SYSTEM FOR CLEANING AND HYGIENIZING A FINNED-PACK HEAT EXCHANGER

Abstract: A system for cleaning and hygienizing a tinned-pack heat exchanger (2) of an air conditioning system. The system (6) has at least one tank (7; 47, 48) for storing a hygienizing and/or cleaning substance, a number of nebulizing units (8; 49, 50) positioned facing the heat exchanger (2) to nebulize the substance and distribute it evenly over the heat exchanger (2), a feed device (9) for drawing the substance from the tank (7; 47, 48) and feeding it to the nebulizing units (8; 49, 50), a coupling device (12) for retaining the tank (7; 47, 48) releasably in an operating position in which the tank (7; 47, 48) is controlled with an inlet (13) of the feed device (9); a measuring device (14) for determining a level of the substance in the tank (7; 47, 48); and a control unit (16) configured to control the feed device (9) on the basis of signals from the measuring device (14).
SYSTEM FOR CLEANING AND HYGIENIZING A FINNED-PACK HEAT EXCHANGER

TECHNICAL FIELD

The present invention relates to a system for cleaning and hygienizing a finned-pack heat exchanger.

BACKGROUND ART

The present invention may be used to advantage, though not exclusively, for cleaning and hygienizing the finned-pack heat exchanger of an internal or external unit of a building air conditioning system, to which the following description refers purely by way of example.

A residential or industrial building air conditioning system normally comprises one or more internal units, each installed in a room of the building and having a respective heat exchanger for absorbing heat from the air in the room, and an external unit which comprises a cooling machine for cooling and circulating a cooling fluid, e.g. a substantially water-based cooling liquid (industrial systems) or a cooling gas (residential systems), along a service circuit connecting the internal units to the cooling machine. The heat exchanger of both the internal units and external unit comprises a finned-pack exchanger, which substantially comprises a finned pack fitted through with a coil in which the cooling fluid circulates. The fin surfaces of the finned pack as a whole form the heat exchange surface of the exchanger. Each internal or
external unit comprises a ventilator for forcing air through the finned pack of the heat exchanger.

Forced air circulation through the heat exchanger causes dust to deposit on and between the fins of the pack, and the heat exchange process produces condensation on the fins. Because dust and condensation create an ideal environment for impurities such as mould and bacteria, which are subsequently spread by the airflow through the fins into the environment serviced by the internal unit, periodic cleaning of the exchanger is required to avoid impairing performance of the exchanger and contaminating the room air. The finned-pack heat exchanger is normally cleaned manually once a year by a service technician, who opens the cowling of the internal or external unit to access the exchanger, and sprays special substances on the finned pack.

Impurities which deposit in the finned pack comprise mould and bacteria. Yearly cleaning is not enough to remove mould and bacteria which deposit on the finned pack and which, if left even for only a few days, can cause respiratory diseases. On the other hand, more frequent, e.g. monthly, manual cleaning to sanitize the heat exchangers is extremely expensive.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a system for cleaning and hygienizing a finned-pack heat exchanger of a domestic or industrial air conditioning system, and which can be installed easily on the heat
exchanger and, at the same time, is cheap and easy to produce.

According to the present invention, there are provided a system and method for cleaning and hygienizing a finned-pack heat exchanger of an air conditioning system, as claimed in the accompanying Claims.

**BRIEF DESCRIPTION OF THE DRAWINGS**

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a schematic of a system in accordance with the teachings of the present invention, for hygienizing a finned-pack heat exchanger of an internal unit of an air conditioning system;

Figure 2 shows a view in perspective of the layout of part of the Figure 1 system with respect to the heat exchanger;

Figure 3 shows a side view of the layout of part of the Figure 1 system with respect to the heat exchanger;

Figure 4 shows a side view of the layout, with respect to the heat exchanger, of part of a finned-pack heat exchanger hygienizing system in accordance with a further embodiment of the invention;

Figure 5 shows a schematic of a finned-pack heat exchanger hygienizing system in accordance with a further embodiment of the invention;

Figures 6 and 7 show an internal unit with (Figure
and without (Figure 7) the cowling, and fitted with a finned-pack heat exchanger hygienizing system in accordance with a further embodiment of the invention;

Figures 8 and 9 show another type of internal unit with (Figure 8) and without (Figure 9) the cowling, and fitted with a finned-pack heat exchanger hygienizing system in accordance with a further embodiment of the invention;

Figure 10 shows a side view of the layout of part of the Figure 8 and 9 system with respect to the heat exchanger.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates an internal unit of a known building air conditioning system (not shown). Internal unit 1 comprises at least one heat exchanger 2 in the form of a finned-pack heat exchanger, i.e. comprising a finned pack 3 fitted through with a coil 4 in which circulates cooling fluid from a cooling machine (not shown), i.e. a moto-condensing unit, of the air conditioning system. The fin surfaces of finned pack 3 as a whole define the heat exchange surface of heat exchanger 2. Internal unit 1 comprises, among other things, a ventilator (not shown) for forcing air through finned pack 3 and a control unit 5 for controlling operation of internal unit 1, e.g. for powering the ventilator electrically and controlling its rotation speed as commanded by the user.

Number 6 in Figure 1 indicates the system,
according to the invention, for hygienizing heat exchanger 2.

With reference to Figure 1, system 6 comprises at least one tank 7 for storing a liquid hygienizing substance and at least one nebulizer unit 8 for nebulizing the hygienizing substance, and which is positioned facing heat exchanger 2 to distribute the nebulized substance over the entire heat exchange surface of heat exchanger 2. System 6 advantageously comprises a plurality of - in the Figure 1 example, four - nebulizer units 8 to distribute the nebulized substance more evenly over the heat exchange surface of heat exchanger 2. Herein, the term nebulization of a liquid substance is intended to mean producing a large number of liquid-phase microdroplets of the substance.

System 6 also comprises a feed device 9 for drawing the substance from tank 7 and feeding it to nebulizer units 8 and a fast-fit, fast-release coupling device 12 interposed between tank 7 and a substance inlet 13 of feed device 9 to move tank 7 to and from a normal operating position in which tank 7 is coupled structurally and hydraulically with inlet 13 of feed device 9.

More specifically, feed device 9 comprises a pump 10, which has an inlet coinciding with inlet 13 to draw the substance directly from tank 7 through inlet 13, and a distribution circuit 11 connecting an outlet 10a of pump 10 to nebulizer units 8. Pump 10, which is known
and not described in detail, draws the substance from tank 7 and feeds it to distribution circuit 11, by which the substance is distributed to nebulizer units 8. Feed device 9 comprises a draw pipe 13a connected to inlet 13 and extending down to the bottom 7a of tank 7, when this is in the operating position, so pump 10 can draw substantially all the substance from tank 7.

System 6 also comprises a level sensor 14 for detecting run-out of the substance in tank 7, a release sensor 15 for detecting release of tank 7 from the operating position, and a electronic control unit 16 for controlling feed device 9, in particular pump 10, on the basis of the signals from sensors 14 and 15, and parameters programmable on control unit 16. It should be pointed out that level sensor 14 is in fact a particular embodiment of a device for measuring the quantity of liquid in a tank. Distribution circuit 11 is fork-structured, i.e. branches off repeatedly to terminate in a number of conduits 11a, each connected to a respective nebulizer unit 8.

Each nebulizer unit 8 comprises a nozzle 17. And each nozzle 17 has a knife jet with a spread angle sized according to the size of heat exchanger 2 and the number of nebulizer units 8, i.e. the number of nozzles 17. Each nozzle 17 has an outlet 18 (Figure 3) with a cross section smaller than that of distribution circuit 11, so as to increase the pressure of the incoming substance from distribution circuit 11 and nebulize the substance
issuing from nozzle 17. In other words, nebulizer unit 8 nebulizes the substance pneumatically. Nozzle 17 is a known type and therefore not described in detail.

Figure 2 shows a view in perspective of an 'example layout of nebulizer units 8 with respect to heat exchanger 2. More specifically, Figure 2 shows nebulizer units 8, distribution circuit 11, and a casing 19 enclosing the other component parts (not shown in Figure 2) of system 6, such as pump 10, tank 7, control unit 16, sensors 14 and 15, and coupling device 12. Nebulizer units 8 are positioned facing, and all at the same distance from, a major face 21 of heat exchanger 2. Heat exchanger 2 being substantially in the form of a rectangular parallelepiped, i.e. a parallelepiped with rectangular faces, here and hereinafter the term major face is intended to mean one of the two larger faces of heat exchanger 2. More specifically, nebulizer units 8 are positioned facing, and all at the same distance from, a longitudinal portion 20 of a major face 21 of heat exchanger 2. In the Figure 2 example layout, heat exchanger 2 is mounted in a vertically tilted position and the longitudinal portion 20 is defined along a top longitudinal edge of heat exchanger 2. Nozzles 17 of nebulizer units 8 are aimed towards major face 21 to spray the nebulized substance downwards onto major face 21.

Internal unit 1 normally comprises a cowling (not shown for the sake of simplicity) which covers heat
exchanger 2 and the other parts of internal unit 1, and which has a slitted portion at heat exchanger 2. System 6 can be installed easily inside internal unit 1, with nebulizer units 8 positioned between the cowling and heat exchanger 2. The distance between nebulizer units 8 and heat exchanger 2 substantially depends on the space available between heat exchanger 2 and the cowling, and on the type of nozzle 17.

Figure 3 shows a side view of the Figure 2 example layout of nebulizer units 8 with respect to heat exchanger 2. Nebulizer units 8 are located at a distance D from longitudinal portion 20. Nozzle 17 of each nebulizer unit 8 has a delivery axis 22. Heat exchanger 2 in Figures 2 and 3 extends parallel to a plane 23 tilted with respect to a vertical plane 24. Each nozzle 17 is positioned with outlet 18 facing major face 21 of heat exchanger 2 and at distance D from longitudinal portion 20. Distance D is advantageously less than 2 cm. Furthermore, the delivery axis 22 of nozzle 17 intersects plane 23 obliquely at an angle 25, which depends on the type of nozzle 17 and in particular on the spread angle of the jet of nozzle 17. The nebulized substance is thus sprayed evenly onto face 21 and therefore over the entire heat exchange surface of heat exchanger 2. Angle 25 ranges between 10° and 60°, and advantageously between 15° and 30°.

In a further embodiment, not shown, of the invention, instead of nozzle 17, each nebulizer unit 8
comprises a piezoelectric transducer for ultrasonic nebulization of the substance.

Internal unit 1 normally comprises a condensation tray underneath heat exchanger 2. In a further embodiment, not shown, of the invention, system 6 comprises a further nebulizer unit 8 positioned to sanitize the tray by spraying it with the nebulized substance.

With reference again to Figure 1, coupling device 12 is designed to hold tank 7 releasably in the operating position in which the tank 7 is coupled with inlet 13 of feed device 9. In other words, coupling device 12 permits fast release of tank 7 from the operating position, e.g. when tank 7 is empty, and the coupling device 12 comprises a member 12a integral with inlet 13 of feed device 9 and a member 12b integral with tank 7 and couplable to member 12a, e.g. by a quarter-turn torque. In the Figure 1 example, member 12a comprises an internally threaded cylindrical mouth, and member 12b is cylindrical and threaded externally to screw in a quarter turn into the cylindrical mouth of member 12a.

Release sensor 15 is located inside coupling device 12, e.g. fitted to member 12a integral with pump 10, and comprises, for example, a normally-open electric contact which closes when tank 7 is in the operating position, and opens when tank 7 is released from the operating position. Level sensor 14 comprises a conduction level
sensor, i.e. employing the conductivity of the substance in tank 7, and is positioned a given height H off the bottom 7a of tank 7 when this is in the operating position. Height H in fact defines the lowest level below which level sensor 14 indicates run-out of the substance in tank 7. More specifically, level sensor 14 is fitted to the bottom end of a rod 26, which is integral with member 12a of coupling device 12 and extends towards the bottom 7a of tank 7 when this is in the operating position.

In a further embodiment, not shown, of the invention, level sensor 14 is defined by a float sensor.

Control unit 16 is connectable electrically to control unit 5 of internal unit 1 to receive electric power and a turn-on signal directly from control unit 5. In other words, when the user turns internal unit 1 on, control unit 16 and system 6 are turned on automatically. That means system 6 is only turned on when internal unit 1 is turned on.

Control unit 16 advantageously comprises a remote turn-on module 27, so the user can turn system 6 on and off by remote control, independently of the operating state (on/off) of internal unit 1.

In a further embodiment, not shown, of the invention, system 6 comprises an electric battery for electrically powering and activating control unit 16 and feed device 9 independently of control unit 5. This embodiment is particularly suitable for domestic
Control unit 16 comprises a commercial microcontroller 28 programmed to control feed device 9, i.e. pump 10, on the basis of signals from release sensor 15 and level sensor 14, and on the basis of user-programmable parameters. Control unit 16 comprises miniswitches 29 for hardware-programming the programmable parameters. Furthermore, control unit 16 comprises an indicator light 30, defined by a LED, for indicating run-out of the substance in tank 7.

In a further embodiment, not shown, of the invention, instead of microcontroller 28, control unit 16 comprises an electronic printed-circuit board configured to control feed device 9 on the basis of signals from sensors 14 and 15 and on the basis of user-programmable parameters. In this case, miniswitches 29 are mounted directly on the electronic board.

In a further embodiment, not shown, of the invention, control unit 16 has no miniswitches 29, and comprises a keyboard for user software programming the programmable parameters. In actual use, the desired parameter values are entered by the user on the keyboard, and are stored in an internal non-volatile memory of control unit 16.

The programmable parameters comprise a substance delivery period TPS, i.e. the time lapse between consecutive deliveries, and a substance delivery
duration TS for each delivery. For example, delivery-period TPS can be programmed within a range of 1 and 48 hours, may advantageously be selected from a set of values comprising 1, 12, 24, 36 and 48 hours, or may be established on a calendar basis, e.g. when internal unit 1 is turned on or off. For example, system 6 may be programmed to turn on at night, when the environment catered to by internal unit 1 is unoccupied. Delivery duration TS determines the amount of substance dispensed at each single delivery, which depends on the size of heat exchanger 2 and the type of environment catered to by internal unit 1. Taking into account all these factors, delivery duration TS can be programmed within a range of 1 and 200 seconds.

According to another aspect of the invention, control unit 16 is designed or programmed to operate system 6 as follows.

Turn-on of internal unit 1 automatically turns on system 6. Once system 6 is turned on, control unit 16 turns on feed device 9, i.e. pump 10, periodically according to the set delivery period TPS, and for a time equal to the set delivery duration TS, so as to repeatedly dispense a given amount of hygienizing substance, which flows along distribution circuit 11 to nebulizer units 8, where it is sprayed onto the fins of heat exchanger 2.

Control unit 16 continually monitors the signals from sensors 14 and 15. When the substance in tank 7
runs out, i.e. falls below minimum level, level sensor 14 signals this to control unit 16, which accordingly turns on indicator light 30 to tell the user that tank 7 is empty and controls pump 10 so that to inhibit substance delivery to prevent the pump from suffering damage by operating dry. To replace the empty tank 7 with a full one, tank 7 must be released temporarily from the operating position. Release sensor 15 signals release of tank 7 to control unit 16, which restores periodic delivery of the substance accordingly, i.e. after the empty tank 7 has been released and a full one has been put again in the operating position.

In a further embodiment of the invention shown in Figure 4, in which corresponding parts are indicated using the same reference numbers and abbreviations as in Figure 3, longitudinal portion 20 is defined along a bottom longitudinal edge of heat exchanger 2 and nozzles 17 of nebulizer units 8 are positioned facing major face 21 to spray the nebulized substance upwards onto major face 21.

In a further embodiment of the invention shown in Figure 5, in which corresponding parts are indicated using the same reference numbers as in Figure 1, inlet 13 coincides with the inlet of distribution circuit 11 and is connected directly to draw pipe 13a and, instead of pump 10 in Figure 1, feed device 9 comprises a compressor 31 for compressing air into tank 7 to force the substance out of tank 7 along draw pipe 13a, and
along distribution circuit 11 to nebulizer units 8. More specifically, feed device 9 comprises a further conduit 32, one end of which is positioned inside tank 7 when this is in the operating position, and the other end of which is connected to an outlet 31a of compressor 31. Compressor 31 injects a compressed-air component which is added to the nebulized substance to improve distribution of the substance over the entire heat exchange surface of heat exchanger 2. Each nebulizer unit 8 is of the type comprising nozzle 17. Control unit 16 is designed to control feed device 9, i.e. compressor 31, on the basis of signals from sensors 14 and 15, and on the basis of programmable parameters.

Figures 6 and 7, in which corresponding parts are indicated using the same reference numbers and abbreviations as in Figures 1 and 2, show an internal unit 1 defined by a split unit for a domestic air conditioning system, and fitted with the system 6 in accordance with a further embodiment of the invention.

With reference to Figures 6 and 7, internal unit 1 comprises a number of heat exchangers 2a, 2b (Figure 7) and a cowling 33 (Figure 6) which covers heat exchangers 2a, 2b, and has a top wall 34 with slits 35 (Figure 6) through which to draw ambient air for cooling. Figure 7, in which part of cowling 33 is removed, shows three heat exchangers, two of which, indicated 2a, are mounted in a tilted position with respect to the vertical and higher than the others (only one shown and indicated 2b).
System 6 comprises two nebulizer units 8 (Figure 7) located between heat exchangers 2a, 2b and cowling 33. Each nebulizer unit 8 comprises a microhole tube 36 of flexible material (Figure 7), which extends along the longitudinal portion 20 of major face 21 of a respective heat exchanger 2a, and a number of fasteners 37 (Figure 7) for fixing tube 36 to heat exchanger 2a. Fasteners 37 each comprise a U-shaped clip, which fits between the fins of finned pack 3 to secure tube 36 to coil 4 of heat exchanger 2a, and provide for installing nebulizer units 8 permanently to heat exchangers 2a.

Each tube 36 is closed at one end and connected at the other end to distribution circuit 11, and comprises a number of substance outlet holes (not shown in Figures 6 and 7) spaced along tube 36 and shaped so that to nebulize the substance. Each hole in tube 36 is truncated-cone-shaped, and increases in diameter from its inlet to its outlet, i.e. outwards of tube 36. The ratio between the inlet and outlet diameters of each hole and the ratio between the inlet diameter of each hole and the inside diameter of tube 36 are such that the substance is nebulized as it is forced through the holes by feed device 9. More specifically, the diameter of tube 36 is roughly ten times the inlet diameter of the holes. Moreover, the outlet diameter of the holes is roughly twice the inlet diameter. Advantageously, tube 36 has an inside diameter of 2 mm, and the holes have an inlet diameter of 0.2 mm and an outlet diameter of 0.35
mm. Tubes 36 are positioned with the holes facing downwards, i.e. to spray the nebulized substance onto major faces 21 of heat exchangers 2a. The spacing of the holes along tube 36 is selected in the range of values comprised between 5 and 12 mm.

In system 6 in Figures 6 and 7, feed device 9 comprises a compressor (not shown) connected to tank 7 and which operates in the same way as compressor 31 in the Figure 5 embodiment. Tank 7 is a sealed disposable type, so system 6 has no level sensor 14, control unit 16 employs a liquid quantity measuring device which determines run-out of the substance in tank 7 by counting the number of seconds the substance is dispensed, and control unit 16 controls feed device 9 on the basis of signals from the measuring device. The system has no release sensor 15. A casing 38, fittable to internal unit 1, encloses the compressor and control unit 16, and is fixed to the outside of a lateral wall 39 (Figure 6) of cowling 33 for easy access by the user.

Tank 7 comprises a cup-shaped body 40, and an outward-facing rib 41 surrounding cup-shaped body 40. Casing 38 comprises a circular seat 42 for receiving tank 7 in the operating position and two diametrically opposite L-shaped elastic retainers 43 (only one shown in Figures 6 and 7) which project from seat 42 to releasably retain rib 41. In other words, rib 41 and retainers 43 form a coupling device for retaining, in a releasably manner in a direction R, tank 7 in the operating position in which
the tank 7 is coupled structurally and hydraulically with feed device 9. Tank 7 is therefore outside casing 38.

It should be pointed out that fasteners 37 can also be used to fix nebulizer units 8 to heat exchanger 2 in the Figure 1 and 2 embodiment, and more specifically to secure conduits 11a (Figure 1) to coil 4 of heat exchanger 2.

System 6 may obviously also be used to nebulize other substances for various purposes, such as a detergent, a deodorant or substance comprising more components, for example an hygienizing and cleaning substance, or a hygienizing and deodorizing substance, or even a hygienizing, cleaning and deodorizing substance. Depending on the type of substance in tank 7, system 6 provides for hygienizing, cleaning, or deodorizing the heat exchange surface of heat exchanger 2 or provides for hygienizing and deodorizing, or hygienizing and cleaning, or cleaning and hygienizing and deodorizing the heat exchange surface of heat exchanger 2. A system 6 employing a detergent, for example, is particularly suitable for cleaning the heat exchanger of an air conditioning system external unit, the heat exchanger finned pack of which rapidly builds up large quantities of dirt, on account of the external unit normally operating outside buildings, and being equipped with a powerful forced-ventilation system.

Figures 8 to 10, in which corresponding parts are
indicated using the same reference numbers and abbreviations as in Figures 1 and 2, show an industrial air conditioning system internal unit 1 fitted with the system 6 in accordance with a further embodiment of the invention.

With reference to Figures 8 and 9, internal unit 1 comprises a cowling 44 (Figure 8), which covers a vertical heat exchanger 2 (Figure 9) and has two stacks 45 and 46 (Figure 8) for respectively drawing in air for cooling, and blowing the cooled air out into the environment for cooling. System 6 is duplicated to nebulize a liquid cleaning substance and a liquid hygienizing substance separately. More specifically, the system comprises two tanks 47 and 48 (Figure 9) for a liquid cleaning substance and a liquid hygienizing substance respectively, first nebulizer units 49 for nebulizing the cleaning substance, second nebulizer units 50 for nebulizing the hygienizing substance and a feed system for drawing the substances from tanks 47 and 48 and feeding them to respective nebulizing units 49 and 50. The feed system comprises two distribution circuits 51 and 52 connecting respective tanks 47 and 48 to respective nebulizer units 49 and 50 and at least one compressor (not shown) for compressing air into tanks 47 and 48 to force the respective substances out into respective distribution circuits 51 and 52, and which therefore operates in the same way as compressor 31 in Figure 5.
With reference to Figures 9 and 10, distribution circuit 51 comprises two conduits 51a and 51b, each extending along at least the longitudinal portion 20 of a respective major face 21 of heat exchanger 2. Nebulizer units 49 are arranged along conduits 51a, 51b. Nebulizer units 49 are positioned to spray the nebulized cleaning substance downwards onto major face 21, so that it is distributed evenly over major face 21. This way, the cleaning substance, as it runs down along major face 21, cleans all the dirt off the major face 21 and is collected in a known condensation tray (not shown) underneath heat exchanger 2. Particularly, nebulizer units 49 comprise respective nozzles similar to and arranged in the same way as nozzles 17 in Figure 2. The delivery axis 49a of each nebulizer unit 49, i.e. of the respective nozzle, advantageously forms an angle ranging substantially between 30° and 15° with plane 23 (Figure 10). Distribution circuit 52 comprises a conduit 52a positioned, by means of a supporting frame 53, facing a major face 21 in a plane parallel to plane 23. Nebulizer units 50 are arranged along conduit 52a. Nebulizer units 50 comprise respective cone-shaped-jet nozzles located the same distance D from major face 21. The distance D is comprised between 20 and 40 cm. Nebulizer units 50 are positioned to spray the nebulized hygienizing substance onto major face 21 in a direction substantially perpendicular to plane 23, i.e. the delivery axis 50a of respective nozzle is substantially perpendicular to
plane 23. This way the hygienizing substance penetrates deeper into the finned pack of heat exchanger 2.

In system 6 in Figures 8 to 10 has, furthermore, the following features. Tanks 47 and 48 are sealed. So, system 6 comprises two litre meters (not shown), each located at the inlet of a respective distribution circuit 51, 52 to detect run-out of the substance in respective tank 47, 48. The litre meters employed operate on the basis of substance flow from respective tanks 47 and 48. System 6 optionally comprises two release sensors 15, one for each tank 47, 48. A casing 54, outside cowling 44, houses the compressor, tanks 47, 48, control unit 16, the litre meters, and release sensors 15 (if any). Two clip coupling devices hold tanks 47, 48 releasably in respective operating positions in which tanks 47 and 48 are ed structurally and hydraulically with the feed system inlets, i.e. to the inlets of distribution circuits 51 and 52.

System 6 in Figures 8 to 10 provides for more effectively cleaning and hygienizing heat exchanger 2. That is, spraying the cleaning substance downwards onto major face 21 of heat exchanger 2 at a small angle with respect to plane 23 provides for more effectively removing dirt and flushing it into condensation tray On the contrary, spraying the hygienizing substance perpendicular to major face 21 provides for deep-down penetration of finned pack 3 of heat exchanger 2, thus for a more effectively hygienization of the heat
exchanger 2.
CLAIMS

1) A system for cleaning and hygienizing a finned-pack heat exchanger (2; 2a, 2b) of an air conditioning system, the system (6) comprising: at least one tank (7; 47, 48) for storing at least one hygienizing and/or cleaning substance; nebulizing means (8; 49, 50) for nebulizing the substance and positioned facing the heat exchanger (2; 2a, 2b) so that to distribute the nebulized substance over the entire heat exchange surface of the heat exchanger (2; 2a, 2b); feed means (9) for drawing the substance from the tank (7; 47, 48) and feeding it to the nebulizing means (8; 49, 50); coupling means (12; 41, 43) for retaining said tank (7; 47, 48) releasably in a respective operating position in which the tank is coupled structurally and hydraulically with a respective inlet (13) of the feed means (9); substance quantity measuring means (14) for determining run-out of the substance in the tank (7; 47, 48); and electronic control means (16) configured to control the feed means (9) on the basis of signals from the substance quantity measuring means (14) and on the basis of programmable parameters programmable on the electronic control means (16).

2) A system according to Claim 1, and comprising sensor means (15) for detecting release of the tank (7) from said operating position; said electronic control means (16) being configured to control said feed means
on the basis of signals from the sensor means (15).  

3) A system according to Claim 1 or 2, wherein said nebulizing means (8; 49) are arranged facing a major face (21) of said heat exchanger (2; 2a, 2b), along a longitudinal portion (20) of the major face (21) and at a given distance (D) from the longitudinal portion (20), so as to spray the nebulized substance onto the major face (21).  

4) A system according to Claim 3, wherein said heat exchanger (2; 2a, 2b) extends parallel to a plane (23); said nebulizing means (8; 49) comprising a number of nozzles (17) arranged along said longitudinal portion (20), with their respective outlets (18) facing said major face (21) and with their respective delivery axes (22; 49a) sloping with respect to said plane (23).  

5) A system according to Claim 3, wherein said nebulizing means (8) comprise at least one microhole tube (36) extending along said longitudinal portion (20) and having a number of substance outlet holes, which are spaced along the tube (36), are shaped to nebulize the substance and are arranged to spray the nebulized substance onto said major face (21).  

6) A system according to any one of Claims 1 to 5, wherein said feed means (9) comprise at least one distribution circuit (11; 51, 52) connecting said inlet (13) to said nebulizing means (8; 49, 50); and a compressor (31) for compressing air into said tank (7; 47, 48) so that to force said substance out of the tank.
(7; 47, 48) and through said inlet (13) into said distribution circuit (11; 51, 52).

7) A system according to any one of Claims 1 to 6, and comprising fastening means (37) for securing said nebulizing means (8) permanently to said heat exchanger (2, 2a).

8) A system according to any one of Claims 1 to 7, wherein said heat exchanger (2) forms part of a unit (1) of said air conditioning system; the system comprising a casing (38) fittable to said unit (1); said coupling means (41, 43) comprising a rib (41) integral with said tank (7) and retaining means (43) integral with said casing (38) for releasably retaining said rib (41).

9) A system according to any one of Claims 1 to 5, and comprising a first and second tank (47, 48) for storing a cleaning substance and a hygienizing substance respectively; said nebulizing means comprising first and second nebulizing means (49, 50) for nebulizing the cleaning substance and the hygienizing substance separately; said feed means (9) comprising a first and second inlet for the cleaning substance and the hygienizing substance respectively, a first and second distribution circuit (51, 52) respectively connecting the first inlet to the first nebulizing means (49) and the second inlet to the second nebulizing means (50), and at least one compressor for compressing air into the tanks (47, 48) to force the substances out of the tanks.
and through said first and second inlet into the respective distribution circuits (51, 52).

10) A system according to any one of Claims 1 to 9, wherein said "substance quantity measuring means (14) comprise at least one litre meter arranged at the inlet (13) of said feed means (9).

11) A system according to any one of Claims 1 to 10, wherein said substance quantity measuring means (14) are implemented by said electronic control means (16).

12) A system according to any one of Claims 1 to 11, wherein said programmable parameters comprise a substance delivery period (TPS), and a substance delivery duration (TS) for each periodically repeated delivery.

13) A method of cleaning and hygienizing a finned-pack heat exchanger (2; 2a, 2b) of an air conditioning system, the method comprising the steps of:

- storing a cleaning and/or hygienizing substance in at least one tank (7; 47, 48);

- coupling the tank (7; 47, 48) to substance feed means (9), so as to releasably retain the tank (7; 47, 48) in a respective operating position in which the tank is coupled structurally and hydraulically with said feed means (9);

- drawing from the tank (7; 47, 48) and delivering a given quantity of the substance by means of said feed means (9);

- nebulizing the delivered substance by means of
nebulizing means (8; 49, 50) positioned facing the heat exchanger (2; 2a, 2b); and
- detecting run-out of the substance in the tank (7; 47, 48) by means of substance quantity measuring means (14).  

14) A method according to Claim 13, and also comprising:
- inhibiting substance delivery when the substance in the tank (7; 47, 48) runs out;
- detecting the release event of the tank (7; 47, 48) from said operating position, by means of release sensor means (15); and
- restoring substance delivery as a function of release event of the tank (7; 47, 48).

15) A method according to Claim 13 or 14, wherein said quantity of the substance is delivered periodically according to a given delivery period (TPS); and the delivery time of each periodically repeated delivery equals a given delivery duration (TS).
INTERNATIONAL SEARCH REPORT

PCT/IB2010/000915

A. CLASSIFICATION OF SUBJECT MATTER

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Category</th>
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Further documents are listed in the continuation of Box C

See patent summary annex

Date of the actual completion of the international search

24 August 2010

Date of mailing of the international search report

06/09/2010

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Mootz, Frank
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