Claims

1. Method for the temperature control of a component, for which a temperature-control system (1) is provided, which comprises:

a) a temperature-control device (3) designed to heat or cool a temperature-control fluid (2);

b) at least two, i.e. ($n \geq 2$) temperature-control assemblies (5,5') designed to conduct a temperature-control fluid (2) through a component (4) to be temperature-controlled and which are connected through ($n \geq 2$) individual feed line parts (6',6'') and through ($n \geq 2$) individual return line parts (7',7'') with the temperature-control device (3), wherein each of the ($n \geq 2$) individual return line parts (7',7'') comprises its own return temperature sensor (8,8') to measure the individual return temperature of the temperature-control fluid (2) from the relevant temperature-control assembly (5,5'); and

c) a controller (9), which comprises valves (10,10') with control elements (11,11') positioned in the ($n \geq 2$) individual feed line parts (6',6'') or ($n \geq 2$) return line parts (7',7''), which are designed to adjust an opening degree of the respectively related valve (10,10'), wherein the controller (9) is designed to control the control elements (11,11') and to read the return temperature sensor (8,8') and comprises a room temperature sensor (12) to detect and report an ACTUAL temperature (13) in direct proximity to the component (4);

wherein the temperature-control method is characterised in that:

i) no feed temperature sensors being used;

ii) a TARGET temperature (14) being predefined for the direct proximity of the component (4);

iii) an initial temperature window (15) not comprising the predefined TARGET temperature (14) being defined as the first positive temperature difference (ΔT_1) for a cooling of component (4) or as a first negative temperature difference (ΔT_2) for heating of component (4) to the predefined TARGET temperature (14) and being implemented in the controller (9); and

iv) the controller (9) issuing the command to control elements (11) of [1 to (n-1)] temperature-control assemblies (5), whose return temperature precedes the return temperatures of the other [1 to (n-1)] temperature-control as-

semblies (5') in the direction of a current temperature change, to close the valve (10) for a first closing time (t_1) in the case of an entering of the ACTUAL temperature (13) into the first temperature window (15), caused by the temperature change and recorded by the room temperature sensor (12), wherein the controller (9) issues the command to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') to keep the valves (10') open during the first closing time (t_1).

2. Temperature-control method in accordance with Claim 1, **characterised in that** a number of (n) temperature-control assemblies (5,5') is selected from a group which comprises (n = 2), (n = 3), (n = 4), and (n = 5) temperature-control assemblies (5,5').

3. Temperature-control method in accordance with Claim 2, **characterised in that** the number (n) of temperature-control assemblies (5,5') is defined as (n > 2), wherein the controller (9) is programmed in such a way that, in the case of an entering of the ACTUAL temperature (13) into the first temperature window (15), caused by a temperature change and recorded by the room temperature sensor (12), it:

iv) issues the command to the control element (11) of an individual temperature-control assembly (5), whose return temperature precedes the return temperatures of the other (n-1) temperature-control assemblies (5') in the direction of the current temperature change, to close the valve (10) for the first closing time (t_1) and issues the command to all other (n-1) temperature-control assemblies (5') to keep the valves (10') open during the first closing time (t_1);

or:

b) issues the command to the control element (11) of (n-1) temperature-control assemblies (5), whose return temperatures precede the return temperature of an individual temperature-control assembly (5') in the direction of the current temperature change, to close the (n-1) valves (10) for the first closing time (t_1) and issues the command to the individual temperature-control assembly (5') to keep the valve (10') open during the first closing time (t_1);

or:

c) should proceed as per method a) until a deviation of the ACTUAL temperature (13) of 0.3 °C from the target temperature (14) has been achieved and should proceed as per method b) from when the deviation of the ACTUAL temperature (13) of 0.2 °C from the target temperature (14) is achieved.

4. Temperature-control method in accordance with Claim 1, 2 or 3, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is still within the first negative temperature difference (ΔT_2), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a second closing time (t_2) after the expiration of the first closing time (t_1), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the second closing time (t_2).

5. Temperature-control method in accordance with Claim 4, **characterised in that** the controller (9), after the expiration of the second closing time (t_5), issues the command to close the valves (10) for a third closing time (t_3) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest, wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the third closing time (t_3).

6. Temperature-control method in accordance with Claim 5, **characterised in that** these method steps are repeated until the temperature-control device (3) is deactivated or a new TARGET temperature (14) is predefined for the direct proximity of the component (4) and is implemented in the controller (9).

7. Temperature-control method in accordance with Claim 1, 2 or 3, **characterised in that** the controller (9) issues the command to the control elements (11,11') of all, i.e. (n), temperature-control assemblies (5,5') to open the valves

(10,10') for a first opening time (t_4) after the expiration of the first closing time (t_1).

8. Temperature-control method in accordance with Claim 7, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature reported by the room temperature sensor (12) is still within the first negative temperature difference (ΔT_2), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a second closing time (t_2) after the expiration of the first opening time (t_4), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the second closing time (t_2), and wherein the controller (9) issues the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5') for a second opening time (t_5) after the expiration of the second closing time (t_2).

9. Temperature-control method in accordance with Claim 8, **characterised in that** the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a third closing time (t_3) after the expiration of the second opening time (t_5), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the third closing time (t_3), and wherein the controller (9) issues the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5') for a third opening time (t_6) after the expiration of the third closing time (t_3).

10. Temperature-control method in accordance with Claim 8 or 9, **characterised in that** if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or m-th opening time ($t_4,t_5,t_6,...,t_m$), the con-

troller (9) will issue the command to close the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

11. Temperature-control method in accordance with Claim 8 or 9, **characterised in that** if the ACTUAL temperature reported by the room temperature sensor (12) is lower than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or m-th opening time ($t_4,t_5,t_6,...,t_m$), the controller (9) will issue the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

12. Temperature-control method in accordance with Claim 9, **characterised in that** these method steps are repeated until the temperature-control device (3) is deactivated or a new TARGET temperature (14) is predefined for the direct proximity of the component (4) and is implemented in the controller (9).

13. Temperature-control method in accordance with Claims 1 to 5 or 8 to 12, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or n-th closing time ($t_1,t_2,t_3,...t_n$), the controller (9) will issue the command to close the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

14. Temperature-control method in accordance with the preceding Claims, **characterised in that** a second temperature window (23) is defined not comprising the predefined TARGET temperature (14) and only comprising parts of the first temperature window (15) and that this is implemented in the controller (9), wherein the second temperature window (23) is defined as a second positive temperature difference (ΔT_3) or as a second negative temperature difference (ΔT_4) to the predefined TARGET temperature (14).

15. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room tem-

perature sensor (12) is lower than the second negative temperature difference (ΔT_4) after the expiration of the first, second, third or n-th closing time ($t_1,t_2,t_3,...t_n$), the controller (9) will issue the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

16. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is within the second negative temperature difference (ΔT_4) after the expiration of the first, second or third closing time (t_1,t_2,t_3), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5,5') whose return temperatures are the highest for an n-th closing time (t_n), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the n-th closing time (t_n).

17. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the second negative temperature difference (ΔT_4) after the expiration of the first, second or third closing time (t_1,t_2,t_3), the controller (9) issues the command to the control elements (11,11') of all (n) temperature-control assemblies (5,5') to close the valves (10,10').

18. Temperature-control system (1) to perform the temperature-control method according to one of Claims 1 to 17, **characterised in that** the temperature-control system (1) comprises:

a) a temperature-control device (3) designed to heat or cool a temperature-control fluid (2);

b) at least two, i.e. ($n \geq 2$), temperature-control assemblies (5,5') which are designed to conduct a temperature-control fluid (2) through a component (4) to be temperature-controlled and are connected through ($n \geq 2$) individual feed line parts (6',6'') and through ($n \geq 2$) individual return line parts

(7',7") with the temperature-control device (3), wherein each of the (n ≥ 2) individual return line parts (7',7") comprises its own return temperature sensor (8,8') to measure the individual return temperature of the temperature-control fluid (2) from the relevant temperature-control assembly (5,5');

c) no feed temperature sensor; and

d) a controller (9), which comprises valves (10,10') with control elements (11,11') positioned in the (n ≥ 2) individual feed line parts (6',6") or (n ≥ 2) return line parts (7',7"), which are designed to adjust an opening degree of the related valve (10,10'), wherein the controller (9) is designed to control the control elements (11,11') and to read the return temperature sensors (8,8') and comprises a room temperature sensor (12) to detect and report an ACTUAL temperature (13) in direct proximity to the component (4).

19. Temperature-control system (1) in accordance with Claim 18, **characterised in that** the controller (9) comprises a memory (16) for saving parameters, wherein the parameters are selected from a group, which comprises at least one TARGET temperature (14), a first temperature window (15), a second temperature window (23), a first, second, third up to n-th closing time (t_1,t_2,t_3,...,t_n) and a first, second, third up to m-th opening time (t_4,t_5,t_6,...,t_m), **and in that** the controller (9) comprises a computer (17) to retrieve and process the parameters from the memory (16) and to monitor the temperature-control system (1).

20. Temperature-control system (1) in accordance with Claim 18 or 19, **characterised in that** the individual feed line parts (6',6") lead into a feed distribution beam (18), wherein the feed distribution beam (18) is connected with the temperature-control device (3) through a shared feed part line (6).

21. Temperature-control system (1) in accordance with Claim 18 or 19, **characterised in that** the individual return line parts (7',7") lead into a return distribution beam (19), wherein the return distribution beam (19) is connected with the temperature-control device (3) through a shared return part line (7).

22. Temperature-control system (1) in accordance with Claim 20 or 21, **characterised in that** it comprises a circulating pump (20) which is installed in the shared feed part line (6) or in the shared return part line (7).

Claims

1. Method for the temperature control of a component, for which a temperature-control system (1) is provided, which comprises:

a) a temperature-control device (3) designed to heat or cool a temperature-control fluid (2);

b) at least two, i.e. ($n \geq 2$) temperature-control assemblies (5,5') designed to conduct a temperature-control fluid (2) through a component (4) to be temperature-controlled and which are connected through ($n \geq 2$) individual feed line parts (6',6'') and through ($n \geq 2$) individual return line parts (7',7'') with the temperature-control device (3), wherein each of the ($n \geq 2$) individual return line parts (7',7'') comprises its own return temperature sensor (8,8') to measure the individual return temperature of the temperature-control fluid (2) from the relevant temperature-control assembly (5,5'); and

c) a controller (9), which comprises valves (10,10') with control elements (11,11') positioned in the ($n \geq 2$) individual feed line parts (6',6'') or ($n \geq 2$) return line parts (7',7''), which are designed to adjust an opening degree of the respectively related valve (10,10'), wherein the controller (9) is designed to control the control elements (11,11') and to read the return temperature sensor (8,8') and comprises a room temperature sensor (12) to detect and report an ACTUAL temperature (13) in direct proximity to the component (4);

wherein the temperature-control method is characterised in that:

i) no feed temperature sensors being used;

ii) a TARGET temperature (14) being predefined for the direct proximity of the component (4);

iii) an initial temperature window (15) not comprising the predefined TARGET temperature (14) being defined as the first positive temperature difference (ΔT_1) for a cooling of component (4) or as a first negative temperature difference (ΔT_2) for heating of component (4) to the predefined TARGET temperature (14) and being implemented in the controller (9); and

iv) the controller (9) issuing the command to control elements (11) of [1 to (n-1)] temperature-control assemblies (5), whose return temperature precedes the return temperatures of the other [1 to (n-1)] temperature-control as-

semblies (5') in the direction of a current temperature change, to close the valve (10) for a first closing time (t_1) in the case of an entering of the ACTUAL temperature (13) into the first temperature window (15), caused by the temperature change and recorded by the room temperature sensor (12), wherein the controller (9) issues the command to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') to keep the valves (10') open during the first closing time (t_1).

2. Temperature-control method in accordance with Claim 1, **characterised in that** a number of (n) temperature-control assemblies (5,5') is selected from a group which comprises (n = 2), (n = 3), (n = 4), and (n = 5) temperature-control assemblies (5,5').

3. Temperature-control method in accordance with Claim 2, **characterised in that** the number (n) of temperature-control assemblies (5,5') is defined as (n > 2), wherein the controller (9) is programmed in such a way that, in the case of an entering of the ACTUAL temperature (13) into the first temperature window (15), caused by a temperature change and recorded by the room temperature sensor (12), it:

iv) issues the command to the control element (11) of an individual temperature-control assembly (5), whose return temperature precedes the return temperatures of the other (n-1) temperature-control assemblies (5') in the direction of the current temperature change, to close the valve (10) for the first closing time (t_1) and issues the command to all other (n-1) temperature-control assemblies (5') to keep the valves (10') open during the first closing time (t_1);

or:

b) issues the command to the control element (11) of (n-1) temperature-control assemblies (5), whose return temperatures precede the return temperature of an individual temperature-control assembly (5') in the direction of the current temperature change, to close the (n-1) valves (10) for the first closing time (t_1) and issues the command to the individual temperature-control assembly (5') to keep the valve (10') open during the first closing time (t_1);

or:

c) should proceed as per method a) until a deviation of the ACTUAL temperature (13) of 0.3 °C from the target temperature (14) has been achieved and should proceed as per method b) from when the deviation of the ACTUAL temperature (13) of 0.2 °C from the target temperature (14) is achieved.

4. Temperature-control method in accordance with Claim 1, 2 or 3, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is still within the first negative temperature difference (ΔT_2), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a second closing time (t_2) after the expiration of the first closing time (t_1), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the second closing time (t_2).

5. Temperature-control method in accordance with Claim 4, **characterised in that** the controller (9), after the expiration of the second closing time (t_5), issues the command to close the valves (10) for a third closing time (t_3) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest, wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the third closing time (t_3).

6. Temperature-control method in accordance with Claim 5, **characterised in that** these method steps are repeated until the temperature-control device (3) is deactivated or a new TARGET temperature (14) is predefined for the direct proximity of the component (4) and is implemented in the controller (9).

7. Temperature-control method in accordance with Claim 1, 2 or 3, **characterised in that** the controller (9) issues the command to the control elements (11,11') of all, i.e. (n), temperature-control assemblies (5,5') to open the valves

(10,10') for a first opening time (t_4) after the expiration of the first closing time (t_1).

8. Temperature-control method in accordance with Claim 7, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature reported by the room temperature sensor (12) is still within the first negative temperature difference (ΔT_2), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a second closing time (t_2) after the expiration of the first opening time (t_4), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the second closing time (t_2), and wherein the controller (9) issues the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5') for a second opening time (t_5) after the expiration of the second closing time (t_2).

9. Temperature-control method in accordance with Claim 8, **characterised in that** the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5) whose return temperatures are the highest for a third closing time (t_3) after the expiration of the second opening time (t_5), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the third closing time (t_3), and wherein the controller (9) issues the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5') for a third opening time (t_6) after the expiration of the third closing time (t_3).

10. Temperature-control method in accordance with Claim 8 or 9, **characterised in that** if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or m-th opening time ($t_4, t_5, t_6, \ldots, t_m$), the con-

troller (9) will issue the command to close the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

11. Temperature-control method in accordance with Claim 8 or 9, **characterised in that** if the ACTUAL temperature reported by the room temperature sensor (12) is lower than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or m-th opening time ($t_4,t_5,t_6,...,t_m$), the controller (9) will issue the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

12. Temperature-control method in accordance with Claim 9, **characterised in that** these method steps are repeated until the temperature-control device (3) is deactivated or a new TARGET temperature (14) is predefined for the direct proximity of the component (4) and is implemented in the controller (9).

13. Temperature-control method in accordance with Claims 1 to 5 or 8 to 12, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the first negative temperature difference (ΔT_2) after the expiration of the first, second, third or n-th closing time ($t_1,t_2,t_3,...t_n$), the controller (9) will issue the command to close the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

14. Temperature-control method in accordance with the preceding Claims, **characterised in that** a second temperature window (23) is defined not comprising the predefined TARGET temperature (14) and only comprising parts of the first temperature window (15) and that this is implemented in the controller (9), wherein the second temperature window (23) is defined as a second positive temperature difference (ΔT_3) or as a second negative temperature difference (ΔT_4) to the predefined TARGET temperature (14).

15. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room tem-

perature sensor (12) is lower than the second negative temperature difference (ΔT_4) after the expiration of the first, second, third or n-th closing time ($t_1,t_2,t_3,...t_n$), the controller (9) will issue the command to open the valves (10,10') to the control elements (11,11') of all (n) temperature-control assemblies (5,5').

16. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is within the second negative temperature difference (ΔT_4) after the expiration of the first, second or third closing time (t_1,t_2,t_3), the controller (9) issues the command to close the valves (10) to the control elements (11) of [1 to (n-1)] temperature-control assemblies (5,5') whose return temperatures are the highest for an n-th closing time (t_n), wherein the controller (9) issues the command to keep the valves (10') open to the control elements (11') of the other [1 to (n-1)] temperature-control assemblies (5') during the n-th closing time (t_n).

17. Temperature-control method in accordance with Claim 14, **characterised in that** if the temperature-control device (3) is designed to heat the temperature-control fluid (2) and if the ACTUAL temperature (13) reported by the room temperature sensor (12) is higher than the second negative temperature difference (ΔT_4) after the expiration of the first, second or third closing time (t_1,t_2,t_3), the controller (9) issues the command to the control elements (11,11') of all (n) temperature-control assemblies (5,5') to close the valves (10,10').