DESCRIPTION

Title of Invention: PERFORMANCE DEGRADATION DIAGNOSIS SYSTEM FOR REFRIGERATION CYCLE APPARATUS

Technical Field

The present disclosure relates to a performance degradation diagnosis system for a refrigeration cycle apparatus.

Background Art

PTL 1 (Japanese Unexamined Patent Application Publication No. 2015-212594) discloses a technique of determining the degree of degradation of a compressor of a refrigeration cycle apparatus on the basis of a difference between a determination reference value, which is an operation state amount in an initial state of the compressor, and a determination index, which is an operation state amount when a predetermined time has elapsed.

Summary of Invention

Technical Problem

However, a cause of performance degradation of a refrigeration cycle apparatus includes not only degradation of a compressor. A plurality of factors, such as soiling of a filter, soiling of a heat exchanger, and refrigerant leakage should be also focused. Grasping of performance degradation of a refrigeration cycle apparatus together with a cause thereof among various performance degradation factors makes it possible to shorten a time for maintenance or the like for alleviating or reducing performance degradation.

Solution to Problem

According to an aspect, there is provided a performance degradation diagnosis system for a refrigeration cycle apparatus that includes a refrigerant circuit including a compressor, a heat-source-side heat exchanger, and a use-side heat exchanger, the refrigeration cycle apparatus further including a heat-source-side fan that supplies air to the heat-source-side heat exchanger and an expansion valve that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit. The performance degradation diagnosis system includes a

determining unit and a control unit. The determining unit determines, based on an index indicating an operation state of the refrigeration cycle apparatus, performance degradation of the refrigeration cycle apparatus with respect to each of a plurality of performance degradation factors of the refrigeration cycle apparatus. In a case where the determining unit determines performance degradation of the refrigeration cycle apparatus with respect to each of the performance degradation factors, the control unit grasps an operation condition of the refrigeration cycle apparatus which is operating, and in a case where the operation condition of the refrigeration cycle apparatus is not suitable for determining performance degradation of the refrigeration cycle apparatus with respect to a performance degradation factor of a determination target, controls the operation condition of the refrigeration cycle apparatus so that the operation condition of the refrigeration cycle apparatus becomes an appropriate operation condition, wherein the performance degradation factors include a decrease in an amount of refrigerant, and in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the decrease in the amount of refrigerant, and a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than a first predetermined value, the control unit causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of decreasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

In the performance degradation diagnosis system according to the first aspect, the operation condition of the refrigeration cycle apparatus is controlled to the appropriate operation condition suitable for each performance degradation factor of a determination target at the time of determination of performance degradation of the refrigeration cycle apparatus with respect to each of the plurality of performance degradation factors. The appropriate operation condition suitable for each performance degradation factor of a determination target means an operation condition suitable for determining performance degradation of the refrigeration cycle apparatus resulting from the performance degradation factor. With this configuration, a cause of performance degradation can be accurately identified from among various performance degradation factors.

In the performance degradation diagnosis system, for example, the control unit controls the operation condition of the refrigeration cycle apparatus to the appropriate operation condition in a case where the operation condition of the refrigeration cycle apparatus which is

operating is an operation condition in which the determining unit is incapable of determining performance degradation of the refrigeration cycle apparatus with respect to the performance degradation factor of the determination target.

In this performance degradation diagnosis system, the operation condition of the refrigeration cycle apparatus is changed in a case where performance degradation of the refrigeration cycle apparatus is not determinable. Thus, it is possible to reduce an influence of performance degradation diagnosis on the operation of the refrigeration cycle apparatus.

~~In an embodiment of the performance degradation diagnosis system, the refrigeration cycle apparatus further includes a heat-source-side fan and an expansion valve. The heat-source-side fan supplies air to the heat-source-side heat exchanger. The expansion valve is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and decompresses refrigerant flowing in the refrigerant circuit. The performance degradation factors include a decrease in an amount of refrigerant. In a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the decrease in the amount of refrigerant, and a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than a first predetermined value, the control unit causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of decreasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.~~

According to the above embodiment of the performance degradation diagnosis system, at the time of determination of performance degradation of the refrigeration cycle apparatus due to a decrease in the amount of refrigerant, the operation condition of the refrigeration cycle apparatus is changed to an operation condition suitable for the determination. In other words, in the performance degradation diagnosis system according to the second aspect, at the time of determination of performance degradation of the refrigeration cycle apparatus due to the refrigerant leakage, the operation condition of the refrigeration cycle apparatus is changed to an operation condition suitable for determining refrigerant leakage. Thus, in the performance degradation diagnosis system according to the second aspect, performance degradation of the refrigeration cycle apparatus due to the refrigerant leakage can be accurately determined.

In an embodiment of the performance degradation diagnosis system, ~~the refrigeration cycle apparatus further includes a heat-source-side fan and an expansion valve. The heat-source-side fan supplies air to the heat-source-side heat exchanger. The expansion valve is~~

~~disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and decompresses refrigerant flowing in the refrigerant circuit. The performance degradation factors include a decrease in an amount of refrigerant. In~~ in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the decrease in the amount of refrigerant, and a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value greater than a second predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of decreasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of increasing an increase of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

According to the above embodiment of the performance degradation diagnosis system, performance degradation of the refrigeration cycle apparatus due to refrigerant leakage can be accurately determined.

In an embodiment of the performance degradation diagnosis system, the ~~refrigeration cycle apparatus further includes a heat-source-side fan. The heat-source-side fan supplies air to the heat-source-side heat exchanger. The~~ performance degradation factors further include soiling of the heat-source-side heat exchanger. In a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the soiling of the heat-source-side heat exchanger, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor and an operation of decreasing the number of rotations of the heat-source-side fan, to control the operation condition of the refrigeration cycle apparatus which is operating to the appropriate operation condition.

According to the above embodiment of the performance degradation diagnosis, performance degradation of the refrigeration cycle apparatus due to soiling of the heat-source-side heat exchanger can be accurately determined.

In an embodiment of the performance degradation diagnosis system, the refrigeration cycle apparatus further includes a use-side fan and a filter. The use-side fan supplies air to the use-side heat exchanger. The filter removes a foreign substance from the air to be supplied to the use-side heat exchanger. The performance degradation factors further include at least one of soiling of the use-side heat exchanger and soiling of the filter. In a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to at least one of the soiling of the use-side heat exchanger and the soiling of the filter, the control unit further

causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor and an operation of decreasing the number of rotations of the use-side fan, to control the operation condition of the refrigeration cycle apparatus which is operating to the appropriate operation condition.

According to the above embodiment of the performance degradation diagnosis system, performance degradation of the refrigeration cycle apparatus due to soiling of the use-side heat exchanger or the filter can be accurately determined.

In an embodiment of the performance degradation diagnosis system, ~~the refrigeration cycle apparatus further includes a heat-source-side fan and an expansion valve. The heat-source-side fan supplies air to the heat-source-side heat exchanger. The expansion valve is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and decompresses refrigerant flowing in the refrigerant circuit. In~~ in a case where a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than or equal to a third predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

According to the above embodiment of the performance degradation diagnosis system, the operation condition of the refrigeration cycle apparatus is controlled to a condition suitable for determining performance degradation of the refrigeration cycle apparatus, and thus the presence or absence of performance degradation can be accurately detected.

In an embodiment of the performance degradation diagnosis system, ~~the refrigeration cycle apparatus further includes a heat-source-side fan and an expansion valve. The heat-source-side fan supplies air to the heat-source-side heat exchanger. The expansion valve is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and decompresses refrigerant flowing in the refrigerant circuit. In~~ in a case where a degree of superheating in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than or equal to a fourth predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the

appropriate operation condition.

According to the above embodiment of the performance degradation diagnosis system, the operation condition of the refrigeration cycle apparatus is controlled to a condition suitable for determining performance degradation of the refrigeration cycle apparatus, and thus the presence or absence of performance degradation can be accurately detected.

In an embodiment of the performance degradation diagnosis system, the performance degradation diagnosis system further includes an overall determining unit that determines overall performance degradation of the refrigeration cycle apparatus. In a case where the overall determining unit determines that the refrigeration cycle apparatus has the overall performance degradation, the determining unit determines performance degradation of the refrigeration cycle apparatus with respect to each of the plurality of performance degradation factors.

According to the above embodiment of the performance degradation diagnosis system, in a case where there is overall performance degradation, performance degradation of the refrigeration cycle apparatus is determined with respect to each of performance degradation factors. Thus, it is possible to minimize the occurrence of a problem in which normal operation is interrupted by the operation of the refrigeration cycle apparatus in which the operation condition is changed for diagnosing the performance degradation.

Brief Description of Drawings

[Fig. 1] Fig. 1 is a block diagram of a performance degradation diagnosis system according to one embodiment of the present disclosure.

[Fig. 2] Fig. 2 is a schematic configuration diagram of an air conditioning apparatus which is a diagnosis target of the performance degradation diagnosis system in Fig. 1.

[Fig. 3] Fig. 3 is a diagram schematically illustrating a configuration in which a determining unit of a diagnosis apparatus of the performance degradation diagnosis system calculates information about the amount of refrigerant.

[Fig. 4A] Fig. 4A to Fig. 4C illustrate an example of a flowchart showing a flow of a process of controlling an operation condition of the air conditioning apparatus performed by the performance degradation diagnosis system when the performance degradation diagnosis system diagnoses performance degradation of the air conditioning apparatus.

[Fig. 4B] Fig. 4A to Fig. 4C illustrate an example of a flowchart showing a flow of a process of controlling an operation condition of the air conditioning apparatus performed by the performance degradation diagnosis system when the performance degradation diagnosis system diagnoses performance degradation of the air conditioning

CLAIMS

~~[Claim 1]~~

1. A performance degradation diagnosis system ~~(200)~~ for a refrigeration cycle apparatus (100) that includes a refrigerant circuit ~~(10)~~ including a compressor ~~(21)~~, a heat-source-side heat exchanger ~~(23)~~, and a use-side heat exchanger ~~(52)~~, the refrigeration cycle apparatus further include~~s~~sing a heat-source-side fan that supplies air to the heat-source-side heat exchanger and an expansion valve that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit,

the performance degradation diagnosis system comprising:

a determining unit ~~(216)~~ that determines, based on an index indicating an operation state of the refrigeration cycle apparatus, performance degradation of the refrigeration cycle apparatus with respect to each of a plurality of performance degradation factors of the refrigeration cycle apparatus; and

a control unit ~~(214)~~ that, in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus with respect to each of the performance degradation factors, grasps an operation condition of the refrigeration cycle apparatus which is operating, and in a case where the operation condition of the refrigeration cycle apparatus is not suitable for determining performance degradation of the refrigeration cycle apparatus with respect to a performance degradation factor of a determination target, controls the operation condition of the refrigeration cycle apparatus so that the operation condition of the refrigeration cycle apparatus becomes an appropriate operation condition~~.~~, wherein

~~[Claim 2]~~

~~The performance degradation diagnosis system for a refrigeration cycle apparatus according to Claim 1, wherein~~

~~the refrigeration cycle apparatus further includes a heat-source-side fan (28) that supplies air to the heat-source-side heat exchanger and an expansion valve (25) that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit,~~

the performance degradation factors include a decrease in an amount of refrigerant, and

in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the decrease in the amount of refrigerant, and a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than a first predetermined value, the control unit causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of decreasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

~~[Claim 3]~~

2. The performance degradation diagnosis system for a refrigeration cycle apparatus according to Claim 1, wherein

~~the refrigeration cycle apparatus further includes a heat-source-side fan (28) that supplies air to the heat-source-side heat exchanger and an expansion valve (25) that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit,~~

~~the performance degradation factors include a decrease in an amount of refrigerant, and~~

in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the decrease in the amount of refrigerant, and a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value greater than a second predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of decreasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of increasing an increase of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

~~[Claim 4]~~

3. The performance degradation diagnosis system for a refrigeration cycle apparatus according to Claim 1, wherein

~~the refrigeration cycle apparatus further includes a heat-source-side fan (28) that supplies air to the heat-source-side heat exchanger,~~

the performance degradation factors further include soiling of the heat-source-side heat exchanger, and

in a case where the determining unit determines performance degradation of the refrigeration cycle apparatus due to the soiling of the heat-source-side heat exchanger, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor and an operation of decreasing the number of rotations of the heat-source-side fan, to control the operation condition of the refrigeration cycle apparatus which is operating to the appropriate operation condition.

~~[Claim 5]~~

4. The performance degradation diagnosis system for a refrigeration cycle apparatus according to any one of Claims 1 to ~~4~~3, wherein

the refrigeration cycle apparatus further includes a use-side fan ~~(53)~~ that supplies air to the use-side heat exchanger and a filter ~~(58)~~ that removes a foreign substance from the air to be supplied to the use-side heat exchanger,

the performance degradation factors further include at least one of soiling of the use-side heat exchanger and soiling of the filter, and

in a case where the determining unit determines performance degradation of the

refrigeration cycle apparatus due to at least one of the soiling of the use-side heat exchanger and the soiling of the filter, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor and an operation of decreasing the number of rotations of the use-side fan, to control the operation condition of the refrigeration cycle apparatus which is operating to the appropriate operation condition.

~~[Claim 6]~~

5. The performance degradation diagnosis system for a refrigeration cycle apparatus according to Claim 1, wherein

~~the refrigeration cycle apparatus further includes a heat-source-side fan (28) that supplies air to the heat-source-side heat exchanger and an expansion valve (25) that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit, and~~

in a case where a degree of subcooling in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than or equal to a third predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

~~[Claim 7]~~

6. The performance degradation diagnosis system for a refrigeration cycle apparatus according to Claim 1, wherein

~~the refrigeration cycle apparatus further includes a heat-source-side fan (28) that supplies air to the heat-source-side heat exchanger and an expansion valve (25) that is disposed between the heat-source-side heat exchanger and the use-side heat exchanger in the refrigerant circuit and that decompresses refrigerant flowing in the refrigerant circuit, and~~

in a case where a degree of superheating in a refrigeration cycle of the refrigeration cycle apparatus which is operating has a value smaller than or equal to a fourth predetermined value, the control unit further causes the refrigeration cycle apparatus to execute at least one of an operation of increasing the number of rotations of the compressor, an operation of increasing the number of rotations of the heat-source-side fan, and an operation of decreasing an opening degree of the expansion valve, to control the operation condition of the refrigeration cycle apparatus to the appropriate operation condition.

~~[Claim 8]~~

7. The performance degradation diagnosis system for a refrigeration cycle apparatus according to any one of Claims 1 to ~~7~~6, further comprising

an overall determining unit ~~(218)~~ that determines overall performance degradation of the refrigeration cycle apparatus,

wherein

in a case where the overall determining unit determines that the refrigeration cycle apparatus has the overall performance degradation, the determining unit determines performance degradation of the refrigeration cycle apparatus with respect to each of the plurality of performance degradation factors.