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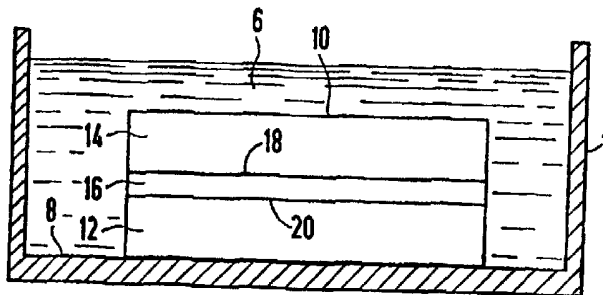
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(54) Title: METHOD OF DISSOLVING A HARDENED GLASS SOLDER, METHOD OF SEPARATING COMPONENTS JOINED BY A GLASS SOLDER, METHOD OF DISMANTLING A FUEL CELL AND DEVICE FOR DISMANTLING A FUEL CELL

(54) Bezeichnung: VERFAHREN ZUM AUFLÖSEN EINES AUSGEHÄRTETEN GLASLOTES, VERFAHREN ZUM TRENNEN VON MIT EINEM GLASLOT ZUSAMMENGEFÜGTEN BAUELEMENTEN, VERFAHREN ZUM ZERLEGEN EINER BRENNSTOFFZELLE UND VORRICHTUNG ZUM ZERLEGEN EINER BRENNSTOFFZELLE



(57) Abstract

The method of dissolving a hardened glass solder (16) involves heating the solder (16) in a hydroxide melt (6). This ensures that the components (12, 14) which were joined by the hardened glass solder (16) can be reused or recycled.

(57) Zusammenfassung

Bei dem vorliegenden Verfahren zum Auflösen eines ausgehärteten Glaslotes (16) wird das ausgehärtete Glaslot (16) in einer Schmelze (6) aus einem Hydroxid erwärmt. Durch diese Maßnahme werden die Bauelemente (12, 14), die durch das ausgehärtete Glaslot (16) zusammengefügt waren, wiederverwendet oder einem Recyclingprozeß unterzogen.

Abstract

Method for dissolving a hardened glass solder, method
for separating components joined by means of a glass
5 solder, method for disassembling a fuel cell, and
apparatus for disassembling a fuel cell

The present method for dissolving a hardened
glass solder (16) involves heating the hardened glass
10 solder (16) in a melt (6) of a hydroxide. As a result
of this action, the components (12, 14) which had been
joined by means of the hardened glass solder (16) are
reused or subjected to a recycling process.

15 FIG 1



Description

Method for dissolving a hardened glass solder, method for separating components joined by means of a glass solder, method for disassembling a fuel cell, and
5 apparatus for disassembling a fuel cell.

The invention relates to a method for dissolving a hardened glass solder, to a method for separating components joined by means of a glass
10 solder, to a method for disassembling a fuel cell, and to an apparatus for disassembling a fuel cell.

It is known, in particular from the "Fuel Cell Handbook" by A. J. Appelby and F.R. Foulkes, Van Nostraud Reinhold, 1988, pp. 442 to 454, that the
15 components of a fuel cell are made of metal alloys or ceramics. In the case of a high-temperature fuel cell, $\text{CrFe}_5\text{Y}_2\text{O}_3$, for example, is used as a material for a bipolar plate. The high requirements placed on the materials to be used, for example the mechanical
20 stability at an operating temperature of more than 800°C in the high-temperature fuel cell give rise to high material costs.

Depleting sources of raw materials and environmental issues necessitate the reuse of the
25 materials of the components. Firstly, the reuse of the original component, once it has been cleaned, is desirable and secondly, after the recycling process has been carried out, the recovered material is used to fabricate a new component.

30 In the high-temperature fuel cell the individual components are joined by a glassy substance, for example a hardened glass solder. Subsequent use of the individual components or of the material of which the components are composed requires suitable



regeneration of the components or of the high-temperature fuel cell.

The objects of the invention are to specify a method for dissolving a hardened glass solder, a method
5 for separating components joined by means of a glass solder, and a method for disassembling a fuel cell. A further object of the invention is to specify an apparatus for disassembling a fuel cell.

The first object is achieved, according to the
10 invention, by a method for dissolving a hardened glass solder, wherein the hardened glass solder is heated in a melt of a hydroxide.

The second object is achieved, according to the invention, by a method for separating components joined
15 by means of a glass solder, wherein the glass solder is heated in a melt of a hydroxide.

The third object is achieved, according to the invention, by a method for disassembling a fuel cell which comprises components joined by means of a glass
20 solder, wherein the fuel cell is heated, at least in the region of said glass solder, in a melt of a hydroxide.

The fourth object is achieved, according to the invention, by an apparatus for disassembling a fuel
25 cell containing a plurality of units, wherein each of these units comprises components joined by means of a glass solder, the apparatus comprising a trough for holding a melt of potassium hydroxide for heating the glass solder, and a mount to accommodate the units so
30 that their faces are parallel, the mount being supported in a lifting means disposed above the trough and the units being completely immersed in the melt of potassium hydroxide.



Employing these methods will preserve, in accordance with current environmental arguments, the raw material sources for the materials of the metallic components. At the same time this will result in savings with respect to high material costs, since the metallic components, once the disassembling operation has been carried out, can be reused or at least subjected to a recycling process. Moreover, these methods have been found to save time, since the metallic components can be pulled apart from one another after as little as a few hours and be subjected to final cleaning.

For the process, the metallic components are treated gently, so that their surface textures, after the methods have been applied, do not differ significantly from their original state, when the components were used in the fuel cell for the first time.

The melt used is preferentially a eutectic mixture of at least two hydroxides. The melt suitable for implementing the method is selected in accordance with the composition of the glass solder.

In particular, the hydroxide used is potassium hydroxide or lithium hydroxide.

In a further embodiment, the hydroxide used is sodium hydroxide.

Preferentially, the melt of potassium hydroxide is admixed with water before it is heated. As a result of the addition of water, the dissolution process takes place in a lower temperature range readily accessible for industrial processes.

In particular, the melt of potassium hydroxide is heated to a temperature of between 250 and 450°C. The high boiling point of the potassium hydroxide enables the melt to be used at high temperatures, resulting in an increase in the reaction



rate. In this temperature range as specified, the method in practical trials proves extremely successful and simple to implement.

In a further embodiment, the melt of potassium hydroxide is heated between 250 and 360°C.

Preferentially, the melt of potassium hydroxide is repeatedly cooled and heated. Cooling and reheating the melt once or a number of times allows the separation process to be accelerated by utilizing the mechanical stress at the temperature differences that occur.

In particular, the units can be moved, by the lifting means, within the trough perpendicular to the bottom. The movement of the units in the melt of potassium hydroxide results in additional acceleration of the method.

The invention is explained in more detail with the aid of diagrammatic, exemplary embodiments in the drawing, in which:

FIGs 1 and 2 schematically depict apparatuses for disassembling metallic components.

According to FIG 1, an apparatus for implementing the method for dissolving a hardened glass solder 16 comprises a trough 4 which is filled with a melt 6 of a hydroxide, for example potassium hydroxide, and a heating means not shown in any detail in the figure.

Disposed on the bottom 8 of the trough 4 is a unit 10 which is composed of two components 12 and 14, these being joined by means of the glass solder 16. The components 12, 14 typically may be made, for example, of a metal or a ceramic alloy, and may be, for example, the components 12, 14 of a fuel



cell, for example the bipolar plates of a high-temperature fuel cell. These bipolar plates can be made, for example, from $\text{CrFe5Y}_2\text{O}_3$.

5 The unit 10 is completely covered, in the trough 4, by the melt 6 of potassium hydroxide. Potassium hydroxide in the nonmolten state is a white, crystalline substance which, if free from water and potassium carbonate, melts at 360°C and boils at 1324°C .

10 The melt 6 is preferentially used at a temperature of between 250 and 450°C . Practical trials of the method in this temperature range have proved successful. For the purpose of these trials, the unit 10, in which the components 12, 14 are made from 15 $\text{CrFe5Y}_2\text{O}_3$, was soaked at approx. 250°C for about 100 hours in the boiling melt 6 of potassium hydroxide. Observation of the surfaces 18, 20 of the components 14, 12, after the method had been applied, showed local corrosion pits of a maximum depth of from 20 to $25\ \mu\text{m}$. 20 These local attacks can be seen as noncritical, since the attacked surfaces 18, 20 of the components 12, 14 are removed, e.g. by means of grinding. The performance of the components 12, 14 is not affected by this removal.

25 We the process carried out in the industrially readily accessible temperature range of between 250 and 360°C , the melt 6 of potassium hydroxide is admixed, prior to heating, with a small amount of water. In general, the water present in the potassium hydroxide 30 will actually be sufficient. The addition of more water will, however, further reduce the melting point of the potassium hydroxide. If 20% water is added, the melting point of the potassium hydroxide drops to 200°C .

To further accelerate the methods, the melt 6 35 of potassium hydroxide in the trough 4 is repeatedly



cooled and heated. Rapid thermal cycling results in additional mechanical stresses which accelerate the method.

Also used as the hydroxide are lithium
5 hydroxide, sodium hydroxide or a eutectic mixture of at least two hydroxides.

This method can therefore be used to
disassemble fuel cells which are composed of components
12, 14 and to make them available for reuse once
10 cleaning has been carried out.

A further apparatus 30 for disassembling
components is shown in FIG 2 in a plan view from above.
Disposed in the rectangular trough 4 is a mount 36, 38
which runs along the edge parallel to the long sides 32
15 and 34.

The plate-like units 40, 42, 44, each
comprising the components 12, 14 joined by means of the
glass solder 16, are clipped into the mount 36, 38 in
such a way that the surfaces 18 and 20 of the
20 components 14 and 12, respectively, are aligned
perpendicular to the long sides 32 and 34 of the
rectangular trough 4 and parallel to its end faces 50
and 52.

The mount 36, 38 in turn is supported in a
25 lifting means 54, 56, 58 disposed above the trough 4.
The lifting means 54, 56, 58 effects movement of the
units 40, 42, 44 perpendicular to the bottom 8 of the
rectangular trough 4 within the melt 6 of potassium
hydroxide. This movement results in additional
30 acceleration of the process defined by the method.



The claims defining the invention are as follows:

1. A method for dissolving a hardened glass solder, wherein the hardened glass solder is heated in a melt of a hydroxide.
2. A method for dissolving a hardened glass solder, substantially as hereinbefore described
5 with reference to the accompanying drawings.
3. A method for separating components joined by means of a glass solder, wherein the glass solder is heated in a melt of a hydroxide.
4. A method for separating components joined by means of a glass solder, substantially as hereinbefore described with reference to the accompanying drawings.
- 10 5. A method for disassembling a fuel cell which comprises components joined by means of a glass solder, wherein the fuel cell is heated, at least in the region of said glass solder, in a melt of a hydroxide.
6. A method for disassembling a fuel cell, substantially as hereinbefore described with reference to the accompanying drawings.
- 15 7. A method as claimed in any one of claims 1 to 6, wherein the melt used is a eutectic mixture of at least two hydroxides.
8. A method as claimed in any one of claims 1 to 6, wherein the hydroxide used is lithium hydroxide.
9. A method as claimed in any one of claims 1 to 6, wherein the hydroxide used is sodium
20 hydroxide.
10. A method as claimed in any one of claims 1 to 6, wherein the hydroxide used is potassium hydroxide.
11. The method as claimed in claim 10, wherein the potassium hydroxide is admixed with water before it is heated.
- 25 12. The method as claimed in claim 11, wherein the melt of potassium hydroxide is preferentially heated to a temperature of between 250 and 450°C.
13. The method as claimed in claim 11, wherein the melt of potassium hydroxide is heated to a temperature of between 250 and 360°C.
14. The method as claimed in any one of claims 11 to 13, wherein the melt of potassium
30 hydroxide is repeatedly cooled and heated.
15. An apparatus for disassembling a fuel cell containing a plurality of units, wherein each of these units comprises components joined by means of a glass solder, the apparatus comprising a trough for holding a melt of potassium hydroxide for heating the glass solder, and a mount to accommodate the units so that their faces are parallel, the mount being supported in a lifting means
35 disposed above the trough and the units being completely immersed in the melt of potassium hydroxide.
16. The apparatus as claimed in claim 15, wherein the units can be moved, by the lifting means, within the trough perpendicular to a bottom.



17. An apparatus for disassembling a fuel cell, substantially as hereinbefore described with reference to the accompanying drawings.

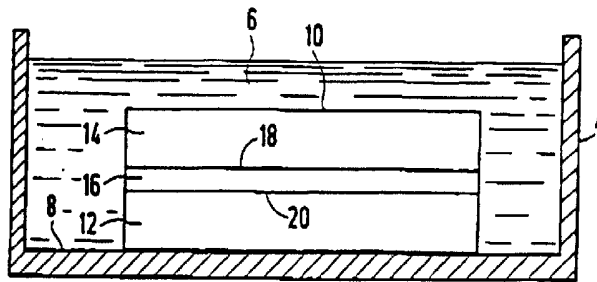
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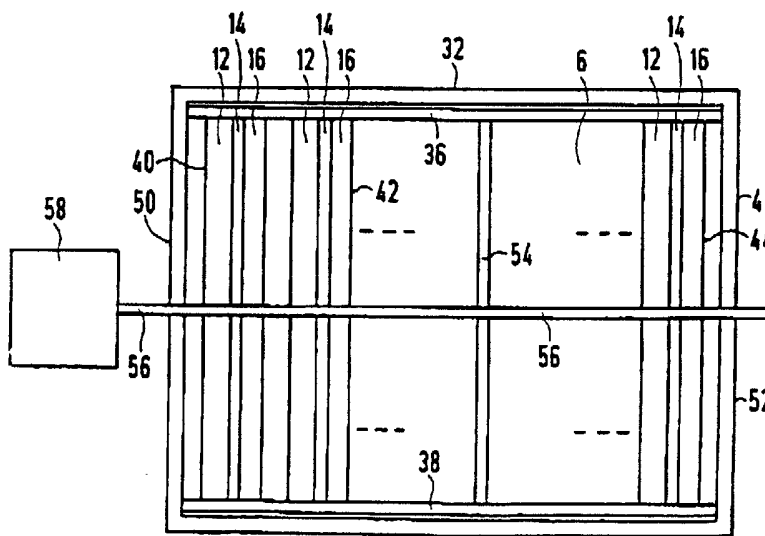
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FIG 1



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FIG 2