Publication Classification

(51) Int. Cl.
A47L 7/00
(2006.01)

(52) U.S. Cl. ................................................................. 15/320

(57) ABSTRACT

Shown and described is a floor cleaning machine with a housing on which a carriage is provided for moving the machine over a floor surface to be cleaned, a fresh-water tank, which is accommodated in the housing, and a cleaning unit, which is attached to the housing and is designed to come into contact with the floor surface to be cleaned, the cleaning unit being connected to the fresh-water tank, and a method for operating a floor cleaning machine. The object of providing a floor cleaning machine and a method for operating it that make it possible at least for the clearing agent requirement to be reduced is achieved in terms of the device by providing an ion-exchanger unit, by the ion-exchanger unit being connected to the fresh-water tank and by the ion-exchanger unit being flowed through by fresh water from an inlet to an outlet.
FLOOR CLEANING MACHINE WITH A WATER SOFTENING DEVICE

[0001] The present invention relates to a floor cleaning machine with a housing, on which a carriage is provided for moving the machine over a floor surface to be cleaned, a fresh-water tank, which is accommodated in the housing, and a cleaning unit, which is attached to the housing and is designed to come into contact with the floor surface to be cleaned, the cleaning unit being connected to the fresh-water tank, and relates to a method for operating a floor cleaning machine.

[0002] Such a floor cleaning machine is known, for example, from EP 0 387 446 A1. During the operation of this machine, water is supplied from a fresh-water tank to a cleaning unit, which has rotating brushes, so that a floor surface can be cleaned by the brushes acting together with the water supplied, to which a cleaning agent has also been added. Although an adequate cleaning effect is achieved with such machines, there is the problem that a comparatively high consumption of cleaning agent takes place.

[0003] This is firstly disadvantageous with regard to aspects of environmental protection, and secondly leads to not inconsiderable operating costs. A further problem that arises when a large amount of cleaning agent is used on a floor surface is that of the residues of cleaning agent that are left there. These quickly cause dirt to reattach itself, so there is an increased incidence of what is known as re-soiling. Residues of lime or other minerals contained in tap water can also be left behind on the floor and lead to a build-up of layers or to rapid re-soiling.

[0004] Against the background of the prior art, the present invention is therefore based on the object of providing a floor cleaning machine and a method for operating it that make it possible at least for the cleaning agent requirement to be reduced.

[0005] This object is achieved in terms of the device by providing an ion-exchanger unit, by the ion-exchanger unit being connected to the fresh-water tank and by the ion-exchanger unit being flowed through by fresh water from an inlet to an outlet.

[0006] For the purposes of the present invention, an “ion-exchanger unit” is understood as meaning a device which is designed inter alia for exchanging positive, limescale-forming ions contained in the water, such as Ca⁺ and Mg⁺, for other ions, such as for instance Na⁺ ions, so that the limescale-causing minerals Ca and Mg are extracted and the water is thereby softened. After passing through the ion-exchanger unit and the exchange thereby involved, the water no longer contains the limescale-causing minerals CaSO₄, MgCl₂, Ca(HCO₃)₂, but other salts, which may take the form of Na₂SO₄, 2NaCl and 2NaHCO₃. This means that, with this method, the overall hardness of the water is reduced.

[0007] In the ion-exchanger unit, the untreated fresh water may also be passed through a combination of cation exchangers and anion exchangers with commercially available cation exchanger resins and anion exchanger resins being used for this. The cations contained in the fresh water (for example Ca, Mg, Na, K) are thereby exchanged by the cation exchanger for H⁺ ions, while the anions (for example Cl⁻, NO₃⁻, SO₄²⁻, HCO₃⁻) are exchanged by the anion exchanger for OH⁻ ions. Subsequently, the H⁺ ions and the OH⁻ ions react with one another and form water (H₂O). With this alternative it is also the case that, inter alia, the limescale-causing minerals Ca and Mg are extracted from the water and the water is thereby softened. Here, both the overall hardness and the electrical conductivity of the water are reduced.

[0008] The fact that the treated water that is supplied to the cleaning unit and used for floor cleaning no longer contains scarcely any limescale-causing minerals, and is therefore softened, allows the requirement for cleaning agent to be significantly reduced, so that a considerably reduced concentration of cleaning agent in the water is adequate to ensure a satisfactory cleaning result. This effect may go so far that it is possible to dispense completely with the adding of cleaning agent to the water for the cleaning unit.

[0009] Since water with less cleaning agent can then be used, the amount of cleaning agent left behind on the floor surface to be cleaned is then also reduced, which in turn has the effect that the adhesive attachment with which new dirt is held on the floor surface is also reduced. Consequently, the susceptibility of the floor surface to become newly soiled is also reduced, so that re-soiling does not occur as readily. Cleaning agents combine with lime contained in the water to form so-called “lime soap”. This can only be removed with increased cleaning effort, and it is also a reason for the tendency of the floor to quickly become newly soiled. This problem is significantly reduced with the floor cleaning machine according to the invention. Since no residues can be left behind on the floor, the sureness of footing (prevention of slipping) is also increased.

[0010] In a preferred embodiment, the inlet of the ion-exchanger unit is connected to a regeneration unit, and there is a bypass line, through which fresh water can flow to the inlet of the ion-exchanger unit without flowing through the regeneration unit.

[0011] With a regeneration unit as provided by the present invention, it is possible for example to restore the capability of the ion-exchanger unit to exchange Ca⁺ and Mg⁺ ions for Na⁺ ions or other ions, once this capability has been lost or at least reduced as a result of the unit being used for a lengthy period of time. For this purpose, the regeneration unit may be filled with sodium chloride, and this sodium chloride is flushed into the ion-exchanger unit as a solution or as brine and remains there for a certain period of time. During this period of time, the material of the ion-exchanger unit gives off once again the CaSO₄ and MgCl₂ it has taken up and instead takes up NaCl ions. Once this re-exchange has taken place to an adequate extent, the ion-exchanger unit is flushed, in order that the solution, which now contains Ca⁺ and Mg⁺ ions, is removed from the ion-exchanger unit.

[0012] The bypass line makes it possible on the one hand for the fresh water, which in normal operation is untreated and does not contain any additional cleaning agents, to pass directly to the ion-exchanger unit, in order to be appropriately treated there. On the other hand, however, when the bypass line is closed, fresh water can be pumped into the regeneration unit, in order to in turn achieve the effect that brine, for example, is forced into the ion-exchanger unit.

[0013] Altogether, the arrangement comprising the regeneration unit and the bypass line makes it possible that the capability of the ion-exchanger unit can be restored without parts on the floor cleaning machine having to be exchanged. Just one interruption to normal operation is required, during which, for example, brine in the ion-exchanger unit reacts. The regeneration is preferably automatically controlled electronically.
In an embodiment of a floor cleaning machine according to the present invention there is a fresh-water connection, which is connected to the inlet of the ion-exchanger unit, the outlet of the ion-exchanger unit is connected to the fresh-water tank, and the cleaning unit is in turn connected to the fresh-water tank, and is consequently arranged downstream of the latter. In this case, the treatment of the fresh water by the ion-exchanger unit can take place during the filling of the fresh-water tank, the fresh water subsequently being passed from the fresh-water tank directly to the cleaning unit during cleaning operation.

Furthermore, a waste-water tank may be provided in the housing of the floor cleaning machine, the outlet of the ion-exchanger unit being connected to the waste-water tank and a valve being provided, so as to release either the connection between the outlet and the waste-water tank.

The valve makes it possible that, during filling, water which has flowed through the ion-exchanger unit passes into the fresh-water tank. If, however, the regeneration unit is being used to regenerate the ion-exchanger unit, after that, during the flushing of the ion-exchanger unit, the flushing liquid can be passed directly into the waste-water tank. This arrangement consequently makes simple operation of the regeneration unit possible.

Finally, a cleaning agent metering device may be provided in the connection between the fresh-water tank and the cleaning unit for adding cleaning agent to the fresh water. This makes it possible, where necessary, also to add cleaning agent to the softened water.

In the case of an alternative embodiment of a floor cleaning machine according to the invention, the fresh-water tank is connected to the inlet of the ion-exchanger unit, and the outlet of the ion-exchanger unit is connected to the cleaning unit. In the case of this embodiment, during cleaning operation water constantly flows out of the fresh-water tank through the ion-exchanger unit and then to the cleaning unit, so that the ion-exchanger unit is not only in operation during the filling of the fresh-water tank, as was the case with the previous embodiment. Therefore, this arrangement has the advantage that the throughput per unit of time for the ion-exchanger unit is less than in the case of the previous embodiment, in which the softening takes place during the filling of the fresh-water tank.

Furthermore, here, too, a waste-water tank may be provided in the housing, the outlet of the ion-exchanger unit being connected to the waste-water tank. Furthermore, a valve is provided, so as to release either the connection between the outlet and the cleaning unit or the connection between the outlet and the waste-water tank. Consequently, in the case of this embodiment too, on the one hand water can be passed through the ion-exchanger to the cleaning unit or on the other hand, after regeneration, the flushing liquid can be passed directly to the waste-water tank, with the respective flow path depending on the position of the valve.

In a preferred embodiment, a bridging line is provided, connecting the fresh-water tank directly to the cleaning unit, so that fresh water can flow to the cleaning unit without passing through the ion-exchanger unit. This makes it possible that, when a cleaning agent which would damage the ion-exchanger unit is added to the fresh water in the fresh-water tank, the fresh water can flow directly to the cleaning unit. This makes the floor cleaning machine more versatile in the way in which it can be used.

Alternatively or in addition, however, a cleaning agent metering device may also be provided between the outlet of the ion-exchanger unit and the cleaning unit.

Finally, the above object is also achieved by a method for operating a floor cleaning machine, the cleaning unit being supplied with fresh water which has flowed through an ion-exchanger unit. This likewise achieves the effect that the water supplied to the cleaning unit no longer contains any limescale-causing minerals, and is therefore softened. This has the advantages already explained in connection with the floor cleaning machine according to the invention. Alternatively, the fresh water may flow through the ion-exchanger unit before or after the filling of the fresh-water tank. In this case, it is also possible that the ion-exchanger unit is not provided in the floor cleaning machine itself but takes the form of a separate unit through which the fresh water flows during the filling of the fresh-water tank.

The present invention is described below merely on the basis of preferred exemplary embodiments, which are represented in the accompanying drawing, in which:

FIG. 1 is a partially broken-away illustration of a floor cleaning machine according to the invention;

FIG. 2 is a perspective-away representation of the water supply system of the floor cleaning machine from FIG. 1;

FIG. 3 is a schematic representation of the water supply system of the floor cleaning machine from FIG. 1;

FIG. 4 is a schematic representation of a first alternative water supply system for a floor cleaning machine according to the invention;

FIG. 5 is a schematic representation of a second alternative water supply system for a floor cleaning machine according to the invention;

FIG. 6 is a schematic representation of a third alternative water supply system for a floor cleaning machine according to the invention and

FIG. 7 is a schematic representation of a system according to the invention comprising a floor cleaning machine with a separate ion-exchanger unit.

In FIGS. 1 to 3, a first exemplary embodiment of a floor cleaning machine according to the invention is represented. FIG. 3 thereby shows a schematic representation of the water supply system of the floor cleaning machine.

The floor cleaning machine has a housing, on which a carriage with wheels is provided. As a result, it is possible to move the floor cleaning machine over a floor surface to be cleaned, the floor cleaning machine being guided by means of a handle attached to the housing.

Accommodated in the housing is a fresh-water tank, which has a float valve and is connected by way of a line to a cleaning unit attached to the housing. The cleaning unit is in a way known per se rotating brushes, which, with the cleaning unit lowered in the direction of the floor surface to be cleaned, come into contact with the latter. In the case of this preferred exemplary embodiment, connected to the line is a cleaning agent metering device, by way of which a cleaning agent can be mixed into the water flowing from the fresh-water tank to the cleaning unit by means of a cleaning agent pump. Finally, attached in the usual way to the housing is a suction foot, with which water applied to the floor surface can be sucked up by way of the cleaning unit.

As shown in particular by FIG. 2, a fresh-water connection is provided, allowing the fresh-water tank to be filled with water. For this purpose, the fresh-water connect-
tion 19 is connected by way of a valve 21 to the inlet 23 of an ion-exchanger unit 25, the outlet 27 of which is in turn connected by way of a valve 29 to a valve 31. The valve 31 is connected on the one hand to the fresh-water tank 7 and on the other hand to a waste-water tank 33, so that the valve 31 is arranged in such a way that it releases either the connection between the outlet 27 and the fresh-water tank 7 or the connection between the outlet 27 and the waste-water tank 33.

[0035] The ion-exchanger unit 25 serves the purpose of softening the water flowing through or exchanged lime-scale-forming ions contained therein, such as Ca" or Mg", for other ions.

[0036] This may take place by these ions being exchanged for Na+ ions.

[0037] Provided upstream of the ion-exchanger unit 25, between the fresh-water connection 19 and the valve 21, is a further valve 35, from which a bypass line 37 leads to the valve 21 upstream of the inlet 23 of the ion-exchanger unit 25 and a further line 39 leads to the inlet of the regeneration unit 41. Finally, the outlet of the regeneration unit 41 is connected to the valve 21.

[0038] The regeneration unit 41 makes it possible to restore the full capacity of the ion-exchanger unit 25 when the latter no longer adequately exchanges Ca" or Mg" ions for Na+ ions, for example, as a result of being used for a relatively long time. For this purpose, in the preferred exemplary embodiment represented here, the regeneration unit 41 is filled with regenerating salt, which corresponds to a slowly dissolving sodium chloride (NaCl) with only a low degree of purity. In the regeneration unit 41 there is also salt dissolved in water, which is referred to as brine. If the valves 35 and 21 are appropriately switched, sodium chloride solution can flow out of the regeneration unit 41 into the ion-exchanger unit 25. Subsequently, the Ca" or Mg" ions taken up during operation by the material of the ion-exchanger unit 25 are exchanged “back” again for Na+ ions. In a final regeneration step, the solution, which then contains Ca" or Mg" ions, is then flushed out of the ion-exchanger unit 25 and, through a corresponding position of the valve 21, into the waste-water tank 33.

[0039] While the ion-exchanger unit 25 has been described in connection with this exemplary embodiment as being based on the exchange of Ca" or Mg" ions for Na+ ions, the present invention is not, however, restricted to such exchanger units. In the same way, exchanger units in which an exchange of the negatively charged cations, inter alia Ca" or Mg" ions, for H+ ions takes place may be used. In addition, an exchange of the negatively charged anions for OH- ions also takes place. In the latter example, however, the ion-exchanger unit 25 cannot regenerate again in the comparatively simple way described, so that there is no need for the regeneration unit 41.

[0040] The exemplary embodiment of a floor cleaning machine 1 that is represented in FIGS. 1 to 3 can operate in the following way.

[0041] Firstly, the floor cleaning machine 1 is connected by means of the fresh-water connection 19 to a water supply, and the valves 35 and 21 are switched in such a way that the water flows from the fresh-water connection 19 through the bypass line 37 to the inlet 23 of the ion-exchanger unit 25. The water passes through the ion-exchanger unit 25, and is thereby softened by the exchange of the lime-scale-forming Ca" or Mg" ions for Na+ ions. The valve 31 is switched in such a way that the softened water can flow into the fresh-water tank 7. The filling operation is stopped when the float valve 8 closes as the intended upper filling level is reached.

[0042] After the filling of the fresh-water tank 7, the floor cleaning machine 1 can be used for cleaning a floor surface, fresh water being passed from the fresh-water tank 7 by way of the line 9 to the cleaning unit 11. In this case, if necessary, a cleaning agent can be added to the fresh water by way of the cleaning agent metering unit 15. However, on account of the previous softening or the exchange of the lime-scale-causing minerals, the requirement for cleaning agent is greatly reduced, and in many cases it is possible to dispense completely with the addition of cleaning agent.

[0043] During the cleaning operation, the water applied by means of the cleaning unit 11 is sucked up again by way of the suction foot 18 and delivered into the waste-water tank 33.

[0044] After a certain amount of throughflow, which is dependent on the hardness of the tap water supplied, it may be necessary to regenerate the material of the ion-exchanger unit 25, since its capability of exchanging Ca" or Mg" ions subsides. For this purpose, the floor cleaning machine 1 is connected by way of the fresh-water connection 19 to a water supply, and the valves 35 and 21 are switched in such a way that water flows into the regeneration unit 41 and, by way of the outlet of the regeneration unit 41, forces Na+-containing brine into the ion-exchanger unit 25. Subsequently, the brine must remain in the ion-exchanger unit 25 for a certain period of time, namely the regeneration time, during which the Ca" or Mg" ions are exchanged back for Na+ ions.

[0045] Subsequently, the valves 35 and 21 are switched in such a way that water can flow from the fresh-water connection 19 by way of the bypass line 37 directly into the ion-exchanger unit 25 for flushing. Furthermore, the valve 31 is switched in such a way that the flushing water flows on into the waste-water tank 33. After completion of the flushing operation, the floor cleaning machine can then be filled again, in the way already described, and operated.

[0046] FIG. 4 schematically shows the construction of the water supply system of a second exemplary embodiment of a floor cleaning machine according to the invention with a housing 3. In the case of this exemplary embodiment, the fresh-water connection 19 is connected directly to the fresh-water tank 7.

[0047] Between the fresh-water tank 7 and the cleaning unit 11, the already described regeneration unit 41 and ion-exchanger unit 25 are provided, the fresh-water tank 7 being connected by way of the bypass line 37 directly to the inlet 23 of the ion-exchanger unit 25. Finally, the outlet 27 of the ion-exchanger unit 25 is connected by way of the valve 43 to the cleaning unit 11. The valve 43 is also connected to the waste-water tank 33, so that the valve 43 is provided, so as to release either the connection between the outlet 27 and the cleaning unit 11 or the connection between the outlet 27 and the waste-water tank 33.

[0048] Furthermore, this exemplary embodiment also has a bridging line 45, which connects the fresh-water tank 7 directly to the valve 43, and consequently the cleaning unit 11, so that fresh water can flow to the cleaning unit 11 without passing through the ion-exchanger unit 25.

[0049] In the case of this embodiment, during cleaning operation water constantly flows out of the fresh-water tank 7 through the bypass line 37 and ion-exchanger unit 25 and then by way of the appropriately switched valve 43 to the cleaning unit 11, so that the ion-exchanger unit 25 is not only in operation during the filling of the fresh-water tank 7, as was the case with the previous example. Therefore, this arrangement has the advantage that the throughflow per unit of time through the ion-exchanger unit 25 is less here. Nevertheless, here, too, there is the advantage that the water supplied to the cleaning unit 11 is softened, and consequently leads to a better cleaning result.
Furthermore, the bridging line 45 makes it possible that, when a cleaning agent which would damage the ion-exchanger unit 25 is added to the fresh-water tank 7, the fresh water can flow directly to the cleaning unit 11. In this case, although the water supplied to the cleaning unit 11 is not softened, the floor cleaning machine 1 is more versatile in the way in which it can be used.

If, in the case of this exemplary embodiment, the ion-exchanger unit 25 has to be regenerated, the valves 47 and 35 are switched in such a way that fresh water flows out of the fresh-water tank 7 into the regeneration unit 41 and forces brine out of it into the ion-exchanger unit 25. Once the already described exchange process between Ca\(^2\) and Mg\(^2\+) on the one hand and Na\(^+\) on the other hand has taken place, the ion-exchanger unit 25 is flushed by way of the bypass line 37, the flushing water being passed by way of the appropriately switched valve 43 into the waste-water tank 33.

The exemplary embodiment represented in FIG. 5 differs from that represented in FIG. 4 in that no bridging line 45 is provided here, but a cleaning agent metering device 15, by way of which a cleaning agent can be added, if required, to the water which has already passed through the ion-exchanger unit 25. Otherwise, the operation of this exemplary embodiment does not differ from the previous one. However, it should be pointed out at this stage that the exemplary embodiments according to FIGS. 4 and 5 can also be combined with one another, so that both a bridging line 45 and a cleaning agent metering device 15 are provided.

The exemplary embodiment represented in FIG. 6 differs from that described in conjunction with FIG. 4 in that no regeneration unit is provided here, but the ion-exchanger unit 25 must be exchanged when its ion exchanging capability has decreased too much, and therefore the unit is depleted. Furthermore, there, too, during operation the water is passed from the fresh-water tank 7 to the ion-exchanger unit 25 to the cleaning unit 11, and is thereby softened, and it is also the case with this exemplary embodiment that a bridging line 45 is provided, making it possible to bypass the ion-exchanger unit 25 if a cleaning agent has been added to the water in the fresh-water tank 7.

Finally, FIG. 7 shows an exemplary embodiment in which the ion-exchanger unit 25\(^n\) is not arranged within the housing 3 of the floor cleaning machine 1, but is provided as an external device. Here, the ion-exchanger unit 25\(^n\) is flowed through when the fresh-water tank 7 in the floor cleaning machine is being filled, so that the mode of operation corresponds substantially to that described in conjunction with the exemplary embodiment according to FIGS. 1 to 3.

In the case of the previously described exemplary embodiments of a floor cleaning machine according to the invention, the cleaning unit is respectively supplied with fresh water which has previously flowed through an ion-exchanger unit. As a result, the supplied water that is used for the floor cleaning no longer contains scarcely any lime-scaling minerals, and is therefore softened. Therefore, the requirement for cleaning agent can be significantly reduced, so that a considerably reduced concentration of cleaning agent in the water is adequate to ensure a satisfactory cleaning result. This effect may go so far that it is possible to dispense completely with the adding of cleaning agent to the water.

1. A floor cleaning machine comprising:
   - a wheeled carriage for moving the machine over a floor surface to be cleaned;
   - a housing mounted to said carriage;
   - a fresh-water tank in the housing;
   - a cleaning unit mounted to the housing for contacting a floor, said cleaning unit being connected to and receiving water from said fresh-water tank; and
   - an ion-exchanger carried by said carriage and connected to said fresh-water tank, said ion-exchanger passing fresh water from an inlet to said fresh-water tank for use in cleaning said floor surface.

2. The floor cleaning machine according to claim 1, further including a regeneration unit wherein said inlet of said ion-exchanger unit may be selectively connected to said regeneration unit and further including a bypass line through which water can flow directly to said inlet of said ion-exchanger unit without flowing through said regeneration unit.

3. The floor cleaning machine of claim 2 further comprising a fresh water connection which is connected to the inlet of the ion-exchanger unit, the outlet of said ion-exchanger unit connected to the fresh-water tank and said cleaning unit is connected to the fresh-water tank.

4. The floor cleaning machine of claim 3 further comprising a waste-water tank within said housing wherein said ion-exchanger unit may be connected to the waste-water tank and further including a valve for coupling the output of said ion-exchanger unit to the inlet of said fresh water tank or to said waste water tank.

5. The floor cleaning machine of claim 3 further including a cleaning agent metering device connected into a line between the fresh-water tank and the cleaning unit for metering cleaning agent to the fresh water fed to the cleaning unit.

6. The floor cleaning machine according to claim 1 characterized in that said fresh-water tank is connected to an inlet of the ion-exchanger unit and the outlet of the fresh water tank ion-exchanger unit is connected to the cleaning unit for delivering de-ionized water.

7. The floor cleaning machine according to claim 6 further comprising a waste-water tank in the housing, the outlet of the ion-exchanger unit being connected to the waste-water tank, and further including a valve for coupling either the connection between said outlet of said ion-exchanger unit and said fresh water tank, or the connection between said outlet of said ion-exchanger and the waste-water tank.

8. The floor cleaning machine of claim 6 further comprising a bridging line connecting the fresh-water tank directly to the cleaning unit, whereby fresh water may flow directly to said cleaning unit without passing through said ion-exchanger unit.

9. A method of operating a floor cleaning machine including:
   - a housing, a carriage, and a cleaning unit, comprising:
     - flowing the fresh water through a first valve to de-ionizing unit and thence de-ionizing unit to a fresh water storage tank;
     - passing the de-ionized water from the fresh water storage tank and mixing the de-ionized water with a cleaning solution;
     - then, passing the mixed de-ionized water and cleaning solution to the cleaning unit and thence to the floor to be cleaned while brushing the floor with the cleaning unit.

* * * * *