described by way of preferred embodiments with reference to the drawings. Fig. 1 is a cross-sectional view schematically showing an exothermic warmer according to a first embodiment of the present invention. An exothermic warmer 1 shown in the diagram has a structure in which an exothermic element 11 having a flat shape is interposed between and covered by a first cover sheet 21 and a second cover sheet 22. The first and second cover sheets 21 and 22 constitute an outer surface of the exothermic warmer 1. The first cover sheet 21 and the second cover sheet 22 may be separate sheets, or may be one sheet that is folded over into two.

[0016]

In the exothermic warmer 1, a water-retaining material 12 is disposed between the exothermic element 11 and the first cover sheet 21 so as to be in contact with the exothermic element 11. Also, a second substrate sheet 13 is disposed between the exothermic element 11 and the second cover sheet 22 so as to be in contact with the exothermic element 11. In this specification, in the exothermic warmer 1, a structural element in which the exothermic element 11 is interposed between the first cover sheet 21 and the second cover sheet 22 will be referred to as "exothermic warmer main body". Also, a structural element that includes the exothermic warmer main body and is ready to be used by the wearer will be referred to as "exothermic warmer". In the present embodiment, "exothermic warmer main body" and "exothermic warmer" refer to the same structural element, and thus, unless it is necessary to make a distinction therebetween, "exothermic warmer main body" and "exothermic warmer" will be collectively referred to as "exothermic warmer".

[0017]

The first and second cover sheets 21 and 22 include extension portions 21a and 22a extending outward from the outer edges of the exothermic element 11, the water-retaining material 12, and the second substrate sheet 13. The extension portions 21a and 22a are joined to each other at their opposing surfaces. Accordingly, the exothermic element 11, the water-retaining material 12, and the second substrate sheet 13 are housed in an enclosed space formed by the two cover sheets 21 and 22. The exothermic warmer 1 configured as described above has a flat shape, and a shape as viewed in plan view according to the specific application of the exothermic warmer. Examples of the shape as viewed in plan view include a polygonal shape such as a

highest surface temperature of the exothermic warmer 1 is measured by bringing a K-type thermocouple into contact with the center position on the outer surface of the first cover sheet 21. The measurement is performed in an atmosphere at 20°C and 65%RH. The temperature difference between the highest internal temperature of the exothermic element 11 and the highest surface temperature of the exothermic warmer 1 measured in that atmosphere is calculated. The difference between the internal temperature of the exothermic element 11 and the highest surface temperature of the exothermic warmer 1 measured in the manner described above is preferably 9°C or less, more preferably 8°C or less, and even more preferably 6°C or less. The lower limit value for this difference is preferably as low as possible, and most preferably 0°C.

[0027]

With respect to the condition (B), the highest skin temperature obtained when the exothermic warmer is applied to human skin is measured by using a thermistor-equipped data logger (LT-8 available from Nikkiso Therm Co., Ltd.). The measurement is performed by fixing the thermistor to a human skin surface such as the upper eyelid by using surgical tape. In the case where the measurement is performed in the absence of the influence of the outer jacket, the exothermic element main body from which the outer jacket has been removed is covered with a bag made of a non-woven fabric before being measured. The non-woven fabric used at this time is a combination of an air-through non-woven fabric and a needle-punched non-woven fabric used in examples, which will be described later. The highest skin temperature measured in this way is, as described above, preferably 38°C or more and 42°C or less, more preferably 38.5°C or more and 41.5°C or less, and even more preferably 39°C or more and 41°C or less.

[0028]

With respect to the condition (C), the amount of steam generated in 10 minutes after the oxidation reaction started was measured in the following manner by using an apparatus 30 shown in Fig. 3. The apparatus 30 shown in Fig. 3 includes a measurement chamber (with a volume of 2.1 L) 31 that is made of aluminum, an inflow channel 32 through which dehumidified air (with a humidity of less than 2% at a flow rate of 2.1 L/min) is allowed to flow into below the measurement chamber 31, and an outflow channel 33 through which air is discharged from above the measurement chamber 31. The inflow channel 32 is equipped with an inlet temperature-humidity meter 34 and an

Accordingly, even if the exothermic warmer comes into contact with the target area in different ways due to differences in the size and shape of the target area that vary from individual to individual, it is possible to uniformly warm the entire target area, and suppress skin temperature variations as compared to the conventional exothermic warmer.

[0039]

It is preferable that the air permeability of the first cover sheet 21 of the exothermic warmer 1 is 0 sec / (100 ml•6.42 cm^2) or more and 1500 sec / (100 ml•6.42 cm^2) or less from the viewpoint of preventing the supply of oxygen from being the rate-determining step in the exothermic reaction. As used herein, the term "air permeability" refers to a numerical index based on the Gurley (JIS P8117) measurement method, and is defined by the time during which 100 ml of air passes through an area of 6.42 cm^2 under a constant pressure. When the first cover sheet 21 has an air permeability of 1500 sec / (100 ml•6.42 cm^2) or less, it means that the time required for 100 ml of air to pass therethrough is 1500 seconds or less, and the greater the value, the smaller the amount of air permeation of the first cover sheet, and conversely, the smaller the value, the greater the amount of air permeation of the first cover sheet. Accordingly, because the state under the Gurley measurement method and the state in which the exothermic element is actually used are not necessarily the same, even if a numerical value is obtained using the Gurley measurement method, this does not necessarily mean that the first cover sheet 21 will hinder the supply of oxygen to the exothermic element 11. The preferred air permeability range varies depending on the composition of the exothermic element 11, the initial amount of water, and the like, but it is better to have lower air permeability. To be specific, the air permeability is preferably 1200 sec / (100 ml•6.42 cm^2) or less, more preferably 1000 sec / (100 ml•6.42 cm^2) or less, and even more preferably 500 sec / (100 ml•6.42 cm^2) or less. An air permeability within an above range is preferable because the exothermic reaction is unlikely to be affected by the external environment, and the amount of steam generated and temperature control can be easily balanced.

[0040]

Through experiments, the inventors of the present invention have selected a range that prevents the supply of oxygen from being the rate-determining step in the oxidation reaction, and specified an air permeability range. Fig. 6 shows profiles

[0058]

The concentration of the electrolyte in the exothermic element 11 before the start of the oxidation reaction is preferably 1 mass% or more, more preferably 3 mass% or more, and even more preferably 4 mass% or more, and preferably 20 mass% or less, more preferably 15 mass% or less, and even more preferably 10 mass% or less. To be specific, it is preferable that the concentration of the electrolyte is 1 mass% or more and 20 mass% or less, more preferably 3 mass% or more and 15 mass% or less, and even more preferably 4 mass% or more and 10 mass% or less. With the above-described range, at the time when the oxidation reaction of the exothermic element 11 is started and the water in the exothermic element 11 is consumed, an excess amount of water is rapidly supplied from the water-retaining material, specifically, a water-absorbing polymer, to the exothermic element 11, and the temperature of the exothermic element 11 and the amount of steam generated during the oxidation reaction are maintained at very favorable levels. From the viewpoint of water absorbency and water releasing properties, it is preferable to use a water-absorbing polymer with high salt tolerance as the water-retaining material. Particularly when the electrolyte content is 3 mass% or more, a high level of water absorbency is exhibited before the oxidation reaction and at a specific salt concentration, and at the same time, water is released with an increase in the salt concentration due to the oxidation reaction, and thus water control suitable for the oxidation reaction is likely to be performed. The reason is for this is that an osmotic pressure difference is likely to occur between the exothermic element 11 and the water-absorbing polymer, and the supply of water from the water-absorbing polymer to the exothermic element 11 is likely to be smooth not only at the start of the oxidation reaction but also during the oxidation reaction.

[0059]

In a state before the oxidation reaction has started, the proportion of the electrolyte with respect to the total of the water content and the electrolyte content in the exothermic element 11 is preferably 5 mass% or more, and more preferably 10 mass% or more, and from the viewpoint of sufficient water retention in the water-absorbing polymer, preferably 50mass% or less, and more preferably 40mass% or less. To be more specific, the electrolyte content with respect to the total of the water content and the electrolyte concentration in the exothermic element 11 is preferably 5 mass% or more and 50 mass% or less, and more preferably 10 mass% or more and 40 mass% or less. The

above-described ranges are preferable because the exothermic reaction of the exothermic element 11 is likely to be smooth, and water is likely to be rapidly supplied to the exothermic element when a water-absorbing polymer is used as the water-retaining material.

[0060]

Also, the electrolyte content in the exothermic element 11 before the start of the oxidation reaction is, with respect to 100 parts by mass of the oxidizable metal, preferably 1 part by mass or more and 20 parts by mass or less, more preferably 2 parts by mass or more and 19 parts by mass or less, and even more preferably 3 parts by mass or more and 18 parts by mass or less. With the above-described range, the promotion of the oxidation reaction of the oxidizable metal can be maintained in a favorable manner.

[0061]

The electrolyte content in the exothermic element 11 is, in terms of basis weight, preferably 5 g/m^2 or more, and more preferably 10 g/m^2 or more, and preferably 80 g/m^2 or less, and more preferably 70 g/m^2 or less. More specifically, the electrolyte content is, in terms of basis weight, preferably 5 g/m^2 or more and 80 g/m^2 or less, and more preferably 10 g/m^2 or more and 70 g/m^2 or less.

[0062]

The exothermic element 11 contains water. Water is used not only in the oxidation reaction of the oxidizable metal, but also used as a source of steam generated by the heat created by the oxidation reaction of the oxidizable metal, and also as a coolant that cools the generated heat to an appropriate temperature. In the exothermic warmer 1 according to the present embodiment, the water-retaining material 12 is disposed so as to be in contact with the exothermic element 11, and the amount of water contained in the exothermic element 11 before the reaction is important in terms of controlling the temperature characteristics at an initial stage of the exothermic reaction. The water in the exothermic warmer 1 is retained in the exothermic element 11 and the water-retaining material 12. The water content in the exothermic element 11 before the reaction starts is preferably 9 mass% or more with respect to the exothermic element 11. With the above-described range, the oxidizable metal can be sufficiently oxidized, and a large

reaction has started" is a state of being present in the hermetically sealed container or a state immediately after being taken out of the hermetically sealed container and exposed to a normal oxygen concentration, and thus is not limited to a state in which no oxidation reaction takes place at all.

[0063]

The exothermic element 11 made of an exothermic composition containing the above-described components can be formed by applying the exothermic composition onto, for example, the first cover sheet 21 in the form of a flat layer. Alternatively, the exothermic element 11 can be formed by applying the exothermic composition onto the second substrate sheet 13 in the form of a flat layer. It is preferable that the total basis weight of the exothermic element 11 is 200 g/m^2 or more, and more preferably 300 g/m^2 or more, and preferably 2500 g/m^2 or less, and more preferably 2000 g/m^2 or less. To be more specific, the total basis weight of the exothermic element 11 is preferably 200 g/m^2 or more and 2500 g/m^2 or less, and more preferably 300 g/m^2 or more and 2000 g/m^2 or less. With the above-described range, the exothermic warmer 1 can be made thinner, and sufficient heat generation period is likely to be obtained.[0064]

As shown in Fig. 1, the water-retaining material 12 is formed as a layer between the exothermic element 11 and the first cover sheet 21. That is, the water-retaining material 12 is disposed on a surface of the exothermic element 11 that is on the first cover sheet 21 side. The water-retaining material 12 is made of a material that is capable of retaining water. In the present invention, the term "water-retaining material" refers to a material that is capable of absorbing and retaining pure water in an amount that is 5 times or more its own weight in terms of mass. As the water-retaining material, it is preferable to use a water-absorbing polymer that is a material that has very high water retention and has a property of releasing water due to changes in heat or salt concentration. The exothermic warmer 1 is configured such that, in the initial stage of the exothermic reaction, the heat capacity of the exothermic element 11 is high due to setting the water content in the exothermic element 11 to be slightly high. With this configuration, an increase in the reaction speed due to free air permeation of the first cover sheet 21 is suppressed. Also, by providing the amount of heat generated by the exothermic reaction to the water contained in the exothermic element 11, the amount of heat is consumed by an increase in

the water temperature (sensible heat). In the initial stage of the exothermic reaction, because the water contained in the exothermic element 11 is used, the electrolyte concentration in the exothermic element 11 increases abruptly. This reduces the osmotic pressure in the water-absorbing polymer, and the water retained in the water-absorbing polymer is released. Also, the water-absorbing polymer has a property of easily releasing water when the temperature becomes high. Accordingly, with these two advantageous effects working in combination, water is released from the water-absorbing polymer.

[0065]

Normally, when the water content in the exothermic element 11 is increased, the exothermic reaction is suppressed, and the electrolyte concentration decreases, as a result of which, the release of water from the water-absorbing polymer is reduced or stops. However, in the exothermic warmer 1, the oxidation reaction is not suppressed by the first cover sheet 21, and thus the oxidation reaction of the oxidizable metal proceeds sufficiently, and water serving as reaction water is quickly consumed. Also, along with this, a sufficient amount of heat generation is obtained, and thus the evaporation rate of water in the exothermic element 11 is high. That is, although a large amount of water is supplied from the water-absorbing polymer to the exothermic element 11, the water content in the exothermic element 11 is constantly low for the reasons described above, and thus the electrolyte concentration is maintained at a high level. As a result, water is continuously released from the water-absorbing polymer due to an osmotic pressure difference, and an excess amount of water is supplied to the exothermic element 11. Then, when the oxidation reaction starts in this state, the amount of water contained in the exothermic warmer 1 is consumed by reaction water used in the oxidation reaction and water emitted from the exothermic warmer in the form of steam, as a result of which, the salt concentration of the exothermic warmer 1 as a whole increases. Then, the consumption of water in the exothermic element 11 and the supply of water from the water-absorbing polymer to the exothermic element 11 are instantaneously repeated.

[0066]

As described above, in the exothermic warmer 1 according to the present embodiment, the consumption of water and the supply of water are repeatedly performed at a high frequency, and thus the water content in the exothermic element 11 is

is manufactured using a different method, first, an exothermic element forming step of forming an exothermic element is performed by performing a step of adding an electrolyte in a solid state to one surface of a second cover sheet 22 and a step of applying a coating material that contains an oxidizable metal, a carbon component, and water, but not the electrolyte, in this order or in a reversed order, or performing the two steps simultaneously. Then, concurrently with the formation of the exothermic element 11, a water-retaining material supplying step of supplying a water-retaining material 12 to a surface side of the second cover sheet 22 on which the exothermic element 11 is to be formed is performed. Through this, the exothermic element 11 and the water-retaining material 12 are brought into a mixed state. After that, a first cover sheet 21 is disposed on the exothermic element 11 forming surface side of the second cover sheet 22, and then extension portions 21a and 22a of the cover sheets 21 and 22 extending from the outer edges of the second substrate sheet 13 are joined to each other. In this way, an intended exothermic warmer 1 is obtained.

[0086]

The exothermic warmer 1 according to each of the embodiments given above is suitable for use to warm a human body. In this case, the exothermic warmer 1 may be used, with the first cover sheet 21 opposing the human body or with the second cover sheet 22 opposing the human body. From the viewpoint of efficiently warming a human body by using a large amount of steam generated from the exothermic warmer 1, it is preferable to use the exothermic warmer 1, with the first cover sheet 21 opposing the human body. In this case, it is preferable to bring the first cover sheet 21 into direct contact with the human body from the viewpoint of efficiently warming the human body, but an additional member may be interposed between the first cover sheet 21 and the human body.

[0087]

Up to here, the present invention has been described by way of preferred embodiments thereof, but the present invention is not limited to the embodiments given above. For example, in the embodiments shown in Figs. 1 and 8, the layer made of the water-retaining material 12 is disposed on a surface of the exothermic element 11 that is on the first cover sheet 21 side, but instead, the layer made of the water-retaining material 12 may be disposed on a surface of the exothermic element 11 that is on the second cover sheet 22 side.

32. The exothermic warmer according to any one of claims 25 to 31,

wherein the exothermic element is formed on a substrate sheet, and the water-absorbing polymer is disposed on a surface of the exothermic element that is opposite to a surface of the exothermic element that opposes the substrate sheet.

33. The exothermic warmer according to any one of claims 25 to 32,

wherein an air permeable sheet is provided between the water-absorbing polymer and the first cover sheet.

34. The exothermic warmer according to any one of claims 25 to 33,

wherein the first cover sheet has an air permeability of 0 sec / (100 ml•6.42 cm^2) or more and 1500 sec / (100 ml•6.42 cm^2) or less, and a water pressure resistance of 1500 mmH_2O or more.

35. The exothermic warmer according to any one of claims 25 to 34,

wherein the water-absorbing polymer is disposed on a surface of the exothermic element that is on the first cover sheet side.

36. The exothermic warmer according to any one of claims 25 to 35,

wherein the exothermic warmer has a thickness of 0.5 mm or more and 8 mm or less.

37. The exothermic warmer according to claim 36,

wherein the exothermic warmer has a thickness of 1 mm or more and 6 mm or less.

38. The exothermic warmer according to any one of claims 25 to 37,

wherein. in the exothermic warmer, an outer jacket is provided on an outer side of the first cover sheet and/ or the second cover sheet.

39. The exothermic warmer according to claim 38,

wherein the first cover sheet is located on a skin contact side that comes into