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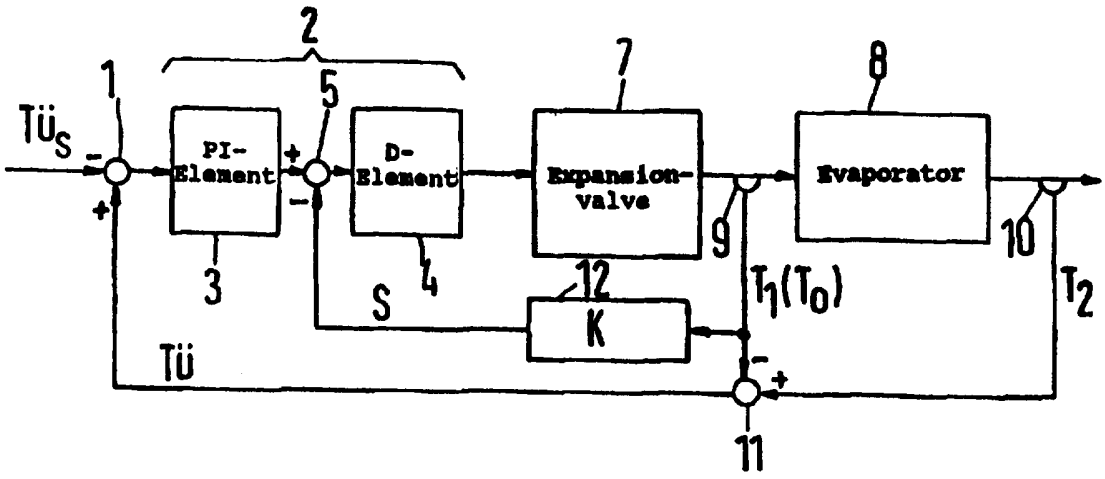
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(54) Title: CONTROL ARRANGEMENT FOR THE SUPERHEAT TEMPERATURE OF AT LEAST ONE EVAPORATOR OF A REFRIGERATION SYSTEM



(57) Abstract

A control arrangement for the superheat temperature of at least one evaporator (8) of a refrigeration system having a refrigerant circulation, in which at least one compressor, a condenser, an electronically controlled expansion valve (7) and the evaporator (8) are arranged in series, contains a measuring device (9, 10, 11) connected to the evaporator (8), which device produces a measurement signal ($T_{ü}$) that is a measure of the superheat temperature of the refrigerant in the evaporator (8), a comparator (1) to which the measurement signal ($T_{ü}$) and a desired superheat temperature signal ($T_{üs}$) are arranged to be supplied, and a PID controller (2) arranged between the comparator (1) and the expansion valve (7). For rapid compensation of changes in the superheat temperature, a control signal (S) proportional to the evaporation temperature (T_o) of the refrigerant is arranged to be supplied additionally to the PID controller (2).

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Control arrangement for the superheat temperature of at least one evaporator of a refrigeration system.

The invention relates to a control arrangement for the superheat temperature of at least one evaporator of a refrigeration system having a refrigerant circulation, in which at least one compressor, a condenser, an electronically controlled expansion valve and the evaporator are arranged in series, a measuring device being connected to the evaporator, which device produces a measurement signal that is a measure of the superheat temperature of the refrigerant in the evaporator, the arrangement having a comparator to which the measurement signal and a desired superheat temperature signal are arranged to be supplied, and having a PID controller, arranged between the output of the comparator and the control input of the expansion valve, to which the output signal of the comparator is supplied and which controls the expansion valve.

In a known control arrangement of that kind, as a measure of the superheat temperature of the refrigerant in the evaporator, the difference between the input and output temperatures is measured and compared with a desired superheat temperature. The control difference is supplied by way of the PID controller to the expansion valve, which controls the quantity of refrigerant injected into the evaporator.

If the load of the evaporator changes abruptly, for example, because of a sudden change in the ambient temperature of the evaporator or as a consequence of compressors of a group of compressors being switched on

and off in steps, the evaporation temperature, which corresponds to the temperature measured at the input of the evaporator or to the evaporation pressure taken as a measure of the evaporation temperature, also changes correspondingly. The superheat temperature consequently also changes, and may fluctuate wildly around the desired value until it is adjusted by the PID controller by way of the expansion valve. It is especially critical if the superheat temperature falls too far below the desired value, because there is then a danger that the refrigerant will still not have evaporated at the output of the evaporator and will be taken up by the compressor.

The invention is based on the problem of providing a control arrangement of the kind mentioned in the introduction, in which too great a departure of the superheat temperature from the desired value because of a change in load is avoided.

According to the invention, this problem is solved in that a control signal proportional to the evaporation temperature of the refrigerant is arranged to be supplied additionally to the PID controller.

That solution is based on the correlation between the refrigeration output or load Q and the temperature difference between the air temperature T_a at the evaporator and the evaporation temperature T_o, that is,

$$Q = K \cdot (T_a - T_o).$$

If the evaporation temperature changes, the refrigeration output also changes in accordance with the equation

$$\Delta Q = K \cdot \Delta T_o,$$

which results in a corresponding shift in the operating point of the controller. The proportionality factor K can here be between 1 and 5.

The solution according to the invention enables an evaporation temperature change ΔT_o to effect a corresponding change of level in the degree of opening of the expansion valve, which corresponds to the change in the refrigeration output. The controller therefore counteracts a change in the evaporation temperature initially to a correspondingly great extent, so that the superheat temperature is not able to change wildly either. As soon as the evaporation temperature is no longer changing, its influence by way of the D-element of the PID controller also becomes ineffective, so that only a change in the superheat temperature controls the expansion valve by way of the PID controller.

Preferably, provision is made for the proportionality factor between evaporation temperature and control signal to be selected to be the same as the ratio of the load on the evaporator to the difference between the air temperature at the evaporator and the evaporation temperature.

It is then advantageous for a summation element to which the additional control signal is supplied to be located between a PI-element and a D-element, connected in series therewith, of the PID controller. A change in the evaporation temperature also has an influence here on the expansion valve, so that sudden changes in the evaporation temperature, and thus the superheat temperature, are correspondingly quickly evened out.

An embodiment of a control arrangement according to the invention is described in greater detail hereinafter with reference to the drawing.

The control arrangement illustrated contains a comparator 1, a PID controller 2, comprising a PI-element 3 with series-connected D-element 4 and a subtractor 5 located between them. The PID controller 2 controls an expansion valve 7, which in turn controls the refrigerant flow from a condenser, not shown, to an evaporator 8 or several evaporators connected in parallel. A compressor, not shown, or several compressors connected in parallel, lies/lie between the output of the evaporator 8 and the input of a condenser, not shown. Additionally connected to the evaporator 8 is a measuring arrangement 9, 10, 11, consisting of two sensors 9, 10 and a subtractor 11. As a measure of the evaporation temperature T_o of the refrigerant in the evaporator 8, the sensor 9 measures the temperature T_1 of the refrigerant at the input of the evaporator 8, as illustrated, or the evaporation pressure in the evaporator. The sensor 10 measures the temperature T_2 of the evaporated refrigerant at the output of the evaporator 8. The subtractor 11 forms the difference of the two temperatures T_1 and T_2 and produces as a measure of the superheat temperature corresponding to that difference a measurement signal $T_ü$, which is supplied to one input of the comparator 1, whilst a desired superheat temperature signal Tü, is supplied to the other input of the comparator 1. The control difference of the measured superheat temperature from the desired superheat temperature determined by the comparator 1 controls the expansion valve 7 by way of the PID controller 2 so that the control difference becomes zero. To avoid sudden changes in the superheat temperature, a control signal

S proportional to the evaporation temperature T_o or the temperature T_i at the input of the evaporator 8 is supplied by way of a P-element 12 with the proportionality factor or transfer factor K to the subtractor 5. The expansion valve 7 is thus also influenced by the control signal S by way of the D-element 4. That is to say, when the evaporation temperature T_o increases because of too high a load on the evaporator or conversely the load increases because of a change in the evaporation temperature T_o, that change in the evaporation temperature T_o, and with it also a corresponding change in the superheat temperature, is counteracted again very quickly.

The transfer factor or proportionality factor K of the P-element 12 is selected to be the same as the ratio $Q/(T_a - T_o)$, T_a being the air temperature at the evaporator. Since Q is proportional to the degree of opening D of the expansion valve, and $t_a - T_o$ can be about 15°C, the mean degree of opening $\overline{D}$ to determine K is selected to be $\overline{D}/15$.

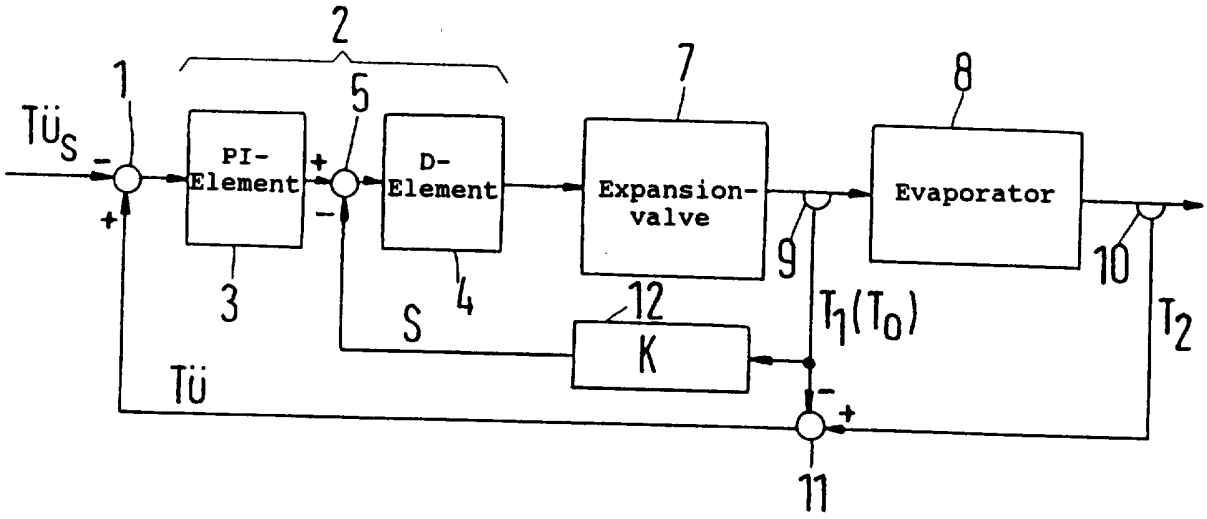
Patent Claims

1. A control arrangement for the superheat temperature of at least one evaporator (8) of a refrigeration system having a refrigerant circulation, in which at least one compressor, a condenser, an electronically controlled expansion valve (7) and the evaporator (8) are arranged in series, a measuring device (9, 10, 11) being connected to the evaporator (8), which device produces a measurement signal ($T_ü$) that is a measure of the superheat temperature of the refrigerant in the evaporator (8), the arrangement having a comparator (1) to which the measurement signal ($T_ü$) and a desired superheat temperature signal ($Tü_s$) are arranged to be supplied, and having a PID controller (2), arranged between the output of the comparator (1) and the control input of the expansion valve (7), to which the output signal of the comparator (1) is supplied and which controls the expansion valve (7), characterized in that a control signal (S) proportional to the evaporation temperature (T_o) of the refrigerant is arranged to be supplied additionally to the PID controller (2).

2. A control arrangement according to claim 1, characterized in that the proportionality factor (K) between evaporation temperature (T_o) and control signal (S) is selected to be the same as the ratio ($Q/(T_s - T_o)$ of the load (Q) on the evaporator to the difference ($T_s - T_o$) between the air temperature (T_s) at the evaporator (8) and the evaporation temperature (T_o).

3. A control arrangement according to claim 1 or 2, characterized in that a summation element (5) to which

the additional control signal (S) is supplied is located between a PI-element (3) and a D-element (4), connected in series therewith, of the PID controller (2).


2
1
Tü$_S$
PI-
Element
5
D-
Element
7
Expansion-
valve
8
Evaporator
3
4
S
12
K
9
$T_1(T_0)$
10
T_2
Tü
11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 95/00402

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F25B 41/06, F25B 49/02
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F25B, G05D

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

SE,DK,FI,NO classes as above

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5157934 A (UCHIDA), 27 October 1992 (27.10.92) --	1
X	EP 0321670 A2 (SüDDEUTSCHE KüHLERFABRIK JULIUS FR. BEHR GMBH & CO. KG), 28 June 1989 (28.06.89) --	1
A	SE 402345 B (S.T.A.L. REFRIGERATION AB), 26 June 1978 (26.06.78) --	
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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PCT/DK 95/00402

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

05/02/96

International application No.
PCT/DK 95/00402

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		KR-B- 9410975	21/11/94
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