



OIL MANAGEMENT SYSTEM FOR MULTIPLE CONDENSERS

5 FIELD OF THE INVENTION

This invention relates to an oil management system for an air conditioning system consisting of a plurality of outdoor and indoor units.

10 DESCRIPTION OF THE BACKGROUND ART

The compressor of an air conditioner is charged with lubricating oil. As some of the oil may be carried out of the compressor into the refrigerating system by the refrigerant
15 when the system is operating, the level of oil in the compressor will decrease with time. This will over time adversely affect the working reliability of the compressor, as the decrease in oil level will have an adverse effect on the internal moving parts.

20 Presently, in a single compressor for a single outdoor unit system, oil separators have been used to retain the oil discharged from the compressor and to return the same to the compressor. But when there are multiple compressors in a refrigeration cycle or where there are multiple outdoor units in a refrigeration cycle, the oil levels may differ from one compressor to another with some compressors operating with below optimum levels
25 of oil.

One approach for resolving a multiple compressor system was to use low-pressure type compressors. The pressure in the compressor shell is same as its suction pressure.
30 The oil sumps of all the compressors are connected to each other with balancing pipes. However, this method becomes complicated when there are multiple outdoor units in the refrigeration cycle. For example, the method described in Japanese patent Published patent application 2001-201200 connects the shells of the compressors with oil balancing pipes connected to the outdoor units. [A 4-way valve of at least one of the
35 outdoor units is set to a heating mode while others are set to a cooling mode, runs the outdoor unit in heating mode and stops the other outdoor units.] Therefore, the discharged gas from the compressor of the outdoor unit in heating mode is directed into



the casing of the compressors of the outdoor unit in the cooling mode through the gas-connecting pipe among the outdoor units. This pressurizes the casing of the compressor of the outdoor unit that is in a cooling mode and purge oil into the casing of the compressor of the outdoor unit that is in a heating mode through a oil balancing pipe
5 that joins the outdoor units.

Although this approach is an improvement over the previous art, it is necessary to stop the operation as this oil balancing process is required to be under a special mode that interrupts the actual operating mode (cooling or heating). Moreover, the
10 compressors that apply this oil balancing process must be of low-pressure shell type.

SUMMARY OF THE INVENTION

15 The present invention relates to an air-conditioning system that consists of multiple outdoor units (1), multiple indoor units, liquid connecting pipeline (20), gas connecting pipeline (21), a oil-balancing pipeline (22) and an electric system to control solenoid valves. The outdoor unit (1) includes multiple compressors (2), 4-way valve (5),
20 outdoor heat-exchanger (8), oil-separator (4) that is connected to the discharge pipe of the compressors, oil-accumulator (7) that is connected to an oil-return port of oil-separator (4) through a solenoid valve (6), an oil-return pipe (18) that connects the oil-accumulator (7) and a suction pipe of the each compressor (2) through metering device (17), a pipe (14) that connects the oil-accumulator (7) and a port (13) at outlet of
25 outdoor unit through a solenoid valve (12) and a pipe (16) that connects the oil-accumulator (7) and a low pressure pipe through a solenoid valve (15), and a control system of these solenoid valves. The liquid connecting pipeline (20) and the gas connecting pipeline (21) are shared among the multiple outdoor units and plural indoor units and the oil-balancing pipeline (22) is connected to every port (13). By controlling
30 the solenoid valves, oil can be transferred among the outdoor units. When oil is to be transferred from an outdoor unit (1a) to another outdoor unit (1b), solenoid valves (6a) and (12a) are opened and (15a) is closed in outdoor unit (1a) and solenoid valves (12b) and (15b) are opened and (6b) is closed. Therefore, oil flows from the oil-accumulator

(7a) in an outdoor unit (1a) to another oil-accumulator (7b) in an outdoor unit (1b).

The invention can also provide a system for detecting the oil level in the oil-accumulator and transferring the oil from an oil-accumulator containing more oil to
5 another containing less oil, and thus balancing the oil level at all times.

The invention can further provide an oil-accumulator that sets a port of oil-balancing pipe between its centre and the bottom and a control system to operate those solenoid valves periodically and in same duration. Therefore, the oil level in every oil-
10 accumulator is equalised.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a piping diagram illustrative of a multiple air conditioning system according
15 to the present invention.

Figure 2 is a structural chart of an oil accumulator according to the present invention.

Figure 3 is an electronics circuit diagram of thermistors according to the present
20 invention.

Figure 4 is a structural chart of an oil accumulator according to the present invention.

25

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 is a piping diagram illustrative of a multiple air conditioning system including
30 a preferred embodiment. In Figure 1, (1a) is an outdoor unit and includes two high-pressure compressors (2a-1) and (2a-2). Check valves (3a-1) and (3a-2) are connected to the discharge pipe of each compressor. The discharge pipes are joined and connected to an oil-separator (4a). The oil-separator (4a) is connected with a pipe that the main refrigerant flows to a 4-way valve (5a) and a pipe that the separated oil flows to an oil-
35 accumulator (7a) through a solenoid valve (6a). The 4-way valve (5a) is connected through a pipe to the outdoor heat-exchanger (8a), gas connecting valve (10a) that is

joined to the gas piping line (21) and a low pressure pipe (11a) to both suction pipes of
 the compressors (2a-1) and (2a-2). The outdoor heat exchanger (8a) is also connected to
 the liquid connecting valve (9a) that is joined to the liquid piping line (20). The oil-
 accumulator (7a) is connected with a pipe (14a) to the connecting valve (13a) that is
 5 joined to the oil-balancing pipeline (22) through a solenoid valve (12a), a pipe (16)
 connected to a low pressure pipe (11a) through a solenoid valve (15a) and two oil
 returning pipes (18a-1) and (18a-2) connected to each suction pipe of compressor (2a-1)
 or (2a-2) through each metering device (17a-1) or (17a-2). Outdoor units (1b) and (1c)
 include the same structural elements as outdoor unit (1a) and are identified using sub-
 10 character a,b,c. The liquid piping line (20) is connected to every liquid connecting valve
 (9a,9b,9c) and the gas piping line (21) is connected with every gas connecting valve
 (10a,10b,10c). The oil-connecting valves (13a, 13b,13c) are connected to the oil-
 balancing pipeline (22) and one another. Further, the liquid piping line (20) and the gas
 piping line (21) are connected in parallel with the indoor units (32) each that include the
 15 expansion device (30) and indoor heat-exchanger (31). Oil is charged in every
 compressor (2) and the same kind of oil is charged in the oil-accumulator (7).

For normal air conditioning in case of cooling, solenoid valves (12) and (15) are closed
 and solenoid valve (6) is opened. Refrigerant to be compressed by compressor (2) is
 20 discharged from compressor (2) with some oil and flows into the oil-separator (4)
 through the connected discharge pipe. At the oil-separator, (4) the refrigerant and oil are
 separated and the refrigerant flows into the 4-way valve (5) and oil flows into the oil-
 accumulator (7) through the solenoid valve (6). In this time all oil cannot be separated
 from refrigerant at the oil-separator (4) and some oil flows out to refrigerating cycle
 25 with refrigerant. Refrigerant flows from the 4-way valve (5) to the outdoor heat-
 exchanger (8), changes form from gas to liquid at the outdoor heat-exchanger (8), flow
 to the liquid piping line (20) through liquid connecting valve (9), join with refrigerant
 that come alike from other outdoor unit and flows to the indoor units (32). In the indoor
 unit (32), refrigerant flows to the expansion device (30), decompress at the expansion
 30 device (30), enter the indoor heat-exchanger (31) and changes form to gas at the indoor
 heat-exchanger (31). At this time air of indoor is cooled. Refrigerant in gas form flows
 to the gas piping line (21), is distributed and comes back to each outdoor unit (1a,1b,1c)

and flows back to the 4-way valve (5) through each gas connecting valve (10). Refrigerant entering the 4-way valve (5) flows to the low-pressure pipe (11) and distributes to each suction pipe of the compressor (2). The gas refrigerant joins with oil that comes from the oil-accumulator (7) through oil returning pipe (18) and is inhaled by the compressor (2). At this time refrigerant brings oil that could not be separated at the oil-separator (4) back to the compressors (2). In one outdoor unit (1) (for example 1a) oil return from the oil-accumulator (7a) to each compressor (2a-1) or (2a-2) is controlled by the metering device (17a-1) or (17a-2) on the oil returning pipes (18a-1) and (18a-2). However, the oil that goes through the entire refrigerant cycle is not distributed evenly at the gas piping line (21) when it comes back to each outdoor unit (1). If this uneven oil returning continues for long time, oil level in the oil-accumulator (7) of every outdoor unit (1) will be different. The oil level in the oil-accumulator (7) is recovered by controlling solenoid valves (6, 12 and 15). For example, if oil level of the oil-accumulator (7a) in outdoor units (1a) is high while oil level of the oil-accumulator (7b) in outdoor units (1b) is low, solenoid valve (6a) and (12a) are open and solenoid valve (15a) is closed in the outdoor unit (1a) and solenoid valve (12b) and (15b) are open and solenoid valve (6b) is closed in the outdoor unit (1b). Pressure in the oil-accumulator (7a) is kept at high pressure by the opening solenoid valve (6a) and closing solenoid valve (15a). On the other hand, pressure in the oil-accumulator (7b) will be low because solenoid valve (15b) is opened and solenoid valve (6b) is closed. At this moment, the oil-accumulator (7a) and the oil-accumulator (7b) are linked through the oil-balancing pipeline (22) because of the opening of solenoid valves (12a) and (12b). Therefore oil in the oil-accumulator (7a) flows to the oil-accumulator (7b) due to pressure difference. And thus the oil levels can be equalised by flowing from oil-accumulator with more oil to oil-accumulator with less oil.

The equalising of oil levels can be done by controlling solenoid valves according to the table below.

outdoor unit			1a			1b			1c		
Valve			6a	12a	15a	6b	12b	15b	6c	12c	15c
normal operation			Open	Cbse	Cbse	Open	Cbse	Cbse	Open	Cbse	Cbse
Oil balance operation	from 1a to 1b	(1)	Open	Open	Cbse	Cbse	Open	Open	Open	Cbse	Cbse
	from 1b to 1c	(2)	Open	Cbse	Cbse	Open	Open	Cbse	Cbse	Open	Open
	from 1c to 1a	(3)	Cbse	Open	Open	Open	Cbse	Cbse	Open	Open	Cbse

5

In the present invention, the intended structure is not to send oil from a casing of compressor directly, therefore the end result regardless of whether the high-pressure type compressor or low-pressure type compressor would be the same

- 10 Figure 2 is a structural chart of one preferred embodiment of the present invention, where a ceiling of the oil-accumulator (7) has a port of the pipe that is connected the oil-separator (4) through a solenoid valve (6) and a port of the pipe (16) to go to a low pressure pipe (11) through a solenoid valve (15) and a bottom of the oil-accumulator (7) has two ports of oil returning pipes (18-1) and (18-2) to go to each suction pipe of
- 15 compressor (2-1) or (2-2) through each metering device (17-1) or (17-2) and a port of the pipe (14) to go to oil connecting valve (13) that is joined with oil-balancing pipeline (22). In the oil-accumulator (7), a thermistor (40) is set at the oil level in the vertical position, that is the same kind as the thermistor (40) is set at the bottom of the oil-accumulator and lead wire of thermistors (40) and (41) are connected to outside
- 20 electronics circuit through a glass terminal (42).

- Figure 3 is an electronics circuit diagram including these thermistors (40) and (41), where these thermistors (40) and (41) and two basic resisters form a bridged circuit and both intermediate voltage can be compared to output the result. In this circuit the same
- 25 current flows through the thermistor (40) and (41), so if heat-radiation of the thermistors (40) and (41) is different, temperature of the thermistors (40) and (41) become different. This difference of temperature leads to a difference of resistance of the thermistors (40) and (41) and intermediate voltage is changed. As the thermistor (41) is near the bottom, it always submerged in oil. When the oil level is enough to dip
- 30 in the thermistor (40), both thermistors (40 and 41) will have the same heat-radiation

performance so that the intermediate voltage of thermistors (40 and 41) is almost the same as the intermediate voltage of the basic resistors. When oil level is poor to expose the thermistor (40) to gas refrigerant, heat-radiation performance at thermistor (40) will be decreased. This will subsequently lead to a decrease in resistance. The intermediate
 5 voltage of thermistors (40 and 41) becomes higher than the intermediate voltage of the basic resistors.

The difference of the intermediate temperature between the thermistors and the basic resistors can be used to determine the level of oil; whether the oil level is sufficient to
 10 submerge the thermistor or if the oil level is poor to expose the thermistor to gas refrigerant. And by utilising this result oil, is able to be sent from the outdoor unit that is rich oil to the outdoor unit that is poor oil by choosing the solenoid valve control above mentioned.

15 In this example, oil detection is done by using thermistor. The same result can be achieved by the use of a float and switch.

Figure 4 is a structural chart of one preferred embodiment of the present invention, where a ceiling of the oil-accumulator (7) has a port of the pipe that is connected the oil-
 20 separator (4) through a solenoid valve (6) and a port of the pipe (16) connected to a low pressure pipe (11) through a solenoid valve (15), the bottom of the oil-accumulator (7) has two ports of oil returning pipes (18-1) and (18-2) connected to each suction pipe of compressor (2-1) or (2-2) through each metering device (17-1) or (17-2). A port of the pipe (14) is connected to connecting valve (13) that is joined with oil-balancing pipeline
 25 (22) is set on a wall in between midway and bottom in height. And the above solenoid valve control (1),(2),(3) takes place periodically and for a same duration. When the oil level is high enough to immerse the port of the pipe (14), oil flows out and when oil level is poor to expose the port of the pipe (14) to gas refrigerant, gas flows out instead of oil. Since the operation of the solenoid occurs periodically and lasts for the same
 30 duration each time, the level of oil in every oil-accumulator can be maintained at the port height of the pipe. Due to the constant equalisation of the oil level in this method, the detection of oil level is not necessary.

Claims

1. An oil management system for multiple condensers in a refrigerating system comprising of
 - 5 an oil separator having a plurality of inlets and outlets for separating refrigerant and oil;
an oil accumulator having a plurality of inlets, outlets and thermistors for equalising the
level of oil in each of the outdoor unit compressor ; and
a valve means for regulating the flow of refrigerant to the outdoor heat-exchanger,
receiving refrigerant from the indoor heat-exchanger and oil accumulator and
10 distributing the refrigerant to compressors.
2. An oil management system as claimed in claim 1, wherein the inlet of the oil
separator is connected to the compressors for receiving the discharge of refrigerant
from the compressors which contains oil and refrigerant.
- 15 3. An oil management system as claimed in claim 1, wherein said valve means is a 4-
way valve.
4. An oil management system as claimed in claim 1, wherein the outlet of the oil
20 separator is connected to oil accumulator by valve means.
5. An oil management as system claimed in claim 1 wherein the second outlet of the
oil separator is connected to 4-way valve by piping means.

6. An apparatus for oil management system as claimed in claim 1 wherein the inlet of the oil accumulator is connected to the oil separator.
7. An apparatus for oil management system as claimed in claim 1 wherein the outlets
5 of the oil accumulator are oil-returning piping means which are connected to the each suction pipe of the compressors via metering devices.
8. An apparatus for oil management system as claimed in claim 1 wherein the thermistors of the oil accumulator are in a substantially vertical position of the oil
10 accumulator for setting the oil level.
9. The oil separator as claimed in claim 4, wherein the valve means is a solenoid valve.
10. An apparatus for oil management system as claimed in claim 1, wherein the
15 thermistors further comprising resistors, which formed a bridge circuit to measure the heat-radiation between the thermistors are connected to the electronics circuit through a terminal.
11. The thermistors as claimed in claim 10, wherein the heat-radiation is relied on
20 changes between intermediate voltage of the thermistors and resistors, which caused by the oil level in the oil accumulator.
12. The thermistors as claimed in claim 11, wherein the terminal is a glass terminal.