

DESCRIPTION

GAS HEATING METHOD, AND GAS-HEATING PIPING MEMBER

TECHNICAL FIELD

[0001]

This invention relates to a gas heating method and a gas-heating piping member for heating a gas to a predetermined temperature that is used for producing a chemical, a semiconductor, or the like.

BACKGROUND ART

• [0002]

In piping used in a semiconductor manufacturing machine, a gas is required to be heated to a predetermined temperature in some cases. In general, therefore, the pipes are wrapped with a tape heater, and heated from the outside thereof.

[0003]

Patent Document 1 describes a flexible piping member wherein two pipes are made into the form of inner and outer pipes so as to improve heating, cooling and temperature-keeping effects.

Patent Document 1: Japanese Utility Model Application
Laid-Open No. H01-91189

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004]

When the heating temperature of a gas is, for example, in the range of about 200 to 300 °C in the above-mentioned conventional heating method, a necessary temperature may not be obtained only by heating the pipe (hollow body) from the outside thereof. In the case of raising the electric power of the heater to cope therewith, a problem that energy costs increase arises. The member of Patent Document 1 is excellent in temperature keeping effect; however, it cannot be said that the member is sufficient for heating from the outside. Thus, a further improvement is necessary.

[0005]

An object of the invention is to provide a heating method making it possible that when a gas inside the body of a piping member, such as a pipe, is heated, the heating efficiency is improved; and a piping member making it possible to perform such a heating method easily.

MEANS FOR SOLVING THE PROBLEMS

[0006]

The gas heating method of this invention is a method wherein a heat keeping member which can transmit a gas to be heated is inserted to the inside of a piping member body into which the gas can be passed in a state that the heat keeping

member is brought into close contact with the inside, and further the piping member body is heated from the outside thereof by means of a heating means.

[0007]

The gas-heating piping member according to this invention is a member comprising a hollow body to be heated from the outside thereof, and a heat keeping member which is formed to permit a gas to be heated to be passed into the member and is inserted to the inside of the body so as to be brought into close contact with the inside.

[0008]

In the gas heating method and the gas-heating piping member according to this invention, the piping member body is usually a pipe. The body may be a pipe joint for connecting pipes, or a block in which a passage is formed. The material flowing therein is usually a gas. The material may be a liquid. The heat keeping member may be made of a porous metal material or a larger number of metallic spheres, or may be made of a porous metal material and a metallic core member.

[0009]

The porous metal material is preferably a lamination made of a porous metal foil with slit and raised pieces, and may be a porous metal sintered body obtained by heating and sintering a metal particle material into which a binder is incorporated. The porous metal material may be a product wherein meshes are

laminated in the passage direction. In short, the porous metal material may be a material selected from various materials as long as the materials have a high thermal conductivity and can keep a sufficient contact area with gas. The metal is, for example, stainless steel, which does not react easily with a fluid to be heated (a gas to be heated or a liquid to be heated). When importance is attached to thermal conductivity, the metal may be copper or the like. The metal may be titanium or some other metal. The metal spheres, the number of which is large, are, for example, steel spheres. The spheres may be made of, for example, stainless steel, copper, titanium or some other metal. The heating means is preferably, for example, a flexible heater called a micro-heater or a tape heater. Other various heating means can be used which can match with the contour of the hollow body.

[0010]

The porous metallic foil with slit and raised pieces is a metallic foil wherein many slit and raised pieces are formed at predetermined intervals lengthwise and crosswise. The thickness of the metal foil is preferably from about 10 to 100 μm . About the size of the pieces, the length of one side of each of the holes is from 200 to 700 μm , and that of the other sides is from about 200 to 700 μm . Such squares or rectangles are the holes. The height (projection quantity) thereof is from 200 to 600 μm . The number of the slit and raised pieces ranges

from about 200 to 600 /cm². The size and the number of the slit and raised pieces are appropriately selected, considering the diameter of the passage, the length of the passage, pressure loss, and others.

[0011]

When the above-mentioned porous metallic foil with the slit and raised pieces is spirally laminated on itself, its layers are closely overlapped with each other to cause the tip of any one of the pieces to contact the metallic foil in the layer adjacent thereto. In this case, a metallic core member may be used. The length in the passage direction of the spiral lamination of the porous metallic foil with the slit and raised pieces does not need to be equal to the length of the body. Plural laminations may be arranged in series, with or without intervals therebetween, inside the body. The lamination of the porous metallic foil with the slit and raised pieces can be made of a single metal foil; thus, the lamination is excellent in thermal conductivity. When the hollow body or the piping member body is heated from the outside thereof, the heat keeping member inside the body is also heated to substantially the same temperature. The fluid to be heated passes from one end of the piping member to the other end through passages composed of spaces made between the slit and raised pieces adjacent to each other and the holes made for the pieces. In this period, the fluid receives heat from the high-temperature piping member,

and the temperature of the fluid is raised to a predetermined temperature.

[0012]

When the heat keeping member is made of a large number of metallic spheres, it is preferred to fit porous plates for hindering the movement of the metallic spheres in the passage direction to both ends of the heat keeping member. It is preferred to urge one of the porous plates toward the side of the other porous plate by means of an urging member (for example, a coiled spring). The urging member may be a leaf spring, or any other spring besides the coiled spring. The urging member may be an elastic member made of rubber or synthetic resin, which has elasticity.

[0013]

If the diameter of the metallic spheres is too large, the contact area falls so that a sufficient heating effect cannot be obtained. Accordingly, the diameter is preferably 50% or less of the inside diameter of the hollow body, more preferably 40% or less thereof. The lower limit of the metallic sphere diameter is not particularly limited. However, if the diameter is too small, the spheres are not easily handled and pressure loss also becomes large. Thus, the diameter is preferably 5% or more, more preferably 20% or more. In such a case, very good thermal conductivity is exhibited and further gaps through which a gas passes are sufficiently kept when the metallic

spheres are closely filled into the hollow body. Thus, efficient heating can be attained. The metallic spheres are successively fitted into the hollow body in a state that one of the porous plates is used as a stopping plate. The metallic spheres filled closely are sandwiched between the two porous plates so as to be held.

EFFECTS OF THE INVENTION

[0014]

According to the gas heating method of this invention, a heat keeping member is inserted to the inside of a piping member body such as a pipe, so as to be brought into close contact with the inside; therefore, when the piping member body is heated from the outside thereof, heat of the piping member body conducts to the heat keeping member so that the heat keeping member is also heated to a temperature substantially equal to that of the piping member body. A gas to be heated is effectively heated to a predetermined temperature while the gas passes in the heat keeping member. Accordingly, even if the heating length of the piping member body is made short, heating can be attained to the same degree as in the method without using any heat keeping member.

[0015]

According to the gas-heating piping member of this invention, a heat keeping member is inserted to the inside of

a hollow body, so as to be brought into close contact with the inside; therefore, when the piping member body is heated from the outside thereof, heat of the body conducts to the heat keeping member so that the heat keeping member is also heated to a temperature substantially equal to that of the body. A gas to be heated is effectively heated to a predetermined temperature while the gas passes in the heat keeping member. Accordingly, even if the heating length of the piping member body is made short, heating can be attained to the same degree as in the member wherein no heat keeping member is used.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a vertical sectional view illustrating a first embodiment of a gas-heating piping member according to this invention.

Fig. 2 is a transverse sectional view of the same.

Fig. 3 is a flow diagram showing a structure of a testing machine.

Fig. 4 is a graph showing measurement results of a change in temperature of the gas-heating piping member of the first embodiment.

Fig. 5 is a vertical sectional view illustrating a second embodiment of the gas-heating piping member according to this invention.

Fig. 6 is a graph showing measurement results of a change in the temperature of the gas-heating piping member of the second embodiment.

EXPLANATION OF REFERENCE NUMBERS

[0017]

- (1) piping member
- (2) tape heater (heating means)
- (3) pipe body (hollow body)
- (4) heat keeping member
- (11) porous metallic foil
- (11a) slit and raised pieces
- (12) metallic core member
- (21) piping member
- (22) tape heater (heating means)
- (23) pipe body (hollow body)
- (24) heat keeping member
- (24a) metallic sphere
- (41) (44) porous plates

BEST MODE FOR CARRYING OUT THE INVENTION

[0018]

With reference to the drawings, embodiments of this invention will be described hereinafter.

[0019]

Figs. 1 and 2 show a first embodiment of a piping member suitable for carrying out the gas heating method of this invention.

[0020]

This piping member (1) is composed of a pipe body (3) as a hollow body, a tape heater (2) as a heating unit formed on the external circumference of the body (3), and a heat keeping member (4) inserted to be brought into close contact with the internal circumference of the body (3).

[0021]

The heat keeping member (4) is a spirally-wound lamination of a porous metallic foil (11) (thickness: 50 μm) with slit and raised pieces (11a). Accordingly, the heat keeping member is made of the single metallic foil (11); thus, the member is very good in thermal conductivity. Furthermore, the contact between the layers adjacent to each other is not face contact that planes of the metallic foil (11) contact each other but point contact on the basis of the slit and raised pieces (11a). Thus, gaps into which a gas passes is sufficiently kept, and pressure loss is also small. The porous metallic foil (11) with the slit and raised pieces (11a) can be obtained, for example, by causing a metallic foil material to pass between a pair of rollers each having a cylindrical surface having a large number of projections.

[0022]

A filter (5) is arranged at an outlet side end of the pipe body (3). The filter (5) is a metallic filter. When this filter (5) receives heat from the tape heater (2), a fall in the temperature of the filter (5) section is prevented.

[0023]

In Fig. 2, a member represented by alternate long and two short dashes lines is a metallic core member (12). If necessary, the heat keeping member (4) is composed of the porous metallic foil (11) with the slit and raised pieces (11a), which is a porous metallic material, and the metallic core member (12).

[0024]

Fig. 4 shows measurement results of a temperature change when a gas was caused to flow into the piping member (1) heated to 200°C. Fig. 3 is a flow diagram of a testing machine for making this measurement. About test conditions, the test fluid was nitrogen gas, and the test pressure was 300 kPa at the primary side. The secondary side was open to the atmosphere. The test flow rate was 5 SLM. The test line was heated to a setup temperature (200 °C), and subsequently the stability of the temperature was ascertained. The temperature of temperature-measuring points was then recorded.

[0025]

As illustrated in Fig. 3, the testing machine has a structure wherein a gas to be heated is introduced into the heating gas piping member (1) through a pressure-reducing valve

(51), a filter (52), a flow rate adjusting valve (53), and a mass flow meter (54), and the gas is opened to the atmosphere through a flow rate adjusting valve (55). The gas temperature at an inlet of the piping member (1) and that at an outlet thereof can be measured with temperature sensors (56) and (57), respectively. The piping member (1) is heated in the range of a length of about 160 mm. The used heating means was a micro-heater (sheath diameter: 1 mm, electric capacity: 300 W, and resistance: 133.3 Ω).

[0026]

As is understood from Fig. 4, about a member having no heat keeping member, the temperature thereof is raised only to about 100 °C although the outside setup temperature is 200°C. On the other hand, according to the piping member (1) of the invention having the heat keeping member (4), the temperature is raised up to about 150°C, and thus the heating efficiency is largely improved.

[0027]

The lamination of the porous metallic foil (11) with the slit and raised pieces (11a) is wound around the cylindrical metallic core member (12), and this structure prevents the gas from the central portion from being released and further causes heat to be kept in the core member (12) itself to improve the heating efficiency.

[0028]

Fig. 5 illustrates a second embodiment of a piping member suitable for carrying out the gas heating method of the invention.

[0029]

This piping member (21) is composed of a pipe body (23) as a hollow body, a tape heater (22) as a heating means formed on the external circumference of the body (23), and a heat keeping member (24) made of many metallic spheres (24a) and inserted to be brought into close contact with the internal circumference of the body (23).

[0030]

Joints (25) and (26) are fitted to both ends of the pipe body (23), respectively. The joint (25), which is one of the joints (i.e., which is on the right side of the figure), is made of a first joint member (31) having, in the external circumference of its intermediate portion, a male screw portion (31a) and having, in the external circumference of its confronting end portion, a flange portion (31b) in a hexagonal prism form. The other joint (26), which is on the left side of the figure, is composed of: a second joint member (32) having, in the external circumference of its intermediate portion, a flange portion (32a) in a hexagonal prism form and having, in the external circumferences in the vicinity of both of its ends, male screw portions (32b) and (32c); a sleeve (33) joined to the pipe body (23); and a cap nut (34) for connecting the second

joint member (32) and the sleeve (33).

[0031]

The metallic spheres (24a) as the heat keeping member (24) are steel spheres. The diameter thereof is set to 1/4 of the inside diameter of the pipe body (23).

[0032]

The first and second joint members (31) and (32) have small diameter passages (35) and (38), respectively, having a small diameter than the inside diameter of the pipe body (23); and have, at their sides confronted with the pipe body (23), large diameter passages (36) and (39), respectively, having a diameter equal to the inside diameter of the pipe body (23). Between the small diameter passages (35) and (38) and the large diameter passages (36) and (39) are formed steps (37) and (40), respectively.

[0033]

The sleeve (33) is composed of a body (33a) having the same diameter as the pipe body (23), and a flange portion (33b) formed at the end not jointed to the pipe body (23). The top wall of the cap nut (34) contacts this flange portion (33b), and further the cap nut (34) is screwed onto the male screw portion (32c) of the second joint member (32), thereby fixing the second joint member (32). Between the sleeve (33) and the second joint member (32), faces of which are confronted with each other, is interposed a gasket (46) for ensuring the

sealability of the confronted face.

[0034]

A circular fringe of a metallic porous plate (41) is struck onto the step (37) of the first joint member (31), the plate (41) having an outside diameter equal to the diameter of the large diameter passage (36) and having many holes (42) made to have a smaller diameter than the diameter of the metallic spheres (24a). This porous plate (41) is a stopper plate for preventing the metallic spheres (24a) from dropping out when and after the metallic spheres (24a) are filled.

[0035]

One end of a cylindrical compression coiled spring having an outside diameter equal to the diameter of the large diameter passage (39) is struck onto the step (40) of the second joint member (32). At the other end of this coiled spring (43), a circular metallic porous plate (44) is arranged which has the same shape as used as the stopper plate, that is, an outside diameter equal to the diameter of the large diameter passage (36), and has many holes (45) made to have a smaller diameter than the diameter of the metallic spheres (24a). The coiled spring (43) has a natural length longer than the distance from the step (40) of the second joint member (32) to one of the end faces of the pipe body (23), and pushes the metallic spheres (24a) filled closely into the pipe body (23) against the side of the other porous plate (41).

[0036]

After the first joint member (31) is fitted to the pipe body (23), the metallic spheres (24a) are successively filled into the pipe body (23) in a state that the porous plate (41) is used as a stopper plate. Thereafter, the other porous plate (44) is arranged inside the sleeve (33) and further the coiled spring (43) is arranged at the second joint member (32). The sleeve (33) is then fixed to the second joint member (32) with the nut (34). In this way, the metallic spheres (24a) filled in the pipe body (23) are sandwiched between the two porous plates (41) and (44), so as to be held. According to this method, the piping member (21) is formed by simple works, the member (21) being very good in thermal conductivity, keeping gaps through which a gas passes sufficiently, and causing a small pressure loss.

[0037]

About this piping member (21), the metallic spheres (24a) were rendered steel spheres and the testing machine in Fig. 3 was used to measure a change in the temperature thereof. As a result, substantially the same results as in Fig. 4 were obtained as illustrated in Fig. 6. It was verified that according to this embodiment also, the heating efficiency was largely raised. In Fig. 6, "GAS 5 slm" and "GAS 10 slm" represent the flow rates (slm = standard liter/min.) of the gas. It is understood that according to this piping member (21), a

remarkable different is generated between the case where the metallic spheres (steel spheres) (24a) are used and the case where no metallic spheres are used when the gas flow rate is large.

INDUSTRIAL APPLICABILITY

[0038]

In the gas heating method of this invention, a heat keeping member is inserted to the inside of a piping member body, such as a pipe, so as to be brought into close contact with the inside; therefore, when the piping member body is heated from the outside thereof, heat of the piping member body conducts to the heat keeping member so that the heat keeping member is also heated to a temperature substantially equal to that of the piping member body. Thus, the gas to be heated is effectively heated to a predetermined temperature while the gas passes into this heat keeping member. Accordingly, the heating can be attained to the same degree as in the case of using no heat keeping member even if the heating length of the piping member body is made short.

CLAIMS

1. A gas heating method, wherein a heat keeping member which can transmit a gas to be heated is inserted to the inside of a piping member body into which the gas can be passed in a state that the heat keeping member is brought into close contact with the inside, and further the piping member body is heated from the outside thereof by means of a heating means, characterized in that the heat keeping member is made of a porous metal material wherein a porous metallic foil having slit and raised pieces is spirally laminated on itself so that its layers are closely overlapped with each other to cause the tip of any one of the pieces to contact the metallic foil in the layer adjacent thereto.

2. The gas heating method according to claim 1, wherein the heat keeping member comprises a metallic core member.

3. A gas-heating piping member, comprising a hollow body to be heated from the outside thereof, and a heat keeping member which is formed to permit a gas to be heated to be passed into the member and is inserted to the inside of the body so as to be brought into close contact with the inside, characterized in that the heat keeping member is made of a porous metal material wherein a porous metallic foil having slit and

raised pieces is spirally laminated on itself so that its layers are closely overlapped with each other to cause the tip of any one of the pieces to contact the metallic foil in the layer adjacent thereto.

4. The gas-heating piping member according to claim 3, wherein the heat keeping member comprises a metallic core member.

5. The gas-heating piping member according to claim 3 or 4, wherein the porous metallic foil with the slit and raised pieces is obtained by causing a metallic foil material to pass between a pair of rollers each having a cylindrical surface having a large number of projections.

6. The gas-heating piping member according to claim 3 or 4, wherein the thickness of the metal foil is from 10 to 100 μm , the length of one side of each of the holes is from 200 to 700 μm , and that of the other sides is from about 200 to 700 μm , the height thereof is from 200 to 600 μm , and the number of the slit and raised pieces ranges from 200 to 600 / cm^2 .

7. A gas-heating piping member, comprising a hollow body to be heated from the outside thereof, and a heat keeping member which is formed to permit a gas to be heated to be passed into

the member and is inserted to the inside of the body so as to be brought into close contact with the inside, characterized in that the heat keeping member is made of a large number of metallic spheres and the porous plates for hindering the movement of the metallic spheres in the passage direction are fitted to both ends of the heat keeping member, wherein one of the porous plates is urged toward the side of the other porous plate by means of an urging member.

8. The gas-heating piping member according to claim 7, wherein the body comprises a tube and joint units fitted to both ends thereof, and a step for receiving one of the porous plates is formed in each of the joint units.