A compressor (2) for a refrigeration cycle according to the invention comprises an inlet port (6), a compression element (10), an outlet port (18), wherein in operation a refrigerant flow (20) of a gaseous refrigerant carrying an amount of oil circulates through the inlet port (6), the compression element (10) and the outlet port (18), and an oil sump (8) in which part of the oil carried by the gaseous refrigerant collects. An oil circulation rate enhancement feature (16) is provided being configured so as to direct oil from the oil sump (8) to the refrigerant flow (20), when the oil in the oil sump (8) exceeds a predetermined oil sump level (24).
Fig. 4

Fig. 5

Fig. 6
Fig. 9
COMPRESSOR FOR A REFRIGERATION CYCLE, REFRIGERATION CYCLE AND METHOD FOR OPERATING THE SAME


BACKGROUND OF THE INVENTION

[0002] 1. Technical Field
[0003] The invention relates to a compressor for a refrigeration cycle, a refrigeration cycle and to methods for operating the same.

[0004] 2. Background Information
[0005] In current refrigeration cycles multiple compressors forming one or more sets of compressors are used. In order to reduce the wear of moving parts of the compressors, like the piston in case of reciprocating compressors or the scroll in case of scroll compressors, the refrigerant circulated through such compressors carries an amount of lubricant, especially machine oil. Normally part of the amount of oil carried by the refrigerant collects in the oil sump of the compressors.

[0006] Each compressor has a certain oil discharge rate or oil circulation rate depending on its design and operating conditions. The oil circulation rate of a compressor defines the amount of oil that can be transported through the compressor and discharged from the compressor per time unit. When multiple compressors are working within a refrigeration cycle, especially when compressors of different sizes having different oil circulation rates are used, it happens that compressors are damaged due to a lack of lubrication when they receive too little oil or due to oil strokes when they receive too much oil. This happens in particular when compressors in such a refrigeration system having a low oil circulation rate receive more oil than they can discharge and when compressors in such a refrigeration system having a high oil circulation rate receive less oil than they need for lubrication thereof. This situation is made even worse if one or more of these compressors is running at variable speed and having different oil circulation rates and displacements than the others.

[0007] It is conceivable to use active oil distribution systems in order to balance the oil distribution for the multiple compressors used therein. However such active oil distribution systems are expensive and add the risk of failure and malfunction to the refrigeration system.

[0008] Accordingly, it would be beneficial to provide a more reliable and failure-free compressor for use in refrigeration systems. Moreover, it would be beneficial to provide a reliable and failure-free operation of refrigeration systems where compressors of different sizes and variable speeds are running.

SUMMARY OF THE INVENTION

[0009] Exemplary embodiment of the invention include a compressor for a refrigeration cycle, comprising an inlet port, a compression element, an outlet port, wherein in operation a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, and an oil sump in which part of the oil carried by the gaseous refrigerant collects, and further comprising an oil circulation rate enhancement feature configured so as to direct oil from the oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

[0010] Exemplary embodiment of the invention further include a refrigeration cycle, comprising, in flow direction, at least one compressor, a heat-rejection heat exchanger, preferably a collecting container, at least one evaporator having an expansion device connected upstream thereof and conduits circulating a refrigerant therethrough.

[0011] Exemplary embodiment of the invention further include a refrigeration cycle, comprising at least one lower suction pressure compressor, at least one lower suction pressure evaporator having an expansion device connected upstream thereof, at least one higher suction pressure evaporator having an expansion device connected upstream thereof and conduits circulating a refrigerant therethrough, wherein the at least one lower suction pressure compressor is configured according to any of the preceding claims.

[0012] Exemplary embodiment of the invention further include a method for operating a compressor of a refrigeration cycle, comprising operating the compression element such that a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, and that part of the oil carried by the gaseous refrigerant collects in the oil sump, further comprising the step of directing oil from the oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

[0013] Exemplary embodiment of the invention further include a method for operating a refrigeration cycle, comprising providing at least one lower suction pressure compressor and at least one higher suction pressure compressor connected in series and being configured such that when the oil sump level of the lower suction pressure compressor is less than its predetermined oil sump level, its oil circulation rate is always lower than the oil circulation rate of the higher suction pressure compressor and that when the oil sump level of the lower suction pressure compressor exceeds its predetermined oil sump level, its oil circulation rate is always higher than the oil circulation rate of the higher suction pressure compressor, operating the compression elements such that a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, and that part of the oil carried by the gaseous refrigerant collects in the oil sump, directing, in the lower suction pressure compressors, oil from the oil sump to the refrigerant flow and thus to the higher suction pressure compressors connected downstream, when the oil in the oil sump exceeds a predetermined oil sump level and thereby achieving a self-regulating balance of oil between the lower suction pressure compressors and the higher suction pressure compressors.

DESCRIPTION OF THE DRAWINGS

[0014] Embodiments of the invention are described in greater detail below with reference to the figures, wherein:

[0015] FIG. 1 shows a schematic view of a compressor of arbitrary type according to an embodiment of the invention;

[0016] FIG. 2 shows a schematic view of a reciprocating compressor according to an embodiment of the invention;
DETAILED DESCRIPTION OF THE INVENTION

[0024] FIG. 1 shows a compressor 2 of arbitrary type for use in a refrigeration cycle.

[0025] The compressor 2 comprises a housing 4 including a crank case, an inlet port 6, an oil sump 8, a compression element 10, which can be the compression element of a reciprocating compressor including a piston, a piston rod and the like or the compression element of a scroll compressor including scrolls and the like or the compression element of any other type of compressor, a crank shaft 12 for driving the compression element 10, a motor 14 rotating the crank shaft 12 and an outlet port 18. The inlet port 6 is connected a suction conduit, specially a piping, to one or more evaporators connected upstream thereof. The outlet port 18 is connected to a discharge or pressure conduit, especially a piping, to a heat-rejection heat exchanger connected downstream thereof. The inlet port 6 of the compressor attaches to its right-hand side wall and the outlet port 18 is attached to the upper side of the compressor 2.

[0026] When the compression element 10 is operated, a refrigerant flow 20 of a gaseous refrigerant carrying an amount of oil, which is depicted by arrows in FIG. 1, forms through the inlet port 6, the compression element 10 and the outlet port 18. Part of the oil carried by the gaseous refrigerant is separated on its way to the compression element 10 and falls into the oil sump 8, where it collects. The gaseous refrigerant together with the remaining oil is sucked into the compression element 10, compressed therein and leaves the compressor 2 at the outlet port 18. The oil from the oil sump 8 is taken to lubricate the bearings, pistons and the like and is finally also leaving the compressor 2 to the heat-rejection heat exchanger connected downstream thereof. If more oil is separated than disgorged, the oil level in the oil sump 8 rises.

[0027] At normal oil level, the oil circulation rate of the compressor 2 is nominal. At a certain predetermined oil sump level the oil circulation rate enhancement feature 16 gets into operation and rises the oil circulation rate of the compressor 2. This oil circulation rate enhancement feature 16 forces oil transport and directs oil from the oil sump 8 to the refrigerant flow 20, when the oil in the oil sump 8 exceeds the predetermined oil sump level 24.

[0028] FIG. 2 shows a reciprocating compressor 26 for use in a refrigeration cycle.

[0029] The oil sump 8 of the reciprocating compressor 26 is formed in the lower left-hand portion of the housing 4. The inlet port 6 attaches on the upper side in the right-hand portion. Directly adjacent to the outlet port 18 a compression element suction line 40 is arranged through which at least part of the refrigerant flow 20 and the oil mist flow 42 runs. The compression element of the reciprocating compressor 26 is formed by the horizontally extending crank shaft 12 rotatably driven by the motor 14 and driving the piston rod 30 which in turn drives the piston 32 and compresses the refrigerant carrying the oil in a compression chamber. Spaced apart to the left-hand side of the bent portion of the crank shaft 12 an oil dispersing blade 28 is fixed to the crank shaft 12 to be rotatably driven by the motor 14. The oil dispersing blade 28 has the function of a slinger. It dips into the oil sump 8 and disperses an amount of oil to form an oil mist in the crank case to be entrained by the refrigerant flow 20, when the oil in the oil sump 8 reaches the predetermined oil sump level 24. This oil mist entrained into the refrigerant gas flow 20 is sucked to the compression chamber and as a result more oil is transported out of the compressor 26 and the oil circulation rate will be increased.

[0030] The crank shaft rotation is indicated by reference numeral 36, the piston rod movement is indicated by reference numeral 38 and the dispersing movement of the oil mist is indicated by reference numeral 34.

[0031] The design of the oil dispersing blade 28 will influence the characteristics of the oil circulation rate. The outer radius and the diameter of the oil dispersing blade 28 measured from the crank shaft axis will control the level of the increase of the oil circulation rate. Its shape will give a function of oil circulation rate as a parameter of the oil level. Alternatively, an oil dispersing disc or another feature which is fixed with the crank shaft and rotates with it can be employed.

[0032] The same dispersing effect can be achieved by using the crank shaft 12 itself as a tool which increases the oil circulation rate. When the oil in the oil sump 8 reaches the predetermined oil sump level 24, the crank shaft itself will dip into the oil sump 8 and disperse an amount of oil to form an oil mist to be entrained by the refrigerant flow 20 thereby increasing the oil circulation rate.

[0033] Additional features can be placed on the crankshaft to further amplify the oil dispersion if needed.

[0034] In these embodiments, the flow of oil mist within the crank case must be sufficient to transfer oil into the suction of the compression element 10. This can be done by appropriately sizing the crankcase as well as the passages which lead from the crankcase to the compression element 10.

[0035] In FIG. 2 the oil circulation rate balancing is carried out by means of an oil dispersing plate 28.

[0036] FIG. 3 shows a scroll compressor 44 for use in a refrigeration cycle.

[0037] In FIG. 3, the crank shaft 12 extends substantially in a vertical direction, the inlet port 6 attaches to the left-hand side wall and the outlet port 18 attaches to the upper side of the housing 4. A by-pass line 46 extends between an entainment point 48 positioned at the left-hand side wall of the crank case 4 substantially at the height of the predetermined oil sump level 24 and the inlet port 6 connected with the suction line leading to the compression element 10. The by-pass line 46 can be fouled as a bore, as a canal or a pump line and can be internal to the compressor housing or external as shown.

[0038] When the level oil in the oil sump 8 exceeds the predetermined oil sump level 24 which equals the nominal oil level, there will be a net flow of oil leaving the oil sump 8 and
being entrained into the suction flow to the compression element 10 which will increase the oil circulation rate of the compressor 44. This effect can be achieved by static pressure entrainment which will work best when the entrainment point 48 is as close as possible to the suction line of the compression element 10, where the static pressure is the lowest. This effect can also be achieved by dynamic pressure entrainment, for example by providing an ejector.

[0039] Since the by-pass line 46 connects the entrainment point 48 to a point internal to the inlet port 6 or the suction line external to the inlet port 6 the static pressure difference will cause a considerable amount of oil from the oil sump 8 to be directed to the refrigerant flow 20.

[0040] The oil feeding flow within the by-pass line 46 is depicted by the arrows 50. When additionally providing a pump or an ejector the oil feeding flow from the oil sump 8 to the suction line of the compression element 10 can be further increased.

[0041] FIG. 4 shows a reciprocating compressor 52 for use in a refrigeration cycle.

[0042] In the side view of FIG. 4, the basic configuration of the reciprocating compressor 52 comprising the rotating crankshaft 12, the piston rod 30 and the piston 32 can be seen. Different from the by-pass line 46, the by-pass line 54 of the reciprocating compressor 52 extends between the entrainment point 56 at the predetermined oil sump level 24 and the compression element suction line 58 through which the refrigerant flow 20 comprising the oil flow 62 runs. The oil feeding flow within the by-pass line 54 is depicted by arrows 60.

[0043] In FIGS. 3 and 4 the oil circulation rate balancing is carried out by means of suction gas entrainment.

[0044] According to the embodiments of the invention, as described above, the oil circulation rate of the compressor is artificially increased when the oil sump level in the compressor is higher than a nominal value. When the oil sump level in the oil sump is high, the oil circulation rate is increased, and the amount of oil leaving the compressor exceeds the net flow of oil entering the compressor. In this way, the oil sump level in the oil sump will decrease until the predetermined oil sump level and, respectively, the nominal level again. At this point, the oil circulation rate will decrease and the amount of oil leaving the compressor will be less than the amount of oil entering the compressor.

[0045] According to embodiments of the invention, as described herein, a self-regulating mechanism for controlling the amount of oil in the compressors employed is achieved, and the balancing of oil between compressors in a multiple compressor system is allowed in a passive or semi-passive way. Thereby the applied costs can be decreased while the reliability of the systems is increased.

[0046] FIG. 5 shows a first oil circulation rate balancing diagram 64.

[0047] This diagram 64 depicts the variation of the oil circulation rate depending on an increasing oil sump level by means of two exemplary functions, namely a gradual change function f1 and a step function f2.

[0048] When the oil in the oil sump 8 exceeds the predetermined oil sump level 24 the oil circulation rate is increased by means of the oil circulation rate enhancement features 16, 28, 46, 54 or any other oil circulation rate enhancement feature such that more oil is transported out of the compressor than fresh oil enters the compressor.

[0049] By adjusting the intensity of the operation of the oil circulation rate enhancement feature a more gradual adjustment of the oil circulation rate like depicted by f1 or a more abrupt adjustment as depicted by the step function f2 can be achieved.

[0050] FIG. 6 shows a first multiple compressor refrigeration system 66.

[0051] The first multiple compressor refrigeration system 66 comprises in flow direction a set of three compressors 68, a heat-rejecting heat exchanger 70, a collecting container 72 and three parallel evaporators 74 having corresponding expansion valves 76 connected upstream thereof.

[0052] The suction line from the set of evaporators 74 divides into three separate suction lines for each compressor of the set of compressors 68, and the pressure lines from the three compressors of the set of compressors 68 join to form a single pressure line before the heat-rejecting heat exchanger 70. Likewise, the line from the collecting container 72 to the set of evaporators 74 divides into three separate lines, and the suction lines from the evaporators 74 join to form a single suction line for the set of compressors 68.

[0053] By providing the compressors 68 with an oil circulation rate enhancement feature, as described above, the oil circulation rate thereof will be individually adjusted and increased in case too much oil collects in the oil sump of one or more compressors 68. Moreover a reliable balancing of the oil in the compressors 68 can be attained in a simple and cost-effective manner. By avoiding that too much oil collects in one compressor, it is guaranteed that the amount of oil returning to the other compressors is sufficient and that they do not receive too little oil.

[0054] FIG. 7 shows a second multiple compressor refrigeration system 68.

[0055] The second multiple compressor refrigeration system 78 comprises two sets of compressors connected in series, namely a set of three lower suction pressure compressors 80 and a set of three medium suction pressure compressors 82, a heat-rejection heat exchanger 70, a collecting container 72 and two sets of evaporators connected in parallel, namely a first set of three medium suction pressure evaporators 88 having respective expansion valves 90 collected upstream thereof and a second set of lower suction pressure evaporators 84 having respective expansion valves 86 collected upstream thereof.

[0056] The discharge lines of the lower suction pressure evaporators 84 combine into a common suction line which then divides into three separate suction lines for each of the lower suction pressure compressors 80. The pressure lines of the lower suction pressure compressors 80 combine into a common suction line that divides into three separated suction lines for the medium suction pressure compressors 82. The pressure lines of the medium suction pressure compressors 82 combine into a common pressure line leading to the heat-rejection heat exchanger 70. The discharge lines of the medium suction pressure evaporators 88 combine into a common suction line discharging into the suction line leading to the medium suction pressure compressors 82.

[0057] For refrigeration systems with compressors in series, like the embodiment of FIG. 7, careful consideration must be made between the oil circulation rates of the lower suction pressure compressors and the higher suction pressure compressors.

[0058] According to a particular embodiment of this invention, the higher suction pressure compressors 82 are selected...
to have a nominal oil circulation rate wherein the lower suction pressure compressors 80 comprise an oil circulation rate enhancement feature, as described above, in order to provide a self-regulating circulation rate.

[0059] It is desirable to choose the variability of the oil circulation rate between the compressors and the operating conditions of the higher suction pressure compressors and the lower suction pressure compressors such that when the oil sump levels of the lower suction pressure compressors are less than nominal, their oil circulation rate is always lower than the one of the higher suction pressure compressors, and that when the oil sump levels of the lower suction pressure compressors are higher than nominal, their oil circulation rate is always higher than the one of the higher suction pressure compressors. In such way, a self-regulating balance of oil between the higher suction pressure compressors and the lower suction pressure compressors can be achieved.

[0060] If additional lines between the discharge of the higher suction pressure compressors 82 and the suction of the lower suction pressure compressors 80 exist, which change the oil circulation rate entering the lower suction pressure compressors 80, the oil circulation rate of the lower suction pressure compressors 80 must be higher than the highest possible oil circulation rate entering the lower suction pressure compressors 80, when the oil sump level of the lower suction pressure compressors 80 is above the predetermined level 24. When the oil sump level is below the predetermined level 24 then the oil discharge rate should be lower than the lowest possible oil circulation rate entering the compressor.

[0061] FIG. 8 shows a third multiple compressor refrigeration system 92.

[0062] The third multiple compressor refrigeration system 92 corresponds to the second multiple compressor refrigeration system 78 with the exception that the two sets of compressors, namely the set of the three lower suction pressure compressors 94 and the set of the three higher suction pressure compressors 96 are not connected in series, but rather in parallel.

[0063] For that purpose the discharge lines of the lower suction pressure evaporators 84 combine into a common suction line for the set of lower suction pressure compressors 94 which then divides up into three separate suction lines for each of the lower suction pressure compressors 94. Likewise, the discharge lines of the medium suction pressure evaporators 88 combine into a common suction line for the set of higher suction pressure compressors 96 which then divides into three separate suction lines for each of the higher suction pressure compressors 96. The pressure lines of the lower suction pressure compressors 94 combine into a common pressure line and the pressure lines of the higher suction pressure compressors 96 combine into a common pressure line, both pressure lines joining before the heat-rejection heat exchanger 70.

[0064] In both multiple compressor refrigeration system 78 and 92 one or more of the compressors can be configured according to this invention to contain an oil circulation rate enhancement feature, as described above, that directs oil from the respective oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

[0065] The heat-rejection heat exchanger 70 of all multiple compressor refrigeration systems 68, 78, 92 can be both a gas cooler when operated in a transcritical mode or a condenser when operated in a subcritical mode.

[0066] According to a further embodiment of the invention a combination of series and parallel compressor sets are also possible.

[0067] All of the aforementioned embodiments require a balance to exist in oil transport to allow the oil levels in all compressor sets to be stable and within a certain range, namely not too low or too high. This balancing is achieved by providing one or more compressors with the oil circulation rate enhancement feature according to embodiments of the invention, as described herein.

[0068] FIG. 9 shows a second oil circulation rate balancing diagram 98 derived from test data for a specific compressor, as an example of the desired effect.

[0069] This diagram 98 shows the oil circulation rate for both the lower suction pressure compressors 94 and the higher suction pressure compressors 96 as a function of increasing oil flow in liters wherein the lower suction pressure compressors 94 are provided with oil circulation rate enhancement features according to the invention therefor allowing for a oil circulation rate adjustment, wherein the higher suction pressure compressors 96 have a nominal oil circulation rate in the range of 0.8 to 1.6% as depicted in the second oil circulation rate balancing diagram 98.

[0070] As can be seen by the curve for the lower suction pressure compressors 94 the oil circulation rate thereof changes flexibly with increasing oil fill so to allow for reliable operation of the refrigeration circuit.

[0071] In FIG. 9 test data for a lower suction pressure reciprocating compressor is shown as a function of the oil sump level. The self-regulating concept of the invention can clearly be seen in this Figure.

[0072] According to a further embodiment of the invention, by ensuring that the nominal oil circulation rate of the higher suction pressure compressors is high relative to the nominal oil circulation rate of the lower suction pressure compressors, various lower suction pressure compressor sizes can be used without danger of oil balancing issues between the lower suction pressure compressors. Each lower suction pressure compressor will be able to self-regulate the amount of oil in its sump to achieve a safe level. With a variety of lower suction pressure compressors sizes in parallel, a closer balance between the required capacity and the delivered capacity can be achieved, which will result in less on/off cycling and lower variations between the desired and actual suction pressure, which will serve to increase the reliability and decrease of energy consumption of the refrigeration system.

[0073] According to exemplary embodiments of the invention, as described above, the oil circulation rate of the compressors rather than the amount of ingoing oil is adjusted. No further parts are needed for active oil supply management, the modifications needed to achieve the desired effects are very inexpensive, the reliability of the system will be improved, and overfilling of the oil sump is reliably avoided. The oil circulation rate enhancement feature works even in complex systems, such as CO2 booster systems, where the rate of higher suction pressure compressors can be approximately ten times higher than the one of the lower suction pressure compressors, and in cases where the operating conditions of the refrigeration system are changing. Both overfilling with oil and running out of oil can be safely avoided by the exemplary embodiments of the invention.

[0074] According to an exemplary embodiment of the invention, the compressors are provided with a mechanism
for self-regulation, which is particularly effective when a big amount of oil circulates within the refrigeration cycle.

It a particular embodiment of the invention, compressors of various sizes are used in a common suction line to better match the required capacity of the system on a dynamic basis.

All the embodiments and advantages as described herein with regards to the compressors or the refrigeration systems also apply mutatis mutandis for the method for operating a compressor and a method for operating a refrigeration system. Such embodiments and advantages are therefore not repeated with regard to such methods in order to avoid redundancy.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and elements may be substituted for equivalents thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A compressor for a refrigeration cycle comprising:
   an inlet port;
   a compression element;
   an outlet port;
   wherein in operation a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port;
   and an oil sump in which part of the oil carried by the gaseous refrigerant collects,
   characterized by an oil circulation rate enhancement feature configured so as to direct oil from the oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

2. The compressor of claim 1, wherein characterized in that the oil circulation rate enhancement feature is formed by the crankshaft rotatably driven by a motor, said crankshaft being configured so as to dip into the oil sump and to disperse an amount of oil to form an oil mist to be entrained by the refrigerant flow, when the oil in the oil sump reaches the predetermined oil sump level.

3. The compressor of claim 1, wherein the oil circulation rate enhancement feature is formed by an oil dispersing element, especially a blade or a disk, fixed to the crankshaft and rotatably driven by a motor, said oil dispersing element being configured so as to dip into the oil sump and to disperse an amount of oil to form an oil mist to be entrained by the refrigerant flow, when the oil in the oil sump reaches the predetermined oil sump level.

4. The compressor of claim 1, wherein the oil circulation rate enhancement feature is formed by a bypass line extending between the oil sump substantially at a height of the predetermined oil sump level and the refrigerant flow at a position before the compression element internal or external to the compressor housing.

5. The compressor of claim 4, wherein an ejector is provided for transporting oil from the oil sump to the refrigerant flow.

6. The compressor of claim 4, wherein oil is transported from the oil sump to the refrigerant flow by static pressure entrainment.

7. The compressor of claim 4, wherein the bypass line extends between the oil sump at the height of the predetermined oil sump level and the inlet port.

8. The compressor of claim, wherein the bypass line extends between the oil sump at the height of the predetermined oil sump level and a suction line connecting to the inlet port (external).

9. The compressor of any claim, wherein the bypass line extends between the oil sump at the height of the predetermined oil sump level and a compression element suction line or a compression element suction portion.

10. (canceled)

11. A refrigeration cycle, comprising:
   at least one lower suction pressure compressor, at least one higher suction pressure compressor, a heat-rejection heat exchanger, preferably a collecting container, at least one lower suction pressure evaporator having an expansion device connected upstream thereof, at least one higher suction pressure evaporator having an expansion device connected upstream thereof and conduits circulating a refrigerant therethrough,
   wherein the at least one lower suction pressure compressor includes an inlet port, a compression element, an outlet port, and an oil sump, wherein in operation a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, wherein a part of the oil carried by the gaseous refrigerant collects within the oil sump, which lower suction pressure compressor is characterized by an oil circulation rate enhancement feature configured so as to direct oil from the oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

12. The refrigeration cycle of claim 11, further comprising compressors having different sizes.

13. The refrigeration cycle of claim 11, wherein the at least one lower suction pressure compressor and the at least one higher suction pressure compressor are connected in parallel.

14. The refrigeration cycle of claim 11, wherein the at least one lower suction pressure compressor and the at least one higher suction pressure compressor are connected in series.

15. The refrigeration cycle of claim 13, wherein the lower suction pressure compressor and the higher suction pressure compressor are configured such that when the oil sump level of the lower suction pressure compressor is less than its predetermined oil sump level, its oil circulation rate is always lower than the oil circulation rate of the higher suction pressure compressor.

16. The refrigeration cycle of claim 15, wherein the lower suction pressure compressor and the higher suction pressure compressor are configured such that when the oil sump level of the lower suction pressure compressor exceeds its predetermined oil sump level, its oil circulation rate is always higher than the oil circulation rate of the higher suction pressure compressor.

17. The refrigeration cycle of claim 11, wherein the lower suction pressure compressor is configured such that when the oil sump level of the lower suction pressure compressor is less than its predetermined oil sump level, its oil circulation rate is always lower than the oil circulation rate entering the lower suction pressure compressor.
18. The refrigeration cycle of claim 11, wherein the lower suction pressure compressor is configured such that when the oil sump level of the lower suction pressure compressor exceeds its predetermined oil sump level its oil circulation rate is always higher than the oil circulation rate entering the lower suction pressure compressor.

19. A method for operating a compressor of a refrigeration cycle, comprising:

- operating the compression element such that a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, and that part of the oil carried by the gaseous refrigerant collects in the oil sump, characterized by the step of directing oil from the oil sump to the refrigerant flow, when the oil in the oil sump exceeds a predetermined oil sump level.

20. A method for operating a refrigeration cycle, comprising:

- providing at least one lower suction pressure compressor and at least one higher suction pressure compressor connected in series and being configured such that when the oil sump level of the lower suction pressure compressor is less than its predetermined oil sump level, its oil circulation rate is always lower than the oil circulation rate of the higher suction pressure compressor and that when the oil sump level of the lower suction pressure compressor exceeds its predetermined oil sump level, its oil circulation rate is always higher than the oil circulation rate of the higher suction pressure compressor.

- operating the compression elements such that a refrigerant flow of a gaseous refrigerant carrying an amount of oil circulates through the inlet port, the compression element and the outlet port, and that part of the oil carried by the gaseous refrigerant collects in the oil sump;

- directing, in the lower suction pressure compressors, oil from the oil sump to the refrigerant flow and thus to the higher suction pressure compressors connected downstream, when the oil in the oil sump exceeds a predetermined oil sump level and thereby achieving a self-regulating balance of oil between the lower suction pressure compressors and the higher suction pressure compressors.

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