes of extraction, cleansing, and returning of the filtration sand as a continuous process, or may perform the above processes as batch processes.

The "extraction of filtration sand" is performed during a backwash operation of the high speed filtration reservoir. This is because the filtration sand filters water in a normal state. If filtration sand is extracted during this state, thin portions are formed in the filtration sand layer, and there is a possibility that contaminants may leak. The extraction of filtration sand may be performed when surface cleansing is being performed concurrently with the backwash cleansing operation. The "returning of filtration sand" is also performed during the backwash operation of the high speed filtration reservoir. This is because during the backwash cleansing operation, purified

water is forced into the filtration reservoir from a lower pressure chamber, thereby causing the filtration sand therein to float. If filtration sand is returned in the filtration reservoir in this state, the filtration sand is capable of forming a flat layer when the backwash cleansing is completed. Note that the returning of filtration sand may be performed when surface cleansing is being performed concurrently with the backwash cleansing operation, in a similar manner to the extraction of filtration sand. The "predetermined amount of filtration sand" refers to an amount of filtration sand that does not affect the purification of water by the filtration reservoir.

It is also preferable that the "extraction of filtration sand" is performed with a suction force of a strength that does not form uneven thicknesses in the gravel layer of the high speed filtration reservoir. The filtration sand layer in a high speed filtration reservoir is about 60cm thick. In case that filtration sand is suctioned out using an excessive suction force, or filtration sand is suctioned out close to the boundary thereof with the gravel layer, the gravel layer, which supports the filtration sand, may become thinner and thicker at portions thereof. Therefore, it is preferable that extraction of filtration sand is performed with a suction force of a strength that does not form uneven thicknesses in the gravel layer. Although there are variances depending on the structure of the

filtration layer and the suction force employed in the extraction, it is preferable that the extraction of filtration sand be performed at a depth from the surface of the filtration sand layer of 15~70% of the thickness thereof. It is further preferable that the extraction of filtration sand be performed at a depth from the surface of the filtration sand layer of 40~60% of the thickness thereof. In the case that an unevenness prevention net is utilized, extraction may be performed at 100% of the depth of the filtration sand layer, that is, from just above the gravel layer.

After contaminants have been removed from the filtration sand by the sand cleansing apparatus, the filtration sand from which contaminants have been removed may be retained in a retention tank. Alternatively, the filtration sand from which contaminants have been removed may be returned to the filtration reservoir before completion of the backwash cleansing operation during which it was extracted, without being retained in the retention tank. In the case that the retention tank is not provided, the extraction, cleansing, and returning processes of the filtration sand may be performed as a continuous process during the backwash cleansing operation.

In the case that a retention tank is provided, it is preferable that water or an oxidizing agent is contained in the retention tank so that the filtration sand retained therein does not contact air. Chlorine, for example, is preferable as the

oxidizing agent. By transferring the cleansed filtration sand from the sand cleansing apparatus to the retention tank, cleansing of sand from other high speed filtration reservoirs is enabled, in the empty sand cleansing apparatus. By keeping water, or water including an oxidizing agent in the retention tank, the filtration sand does not dry. Thereby, the activation of a manganese layer of the filtration sand, which has the ability to remove manganese from water to be filtered, can be preserved. With regard to the size of the retention tank, a size sufficiently large enough to retain filtration sand of the predetermined amount, extracted from the filtration reservoir in one extraction operation, in water so that it does not contact air, may be adopted.

The method and system for cleansing filtration sand of the present invention is applicable to cleansing of filtration sand of a "Greenleaf" high speed filtration reservoir, wherein four to six high speed filtration reservoirs are connected. That is, the method of cleansing filtration sand of the present invention comprises the steps of:

extracting a predetermined amount of filtration sand from a high speed filtration reservoir, that performs purification of water using filtration sand, during a backwash cleansing operation;

supplying the extracted filtration sand to a sand cleansing apparatus;

cleansing the filtration sand to remove contaminants therefrom with the sand cleansing apparatus;

retaining the filtration sand, from which contaminants have been removed, in a retention tank;

returning the retained filtration sand, into a high speed filtration reservoir different from that from which the filtration sand has been extracted, during a backwash cleansing operation thereof; and

repeating the above extracting, cleansing, retaining, and returning operations to cleanse the filtration sand of a plurality of high speed filtration reservoirs.

The retained filtration sand is returned to a filtration reservoir different from that from which the filtration sand has been extracted. This is because the cleansed filtration sand cannot be returned to the same filtration reservoir until the next backwash cleansing operation thereof. Therefore, essentially the same amount of time will be required as the case in which the filtration sand is cleansed for each filtration reservoir one by one. If a plurality of retention tanks is provided, there would be no difference in time from the case in which filtration sand from a single filtration reservoir is cleansed, even if the cleansed filtration sand is returned to the same filtration reservoir. However, to do so would require a substantial installation cost and space, and therefore is not economically

practical. Alternatively, if a large retention tank is provided, retention of cleansed filtration sand which has been extracted from a plurality of filtration reservoirs would be possible. However, this would also incur large installation costs. Normally, at water treatment plants where a plurality of high speed filtration reservoirs are connected, backwash cleansing of the high speed filtration reservoirs is not performed simultaneously, from the viewpoint of processing capacity. Backwash cleansing is performed for each of the high speed filtration reservoirs at a staggered timing. By taking advantage of this staggered timing, cleansing of the filtration sand of all of the filtration reservoirs is enabled in substantially the same time as that expended in the cleansing of all of the filtration sand for one filtration reservoir, even in the case that the number of high speed filtration reservoirs increases. In addition, as the retention tank is of the same scale as that used in the case in which filtration sand from a single filtration reservoir is cleansed, this is preferable from the viewpoint of installation costs.

At water treatment plants having a plurality of high speed filtration reservoirs, there are cases in which filtration reservoirs with filtration sand which is highly contaminated and filtration reservoirs with filtration sand which is relatively lightly contaminated coexist. In cases like these, it is

preferable, from the viewpoint of equalization of filtration sand of the plurality of filtration reservoirs, to return filtration sand extracted from a highly contaminated filtration reservoir to a filtration reservoir which is lightly contaminated, and vice versa.

It is preferable that the repetition of each of these steps is automatically performed by sequence control. That is, because the backwash cleansing of a high speed filtration reservoir is controllable by using pressure loss or time as factors, the steps of extraction; cleansing; and returning of the filtration sand, or the steps of extraction; cleansing; retention; and returning of the filtration sand can be automatically performed by sequence control.

Both the extraction and return of filtration sand are performed during backwash cleansing, when filtration sand is in a floating state. It is preferable that the filtration sand which has already been cleansed not be mixed in with the filtration sand to be extracted, in order to increase the cleansing efficiency. Accordingly, it is preferable that the filtration sand from which contaminants have been removed be returned to the high speed filtration reservoir at a position remote from the position from which filtration sand is extracted. That is, it is preferable that the means for extracting filtration sand from the high speed filtration reservoir and the means for returning filtration sand,

from which contaminants have been removed, are provided remote from each other. It is also preferable, from the viewpoint of cleansing efficiency, that the position at which filtration sand is extracted is changed per every extraction operation, and that the position to which the filtration sand, from which contaminants have been removed, is returned is changed per every returning operation. That is, it is preferable that at least one of the means for extracting filtration sand from the high speed filtration reservoir and the means for returning filtration sand, from which contaminants have been removed, to the high speed filtration reservoir be provided so as to be movable.

As the "sand cleansing apparatus", it is preferable to employ that which is disclosed in Japanese Unexamined Patent Publication No. Hei10-109051, which comprises: a cleansing tank for containing sand and cleansing water therein; a screw conveyor that rotates about a substantially perpendicular axis within the cleansing tank; a rotating means for rotating the screw conveyor at a speed so that: the rotation of the screw conveyor causes the sand and cleansing water to be elevated while contaminants are removed from the sand by contact between particles thereof with the cleansing water therebetween, at a lower portion of the screw conveyor which is beneath the surface of the cleansing water, and the rotation of the screw conveyor causes the sand to flow while contaminants are removed from the sand by contact between

particles thereof with a slight amount of contaminant-laden water therebetween; and a circulation means for causing the elevated sand to descend to the lower portion of the screw conveyor so that the sand is elevated again.

Whereas conventionally, cleansing of filtration sand relied solely on backwash cleansing, the method of cleansing filtration sand of the present invention extracts a predetermined amount of filtration sand from a high speed filtration reservoir during a backwash cleansing operation thereof; supplies the extracted filtration sand to a sand cleansing apparatus; cleanses the filtration sand with the sand cleansing apparatus to remove contaminants therefrom; returns the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir during a backwash cleansing operation thereof; and repeats the extraction, cleansing, and returning of the filtration sand to cleanse the filtration sand within the high speed filtration reservoir. Therefore, the filtration sand is enabled to be effectively cleansed without ceasing operation of the filtration reservoir, and the time period between regeneration processes can be dramatically extended.

More specifically, if substantially all of the filtration sand within a high speed filtration reservoir is automatically cleansed by repeating the extraction, cleansing, and returning of the filtration sand, it becomes possible to restore the water

purification function of the filtration reservoir. In addition, if contaminants are removed from the filtration sand, a decrease in the filtration resistance becomes possible, and backwash cleansing can be performed at pressures as designed. Accordingly, it becomes possible to reduce the leakage of filtration sand, as well as to dramatically reduce the leakage of contaminants removed therefrom. Further, it becomes possible to delay the formation of unevenness of thickness in the gravel layer. From this point also, the time period between regeneration processes can be dramatically extended.

Note that by: extracting a predetermined amount of filtration sand from a high speed filtration reservoir during a backwash cleansing operation; supplying the extracted filtration sand to a sand cleansing apparatus; cleansing the filtration sand to remove contaminants therefrom with the sand cleansing apparatus; retaining the filtration sand, from which contaminants have been removed, in a retention tank; returning the retained filtration sand, into a high speed filtration reservoir different from that from which the filtration sand has been extracted, during a backwash cleansing operation thereof; and repeating the above extracting, cleansing, retaining, and returning operations, the filtration sand of a plurality of high speed filtration reservoirs can be cleansed efficiently without ceasing the operations thereof. In addition, because the filtration sand which is

retained in the retention tank is returned to a high speed filtration reservoir different from that from which the filtration sand has been extracted, cleansing of filtration sand of a plurality of filtration reservoirs is capable in substantially the same amount of time as the case in which filtration sand from a single filtration reservoir is cleansed. Further, by returning filtration sand extracted from a highly contaminated filtration reservoir to a filtration reservoir which is lightly contaminated and vice versa, equalization of the filtration sand of the filtration reservoirs can be realized.

Further, by employing a sand cleansing apparatus comprising: a cleansing tank for containing sand and cleansing water therein; a screw conveyor that rotates about a substantially perpendicular axis within the cleansing tank; a rotating means for rotating the screw conveyor at a speed so that: the rotation of the screw conveyor causes the sand and cleansing water to be elevated while contaminants are removed from the sand by contact between particles thereof with the cleansing water therebetween, at a lower portion of the screw conveyor which is beneath the surface of the cleansing water, and the rotation of the screw conveyor causes the sand to flow while contaminants are removed from the sand by contact between particles thereof with a slight amount of contaminant-laden water therebetween; and a circulation means for causing the elevated sand to descend to the lower portion

of the screw conveyor so that the sand is elevated again, as the sand cleansing apparatus for the method and system for cleansing filtration sand of the present invention, contaminants can be removed without crushing the sand by the particles of sand scrubbing each other. Therefore, the water purification function of the filtration sand can be restored to a state close to that of new sand. Accordingly, the time period between regeneration processes of the filtration reservoir can be further extended.

In addition, water treatment plants had been increasing the frequency of conventional surface cleansing and backwash cleansing as a cryptosporidium measure. However, it becomes possible to maintain the degree of contamination to less than or equal to 0.1 at the exit of the filtration reservoir, while performing the surface cleansing and the backwash cleansing at normal frequency, by the method and system for cleansing filtration sand of the present invention. Therefore, the cryptosporidium measure is aided, and water treatment plants can be operated without reducing the purification efficiency.

Brief Description of the Drawings

Figure 1 is a process diagram showing an embodiment of the filtration sand cleansing method of the present invention.

Figure 2 is a schematic view showing a first embodiment of the filtration sand cleansing system of the present invention.

Figure 3 is a schematic view showing a second embodiment of the filtration sand cleansing system of the present invention.

Figure 4 is a process diagram showing another embodiment of the filtration sand cleansing method of the present invention.

Figure 5 is a process diagram showing yet another embodiment of the filtration sand cleansing method of the present invention.

Figure 6 is a sectional view of a high speed filtration reservoir, taken along the line A-A of Figure 2.

Figure 7 is a diagram showing the flow of filtration sand corresponding to a plurality of filtration reservoirs.

Figure 8 is a diagram that shows an example of the movement of filtration sand among filtration reservoirs.

Best Mode for Carrying out the Invention

The filtration sand cleansing system of the present invention comprises: a high speed filtration reservoir 1; a pump 2 for suctioning out filtration sand having contaminants attached thereto from the high speed filtration reservoir 1; a sand cleansing apparatus 3 for cleansing the filtration sand 5 having contaminants attached thereto; a stock tank 4 for stocking the filtration sand 6, which has been cleansed by the sand cleansing apparatus 3; and a path 7 for returning the sand from which

contaminants have been removed from the stock tank 4 to the high speed filtration reservoir 1, as shown in Figure 2 (the details of the process steps of the filtration sand cleansing system will be described later in the embodiments).

Alternatively, the filtration sand cleansing system of the present invention may comprise: a high speed filtration reservoir 1; a pump 2 for suctioning out filtration sand having contaminants attached thereto from the high speed filtration reservoir 1; a sand cleansing apparatus 3 for cleansing the filtration sand 5 having contaminants attached thereto; and a path 7 for returning the sand from which contaminants have been removed from the stock tank 4 to the high speed filtration reservoir 1, as shown in Figure 3. That is, the system may adopt a construction wherein a stock tank for cleansed sand is not provided. In the case that the filtration sand cleansing system is not provided with the stock tank for cleansed sand, it becomes possible to save the costs required therefor. In addition, this system is preferable when there is in sufficient space in the vicinity of the high speed filtration reservoir to install the stock tank for cleansed sand.

As an example of the processes performed by the filtration sand cleansing system shown in Figure 3 is shown in Figure 4. First, approximately 1m^3 of contaminated filtration sand is suctioned out of the filtration reservoir 1 with the pump 2 during the time (e.g., 15~25 minutes) when surface cleansing and backwash

cleansing is being performed. The filtration sand suctioned by the pump 2 is sent to the sand cleansing apparatus 3, where cleansing is performed for a short time (approximately 10 minutes) thereby. Then, the cleansed filtration sand (cleansed sand) is returned to the filtration reservoir 1 before the surface cleansing and backwash cleansing are completed. By performing the suctioning of contaminated sand and the returning of cleansed sand within the time period during which one surface cleansing and backwash cleansing are performed in this manner, it becomes possible to perform cleansing of contaminated sand within a short time.

Alternatively, as shown in Figure 5, contaminated filtration sand may be continuously suctioned out of the filtration reservoir 1 with the pump 2 during the time (e.g., 7~10 minutes) when surface cleansing and backwash cleansing is being performed. The filtration sand suctioned by the pump 2 may be continuously sent to the sand cleansing apparatus 3, where continuous cleansing is performed thereby. Then, the cleansed filtration sand (cleansed sand) may be continuously returned to the filtration reservoir 1 before the surface cleansing and backwash cleansing are completed. By performing these processes continuously within the time period during which surface cleansing and backwash cleansing are performed in this manner, it becomes possible to perform cleansing of a greater amount of

contaminated sand within a short time.

As shown in Figure 6, the high speed filtration reservoir 1 is provided with a filtration sand layer 12, which acts as a filtration layer, and gravel layers 13 through 16 for supporting the filtration sand layer 12. The filtration sand layer comprises sand having effective particle diameters of 0.6mm, and a uniformity coefficient of less than or equal to 1.5. The gravel layers are formed of four layers having different particle diameters, and serve as supporting layers to prevent the filtration sand 12 from entering a water collection apparatus (not shown, but the apparatus for collecting purified water is provided at a still lower portion of the high speed filtration reservoir 1). Spherical, hard, clean, and uniform gravel is selected for the gravel layers 13 through 16, in order to perform backwash cleansing uniformly. As particle diameters thereof, those which are commonly used, that is, gravel having effective particle diameters of 2.0~3.5mm for the gravel layer 13; gravel having effective particle diameters of 3.5~7.0mm for the gravel layer 14; gravel having effective particle diameters of 7.0~13.0mm for the gravel layer 15; and gravel having effective particle diameters of 13.0~20.0mm are employed for the gravel layer 16. These layers are sequentially laid with the coarser grain gravel in the lower layers and the finer grain gravel in the upper layers, and without unevenness of thicknesses thereof. Pretreated water,

of which contaminants therein have been consolidated by a flocculant and caused to deposit at the bottom, is introduced above the filtration sand layer 12. In addition, a surface cleansing pipe 22, for spraying water from a nozzle to strike the surface of the filtration sand layer during surface cleansing; and a trough 21, for draining the wastewater generated during surface cleansing and backwash cleansing, are provided above the filtration sand layer 12.

Next, purification process steps commonly used for purifying untreated water will be briefly described. Untreated water is drawn into a consolidation/deposition reservoir from rivers, lakes, and the like. The contaminants in the untreated water are consolidated by adding a flocculant such as polychlorinated aluminum, and the consolidated contaminants are caused to deposit on the bottom of the consolidation/deposition reservoir. The supernatant water is skimmed and sent to the high speed filtration reservoir 1 above the filtration sand layer 12. Fine suspended matter which was not removed in the consolidation/deposition reservoir is removed by the filtration sand 12. The filtered water is collected at the water collection apparatus provided at the lower portion of the high speed filtration reservoir 1. The collected water is disinfected with chlorine, and retained at a water distribution reservoir. The filtration speed is normally 120~150m per day. Cleansing of sand

by ceasing filtration operations and forcing cleansing water from a lower pressure chamber of the high speed filtration reservoir, thereby causing the particles of filtration sand to float and rub against each other, is performed at regular intervals, or when head loss reaches 1.5m. Surface cleansing is performed by spraying cleansing water from the surface cleansing pipe 22 onto the surfaces of the filtration sand 12, during the backwash cleansing or at a timing matched with a certain point in the backwash cycle. The wastewater generated by the surface cleansing and the backwash cleansing is drained by the trough 21. When cleansing is complete, pretreated water to be purified is again sent to the filtration reservoir, and filtration is recommenced. Normally, the water purification and sand cleansing steps are automated. Depending on the state of the untreated water to be purified at the water treatment plant with the high speed filtration method, the timing of the surface cleansing and backwash cleansing may be preset. Alternatively, the surface cleansing and backwash cleansing may be set to be automatically performed when the head loss exceeds a predetermined value.

As shown in Table 2, standards for filtration sand (Japanese Water Works Association Technical Standard JWWA A 103-1988) are established as: less than or equal to 30 degrees for post cleansing contamination degree; less than or equal to 3.5% for hydrochloric acid solubility; 0.45~0.70mm for effective particle diameters;

and less than or equal to 1.7 for uniformity coefficient. Even if surface cleansing and backwash cleansing is performed regularly as described above and regeneration processes are performed every seven years, if ten years pass from the time when new sand is introduced, as indicated by the contaminated sand of Table 2, contaminants attach to the filtration sand to contaminate it so that the post cleansing contamination degree is 1,480 degrees, the hydrochloric acid solubility is 9.7%, the effective particle diameter is 0.533, and the uniformity coefficient is 1.485.

[Table 2]

	Established Standards for Filtration Sand	Contaminated Sand
Contamination Post Cleansing	30 degrees or less	1,480 degrees
Hydrochloric Acid Solubility	3.5% or less	9.7%
Effective Particle Diameter	0.45~0.70mm	0.533
Uniformity Coefficient	1.7 or less	1.485

If filtration sand to which contaminants are attached in this manner continues to be utilized, clogging due to contaminants occurs, causing rapid increases in head loss. Therefore, the frequency of backwash cleansing is increased, and the water pressure involved therewith affects the gravel layers, quickening the formation of unevenness in the thickness thereof. By the formation of unevenness in the thickness of the gravel layers, the sand layer becomes thin at the portions where the gravel layers are thick, causing insufficient filtration at these portions. In addition, breakthrough of sludge and contaminants that separate

from the filtration sand occurs, negatively influencing the quality of the filtered water. A regeneration process becomes necessary if the filtration reservoir arrives at this state.

Hereinbelow, embodiments of the filtration sand cleansing system, which performs the steps of: extracting a portion of filtration sand; cleansing the extracted sand in a sand cleansing apparatus; and returning the sand, from which contaminants have been removed, to a filtration reservoir; in addition to the conventional cleansing steps described above, will be described. (Embodiment 1)

A sand cleansing apparatus as disclosed in Japanese Unexamined Patent Publication No. Hei10-109051, which comprises: a cleansing tank for containing sand and cleansing water therein; a screw conveyor that rotates about a substantially perpendicular axis within the cleansing tank; a rotating means for rotating the screw conveyor at a speed so that: the rotation of the screw conveyor causes the sand and cleansing water to be elevated while contaminants are removed from the sand by contact between particles thereof with the cleansing water therebetween, at a lower portion of the screw conveyor which is beneath the surface of the cleansing water, and the rotation of the screw conveyor causes the sand to flow while contaminants are removed from the sand by contact between particles thereof with a slight amount of contaminant-laden water therebetween; and a circulation means

for causing the elevated sand to descend to the lower portion of the screw conveyor so that the sand is elevated again, thereby realizing a scrubbing method of cleansing, was employed as the sand cleansing apparatus 3. As shown in Figure 1 and Figure 2, 1m³ of contaminated filtration sand was suctioned out from a corner (1a) of the filtration reservoir 1 by the pump 2, during the time (7 minutes~10 minutes) when surface cleansing and backwash cleansing was being performed. The suctioning of the filtration sand was performed at a depth of approximately 10cm above the gravel layer 13 (the filtration sand layer thickness is 60cm). The filtration sand (5) suctioned by the pump 2 was sent to the sand cleansing apparatus 3, and cleansing was performed for approximately one hour. As shown in Table 3, the degree of contamination of the suctioned filtration sand (5) decreased to 11 degrees from 1480 degrees; the hydrochloric acid solubility decreased from 9.7% to 2.8%; and the uniformity coefficient was improved from 1.485 to 1.280. It can be understood that the filtration sand is returned to levels of new sand, by cleansing for approximately an hour.

[Table 3]

	Contaminated Sand	After Cleansing (minutes)			
		10	20	30	60
Contamination (degree)	1,480	77	44	14	11
Hydrochloric Acid Solubility	9.7%	7.7%	4.3%	3.5%	2.8%
Effective Particle Diameter	0.533mm	0.599mm	0.596mm	0.597mm	0.595mm
Uniformity Coefficient	1.485	1.287	1.284	1.284	1.280

The cleansed filtration sand (6a) was stored in a cleansed sand stock tank, containing water. Approximately 48 hours after filtration was recommenced at the high speed filtration reservoir 1, filtration was ceased, and surface cleansing and backwash cleansing was performed again. During this time, the cleansed sand was returned to the filtration reservoir 1 at a corner (1b) opposite the corner (1a) thereof. By repeating this cycle, substantially all 60m³ of filtration sand in the filtration reservoir 1 was cleansed in approximately 120 days.

(Embodiment 2)

Filtration sand cleansing was performed in the same manner as Embodiment 1 described above, except that the specific sand cleansing apparatus was replaced with a conventional jet water stream sand cleansing apparatus. As shown in Table 4, although there are slight significant differences between Embodiment 1, which employed the specific sand cleansing apparatus, and Embodiment 2, the contaminated sand was dramatically cleansed. In the case of Embodiment 1, there was hardly any change in the effective particle diameter. However, in Embodiment 2, as cleansing was performed for a long time, the effective particle diameter decreased, and the uniformity coefficient increased. It can be understood that in a conventional sand cleansing apparatus that employs a jet water stream, the sand collides with pipes, walls, and the like during cleansing, causing destruction

thereof.

[Table 4]

	Contaminated Sand	After Cleansing (minutes)			
		10	20	30	60
Contamination (degree)	1,480	208	173	167	88
Hydrochloric Acid Solubility	9.7%	9.2%	8.9%	8.7%	6.6%
Effective Particle Diameter	0.533mm	0.606mm	0.603mm	0.590mm	0.577mm
Uniformity Coefficient	1.485	1.287	1.287	1.290	1.301

Next, a method and system for cleansing filtration sand in the case that a plurality of high speed filtration reservoirs are provided will be described with reference to Figure 7 and Figure 8. Figure 7 is a diagram showing the flow of filtration sand corresponding to a plurality of filtration reservoirs. Figure 8 is a diagram that shows an example of the movement of filtration sand among filtration reservoirs. Here, a filtration sand system as shown in Figure 7, comprising: six high speed filtration reservoirs A through F; one sand cleansing apparatus; and one retention tank will be described as an example. However, the principle is exactly the same whether the number of filtration reservoirs is greater than or less than six.

Filtration reservoirs A through F are filtration reservoirs at which backwash cleansing is performed every 48 hours. As shown in Figure 7, the intervals between the backwash cleansing of each of the filtration reservoirs is eight hours. First, a predetermined amount of filtration sand is suctioned

out of filtration reservoir A. The suctioned filtration sand is cleansed for one hour in the sand cleansing apparatus. The filtration sand, from which contaminants have been removed, is retained in the retention tank, which contains water or water containing an oxidizing agent. The retained cleansed filtration sand is returned to filtration reservoir B, at which backwash cleansing is commenced eight hours after the backwash cleansing of filtration reservoir A. During the backwash cleansing of filtration reservoir B, contaminated filtration sand is suctioned out therefrom, while cleansed filtration sand is returned thereto. The filtration sand suctioned out from filtration reservoir B is cleansed for one hour by the sand cleansing apparatus, and the cleansed sand is retained in the retention tank, which contains water or water containing an oxidizing agent. The retained cleansed filtration sand is returned to filtration reservoir C, at which backwash cleansing is commenced eight hours after the backwash cleansing of filtration reservoir B. During the backwash cleansing of filtration reservoir C, contaminated filtration sand is suctioned out therefrom, while cleansed filtration sand is returned thereto. In this manner, when 48 hours pass, a predetermined amount of filtration sand is suctioned out from each of all of the filtration reservoirs A through F, and a predetermined amount of cleansed filtration sand is returned

to each of all of the filtration reservoirs A through F. By repeating these steps, all of the filtration sand of the filtration reservoirs A through F may be cleansed. By matching the extracting, cleansing, and returning steps to the timing of the backwash cleansing operations of a plurality of filtration reservoirs, filtration sand of a plurality of filtration reservoirs may be cleansed in substantially the same amount of time as that required for the cleansing of filtration sand of a single filtration reservoir.

In addition, in the case that the degree of contamination of the filtration sand increases in order from filtration reservoir A to filtration reservoir F: by returning the filtration sand, extracted from filtration reservoir A and cleansed, to filtration reservoir E; returning the filtration sand, extracted from filtration reservoir E and cleansed, to filtration reservoir C; returning the filtration sand, extracted from filtration reservoir C and cleansed, to filtration reservoir A; and so on as shown in Figure 8, equalization of filtration sand among the filtration reservoirs A through F can be realized.

Further, by automatically performing at least the three steps of: suctioning out filtration sand from the high speed filtration reservoir; cleansing the filtration sand with the sand cleansing apparatus; and returning the filtration sand,

from which contaminants have been removed, to the high speed filtration reservoir, or the four steps of: suctioning out filtration sand from the high speed filtration reservoir; cleansing the filtration sand with the sand cleansing apparatus; retaining the cleansed filtration sand in the retention tank; and returning the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir, by sequence control, it becomes possible to maintain the filtration sand in a state similar to that of new sand for an extended period of time. Therefore, the time period between regeneration processes can be dramatically extended.

SCOPE OF DEMAND FOR PATENT

(1) A method for cleansing filtration sand comprising the steps of:

suctioning out a predetermined amount of filtration sand from a high speed filtration reservoir, that performs purification of water using filtration sand, during a backwash cleansing operation;

() supplying the extracted filtration sand to a sand cleansing apparatus;

cleansing the filtration sand to remove contaminants therefrom with the sand cleansing apparatus;

returning the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir, during the back wash cleansing operation; and

() repeating the above suctioning, cleansing, and returning steps to cleanse the filtration sand of the high speed filtration reservoir.

(2) A method for cleansing filtration sand as defined in Claim 1, wherein:

an apparatus comprising:

a cleansing tank for containing sand and cleansing water therein;

a screw conveyor that rotates about a substantially perpendicular axis within the cleansing tank;

a rotating means for rotating the screw conveyor at a speed so that: the rotation of the screw conveyor causes the sand and cleansing water to be elevated while contaminants are removed from the sand by contact between particles thereof with the cleansing water therebetween, at a lower portion of the screw conveyor which is beneath the surface of the cleansing water, and the rotation of the screw conveyor causes the sand to flow while contaminants are removed from the sand by contact between particles thereof with a slight amount of contaminant-laden water therebetween; and

a circulation means for causing the elevated sand to descend to the lower portion of the screw conveyor so that the sand is elevated again, is utilized as the sand cleansing apparatus.

(3) A method for cleansing filtration sand as defined in either Claim 1 or Claim 2, wherein:

after contaminants are removed from the filtration sand by the sand cleansing apparatus, the filtration sand, from which contaminants have been removed, is retained in a retention tank.

(4) A method for cleansing filtration sand as defined in either Claim 1 or Claim 2, wherein:

the filtration sand, from which contaminants have been removed, is returned to the high speed filtration reservoir before the completion of the backwash cleansing operation during which the filtration sand was suctioned out.

(5) A method for cleansing filtration sand as defined in

Claim 4, wherein:

the steps of suctioning, cleansing, and returning the filtration sand are performed continuously during the backwash cleansing operation.

(6) A method for cleansing filtration sand as defined in Claim 3, wherein:

the retention tank contains water or water containing an oxidizing agent to prevent the filtration sand retained therein from contacting air.

(7) A method for cleansing filtration sand, comprising the steps of:

suctioning out a predetermined amount of filtration sand from a high speed filtration reservoir, that performs purification of water using filtration sand, during a backwash cleansing operation;

supplying the extracted filtration sand to a sand cleansing apparatus;

cleansing the filtration sand to remove contaminants therefrom with the sand cleansing apparatus;

retaining the filtration sand, from which contaminants have been removed, in a retention tank;

returning the retained filtration sand, into a high speed filtration reservoir different from that from which the filtration sand has been extracted, during a backwash cleansing

operation thereof; and

repeating the above suctioning, cleansing, retaining, and returning operations to cleanse the filtration sand of a plurality of high speed filtration reservoirs.

(8) A method for cleansing filtration sand as defined in any of claims 1 through 7, wherein:

the repetition of each of the steps is automatically performed by sequence control. ()

(9) A method for cleansing filtration sand as defined in any of claims 1 through 8, wherein:

the filtration sand from which contaminants have been removed is returned to the high speed filtration reservoir at a position remote from the position from which the filtration sand has been suctioned out.

(10) A method for cleansing filtration sand as defined in any of claims 1 through 9, wherein:

the position at which filtration sand is suctioned out is changed per every suctioning operation. O

(11) A method for cleansing filtration sand as defined in any of claims 1 through 10, wherein:

the position to which the filtration sand, from which contaminants have been removed, is returned is changed per every returning operation.

(12) A method for cleansing filtration sand as defined in

any of claims 1 through 11, wherein:

the suctioning of filtration sand is performed with a suction force of a strength that does not form unevenness of thickness in gravel layers of the high speed filtration reservoir.

(13) A system for cleansing filtration sand comprising:

a high speed filtration reservoir;

a suctioning means for suctioning out filtration sand from the high speed filtration reservoir;

a sand cleansing apparatus for cleansing the suctioned filtration sand;

a returning means for returning the sand, from which contaminants have been removed, from the sand cleansing apparatus to the high speed filtration reservoir.

(14) A system for cleansing filtration sand as defined in Claim 13, further comprising:

a retention tank for retaining the filtration sand, from which contaminants have been removed by the sand cleansing apparatus, before returning the filtration sand to the high speed filtration reservoir.

(15) A system for cleansing filtration sand as defined in Claim 14, wherein:

the retention tank further comprises a means for supplying water, so that the filtration sand within the retention tank does not contact air.

(16) A system for cleansing filtration sand as defined in any of Claim 13, Claim 14, or Claim 15, further comprising:

a plurality of high speed filtration reservoirs.

(17) A system for cleansing filtration sand as defined in any of claims 13 through 16, further comprising:

a control means for automatically performing at least the three steps of: suctioning out filtration sand from the high speed filtration reservoir; cleansing the filtration sand with the sand cleansing apparatus; and returning the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir, or the four steps of: suctioning out filtration sand from the high speed filtration reservoir; cleansing the filtration sand with the sand cleansing apparatus; retaining the cleansed filtration sand in the retention tank; and returning the filtration sand, from which contaminants have been removed, to the high speed filtration reservoir, by sequence control.

(18) A system for cleansing filtration sand as defined in any of claims 13 through 17, wherein:

the suctioning means for suctioning out the filtration sand from the high speed filtration reservoir and the returning means for returning the filtration sand, from which contaminants have been removed, are provided remote from each other.

(19) A system for cleansing filtration sand as defined in any of claims 13 through 18, wherein:

at least one of the suctioning means for suctioning out filtration sand from the high speed filtration reservoir and the returning means for returning filtration sand, from which contaminants have been removed, to the high speed filtration reservoir be provided so as to be movable.

() (20) A system for cleansing filtration sand as defined in any of claims 13 through 19, wherein the sand cleansing apparatus comprises:

a cleansing tank for containing sand and cleansing water therein;

a screw conveyor that rotates about a substantially perpendicular axis within the cleansing tank;

() a rotating means for rotating the screw conveyor at a speed so that: the rotation of the screw conveyor causes the sand and cleansing water to be elevated while contaminants are removed from the sand by contact between particles thereof with the cleansing water therebetween, at a lower portion of the screw conveyor which is beneath the surface of the cleansing water, and the rotation of the screw conveyor causes the sand to flow while contaminants are removed from the sand by contact between particles thereof with a slight amount of contaminant-laden water therebetween; and

a circulation means for causing the elevated sand to descend to the lower portion of the screw conveyor so that the sand is elevated again.