silicon may, in the melting depressant component, be represented by the boron and silicon in various boron and silicon compounds.

Obviously, the melting depressant composition is very different from conventional brazing substances since they have much more filling metal relative melting depressing substances like boron and silicon. Generally, brazing substances have less than 18 wt% boron and silicon.

The method is advantageous in that filler metal may be reduced or even excluded and in that it may be applied for metal plates that are made of different materials. Of course, the melting depressant composition may be applied on the second metal plate as well.

The boron may originate from any of elemental boron and boron of a boron compound selected from at least any of the following compounds: boron carbide, silicon boride, nickel boride and iron boride. The silicon may originate from any of elemental silicon and silicon of a silicon compound selected from at least any of the following compounds: silicon carbide, silicon boride and ferrosilicon.

The melting depressant component may comprise at least 40 wt% boron and silicon, or may even comprise at least 85 wt% boron and silicon. This means that if any filler metal is present it is present in amounts of less than 60 wt% respectively less than 15 wt%. The melting depressant component may even comprise at least 95 wt% boron and silicon.

Boron may constitute at least 10 wt% of the boron and silicon content of the melting depressant ~~compound~~ component. This means that, when the melting depressant component comprise at least 25 wt% boron and silicon, then the melting depressant component comprises at least at least 2.5 wt% boron. Silicon may constitute at least 55 wt% of the boron and silicon content of the melting depressant ~~compound~~ component.

The melting depressant component may comprise less than 50 wt% metallic elements, or less than 10 wt% metallic elements. Such metallic elements corresponds to the "metal filler" discussed above. Such small amounts of metallic elements or metal filler differentiates the melting depressant composition starkly from e.g. known brazing compositions since they comprise at least 60 wt% metallic elements. Here, "metallic elements" include e.g. all transition metals, which are the elements in the d-block of the periodic table, which includes groups 3 to 12 on the periodic table. This means that, for example, iron (Fe), nickel (Ni), cobalt (Co), chromium (Cr) and molybdenum (Mo) are "metallic elements. Elements that are not "metallic elements" are the noble gases, the halogens and the following elements: boron (B), carbon (C), silicon (Si), nitrogen (N),

Fig. 4 is a flow chart of a method for joining plates in plate heat exchanger according to the method of the invention,.

Fig. 5 shows a pressed plate that is used in a number of examples that described how two metal parts may be joined,

Fig. 6 is a photo of a cross-section of a joint between the plate shown in Fig.5 and a flat plate,

Fig. 7 shows a diagram where a measured joint width is plotted as a function of an applied amount (g/3500mm^2) of melting depressant composition, including trend lines,

Fig. 8 shows another diagram where a calculated filled area of the joint based on the measured width is plotted as a function of applied amount (g/3500mm^2) of melting depressant composition, including trend lines,

Fig. 9 shows another diagram where the % of tensile tested samples where the joint was stronger or the same as the plate material is plotted as a function of applied amount (g/3500 mm^2) of melting depressant composition, including trend lines, and

Fig. 10 shows a picture of other test samples that has been joined.

Detailed description

With reference to the figures attached, a plate heat exchanger is disclosed, see Figs. 1 and 2, respectively. The plate heat exchanger 1 comprises a plurality of heat exchanger plates 2 which are provided beside each other for forming a plate package 3 with first plate interspaces 4 for a first medium and second plate interspaces 5 for a second medium. The first plate interspaces 4 and the second plate interspaces 5 are provided in an alternating order in the plate package 3, i.e. every second plate interspace is a first plate interspace 4 and every second a second plate interspace 5, see Fig. 3.

The plate heat exchanger 1 disclosed in Figs. 1<u>& 2</u>~~-3~~ has heat exchanger plates 2 which are permanently joined to each other. The two outermost heat exchanger plates may form or be replaced by end plates.

The plate heat exchanger 1 also comprises inlet and outlet channels 6-9, which are arranged to convey the first medium into the first plate interspaces 4 and out from the same, and to convey the second medium into the second plate interspaces 5 and out from the same. Each heat exchanger plate 2 extends a main extension plane p, and comprises a heat transfer area 10 and an edge area 11 extending around the heat transfer area 10. Each heat exchanger plate 1 also comprises two porthole areas 12

and 13, which are provided at a first end 1A of the heat exchanger plate 1 and at a second end 1 B of the heat exchanger plate 1, respectively. The porthole areas 12 and 13 are located inside the edge area 11, and more specifically between the edge area 11 and the heat transfer area 10. Each porthole area 12, 13 comprises at least one porthole 14 which are aligned with respective inlet and outlet channels 6-9.

The heat transfer area 10 comprises a corrugation of elevations 18 and depressions 19. Such depressions and elevations may e g be formed as ridges and grooves or as dimples.

The plates 2 may be made of of eg iron-, nickel and cobalt-based metallic alloys, as they typically have a solidus temperature above 1100 °C. The plates may not be made of pure copper, pure aluminum or aluminum-based alloys that do not have a solidus temperature above 1100 °C. For example the plates may typically be made of iron-, nickel- and cobalt-based alloys.

The metal in the plates 2 or even the plates 2 per se may be referred to as the "parent metal" or "parent material". In this context, an "iron-based" alloy is an alloy where iron has the largest weight percentage of all elements in the alloy (wt%). The corresponding situation also applies for e g nickel-, copper-, cobalt-, chromium- and aluminum-based alloys.

With reference to Fig. 4 a flow chart of a method for joining plates 2 for a plate heat exchanger 1 is illustrated. The plates 2 may be made of different materials as described above.

In a first step 201 a melting depressant composition ~~20~~ is applied on at least a part of the corrugation of elevations 18 and depressions 19. The melting depressant composition ~~20~~ may be applied on only a part of the corrugation, i e on contact points 23.

The application per se may be done by conventional techniques, e.g. by spraying, screen printing, rolling or painting in case the melting depressant composition comprises a binder component, by PVD or CVD or with only melting point depressants in case not binder component is used.

The melting depressant composition ~~20~~ comprises at least one component, which is the melting depressant component. Optionally, the melting depressant composition comprises a binder component. All substances or parts of the melting depressant composition that contributes to decreasing a melting temperature of at least the first metal part is considered to be part of the melting depressant component. Parts of the melting depressant composition that are not involved in decreasing a melting

joining heat transfer plates or any suitable metal objects that otherwise are joined by e.g. welding or conventional brazing.

In another embodiment of the invention the melting depressant composition ~~20~~ is applied on a coil which subsequently is cut into plates 2.

In a following step 202 the corrugation of elevations 18 and depressions 19 on a second side of a second plate 22 is brought into contact with the melting depressant composition ~~20~~ on the corrugation of elevations 18 and depressions 19 on the first side of the first plate 21 by stacking the plates into a plate package 3. By stacking the first 21 and second plates 22 a plate package 3 is created. This can be done manually or automatically by employing conventional, automated manufacturing systems. Of course, the melting depressant composition ~~20~~ may be applied on the second plates 22 as well.

The boron may originate from any of elemental boron and boron of a boron compound selected from at least any of the following compounds: boron carbide, silicon boride, nickel boride and iron boride. The silicon may originate from any of elemental silicon and silicon of a silicon compound selected from at least any of the following compounds: silicon carbide, silicon boride and ferrosilicon.

The melting depressant component may comprise at least 40 wt% boron and silicon, or may even comprise at least 85 wt% boron and silicon. This means that if any filler metal is present it is present in amounts of less than 60 wt% respectively less than 15 wt%. The melting depressant component may even comprise at least 95 wt% boron and silicon.

Boron may constitute at least 10 wt% of the boron and silicon content of the melting depressant ~~compound~~ component. This means that, when the melting depressant component comprise at least 25 wt% boron and silicon, then the melting depressant component comprises at least at least 2.5 wt% boron. Silicon may constitute at least 55 wt% of the boron and silicon content of the melting depressant ~~compound~~ component.

The melting depressant component may comprise less than 50 wt% metallic elements, or less than 10 wt% metallic elements. Such metallic elements corresponds to the "metal filler" discussed above. Such small amounts of metallic elements or metal filler differentiates the melting depressant composition ~~20~~ from e.g. known brazing compositions since they comprise at least 60 wt% metallic elements. Here, "metallic elements" include e.g. all transition metals, which are the elements in the d-block of the periodic table, which includes groups 3 to 12 on the periodic table. This means that, for example, iron (Fe), nickel (Ni), cobalt (Co), chromium (Cr) and molybdenum (Mo) are

iii) >65 wt% Fe and >13wt% Cr;

iv) >50 wt% Fe, >15.5 wt% Cr and >6 wt% Ni;

v) >50 wt% Fe, >15.5 wt% Cr, 1-10 wt% Mo and >8 wt% Ni;

vi) >97 wt% Ni;

vii) >10 wt% Cr and >60 wt% Ni;

viii) >15 wt% Cr, >10 wt% Mo and >50 wt% Ni;

ix) >70 wt% Co; and

x) >10 wt% Fe, 0.1-30wt% Mo, 0.1-30 wt% Ni and >50 wt% Co.

The above means that the plates 2 may be made of a large number of different alloys. Obviously, the examples above are balanced with other metals or elements, as common within the industry.

In a next step 203 the plate package 3 is heated to a temperature which is above 1100 °C. The exact temperature can be found in the following examples.

During the heating 203 the surface 15 of the corrugation of elevations 18 and depressions 19 on the first side of the first plate 21 melt forms a surface layer ~~24~~ and, together with the melting depressant component, forms a melted metal layer ~~25~~ that is in contact with the corrugation of elevations 18 and depressions 19 on the second plate 22 at contact points 23 between the first plate 21 and the second plate 22. When this happen, metal of the melted metal layer flows towards the contact point 23.

In a final step 204 the melted metal layer ~~25~~ is allowed to solidify, such that a joint ~~26~~ is obtained at the contact points 23 between the plates in the plate package 3 . i.e. the metal that has flown to the contact points 23 solidifies.

By applying 201 the melting depressant composition ~~20~~ on the plates 2 ~~1st~~ it was surprisingly observed that the plate changed in shape after brazing, when the blend was applied on one surface, only. The change in shape occurs when the blend alloy with the surface also meaning that there will be a compressive stress in the surface due to the alloying. Compressive stresses are beneficial for e.g. the fatigue strength. The highest stresses in a brazed heat exchanger is normally located at and around the braze joints. By only applying the blend at and near the contact points by e.g. screen printing or rolling the amount of blend and used binder can be minimized but still having the effect of compressive stresses at the area where they are most beneficial. By decreasing the amount of blend and binder the cost will be reduced and also the needed evaporating process of binders. The evaporation of binders can be critical since it can be difficult to evaporate all of the binders applied. Furthermore, the

flat plate a joint is created. To estimate the amount of metal that forms the joint the following approximations and calculations have been made.

It has been estimated that the volume in the center of the joint is negligible. Therefore, the created metal volume for joints over a width like width B (in the example 1.21 mm or less), is set to zero. On the outer sides of the beam v, which has a distance of (X - B)/2, metal has been accumulated. When blend (melting depressant composition) is applied on the flat plate, the plates are held together and heated surface layers of the plates melt and metal in melted form is transported by capillary action to the area of the joint from neighboring areas, thus forming volumes of metal that constitutes the joint.

It is possible to calculate an area by estimating that two triangles are formed on each side of the center of the joint. The angle α in the triangle is measured to 28°. The total measured width is X and the center width is B. The total area A of the two triangles are therefore $A = 2 \cdot (((X - B)/2) \cdot ((X - B)/2) \cdot \tan(\alpha)) / 2$. When measuring B to 1.21 mm, then $A = 2 \cdot (((X - 1.21)/2) \cdot ((X - 1.21)/2) \cdot \tan(28)) / 2$. The total created volume of braze alloy, which has flown to the crevices to form the joint, would be the area times the length of the two beams v, h. Some of the formed braze alloy does not flow to the crevices and is left on the surface where the blend was applied.

Fig. 7 is a diagram showing the measured width as a function of applied amount of different embodiments of the blend (g/3500mm^2, i.e. gram per 3500 square mm) with trend lines. The results of the tests are shown in table 8 and 9 (see Example 5 below) and in Fig. 7. ~~The trend lines of Fig. 3 are bases on function Y = K · X + L, where Y is the area, K is the inclination of the line, X is the applied amount of blend and L is a constant.~~ The results of the measured widths and the estimated areas are illustrated by Fig. 7. The applied amounts of blend, see tables 8 and 9, were from 0.06 g/3500 mm^2 to 0.96 gram/3500 mm^2, which correspond to from approximately 0.017 mg/mm^2 to 0.274 mg/mm^2.

The trend line $Y = K \cdot X + L$ for the blend was measured, where Y is the joint width, K is the inclination of the line, X is the applied amount of blend and L is a constant, see Fig surface 15 3. Thus, the width of braze joint is:

Y (width for A3.3) = 1.554 + 9.922 · (applied amount of blend A3.3)

Y (width for B2) = 0.626 + 10.807 · (applied amount of blend B2)

Y (width for C1) = 0.537 + 8.342 · (applied amount of blend C1)

Y (width for F0) = 0.632 + 7.456 · (applied amount of blend F0)

CLAIMS

1. A method for producing a permanently joined plate heat exchanger (1) comprising a plurality of metal heat exchanger plates (2) having a solidus temperature above 1100 °C, provided beside each other and forming a plate package (3) with first plate interspaces (4) for a first medium and second plate interspaces (5) for a second medium, wherein the first and second plate interspaces (4,5) are provided in an alternating order in the plate package (3),

wherein each heat exchanger plate (2) comprises a heat transfer area (10) and an edge area (11) which extend around the heat transfer area (10),

wherein the heat transfer area (10) comprises a corrugation of elevations (18) and depressions (19),

wherein said corrugation of the plates are provided by pressing the plates (2)

the method comprising

applying (201) a melting depressant composition (20) on a surface (15) of the corrugation of elevations (18) and depressions (19) on the first side of a first plate (21), the melting depressant composition (20) comprising

- a melting depressant component that comprises at least 25 wt% boron and silicon for decreasing a melting temperature of the first plate (21), and
- optionally, a binder component for facilitating the applying (201) of the melting depressant composition (20) on the first plate (21),

bringing (202) the corrugation of elevations (18) and depressions (19) on a second side of a second plate (22) into contact with the melting depressant composition (20) on the corrugation of elevations (18) and depressions (19) on the first side of the first plate (21) by stacking the plates into a plate package (3),

heating (203) the first and second plates (21,22) to a temperature above 1100 °C, said surface (15) of the corrugation of elevations (18) and depressions (19) on the first side of the first plate (21) thereby melting such that a surface layer (24) of the first plate (21) melts and, together with the melting depressant component, forms a molten metal layer (25) that is in contact with the corrugation of elevations (18) and depressions (19) on the second plate (22) at contact points (23) between the first plate (21) and the second plate (22), and

allowing the molten metal layer (25) to solidify, such that a joint (26) is obtained at the contact points (23) between the plates (2) in the plate package (3).

2. Method according to claim 1, wherein the boron originates from any of elemental boron and boron of a boron compound selected from any of the following compounds: boron carbide, silicon boride, nickel boride and iron boride.

3. A method according to claim 1 or 2, wherein the silicon originates from any of elemental silicon and silicon of a silicon compound selected from any of the following compounds: silicon carbide, silicon boride and ferrosilicon.

4. A method according to any one of claims 1 - 3, wherein the melting depressant component comprises at least 40 wt% boron and silicon.

5. A method according to any one of claims 1 - 4, wherein the melting depressant component comprises at least 85 wt% boron and silicon.

6. A method according to any one of claims 1 - 5, wherein boron constitutes at least 10 wt% of the boron and silicon content of the melting depressant compound.

7. A method according to any one of claims 1 - 6, wherein boron constitutes at least 55 wt% of the boron and silicon content of the melting depressant compound.

8. A method according to any one of claims 1 - 7, wherein the melting depressant component comprises less than 50 wt% metallic elements.

9. A method according to any one of claims 1 - 8, wherein the melting depressant component comprises less than 10wt% metallic elements.

10. A method according to any one of claims 1 - 9, wherein the plates (2) have a thickness of 0,3 - 0,6.

11. A method according to any one of claims 1 - 9, wherein the plates (2) comprises a thickness of 0,6 - 1,0 mm..

12. A method according to any one of claims 1 - 11, wherein the applying (201) of the melting depressant composition (20) comprises

- heating (203) the plates (2) until the melting depressant composition binds to the surface (15) of the first plate (21), and
- decreasing the temperature of the plates (2), before all boron and silicon in the melting depressant composition () have formed a compound with the metal in the first plate ().

13. A method according to any one of claims 1 - 11, wherein the applying (201) of the melting depressant composition (20) is made by means of screen-printing.

14. A method according to any one of claims 1 - 13, wherein the first surface (15) has an area (A1) that is larger than an area (A2) defined by the contact points (23) on said surface (16), such that metal in the melted metal layer (25) flows to the contact point (23) when allowing (204) the joint (26) to form.

15. A method according to claim 14, wherein the area (A1) of the surface (15) is at least 10 times larger than the area (A2) defined by the contact point (26).

16. A method according to claim 14 or 15, wherein the area (A1) of the surface (15) is at least 3 times larger than a cross-sectional area (A3) of the joint (26).

17. A method according to any one of claims 1 - 20, wherein the joint (26) comprises at least 50 wt% metal that, before the heating (203), was part of any of the plates (2).

18. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >50 wt% Fe, <13 wt% Cr, <1 wt% Mo, <1 wt% Ni and <3 wt% Mn.

19. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >90 wt% Fe.

20. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >65 wt% Fe and >13wt% Cr.

21. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >50 wt% Fe, >15.5 wt% Cr and >6 wt% Ni.

22. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >50 wt% Fe, >15.5 wt% Cr, 1-10 wt% Mo and >8 wt% Ni.

23. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >97 wt% Ni.

24. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >10 wt% Cr and >60 wt% Ni.

25. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >15 wt% Cr, >10 wt% Mo and >50 wt% Ni.

26. A method according to any one of claims 1 - 17, wherein the plates (2) comprises >70 wt% Co.

27. A method according to any one of claims 1 - 17, wherein the first plate comprises >10 wt% Fe, 0.1-30wt% Mo, 0.1-30 wt% Ni and >50 wt% Co.

28. A permanently joined plate heat exchanger (1) comprising a plurality of metal heat exchanger plates (2) having a solidus temperature above 1100 °C, provided beside each other and forming a plate package (3) with first plate interspaces (4) for a first medium and second plate interspaces (5) for a second medium, wherein the first and second plate interspaces (4,5) are provided in an alternating order in the plate package (3),

wherein each heat exchanger plate (2) comprises a heat transfer area (10) and an edge area (11) which extend around the heat transfer area (10),

wherein the heat transfer area (10) comprises a corrugation of elevations (18) and depressions (19),

wherein said corrugation of the plates are provided by pressing the plates (2),

wherein the plate heat exchanger is produced by the method according to any one of claims 1-27.

29. A plate heat exchanger (1) according to claim 28 comprising a first plate (21) that is joined with a second plate (22) by a joint (26), the plates (2) having a solidus temperature above 1100 °C, wherein the joint (26) comprises at least 50 wt% metallic elements that have been drawn from an area (A1) that surrounds the joint (26) and was part of any of the first plate (21) and the second plate (22).

CLAIMS

1. A method for producing a permanently joined plate heat exchanger comprising a plurality of metal heat exchanger plates having a solidus temperature above 1100 °C, provided beside each other and forming a plate package with first plate interspaces for a first medium and second plate interspaces for a second medium, wherein the first and second plate interspaces are provided in an alternating order in the plate package,

wherein each heat exchanger plate comprises a heat transfer area and an edge area which extend around the heat transfer area,

wherein the heat transfer area comprises a corrugation of elevations and depressions,

wherein said corrugation of the plates are provided by pressing the plates the method comprising

applying a melting depressant composition on a surface of the corrugation of elevations and depressions on the first side of a first plate, the melting depressant composition comprising a melting depressant component that comprises at least 25 wt% boron and silicon for decreasing a melting temperature of the first plate,

bringing the corrugation of elevations and depressions on a second side of a second plate into contact with the melting depressant composition on the corrugation of elevations and depressions on the first side of the first plate by stacking the plates into a plate package,

heating the first and second plates to a temperature above 1100 °C, said surface of the corrugation of elevations and depressions on the first side of the first plate thereby melting such that a surface layer of the first plate melts and, together with the melting depressant component, forms a molten metal layer that is in contact with the corrugation of elevations and depressions on the second plate at contact points between the first plate and the second plate, and

allowing the molten metal layer to solidify, such that a joint is obtained at the contact points between the plates in the plate package.

2. The method according to claim 1, wherein the melting depressant composition further comprises a binder component for facilitating the applying of the melting depressant composition on the first plate.

3. The method according to claim 1 or claim 2, wherein the boron originates from any of elemental boron and boron of a boron compound selected from any of the following compounds: boron carbide, silicon boride, nickel boride and iron boride.

4. The method according to any one of claims 1 - 3, wherein the silicon originates from any of elemental silicon and silicon of a silicon compound selected from any of the following compounds: silicon carbide, silicon boride and ferrosilicon.

5. The method according to any one of claims 1 - 4, wherein the melting depressant component comprises at least 40 wt% boron and silicon.

6. The method according to any one of claims 1 - 5, wherein the melting depressant component comprises at least 85 wt% boron and silicon.

7. The method according to any one of claims 1 - 6, wherein boron constitutes at least 10 wt% of the boron and silicon content of the melting depressant component.

8. The method according to any one of claims 1 - 7, wherein boron constitutes at least 55 wt% of the boron and silicon content of the melting depressant component.

9. The method according to any one of claims 1 - 8, wherein the melting depressant component comprises less than 50 wt% metallic elements.

10. The method according to any one of claims 1 - 9, wherein the melting depressant component comprises less than 10 wt% metallic elements.

11. The method according to any one of claims 1 - 10, wherein the plates have a thickness of 0.3 – 0.6 mm.

12. The method according to any one of claims 1 - 10, wherein the plates comprises a thickness of 0.6 – 1.0 mm..

13. The method according to any one of claims 1 - 12, wherein the applying of the melting depressant composition comprises

- heating the plates until the melting depressant composition binds to the surface of the first plate, and
- decreasing the temperature of the plates, before all boron and silicon in the melting depressant composition have formed a compound with the metal in the first plate.

14. The method according to any one of claims 1 - 12, wherein the applying of the melting depressant composition is made by means of screen-printing.

15. The method according to any one of claims 1 - 14, wherein the first surface has an area (A1) that is larger than an area (A2) defined by the contact points on said surface, such that metal in the melted metal layer flows to the contact point when allowing the joint to form.

16. The method according to claim 15, wherein the area (A1) of the surface is at least 10 times larger than the area (A2) defined by the contact point.

17. The method according to claim 15 or 16, wherein the area (A1) of the surface is at least 3 times larger than a cross-sectional area (A3) of the joint.

18. The method according to any one of claims 1 - 21, wherein the joint comprises at least 50 wt% metal that, before the heating, was part of any of the plates.

19. The method according to any one of claims 1 - 18, wherein the plates comprises >50 wt% Fe, <13 wt% Cr, <1 wt% Mo, <1 wt% Ni and <3 wt% Mn.

20. The method according to any one of claims 1 - 18, wherein the plates comprises >90 wt% Fe.

21. The method according to any one of claims 1 - 18, wherein the plates comprises >65 wt% Fe and >13wt% Cr.

22. The method according to any one of claims 1 - 18, wherein the plates comprises >50 wt% Fe, >15.5 wt% Cr and >6 wt% Ni.

23. The method according to any one of claims 1 - 18, wherein the plates comprises >50 wt% Fe, >15.5 wt% Cr, 1-10 wt% Mo and >8 wt% Ni.

24. The method according to any one of claims 1 - 18, wherein the plates comprises >97 wt% Ni.

25. The method according to any one of claims 1 - 18, wherein the plates comprises >10 wt% Cr and >60 wt% Ni.

26. The method according to any one of claims 1 - 18, wherein the plates comprises >15 wt% Cr, >10 wt% Mo and >50 wt% Ni.

27. The method according to any one of claims 1 - 18, wherein the plates comprises >70 wt% Co.

28. The method according to any one of claims 1 - 18, wherein the first plate comprises >10 wt% Fe, 0.1-30wt% Mo, 0.1-30 wt% Ni and >50 wt% Co.

29. A permanently joined plate heat exchanger comprising a plurality of metal heat exchanger plates having a solidus temperature above 1100 °C, provided beside each other and forming a plate package with first plate interspaces for a first medium and second plate interspaces for a second medium, wherein the first and second plate interspaces are provided in an alternating order in the plate package,

wherein each heat exchanger plate comprises a heat transfer area and an edge area which extend around the heat transfer area,

wherein the heat transfer area comprises a corrugation of elevations and depressions,

wherein said corrugation of the plates are provided by pressing the plates,

wherein the plate heat exchanger is produced by the method according to any one of claims 1-28.

30. The plate heat exchanger according to claim 29 comprising a first plate that is joined with a second plate by a joint, the plates having a solidus temperature above 1100 °C, wherein the joint comprises at least 50 wt% metallic elements that have been drawn from an area (A1) that surrounds the joint and was part of any of the first plate and the second plate.