Patent claims

1. Method for operating a circulation system (10) having a temperature control device with an input port and an output port for the temperature control of water and having a pipeline system with multiple branches comprising one or more partial sections with given thermal coupling to the surroundings and being connected by means of nodes, wherein one or more of the lines of the pipeline system are configured as a flow pipe (4, 5, 6), at least one as a single supply line (7) connected to a tapping point (9), and at least one line configured as a circulation conduit (10a) connected to the flow pipe or pipes (4, 5, 6),

with the steps

- setting a water temperature at the output port to a value T_a by means of the temperature controlled device

- setting a volume flow at the input port to a value V_z

characterized by the following steps

- determining, in particular calculating, a temperature change of the water between the initial region and the end region according to a model of the axial temperature change for the first partial section connected to the output port, starting from a temperature start value T_{MA}* and a volume flow start value V_z*,

- determining, in particular calculating, a temperature change of the water between the initial region and the end region for each further given partial section according to the model of the temperature change, under the boundary condition that the water temperature in the initial region of the given partial section is equal to the water temperature in the end region of the partial section to which the given partial section is connected, and

- selecting the value T_a of the water temperature and the value V_z of the volume flow at the output port such that, in the end region of each partial section, the water temperature T_{ME} lies in a given temperature interval around T_{soll}, in particular, at the input port the water temperature is set at $T_b < T_{soll}$ with $T_{soll} - T_b < \theta$, where $\theta>0$ is a given value,

- wherein the temperature control device (12‘) with the inlet port (12a‘) is connected by a line (2‘) to a water supply (1), or
- where a cooling device (20) is provided, which with the inlet port (20a) is connected by a line (2‘) with a water supply (1), whereas the circulation line (10a) is connected downstream from the outlet port (20b‘).

2. The method according to claim 1, characterized in that the values T_a and V_z are determined in an iterative approximation procedure, wherein the temperature change of the water between the initial region and the end region is calculated starting from a temperature start value T_{MA}* and a volume flow start value V_z* for the first partial section connected to the output port for each further given partial section under the boundary condition that the water temperature in the initial region of the given partial section is equal to the water temperature in the end region of the partial section to which the given partial section is connected.

3. The method according to claim 1 or 2, characterized in that the partial sections are designed uniformly in regard to their thermal coupling to the surroundings along the length between their initial region and their end region.

4. The method according to claim 3, characterized in that the water temperature T_{ME} in the end region of at least one partial section with length L is determined by means of the formula

$$T_{ME} = (T_{MA} - T_{Luft}) * e^{-\varepsilon * L} + T_{Luft}$$

$$\varepsilon = \frac{k_R}{m_M * c_{pm}} = \frac{k_R}{V_M * \rho_M * c_{pm}}$$

where

L = the length of the uniform partial section (T_{S1}) (m)
T_{MA} = the water temperature in the initial region (°C)
T_{ME} = the water temperature in the end region (°C)
T_{Luft} = the temperature of the ambient air(°C)
k_R = the heat transfer coefficient of the pipeline (W/(m*K))
m_M = the mass flow of the water in the partial section (kg/ s)
$c_{p,m}$ = the spec. heat capacity of the water (J/(kg*K))

V_M = the volume flow of the water in the partial section (m^3/s)

p_M = the density of the water (kg/m^3)

5. The method according to claim 4, characterized in that the heat transfer coefficient of the partial sections is determined by the formula

$$\frac{1}{k_R} = \frac{1}{d_i * \alpha_i * \pi} + \frac{1}{\Lambda_R} + \frac{1}{d_a * \alpha_a * \pi}$$

where

$1/k_R$ = the heat transmission resistance of the pipeline (m * K/W)

αi = the inward heat transfer coefficient ($W/(m^2 * K)$)

$1/\Lambda R$ = the thermal resistance (m * K/W)

a_a = the outward heat transfer coefficient ($W/(m^2 * K)$)

d_a = the outer diameter (m)

d_i = the inner diameter (m)

and

$$\frac{1}{\Lambda_R} = \frac{1}{2*\pi} * \left(\frac{1}{\lambda_r} * ln\frac{d_{aR}}{d_{iR}} + \frac{1}{\lambda_D} * ln\frac{d_{aD}}{d_{iD}}\right)$$

6. The method according to one of the preceding claims, characterized in that a circulation pump (10b) is integrated in the circulation system (10).

7. The method according to one of the preceding claims, characterized in that the parameter T_a and V_z as determined by the method are used in order to determine the design of the temperature control device in terms of its cooling power in a given circulation system, in which the pipeline system is designed in accordance with legal specifications regarding nominal widths and thermal coupling of the circulating water to the surroundings and/or that the design of a circulation pump may be determined in regard to its pumping power.

8. The method according to any one of claims 6 to 7, characterized by

- determining a consumer characteristic of the circulation pump (10b) in dependence on a delivered volume flow of the circulation pump (10b)

- determining a consumer characteristic of the temperature control device in dependence on a water temperature at the output port

- setting a volume flow V_z and a water temperature T_a at the output port such that the power consumption of the circulation pump (10b) and the temperature control device takes on a relative or absolute minimum value.

9. A circulation system having a temperature control device with an input port and an output port for the cooling of water and having a pipeline system with multiple branches comprising one or more partial sections with given thermal coupling to the surroundings and being connected by means of nodes,

- wherein, for a given apportionment of the volume flows emerging from the nodes, a mixed water temperature is determinable from the volume flows emerging from the nodes in dependence on the volume flows entering the nodes,

- wherein one or more of the lines of the pipeline system are configured as a flow pipe (4, 5, 6), at least one as a single supply line (7) connected to a tapping point (9), and at least one line configured as a circulation conduit (10a) connected to the flow pipe or pipes (4, 5, 6),

having

- means of setting the water temperature at the output port (12b, 14b) to a value T_a by means of the temperature control device

- means of setting a stationary volume flow of circulating water at the input port (12a, 14a) to a value V_z

characterized by

- device means for determining a temperature change of the water between the initial region and the end region of each partial section under the boundary condition that the water temperature in the end region of a given partial section is

chosen equal to the water temperature in the initial region of the partial section connected to the given partial section in the flow direction of the circulating water and

- device means for selecting the value T_a of the water temperature and the value V_z of the volume flow at the output port (12b, 14b) such that, in the end region of each partial section, the water temperature T_{ME} lies in a given temperature interval around T_{soll}, in particular, at the input port (12a, 14a) the water temperature is set at $T_b < T_{soll}$ with $T_{soll} - T_b < \theta$, where $\theta > 0$ is a given value, and

wherein the temperature control device (12‘) with the inlet port (12a‘) is connected by a line (2‘) to a water supply (1), or

wherein a cooling device (20) is provided, which with the inlet port (20a) is connected by a line (2‘) with a water supply (1), whereas the circulation line (10a) is connected downstream from the outlet port (20b‘).

10. The circulation system according to claim 9, characterized in that device means are provided for determining the values T_a and V_z in an iterative approximation procedure, wherein the water temperature T_{ME} is calculated for each given partial section in its end region, starting from a temperature start value $T_{MA}^* < T_{soll}$ and a volume flow start value V_z^* for the first partial section connected to the output port (12b), wherein the water temperature T_{MA}‘ in the initial region of the next attached partial section is chosen equal to the water temperature T_{ME} in the end region of the given partial section.

11. The circulation system according to any one of claims 9 to 10, characterized in that the partial sections are designed uniformly in regard to their thermal coupling to the surroundings along the length between their initial region and their end region.

12. The circulation system according to any one claims 9 to 11, characterized in that a circulation pump (7) is integrated in the circulation system (10).

13. The circulation system according to any one of claims 9 to 12, characterized in that, by means of the temperature control device, thermal energy from the circulating water is transferred to another material flow by means of heat exchange means.

14. The circulation system according to claims 9 to 12, characterized in that in that the parameter T_a and V_z as determined by the method are used in order to determine the design of the temperature control device in terms of its cooling power in a given circulation system, in which the pipeline system is designed in accordance with the legal specifications regarding nominal widths and thermal coupling of the circulating water to the surroundings and/or that the design of a circulation pump may be determined in regard to its pumping power.