A water heating device which includes a thermally insulated water storage tank having a side wall and being configured to receive drinking water, a water inlet as an inlet for drinking water, a water outlet as an outlet for hot water, and a heating unit arranged inside the water storage tank adapted to heat water inside the water storage tank. The heating unit is inclined with respect to the side wall of the water storage tank, in particular at an angle other than 90° with respect to the side wall of the water tank.
WATER HEATING DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates to a water heating device.

[0002] Water heating devices consists of a storage water tank and a heat source which heats the tank. In many cases the heat up of the water is executed with an electric element for example a sheathed electric heating element. The surface of the heating element can be immersed in potable water of the storage tank. The heating element typically comprises a flange and is screwed into the storage water tank. In order to ensure that the storage water tank is sealed, a sealing gasket is provided between the flange of the heating element and the tank.

[0003] In order to be able to control the water temperature in the storage water tank, the storage water tank typically comprises a temperature regulation unit which controls a heating element to heat the water inside the storage water tank according to a set point set by the consumer. To avoid overheating of the inside the water tank, a temperature and pressure relief valve and a temperature cut off device is needed.

[0004] In order to reduce corrosion of the storage water tank, a sacrificial anode is provided.

[0005] The above described water tank increases the maintenance expense because in case of a defect heating element the complete water content of the tank needs to be drained. Furthermore, in case of a replacement of a defect element, there is a risk of leaking water out of a not proper sealed flange. If no water is present in the water tank and the fired heating element is not cooled by water and is thus in a dry fire operation, there is a high risk that the heat element can be damaged due to overheating of the heat element.

[0006] Sacrificial anodes may corrode fast if the water inside the water tank has a high conductivity and the water has a high salt content. The corrosion process of the sacrificial anode may increase the maintenance expense because the anode needs to be replaced more frequent. Furthermore, a unwanted high production rate of hydrogen occurs because of the electrolysis process during the operation of the sacrificial anode may also be present. During the tapping process the released hydrogen gas produces unwanted noise and there is as well an increased fire risk.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide an improved water heating device.

[0008] This object is solved by a water heating device which comprises a thermally insulated water storage tank having a side wall which is configured to receive drinking water. The water heating device furthermore comprises a water inlet for the incoming drinking water, a water outlet for the outgoing hot water and a heating unit inside the water tank adapted to heat water inside the water tank. The heating unit is inclined with respect to the side wall of the water tank. The angle between the heating unit and the side wall of the water tank is an angle other than 90°.

[0009] According to an aspect of the invention, the water tank comprises a pocket which is adapted or configured to receive at least part of the heating unit.

[0010] According to a further aspect of the invention, the pocket is inclined with respect to the side wall of the water storage tank.

[0011] To a further aspect of the invention, the pocket is designed like a tube which is welded or glued to the side wall of the water storage tank. The tube end which is in contact with potable water is closed using a welded cap. The tube end which is opposite to the closed end has an open end.

[0012] To a further aspect of the invention, the length of the heating element is less than the length of the tube. Hence, a portion in the open end tube between an end of the heating unit and the side wall is not directly heated. Alternatively the heating unit comprises a heating element (e.g. in form of a heating wire) which does not extend along the entire length of the heating unit thus a section of the heating unit is not directly heated by the heating element. This reduces the temperature in the wiring housing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 shows a schematic representation of a water heating device according to a first embodiment;

[0014] FIG. 2 shows a schematic representation of a water heating device according to a second embodiment;

[0015] FIGS. 3A-3C show different representations of a heating element according to the invention;

[0016] FIG. 4A shows a schematic representation of a water heating device according to a third embodiment;

[0017] FIG. 4B shows a schematic representation of a water heating device according to the prior art;

[0018] FIG. 5 shows a schematic representation of a part of FIG. 4A;

[0019] FIG. 6 shows a schematic representation of part of a water heating device according to a fourth embodiment; and

[0020] FIG. 7 shows a schematic representation of a heating element according to a fifth embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0021] It is to be understood that the figures and descriptions of the present invention have been simplified to illustrate elements that are relevant for a clear understanding of the present invention, while eliminating, for purposes of clarity, many other elements which are conventional in this art. Those of ordinary skill in the art will recognize that other elements are desirable for implementing the present invention. However, because such elements are well known in the art, and because they do not facilitate a better understanding of the present invention, a discussion of such elements is not provided herein.

[0022] The present invention will now be described in detail on the basis of exemplary embodiments.

[0023] FIG. 1 shows a schematic representation of a water heating device according to a first embodiment. The water heating device 100 comprises a thermally insulated metal water storage tank 100a for receiving potable water which needs to be heated. The storage tank 100a comprises a hot water outlet 101, a cold water (potable water) inlet 102 and an inlet 103 for a pressure and temperature relief valve (“P & T valve”). A metal tube 104 is welded into the metal water storage tank 100a. The end of the metal tube 104 which is in contact with potable water is closed with a welded cap. The opposite end of the tube 104 is open to the atmosphere. According to the invention, the metal tube 104 is welded to
the side wall 100b of the tank and comprises an inclination. A heating element 105 is inserted into the tube 104 such that the tube transfers heat to the water. By the inclination of the tube 104 and thus the inclination of the heating element 105, the water inside the water tank is efficiently heated. Because of the pocket design of the welded tube 104 it is possible to service a damaged heat element 105 without draining the water content of the water storage tank 100a. The inner diameter of the tube 104 is larger than the outer diameter of the heat element 105 in order to incorporate the heat element 105. Thus, the maintenance of the water heating device is significantly improved without risk of leaking water after a service.

[0024] The water storage tank 100a may comprise a second tube 106 which is welded into the water tank 100a. This second tube 106 is a metallic sleeve tube 106 with an open end outside the water tank to insert a temperature sensor 107. The temperature sensor 107 may be connected to a safety cut out 108 or a thermostat. Optionally, the second tube 106 is inclined towards the side wall of the water tank. Optionally, the angle of the inclination of the first tube does not correspond to the angle of inclination of the second tube.

[0025] According to an aspect of the invention, the outer surfaces of the first and second tubes 104, 106 can be enamelled. In particular, only those portions of the outer surfaces of the first and second tube 104, 106 which are in contact with water are enamelled.

[0026] Optionally, the water tank 100a also comprises a sensor and a further temperature sensor unit 109, which exists of a plurality of temperature sensors vertically arranged like a chain.

[0027] Furthermore, optionally an anode rod 110 is provided to avoid corrosion of the metallic tank. In addition, the anode rod 110 is used for a dry fire prevention sensor. The electronic impressed anode rod 110 is connected to an electronic device 111 which may be arranged at the outside of the water tank 100a.

[0028] Optionally, the water tank 100a may comprise further an inlet port and an outlet port 112, 113 for an add-on heating unit or heat generator to be retrofitted later. This add-on heat generator can be a heat pump. The heat pump can be connected to the electronic unit 111. In particular, an electrical connection can be provided to the electronic device 111.

[0029] FIG. 2 shows a schematic representation of a water heating device according to a second embodiment. The water tank 100a comprises a hot water outlet 101, a cold water inlet 102, an inlet 200 for a P & T valve. Furthermore, a first tube 104 is welded or glued to the side wall of the water tank 100a. The closed end of the tube 104 which is in contact with potable water can be covered by a welded cap. The opposite end is open to the atmosphere. The first tube 104 is a heat exchanger if a heating element 105 is assembled inside it. The outside diameter of the heating element 105 is smaller than the inside diameter of the first tube 104. As shown in the first embodiment, the first tube 104 is arranged with an inclination towards the side wall of the water tank. Thus, the water in the cold sump section can be heated advantageously. This increases the mix water amount of the usable tank volume.

[0030] As shown in the first embodiment, a second tube can be provided in which a temperature sensor 107 is inserted. Furthermore, a wiring enclosure 120 is connected to the electric heat element 104 via an electrical grid with the wires 122 and 123. The wire 121 is the ground line for safety reasons. This line 121 needs to be grounded via any metallic part of the tank. In FIG. 2, convection C is depicted to illustrate cold water flowing down towards the heating element 105, where the water is heated and due to the heat convection, the heated water then moving upwards. Because of the inclination of the heating element 105 also water of the cold sump of the water tank 100a is heated.

[0031] FIGS. 3A-3C show different views of the heating element according to the invention. In FIG. 3A, the heating element 105 is a ceramic heat element and may comprise of a number of ceramic elements 114 which are stacked together using a central thread bar. FIG. 3B shows a single ceramic element and FIG. 3C shows a schematic cross section of the heating element 105. The heating element comprises a plurality of ceramic fins 115 which transfers heat from the spiral heating wire to the inner wall of the surface of the tube 104. The ceramic nature of the fin 115 creates spacing for the high voltages of the hot wire in front of the conductive tube 103. Between the fins, a number of gaps 116 provides enough spacing for the spiral heat wire. In the middle of the heating element 105, a central bore hole 117 is provided. This central bore hole 117 acts like a gap for the central thread bar. Each of the ceramic elements is divided from the following by a heal 118 providing a distance between adjacent ceramic elements.

[0032] FIG. 4A shows a schematic representation of a water heating device according to a third embodiment. The water heating device 100 comprises a thermally insulated metal water storage tank 100a for receiving potable water which needs to be heated. The water storage tank 100a comprises a shell section or side wall 100b, a top section 100c as well as a bottom section 100e. The top and bottom section 100d, 100e is welded to the side wall 100b. At the lower part of the side wall 100b a metal tube 104 is welded to the side wall 100b. The end 104a of the metal tube 104 is in contact with potable water and closed with a welded cap. Preferably, the metal tube 104 is inclined at an angle from 5° to 30° with respect to a horizontal plane. Inside the metal tube 104 a heating element 105 is inserted. FIG. 4A shows the closed end 104a of the metal tube 104. It is arranged in the area of the bottom section 100e. This arrangement of the metal tube 104 and thus the arrangement heating element 105 is advantageous, because the water which of the bottom section 100c is also heated.

[0033] In FIG. 4A two convection zone C1, C2 are depicted, they are active during times, when the heating element 105 is activated. As declared in FIG. 4A, especially the second convection current C2 heats the lower part of the bottom section 100c. Thus, also the water inside the bottom section 100c is heated as well.

[0034] In contrast, in FIG. 4B, where the heating element is arranged horizontally it is visible that the convection currents C3, C4 do not reach into the bottom section 100c of the water tank. The bottom section remains cold which reduces the amount of usable water of the tank content.

[0035] FIG. 5 shows a schematic representation of a part of FIG. 4A. In the lower part of the shell section or the side wall 100b, the open end of the metal tube 104 is depicted. The open end of the metal tube 104 can be welded to the shell section 100c for example by means of a welded joint 100e. Furthermore, the bottom region 100c and the shell section or the side wall 100b can also be welded together by
means of a welded round joint 100f. According to the invention, the distance between the welded joint 100e for the metal tube 104 and the welded joint 100f for the side wall 100b and the bottom section 100 are arranged not closer than 25 mm from each other. In other words, the minimum distance between the two welded joints is more than 25 mm. The reason for this minimal distance is to avoid any thermal deformation during the welding process and durability according to required pressure lifetime cycle.

[0036] FIG. 6 shows a schematic representation of a part of a water heating device according to a fourth embodiment. In FIG. 6, the storage tank 100e as well as the bottom section 100c is depicted. Furthermore, the inclined metal tube 104 as well as the inclined heating element 105 is depicted. Preferably, the heating element 105 comprises a section 105e which is not heated. This section 105e is preferably arranged at the proximal end of the heating element 105.

[0037] FIG. 7 shows a schematic representation of a heating element according to a fifth embodiment. In FIG. 7, a schematic cross section of the heating element is depicted. The heating element 105 thus comprises two bolts 105b connected to each heating wire 105f. The length of the two bolts 105b will determine the non-heated section 105c of the heating element. The heating element may also comprise high conductive ceramic fins 105c in order to avoid a short between the single element wire. The arrangement of the ceramic fins create a duct for a single heat element and transfers the heat to the surrounding tube wall 105f.

[0038] According to the invention, the not-heated section 105c is provided so that the temperature inside the wiring enclosure 108 does not exceed a threshold value. Accordingly, the section 105c acts like a cooling section.

[0039] While this invention has been described in conjunction with the specific embodiments outlined above, it is evident that many alternatives, modifications, and variations will be apparent to those skilled in the art. Accordingly, the preferred embodiments of the invention as set forth above are intended to be illustrative, not limiting. Various changes may be made without departing from the spirit and scope of the inventions as defined in the following claims.

[0040] In addition, it is noted that citation or identification of any document in this application is not an admission that such document is available as prior art to the present invention.

[0041] It is also noted that in this disclosure and particularly in the claims and/or paragraphs, terms such as “comprises”, “comprised”, “comprising” and the like can have the meaning attributed to it in U.S. Patent law; e.g., they can mean “includes”, “included”, “including", and the like; and that terms such as “consisting essentially of” and “consists essentially of” have the meaning ascribed to them in U.S. Patent law, e.g., they allow for elements not explicitly recited, but exclude elements that are found in the prior art or that affect a basic or novel characteristic of the invention.

[0042] It is further noted that the invention does not intend to encompass within the scope of the invention any previously disclosed product, process of making the product or method of using the product, which meets the written description and enablement requirements of the USPTO (35 U.S.C. 112), such that applicant(s) reserve the right to disclaim, and hereby disclose a disclaimer of any previously described product, method of making the product, or process of using the product.

1. A water heating device, comprising: a thermally insulated water storage tank having a side wall and being configured to receive drinking water; a water inlet as an inlet for drinking water; a water outlet as an outlet for hot water; and a heating unit arranged inside the water storage tank adapted to heat water inside the water storage tank; wherein the heating unit is inclined with respect to the side wall of the water storage tank.

2. The water heating device according to claim 1; wherein the water storage tank comprises at least one recess adapted to receive at least a part of the heating unit.

3. The water heating device according to claim 1; wherein the recess is arranged at an inclination with respect to the side wall of the water storage tank.

4. The water heating device according to claim 2; wherein the recess is arranged at an inclination with respect to the side wall of the water storage tank.

5. The water heating device according to claim 2; wherein the recess is in form of a tube which is welded or glued to the water storage tank side wall; and wherein a water immersable end of the tube is closed, and an opposite end of the tube towards the side wall is opened and is adapted to receive the heating unit.

6. The water heating device according to claim 3; wherein the recess is in form of a tube which is welded or glued to the water storage tank side wall; and wherein a water immersable end of the tube is closed, and an opposite end of the tube towards the side wall is opened and is adapted to receive the heating unit.

7. The water heating device according to claim 4; wherein the recess is in form of a tube which is welded or glued to the water storage tank side wall; and wherein a water immersable end of the tube is closed, and an opposite end of the tube towards the side wall is opened and is adapted to receive the heating unit.

8. The water heating device according to claim 5; wherein a length of the heating unit is less than a length of the tube so that a portion of the tube between an end of the heating unit and the side wall is not directly heated.

9. The water heating device according to claim 6; wherein a length of the heating unit is less than a length of the tube so that a portion of the tube between an end of the heating unit and the side wall is not directly heated.

10. The water heating device according to claim 7; wherein a length of the heating unit is less than a length of the tube so that a portion of the tube between an end of the heating unit and the side wall is not directly heated.

11. The water heating device according to claim 1; wherein the heating unit is inclined at an angle other than 90° with respect to a side wall of the water storage tank.