DESCRIPTION

TITLE

TEMPERATURE MEASUREMENT DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to a temperature measurement device.

BACKGROUND

[0002] A temperature measurement device that measures the temperature of a fluid inside a pipe by measuring the temperature of the pipe surface with a thermometer is known. See, for example, Patent Literature (PTL) 1 to 3.

CITATION LIST

Patent Literature

[0003] PTL 1: JP 4584388 B2

PTL 2: JP 4537776 B2

PTL 3: JP 6835856 B2

SUMMARY

(Technical Problem)

[0004] It is an object of the present disclosure to provide a temperature measurement device that has high measurement accuracy and is easy to install.

(Solution to Problem)

[0005] An aspect of the present disclosure is as follows.

[0006] [1]

A temperature measurement device comprising:

a thermometer, a first clamping member, a second clamping member, a first enclosure, and a second enclosure,

wherein the first clamping member and the second clamping member are configured to clamp a pipe through which a fluid flows and the thermometer,

wherein the first enclosure and the second enclosure are configured to clamp the pipe so as to define a thermally insulating space around the pipe, the thermally insulating space facing the first clamping member and the

second clamping member, and

wherein the temperature measurement device measures a temperature of the fluid inside the pipe by measuring, with the thermometer, a temperature of a surface of the pipe at a portion enclosed by the first enclosure and the second enclosure.

[0007] [2]

The temperature measurement device according to [1], further comprising a pressing portion configured to press a temperature sensing portion of the thermometer toward the surface of the pipe.

[0008] [3]

The temperature measurement device according to [2],

wherein the first clamping member includes a first main clamping portion and a first auxiliary clamping portion integrally provided on the first main clamping portion,

wherein the second clamping member includes a second main clamping portion and a second auxiliary clamping portion integrally provided on the second main clamping portion,

wherein the pressing portion is configured by the first auxiliary clamping portion and the second auxiliary clamping portion, and

wherein the first auxiliary clamping portion and the second auxiliary clamping portion are configured to clamp the pipe and the temperature sensing portion of the thermometer by the first main clamping portion and the second main clamping portion clamping the pipe and the thermometer.

[0009] [4]

The temperature measurement device according to any one of [1] to [3], wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the first clamping member is integrally provided on the first enclosure.

[0010] [5]

The temperature measurement device according to any one of [1] to [4], wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the thermometer is integrally provided on the first enclosure.

[0011] [6]

The temperature measurement device according to any one of [1] to [5], further comprising a thermal conductor configured to fill a gap between

the surface of the pipe and a temperature sensing portion of the thermometer.

[0012] [7]

The temperature measurement device according to [6], wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the thermal conductor is integrally provided on the first enclosure.

[0013] [8]

The temperature measurement device according to any one of [1] to [7], further comprising a reference thermometer configured to measure a temperature outside the pipe.

[0014] [9]

The temperature measurement device according to [8], wherein the reference thermometer is configured to measure a temperature at a position inward from an outer surface of a container formed by the first enclosure and the second enclosure.

[0015] [10]

The temperature measurement device according to [9], wherein the reference thermometer is configured to measure a temperature of the first enclosure, the second enclosure, or the thermally insulating space.

[0016] [11]

The temperature measurement device according to any one of [8] to [10], wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the reference thermometer is integrally provided on the first enclosure.

[0017] [12]

The temperature measurement device according to any one of [1] to [11], wherein the thermally insulating space is a space in which no object is disposed or a space in which a thermally insulating material is disposed.

[0018] [13]

The temperature measurement device according to any one of [1] to [12], wherein a temperature sensing portion of the thermometer is disposed within a container formed by the first enclosure and the second enclosure and is biased toward a downstream side of the fluid inside the pipe in a longitudinal direction of the pipe.

(Advantageous Effect)

[0019] According to the present disclosure, a temperature measurement

device that has high measurement accuracy and is easy to install can be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the accompanying drawings:

FIG. 1 is a perspective view illustrating a temperature measurement device according to a first embodiment of the present disclosure;

FIG. 2 is a perspective view, from a different angle, of the temperature measurement device illustrated in FIG. 1 with a second enclosure omitted;

FIG. 3 is a perspective view illustrating a temperature measurement device according to a second embodiment of the present disclosure, with a second enclosure omitted; and

FIG. 4 is a perspective view illustrating a temperature measurement device according to a third embodiment of the present disclosure, with a second enclosure omitted.

DETAILED DESCRIPTION

[0021] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the drawings.

[0022] As illustrated in FIGS. 1 and 2, the temperature measurement device 1 according to a first embodiment of the present disclosure includes a thermometer 2, a first clamping member 3, a second clamping member 4, a first enclosure 5, and a second enclosure 6. The first clamping member 3 and the second clamping member 4 clamp a pipe 7, through which a fluid (see the bold arrows in FIGS. 1 and 2) flows, and the thermometer 2 in a first direction D1. The first enclosure 5 and the second enclosure 6 clamp the pipe 7 in a second direction D2 (see the white arrow in FIG. 1) so as to define a thermally insulating space S around the pipe 7, the thermally insulating space S facing the first clamping member 3 and the second clamping member 4. The temperature measurement device 1 measures the temperature of the fluid inside the pipe 7 by measuring, with the thermometer 2, the temperature of the surface (outer surface) of the pipe 7 at a portion enclosed by the first enclosure 5 and the second enclosure 6.

[0023] With the above configuration, the state in which the thermometer 2 is disposed along the surface of the pipe 7 to measure the surface temperature of the pipe 7 can be maintained by the first clamping member 3 and the second

clamping member 4, and the influence of the external environment on the surface temperature of the pipe 7 can be suppressed by the thermally insulating space S formed by the first enclosure 5 and the second enclosure 6. Therefore, the temperature of the fluid inside the pipe 7 can be measured with high accuracy (reproducibility). Furthermore, the temperature measurement device 1 can be installed by a simple procedure by clamping the pipe 7 and the thermometer 2 with the first clamping member 3 and the second clamping member 4, and then clamping the pipe 7 with the first enclosure 5 and the second enclosure 6. The thermometer 2 is, for example, a resistance thermometer (such as a platinum resistance thermometer) or a thermocouple. The thermally insulating space S is a space in which no object is disposed (for example, a space filled with air) or a space in which a thermally insulating material (not illustrated) is disposed.

[0024] The fluid is not particularly limited, but in the present embodiment the fluid is a liquid. The fluid may, for example, be a corrosive fluid such as a chemical. The temperature measurement device 1 of the present embodiment measures the temperature of the fluid without contacting the fluid itself and is therefore particularly suitable when the fluid is corrosive.

[0025] In the present embodiment, the first direction D1 is perpendicular to the pipe 7 that extends linearly within the temperature measurement device 1, but this configuration is not limiting. Furthermore, the first direction D1 is horizontal in the present embodiment, but this configuration is not limiting. The second direction D2 is perpendicular to the first direction D1 in the present embodiment, but this configuration is not limiting. Furthermore, the second direction D2 is the vertical direction in the present embodiment, but this configuration is not limiting. The second direction D2 is different from the first direction D1 in the present embodiment, but this configuration is not limiting.

[0026] The temperature measurement device 1 includes a pressing portion 8 that presses a temperature sensing portion 2a of the thermometer 2 toward the surface of the pipe 7. With the above configuration, the pressing portion 8 facilitates transmission of the surface temperature of the pipe 7 to the temperature sensing portion 2a of the thermometer 2, thereby improving measurement accuracy.

[0027] In the present embodiment, the pressing portion 8 is an elastic annular member 9 that surrounds and tightens the pipe 7 and the temperature sensing

portion 2a of the thermometer 2, but this configuration is not limiting. For example, as illustrated in a second embodiment in FIG. 3, the first clamping member 3 may include a first main clamping portion 3a and a first auxiliary clamping portion 3b integrally provided on the first main clamping portion 3a, the second clamping member 4 may include a second main clamping portion 4a and a second auxiliary clamping portion 4b integrally provided on the second main clamping portion 4a, the pressing portion 8 may be formed by the first auxiliary clamping portion 3b and the second auxiliary clamping portion 4b, and the first auxiliary clamping portion 3b and the second auxiliary clamping portion 4b may be configured to clamp the pipe 7 and the temperature sensing portion 2a of the thermometer 2 by the first main clamping portion 3a and the second main clamping portion 4a clamping the pipe 7 and the thermometer 2. With the above configuration, the temperature sensing portion 2a of the thermometer 2 can be pressed toward the surface of the pipe 7 by the first auxiliary clamping portion 3b and the second auxiliary clamping portion 4b, which serve as the pressing portion 8, simply by clamping the pipe 7 and the thermometer 2 with the first main clamping portion 3a and the second main clamping portion 4a, thereby improving ease of installation.

[0028] The first auxiliary clamping portion 3b is integrally formed on the first main clamping portion 3a in the present embodiment, but this configuration is not limiting, and the first auxiliary clamping portion 3b may be integrally connected to the first main clamping portion 3a. Furthermore, the second auxiliary clamping portion 4b is integrally formed on the second main clamping portion 4a in the present embodiment, but this configuration is not limiting, and the second auxiliary clamping portion 4b may be integrally connected to the second main clamping portion 4a.

[0029] The first auxiliary clamping portion 3b includes a first arm 3b1 that projects from the first main clamping portion 3a in the longitudinal direction of the pipe 7 and a first projection 3b2 that projects from the tip of the first arm 3b1 toward the pipe 7 in a first direction D1 and presses the temperature sensing portion 2a of the thermometer 2 toward the surface of the pipe 7. The second auxiliary clamping portion 4b includes a second arm 4b1 that projects from the second main clamping portion 4a in the longitudinal direction of the pipe 7 and a second projection 4b2 that projects from the tip of the second arm 4b1 toward the pipe 7 in the first direction D1 and presses the surface of the

pipe 7.

[0030] In the present embodiment, the first auxiliary clamping portion 3b and the second auxiliary clamping portion 4b (pressing portion 8) are located on the upstream side of the fluid in the pipe 7 from the first main clamping portion 3a and the second main clamping portion 4a in the longitudinal direction of the pipe 7. With the above configuration, even if there is an effect on the fluid flow inside the pipe 7 due to the clamping of the first main clamping portion 3a and the second main clamping portion 4a, the effect on the fluid flow near the temperature sensing portion 2a of the thermometer 2 can be suppressed, thereby further improving the measurement accuracy.

[0031] Furthermore, a first plate member 3c and a second plate member 4c may be added to the configuration of the second embodiment, as illustrated in the third embodiment in FIG. 4. In the third embodiment, the first clamping member 3 includes a first plate member 3c that has a first leaf spring portion 3c1. The first leaf spring portion 3c1 is formed in a plate shape perpendicular to the first direction D1, is held by the first main clamping portion 3a, and presses the first auxiliary clamping portion 3b toward the surface of the pipe 7 in the first direction D1. The second clamping member 4 includes a second plate member 4c that has a second leaf spring portion 4c1. The second leaf spring portion 4c1 is formed in a plate shape perpendicular to the first direction D1, is held by the second main clamping portion 4a, and presses the second auxiliary clamping portion 4b toward the surface of the pipe 7 in the first direction D1.

[0032] Although not illustrated, the temperature measurement device 1 may be configured without the pressing portion 8. For example, the first clamping member 3 may be configured to include the first main clamping portion 3a but not the first auxiliary clamping portion 3b, and the second clamping member 4 may be configured to include the main clamping portion 4a but not the second auxiliary clamping portion 4b.

[0033] The first clamping member 3 and the second clamping member 4 clamp the pipe 7 and the thermometer 2 while the first clamping member 3 is integrally provided on the first enclosure 5. The above configuration eliminates the effort required to attach the first clamping member 3 to the first enclosure 5 during installation, thereby further improving the ease of installation.

[0034] The first clamping member 3 and the second clamping member 4

clamp the pipe 7 and the thermometer 2 while the thermometer 2 is integrally provided on the first enclosure 5. The above configuration eliminates the effort required to attach the thermometer 2 to the first enclosure 5 during installation, thereby further improving the ease of installation.

[0035] The temperature measurement device 1 includes a thermal conductor 10 that fills the gap between the surface of the pipe 7 and the temperature sensing portion 2a of the thermometer 2. With the above configuration, the thermal conductor 10 facilitates transmission of the surface temperature of the pipe 7 to the temperature sensing portion 2a of the thermometer 2, thereby improving measurement accuracy.

[0036] The first clamping member 3 and the second clamping member 4 clamp the pipe 7 and the thermometer 2 while the thermal conductor 10 is integrally provided on the first enclosure 5. The above configuration eliminates the effort required to attach the thermal conductor 10 to the first enclosure 5 during installation, thereby further improving the ease of installation.

[0037] The temperature measurement device 1 includes a reference thermometer 11 that measures the temperature outside the pipe 7. With the above configuration, the temperature of the fluid inside the pipe 7 can be measured by utilizing the temperature gradient between the measurement value from the reference thermometer 11 and the measurement value from the thermometer 2, thereby further improving the measurement accuracy. The reference thermometer 11 is, for example, a resistance thermometer (such as a platinum resistance thermometer) or a thermocouple.

[0038] The reference thermometer 11 measures the temperature at a position inward from the outer surface of a container 12 formed by the first enclosure 5 and the second enclosure 6. With the above configuration, the influence of the external environment on the measurement value by the reference thermometer 11 can be suppressed, thereby further improving the measurement accuracy.

[0039] The reference thermometer 11 measures the temperature of the first enclosure 5, the second enclosure 6, or the thermally insulating space S (in the present embodiment, the thermally insulating space S). In the present embodiment, a reference temperature sensing portion 11a of the reference thermometer 11 is disposed to face the thermally insulating space S and measures the temperature of the thermally insulating space S, but this configuration is not limiting. For example, the reference temperature sensing

portion 11a may be embedded in the first enclosure 5 to measure the temperature of the first enclosure 5 or embedded in the second enclosure 6 to measure the temperature of the second enclosure 6. With the above configuration, the temperature of the fluid inside the pipe 7 can be measured by utilizing the high temperature gradient between the measurement value from the reference thermometer 11 and the measurement value from the thermometer 2, while suppressing the influence of the external environment on the measurement value from the reference thermometer 11, thereby further improving the measurement accuracy.

[0040] The first clamping member 3 and the second clamping member 4 clamp the pipe 7 and the thermometer 2 while the reference thermometer 11 is integrally provided on the first enclosure 5. The above configuration eliminates the effort required to attach the reference thermometer 11 to the first enclosure 5 during installation, thereby further improving the ease of installation.

[0041] The temperature sensing portion 2a of the thermometer 2 is disposed within the container 12 and is biased toward the downstream side of the fluid inside the pipe 7 in the longitudinal direction of the pipe 7. With the above configuration, the temperature is measured by the temperature sensing portion 2a of the thermometer 2 at a position where the fluid flowing in the pipe 7 has been rectified by flowing linearly within the container 12 (for example, a position downstream from the inlet of the container 12 by a distance of about ten times the inner diameter of the pipe 7), thereby further improving measurement accuracy.

[0042] The first clamping member 3 includes a first recess 3d, and the second clamping member 4 includes a second recess 4d. The first clamping member 3 and the second clamping member 4 clamp the pipe 7 and the thermometer 2 in the first recess 3d and the second recess 4d, respectively. With the above configuration, the pipe 7 and the thermometer 2 can be easily clamped, further improving ease of installation.

[0043] The temperature measurement device 1 includes a fastener 13 that tightens the second clamping member 4 in the first direction D1 against the first clamping member 3. With the above configuration, the degree to which the fastener 13 is tightened can be adjusted according to the size of the pipe 7, thereby allowing the pipe 7 and the thermometer 2 to be clamped with an appropriate force. In the present embodiment, the fastener 13 is configured by

a bolt 13a, having a threaded shaft (not illustrated) and a head 13a1, and a threaded hole (not illustrated) provided in the second clamping member 4 to engage with the threaded shaft of the bolt 13a, but this configuration is not limiting. The number of fasteners 13 provided on the temperature measurement device 1 is two in the present embodiment, but this number may be set as appropriate.

[0044] The first clamping member 3, the second clamping member 4, the first enclosure 5, and the second enclosure 6 are each formed from resin, for example, such as PEEK (polyetheretherketone), but this configuration is not limiting.

[0045] Although embodiments of the present disclosure have been described above, the present disclosure is not limited to the above-described embodiments, and the above-described embodiments can be modified in various ways without departing from the scope of the present disclosure.

REFERENCE SIGNS LIST

[0046]

1	Temperature measurement device
2	Thermometer
2a	Temperature sensing portion
3	First clamping member
3a	First main clamping portion
3b	First auxiliary clamping portion
3b1	First arm
3b2	First projection
3c	First plate member
3c1	First leaf spring portion
3d	First recess
4	Second clamping member
4a	Second main clamping portion
4b	Second auxiliary clamping portion
4b1	Second arm
4b2	Second projection
4c	Second plate member
4c1	Second leaf spring portion
4d	Second recess
5	First enclosure

6	Second enclosure
7	Pipe
8	Pressing portion
9	Elastic annular member
10	Thermal conductor
11	Reference thermometer
11a	Reference temperature sensing portion
12	Container
13	Fastener
13a	Bolt
13a1	Head
S	Thermally insulating space
D1	First direction
D2	Second direction

CLAIMS

[Claim 1] A temperature measurement device comprising:

a thermometer, a first clamping member, a second clamping member, a first enclosure, and a second enclosure,

wherein the first clamping member and the second clamping member are configured to clamp a pipe through which a fluid flows and the thermometer,

wherein the first enclosure and the second enclosure are configured to clamp the pipe so as to define a thermally insulating space around the pipe, the thermally insulating space facing the first clamping member and the second clamping member, and

wherein the temperature measurement device measures a temperature of the fluid inside the pipe by measuring, with the thermometer, a temperature of a surface of the pipe at a portion enclosed by the first enclosure and the second enclosure.

[Claim 2] The temperature measurement device according to claim 1, further comprising a pressing portion configured to press a temperature sensing portion of the thermometer toward the surface of the pipe.

[Claim 3] The temperature measurement device according to claim 2,

wherein the first clamping member includes a first main clamping portion and a first auxiliary clamping portion integrally provided on the first main clamping portion,

wherein the second clamping member includes a second main clamping portion and a second auxiliary clamping portion integrally provided on the second main clamping portion,

wherein the pressing portion is configured by the first auxiliary clamping portion and the second auxiliary clamping portion, and

wherein the first auxiliary clamping portion and the second auxiliary clamping portion are configured to clamp the pipe and the temperature sensing portion of the thermometer by the first main clamping portion and the second main clamping portion clamping the pipe and the thermometer.

[Claim 4] The temperature measurement device according to claim 1,

wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the first clamping member is integrally provided on the first enclosure.

[Claim 5] The temperature measurement device according to claim 1, wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the thermometer is integrally provided on the first enclosure.

[Claim 6] The temperature measurement device according to claim 1, further comprising a thermal conductor configured to fill a gap between the surface of the pipe and a temperature sensing portion of the thermometer.

[Claim 7] The temperature measurement device according to claim 6, wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the thermal conductor is integrally provided on the first enclosure.

[Claim 8] The temperature measurement device according to claim 1, further comprising a reference thermometer configured to measure a temperature outside the pipe.

[Claim 9] The temperature measurement device according to claim 8, wherein the reference thermometer is configured to measure a temperature at a position inward from an outer surface of a container formed by the first enclosure and the second enclosure.

[Claim 10] The temperature measurement device according to claim 9, wherein the reference thermometer is configured to measure a temperature of the first enclosure, the second enclosure, or the thermally insulating space.

[Claim 11] The temperature measurement device according to claim 8, wherein the first clamping member and the second clamping member are configured to clamp the pipe and the thermometer while the reference thermometer is integrally provided on the first enclosure.

[Claim 12] The temperature measurement device according to claim 1, wherein the thermally insulating space is a space in which no object is disposed or a space in which a thermally insulating material is disposed.

[Claim 13] The temperature measurement device according to claim 1, wherein a temperature sensing portion of the thermometer is disposed within a container formed by the first enclosure and the second enclosure and is biased toward a downstream side of the fluid inside the pipe in a longitudinal direction of the pipe.