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(54) Title: AIR CONDITIONER AND CONTROL METHOD THEREOF

(57) Abstract: Disclosed are an air conditioner and a control method thereof, which improve a power factor of the air conditioner by reducing a phase difference between a voltage and an electric current of a power source inputted to a compressor; and an air conditioner and a control method thereof, which enhance harmonic components by inputting an electric current of a sine wave to a compressor. In the air conditioner and a control method thereof, a power factor of three power source is compensated by phases and is inputted to a rectifier, thereby causing a voltage and an electric current of a power source applied to a compressor to become the same phase. Further, the electric current is inputted in a form of a sine wave in order to improve a power factor of the air conditioner and remove harmonic components of the power source occurred. Moreover, an improvement in the power factor of the air conditioner and a removal of the harmonic components in the power source occurred enhance a performance and reliance of a product.



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## Description

### AIR CONDITIONER AND CONTROL METHOD THEREOF

#### Technical Field

- [1] The present invention relates to an air conditioner and a control method thereof. More particularly, the present invention relates to an air conditioner, which includes a power factor compensator at each terminal of a three phase power source applied to a converter and compensate for a power factor and improve harmonic by inputting a sine wave current to a compressor, and a control method thereof.

#### Background Art

- [2] Generally, an air conditioner is provided for cooling, heating, or air condition, and is installed to discharge cooling/heating air to an indoor, and clean indoor air to provide comfortable indoor environment to a man.
- [3] Such an air conditioner is divided into an indoor unit composed of an indoor heat exchanger, and an outdoor unit composed of a compressor and an outdoor heat exchanger. The air conditioner operates by controlling a power source supplied to the compressor and etc.
- [4] On the other hand, a conventional air conditioner includes a power supply, a magnet switch, a rectifier, a reactor, a DC link section, and an inverter. The power supply supplies a power source of a predetermined amplitude. The inverter converts a direct current voltage into an alternating current voltage of a constant voltage or frequency, and supplies the alternating current voltage to a compressor.
- [5] When a power source inputted and converted from the power supply is greater than a voltage of the DC link section, an electric current is applied to a motor of the compressor to be operated.
- [6] However, as described earlier, because the conventional air conditioner applies an electric current only corresponding to a direct current power source equal to or greater than a voltage applied to the DC link section, an input power source supplied to the compressor through the inverter increases a phase difference between a voltage and an electric current.
- [7] That is, when the inverter applies an alternating power source to the compressor motor, an alternating current power source having a voltage and current wave as shown in FIG. 1 is inputted to the compressor motor.
- [8] At this time, upon comparing a wave of the voltage inputted to the motor with a wave of the electric current inputted thereto, an input voltage is applied and then an electric current flows. Accordingly, a real valid power of a power source inputted to the compressor of the air conditioner is reduced as much as a phase difference between

the voltage and the electric current, thereby causing a power factor of the air conditioner to be significantly deteriorated.

## **Disclosure of Invention**

### **Technical Problem**

[9] Accordingly, the present invention has been developed in order to solve the above-mentioned problems occurring in the prior art, and an object of the present invention is to provide an air conditioner and a control method thereof, which improve a power factor of the air conditioner by reducing a phase difference between a voltage and an electric current of a power source inputted to a compressor.

[10] It is a second object of the present invention is to provide an air conditioner and a control method thereof, which enhance harmonic components by inputting an electric current of a sine wave to a compressor.

### **Technical Solution**

[11] In order to accomplish this object, according to a first aspect of the present invention, there is provided an air conditioner comprising: a power supply section for receiving a three phase power source; a voltage wave sensor for sensing a voltage wave of the three phase power source received by the power supply section; a power factor compensator connected to the power supply section for compensating a power factor of the three phase power source; and a controller for controlling an operation of the power factor compensator so that the power factor is compensated according to a voltage wave from the voltage wave sensor.

[12] According to a second aspect of the present invention, there is provided an air conditioner comprising: a power supply section; a voltage wave sensor for sensing a voltage wave of the three phase power source received by the power supply section; a rectifier for rectifying a power source received by the three phase power supply section; a direct current link section for generating a direct current power source of a predetermined amplitude based on the three phase power source rectified by the rectifier; an inverter for converting the direct current power source into an alternating current power source and supplying the alternating current power source to a compressor motor; a power factor compensator connected to the power supply section for compensating a power factor of the three phase power source; and a controller for controlling an operation of the power factor compensator according to a voltage wave from the voltage wave sensor so that a power source having an improved power factor is applied to the compressor motor.

[13] According to a third aspect of the present invention, there is provided a method for controlling an air conditioner, comprising the steps of: sensing a voltage wave inputted to a three phase power supply section by a voltage wave sensor; and compensating a

power factor of an input power according to a voltage wave inputted from the voltage wave sensor.

### **Advantageous Effects**

[14] According to the air conditioner of the present invention as suggested above, a power factor of three power source is compensated by phases and is inputted to a rectifier, thereby causing a voltage and an electric current of a power source applied to a compressor to become the same phase. Further, the electric current is inputted in a form of a sine wave in order to improve a power factor of the air conditioner and remove harmonic components of the power source occurred.

[15] Moreover, as described above, an improvement in the power factor of the air conditioner and a removal of the harmonic components in the power source occurred enhance a performance and reliance of a product.

### **Brief Description of the Drawings**

[16] The above and other objects, features, and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

[17] FIG. 1 is a graph showing a wave of a compressor input power source in an air conditioner according a prior art;

[18] FIG. 2 is a view showing a control arrangement of an air conditioner according to the present invention;

[19] FIG. 3 is a graph showing a switching pattern with respect to a control signal, which is applied to a power factor compensator of an air conditioner according to the present invention from a controller thereof; and

[20] FIG. 4 is a graph showing a wave of a compressor input power source in an air conditioner according to the present invention.

### **Best Mode for Carrying Out the Invention**

[21] Hereinafter, the preferred embodiment of the present invention will be described in detail with reference to the accompanying drawings. Like reference numeral denotes the same element throughout drawings and the description. In the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted to avoid making the subject matter of the present invention unclear.

[22] FIG. 2 is a view showing a control arrangement of an air conditioner according to the present invention.

[23] With reference to FIG. 2, the air conditioner according to the present invention includes a power supply section 10, a voltage wave sensor 20, a rectifier 40, a reactor 50, a DC link section 60, an inverter 70, and a compressor motor 80. The power supply

section 10 receives a three phase power source. The voltage wave sensor 20 senses a voltage wave of the three phase power source received by the power supply section. The rectifier 40 rectifies a power source received by the three phase power supply section 10. The DC link section 60 generates a direct current power source of a pre-determined amplitude based on the three phase power source rectified by the rectifier 40. The inverter 70 converts the direct current power source into an alternating current power source and supplies the alternating current power source to a compressor.

[24] The air conditioner further includes a power factor compensator 30 and a controller 90. The power factor compensator 30 connected to a front terminal of the rectifier 40, and compensates a power factor of the three phase power source from the power supply section 10. The controller 90 controls the power factor compensator 30 and the inverter 70 according to a sensing result of the voltage wave sensor 20.

[25] More particularly, the voltage wave sensor 20 is connected to one of three phase terminals and a neutral line N in the power supply section 10, and senses a voltage wave of an input power source.

[26] Here, the voltage wave sensor 20 can be connected to one of three phase terminals of the power supply section 10. Although the voltage wave sensor 20 is connected to an R phase terminal, it may be connected to an S phase terminal or a T phase terminal.

[27] Moreover, the voltage wave sensor 20 senses a voltage wave of an input alternating current power source and applies it to the controller 90.

[28] On the other hand, the power factor compensator 30 is connected to the power supply section 10 and the rectifier 40, and compensates a power factor of a power source inputted from the power supply section 10 according to a control command of the controller 90, and supplies the power source the power factor of which is compensated to the rectifier 40.

[29] Further, the power factor compensator 30 includes at least one reactor L1 to L3, and at least one switch elements Q1 to Q3.

[30] More particularly, in the power factor compensator 30, each of the reactors L1, L2, and L3, and each of the switch elements Q1, Q2, and Q3 is connected to each phase of the power supply section 10, and operate according to a control signal from the controller 90. Here, the reactors L1, L2, and L3 are connected to the power supply section 10 in series with respect to the rectifier 40. In contrast to this, the switch elements Q1, Q2, and Q3 are connected to the rectifier 40 in parallel.

[31] That is, a first reactor L1 is connected to a first phase terminal R among three phase terminals of the power supply section 10, and a first switch element Q1 is connected to the first reactor L1.

[32] Further, a second reactor L2 and a second switch element Q2 are connected to a second phase terminal S, and a third reactor L3 and a third switch element Q3 are

connected to a third phase terminal T.

[33] Drains of the first to third switch elements Q1 to Q3 are connected to the respective reactors L1, L2, and L3, and sources thereof are connected to the neural line N of the power supply section 10.

[34] Here, gates of the first to third switch elements Q1 to Q3 are connected to the controller 90. The first to third switch elements Q1 to Q3 are turned on/off and perform a switching operation according to a control signal from the controller 90, so that power factors of three phases of the power supply section 10 are compensated.

[35] On the other hand, the rectifier 40 is composed of a plurality of bridge diodes, receives and rectifies a power source from the power factor compensator 30, and causes the power source rectified by the reactor 50 to be inputted to the DC link section 60.

[36] The DC link section 60 receives and smoothes a power source of the rectifier 40 and outputs a direct current power source. Here, the DC link section 60 includes at least one capacitor for smoothing the input power source.

[37] The inverter 70 is driven according to a control signal from the controller 90 and converts the rectified and smoothed direct current power source into an alternating current power source, and supplies the alternating current power source to the compressor motor 80.

[38] By the aforementioned arrangement, when the power supply section applies an alternating current power source to the voltage wave sensor 20, it senses and applies a voltage wave of the alternating current power source to the controller 90. Accordingly, the controller 90 generates a control signal to control the power factor compensator 30 according to the voltage wave of the alternating current power source from the voltage wave sensor 20, and applies the control signal to the power factor compensator 30.

[39] In detail, the controller 90 judges a voltage level of the power source from the power supply section 10 based on the sensed voltage wave from the voltage wave sensor 20, and accordingly controls the power factor compensator 30 connected to respective phase terminals of the power supply section 10 to operate.

[40] Namely, the controller 90 analyzes an input voltage wave of the power source of one phase terminal of the power supply section 10 sensed by the voltage wave sensor 20 to judge a voltage level thereof. The controller 90 applies a control signal to the respective switch elements Q1, Q2, and Q3 of the power factor compensator 30 to be driven.

[41] Accordingly, the switch elements Q1, Q2, and Q3 operate under a control of the controller 90, so that three phases of the power supply section 10 are compensated in a power factor.

[42] Next, the rectifier 40 rectifies the power source the power factor of which is

improved, and the rectified power source to the DC link section 60. Accordingly, the DC link section 60 generates a direct current power source having a predetermined amplitude to drive a compressor, and supplies the direct current power source to the compressor motor 80 through the inverter 70.

[43] FIG. 3 is a graph showing a switching pattern with respect to a control signal, which is applied to a power factor compensator of an air conditioner according to the present invention from a controller thereof.

[44] In FIG. 3, LD represents a graph for display a reference voltage for a switch control, SI is a voltage wave sensed by the voltage wave sensor 20, and SO is a switching control signal to the power factor compensator 30 from the controller 90.

[45] Referring to FIG. 3, the controller 90 compares a voltage level of the voltage wave SI sensed by the voltage wave sensor 20 with a reference voltage LD. When the voltage level of the voltage wave SI is greater than the reference voltage LD, the controller 90 a control signal SO to the power factor compensator 30 so that switch elements of the power factor compensator 30 are driven.

[46] At this time, the controller 90 applies a control signal SO of a switching pattern as described above to one of three phase terminals of the power supply section 10, which is connected to the voltage wave sensor 20, so that switch elements of the power factor compensator 30 are driven.

[47] Furthermore, since three phase power sources of the power supply section 10 have a phase difference of 120 degrees, the controller 90 applies a control signal of a switching pattern having a phase difference of 120 degrees to respective switching elements of the power factor compensator 30, which is connected to a phase terminal of the power supply section 10 other than a phase terminal thereof connected to the voltage wave sensor 20.

[48] That is, the controller 90 compares a voltage level of the voltage wave SI sensed and inputted from the first phase terminal R of the power supply section 10 with the reference voltage LD, and applies the control signal SO having a switching pattern as explained earlier to the first switch element Q1.

[49] Moreover, the controller 90 applies a control signal of a switching pattern having a phase difference of 120 degrees from the control signal SO to a second switch element Q2 connected to the second phase terminal S of the power supply section 10.

[50] In addition, the controller 90 applies a control signal to the third switch element Q3 so that it can perform a switching operation wherein the applied control has a phase difference of 240 degrees from the control signal applied to the first switch element Q1, and a phase difference of 120 degrees from the control signal applied to the second switch element Q2.

[51] As is seen from the foregoing description, according to a voltage level and a phase of

an input power source, respective switch elements Q1 to Q3 of the power factor compensator 30 connected to three phase terminals of the power supply section 10 are turned on/off, the three input phases of the power source may be compensated in the power factor. This causes a power source having an enhanced power factor to be supplied to the compressor.

[52] FIG. 4 is a graph showing a wave of a compressor input power source in an air conditioner according to the present invention.

[53] With reference to FIG. 4, the air conditioner senses a voltage wave of one of three phase in a power supply section and controls a switching of the power factor compensator 30 based on the sensed result, so that an electric current flows according the sensed voltage wave. Thus, a phase difference between a voltage and an electric current of the power source is significantly reduced, and accordingly a voltage LV1 and an electric current LI1 having the same phase are applied to the compressor motor 80.

[54] In addition, the air conditioner senses a voltage wave of one of three phase in a power supply section and applies a control signal to respective switch elements of the power factor compensator 30 to have a phase difference of 120 degrees from each other, so that a current wave of a power source supplied to the compressor has a form of a sine wave.

[55] Therefore, a power factor of the power source applied to the compressor is enhanced, and generated harmonic components are improved by flowing the electric current of the sine wave.

### **Industrial Applicability**

[56] According to the air conditioner of the present invention, a voltage and an electric current of a power source applied to the compressor are equalized and the electric current is inputted in a form of a sine wave. Accordingly, a power factor of the air conditioner is improved and generated harmonic components of a power source are removed, thereby having excellent industrial applicability.

## Claims

- [1] An air conditioner comprising:  
a power supply section for receiving a three phase power source;  
a voltage wave sensor for sensing a voltage wave of the three phase power source received by the power supply section;  
a power factor compensator connected to the power supply section for compensating a power factor of the three phase power source; and  
a controller for controlling an operation of the power factor compensator so that the power factor is compensated according to a voltage wave from the voltage wave sensor.
- [2] The air conditioner as claimed in claim 1, wherein the voltage wave sensor is connected to one of three phase terminals and a neutral line of the power supply section.
- [3] The air conditioner as claimed in claim 1, wherein the power factor is compensated by phases of the power supply section.
- [4] The air conditioner as claimed in claim 1, wherein the power factor compensator includes at least one reactor and at least one switch element.
- [5] The air conditioner as claimed in claim 4, wherein the reactor and the switch element are connected to respective phases of the three phase power source.
- [6] The air conditioner as claimed in claim 3, further comprising a rectifier for rectifying an alternating current power source received by the power supply section,  
wherein the reactor is connected to the rectifier, the switch element is connected to the reactor in series and is connected to the rectifier in parallel.
- [7] The air conditioner as claimed in claim 3, wherein a gate, a drain, and a source of the switch element are connected to the controller, the reactor, and the neutral line, respectively.
- [8] The air conditioner as claimed in claim 3, wherein the controller compares a voltage level of the voltage wave from the voltage wave sensor with a reference voltage, and compensates a power factor for a level equal to or greater than the reference voltage.
- [9] The air conditioner as claimed in claim 8, wherein a control signal of a predetermined switching pattern having a phase difference of 120 degrees is applied to respective switch elements connected to three phases of the power source.
- [10] An air conditioner comprising:  
a power supply section;  
a voltage wave sensor for sensing a voltage wave of the three phase power

source received by the power supply section;  
a rectifier for rectifying a power source received by the three phase power supply section;  
a direct current link section for generating a direct current power source of a predetermined amplitude based on the three phase power source rectified by the rectifier;  
an inverter for converting the direct current power source into an alternating current power source and supplying the alternating current power source to a compressor motor;  
a power factor compensator connected to the power supply section for compensating a power factor of the three phase power source; and  
a controller for controlling an operation of the power factor compensator according to a voltage wave from the voltage wave sensor so that a power source having an improved power factor is applied to the compressor motor.

[11] The air conditioner as claimed in claim 10, wherein the power supply section receives a three phase power source, and the power factor compensator is connected to respective phases.

[12] The air conditioner as claimed in claim 10, wherein the power factor compensator includes a reactor and a switch element, the reactor is connected to the rectifier, the switch element is connected to the reactor in series and is connected to the rectifier in parallel.

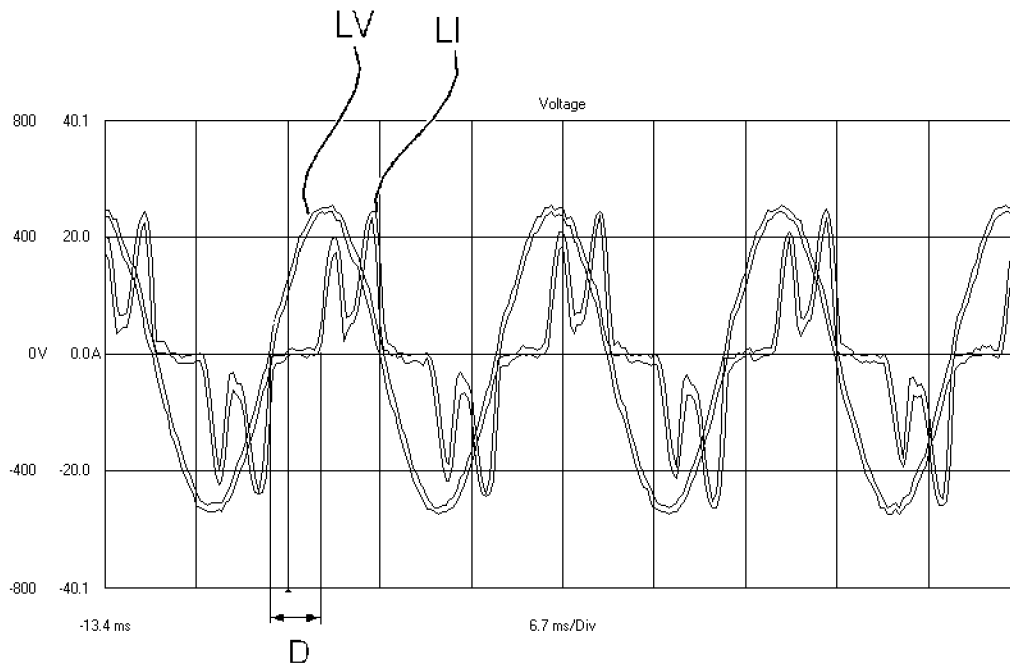
[13] A method for controlling an air conditioner, comprising the steps of:  
sensing a voltage wave inputted to a three phase power supply section by a voltage wave sensor; and  
compensating a power factor of an input power according to a voltage wave inputted from the voltage wave sensor.

[14] The method as claimed in claim 13, wherein the power factor is compensated when the sensed voltage level of a voltage wave is equal to or greater than the reference voltage.

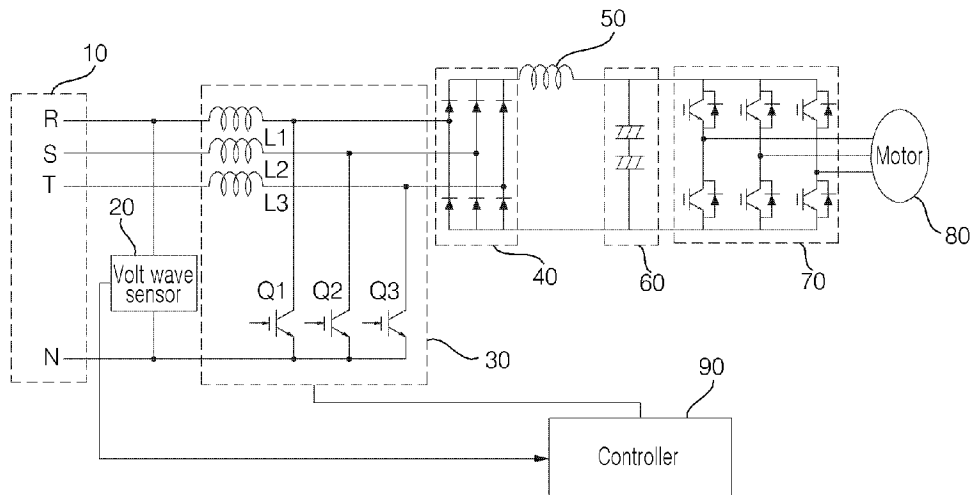
[15] The method as claimed in claim 13, wherein the power factor is compensated by phases of the three phase power supply section.

[16] The method as claimed in claim 13, wherein the power factor compensator connected to three phases of the power source operates to have a phase difference of 120 degrees.

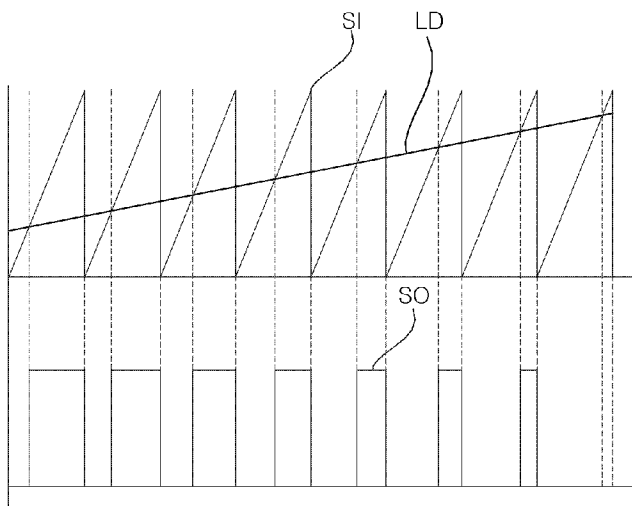
[Fig. 1]



[Fig. 2]



[Fig. 3]



[Fig. 4]

