



(11) **EP 2 056 302 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
21.12.2011 Bulletin 2011/51

(51) Int Cl.:
G21F 9/28 (2006.01) G21F 9/00 (2006.01)

(21) Application number: **07119543.2**

(22) Date of filing: **29.10.2007**

(54) **Decontamination method of metal surface contaminated by radioactive element**

Dekontaminierungsverfahren für eine durch radioaktive Elemente kontaminierte Metalloberfläche

Procédé de décontamination pour surface métallique contaminé par des éléments radioactifs

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE
SI SK TR**

(43) Date of publication of application:
06.05.2009 Bulletin 2009/19

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(56) References cited:
**US-A- 5 763 734 US-A1- 2003 172 959
US-B1- 6 689 226**

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Description

Field of the invention

[0001] The present invention relates to a decontamination method of a metal surface contaminated by radioactive element; more particularly, relates to mixing a blend of polymers, characteristic additives and a decontamination reagent to obtain a decontamination gel for indicating contaminations of Co, Cs and Sr and to obtain good decontamination effect by cleaning the contaminations by removing a film of the decontamination gel dried-up

Description of the Related Arts

[0002] Different decontamination reagents are used for cleansing. For example, distilled products from petroleum are used to clean contaminations on surfaces of tire, break, etc. These reagents usually contain hydrocarbon solvents like methylbenzene and xylene. Yet, environmental-friendly products are developed and widely used in the modern time. As disclosed in US 4,511,488, D-limonene is used to cleanse oil and earth on mechanical facilities. In US 5,660,641, 2 to 8 weight percents (wt%) of terpene, or 5 to 25 wt% of anionic or nonionic surfactant, is used to effectively remove grease or tar on a surface. However, a surface having a pollution of radionuclides is not effectively cleansed. And, a solution obtained after cleansing the surface may need further treatment.

[0003] Technologies of decontamination, including chemical and non-chemical decontamination technologies, are developed. The chemical decontamination technologies use chemical reagents, such as organic acids having reduction property, chelating agents, oxidants, reductive agent, etc. These chemical reagents are soft and are used for precision machines such as reactor coolant pump (RCP). But its decontamination factor is usually small. The later non-chemical technologies are more widely used, such as electrochemical decontamination, abrading decontamination, high pressure water-jet decontamination, mechanical decontamination, etc. These methods are usually severe and may even ruin machine; though the decontamination factors may reach 103 to 104.

[0004] The above technologies are usually used for decontamination of removable material. Yet, fission products from nuclear reactions, like ^{60}Co , ^{137}Cs and ^{90}Sr , may be adhered on irremovable materials, like industrial facilities, floor, ceiling, wall, etc. Hence, an on-the-spot decontamination method is required.

[0005] Traditional decontamination reagent for radioactive waste usually contains strong acid or alkali to improve decontamination effect, like phosphoric acid, sulfuric acid, nitric acid, fluoroboric acid, potassium permanganate or sodium hydroxide. And the operation is usually processed under a high temperature. When contaminations

are gradually accumulated in the decontamination reagent, its decontamination effect decreases while radioactive activity of the accumulated contaminations increases. At the minute, the decontamination reagent needs further treatment or becomes a waste. But, the treatment may not be easy owing to the complex components contained in the used decontamination reagent. And, the waste may be a great amount. All these may greatly heighten the cost.

[0006] To decrease the amount of the waste, surface protective films are developed. They are usually used as protective layers on industrial objects to prevent from contamination and collision, and thus are soft. For example, US 5,891,261 discloses (meth)acrylic acid ester combined with other polymer monomers, like less than 5%wt of carbonyl group, to form a gel. And the gel is pasted on a surface to be dried for obtaining a film. Then cold or hot water (even vapor) are sprayed on the dried film to remove it.

[0007] However, the above prior arts are not suitable to radioactive pollutions.

[0008] US 2003/172959 A1 discloses a method for removing a wide variety of radioactive contaminants from a contaminated surface.

[0009] US 5,763,734 discloses another method of decontaminating devices in nuclear power plants.

[0010] US 6,689,226 B1 discloses a decontamination gel including a decontamination agent, two organic polymers and water.

[0011] US 6,203,624 B1 discloses a decontamination gel that can be used to decontaminate metal surfaces, while decontamination is understood to be related to the removal of radioactive elements. Conventional decontaminations gels comprise a viscosing agent that is generally mineral and a decontamination agent chosen in relation to the type of the surface. Because of the viscosing agent spraying of the gel is difficult. US 6,203,624 B1 therefore suggests combining a mineral viscosing agent and an organic viscosing agent chosen from hydrosoluble organic polymers and surfactants.

Summary of the invention

[0012] The present invention provides a decontamination method comprising the steps of claim 1. Advantageous embodiments of the claimed method are laid down in further claims.

[0013] Further, the present invention provides a decontamination gel according to claim 15.

[0014] The decontamination reagent contains at least one polymer to be sprayed on a contaminated material for forming a film for cleaning contamination.

[0015] Evaporable organic solvent is added to increase fluidity of gel and to control time for obtaining the film.

[0016] A colorimetric indicator is added in the decontamination gel to be sprayed on the contaminated material to show places of contaminations.

[0017] Preferably, the decontamination reagent has abilities of physical absorbing or chemical chelating to Co, Cs and Sr.

Brief description of the drawings

[0018] The present invention will be better understood from the following detailed description of the preferred embodiment according to the present invention, taken in conjunction with the accompanying drawings, in which

- FIG. 1 is the flow view showing the preferred embodiment according to the present invention;
 FIG. 2 is the flow view showing fabricating the gel fluid;
 FIG. 3 is the flow view showing fabricating the decontamination gel;
 FIG. 4 is the flow view showing fabricating the colorimetric decontamination gel;
 FIG. 5 is the view showing the colors of the first state of use; and
 FIG. 6 is the view showing the colors of the second state of use.

Description of the preferred embodiment

[0019] The following description of the preferred embodiment is provided to understand the features and the structures of the present invention.

[0020] Please refer to FIG. 1, which is a flow view showing a preferred embodiment according to the present invention. As shown in the figures, the present invention is a decontamination method of a metal surface contaminated by radioactive element, comprising the following steps:

(a) Fabricating gel fluid [11]: A mixed solution with a proper ratio of an evaporable organic solution to water is obtained at first. Then, at least one polymer with different weight ratio is mixed at 80 to 95 Celsius degrees (°C) to obtain a gel fluid. With the organic solution, a density of the gel fluid is controlled and a decontamination ability to a surface of a material is increased. Therein, the organic solution is acetylene acetone (ACAC), acetonitrile or ethanol; and the polymer is polyethylene oxide (PEO), polyacrylonitrile (PAN), polyvinyl alcohol (PVA), polyvinyl pyrrolidone (PVP), polyvinyl acetate, carboxymethyl cellulose, polyethylene oxide, polyethylene glycol, gelatin, apple pectin or arabic gum.

(b) Fabricating decontamination gel [12]: A decontamination reagent is added in the gel fluid as an absorbing agent or a chelating agent to change a density of the gel fluid for controlling time for forming a film. A plasticizer is further added to change a fragile property of the gel fluid for improving plasticity of the gel fluid. After the above added substances are fully mixed, the temperature of the mixed solution is cooled down to room temperature; and then at least

one colorimetric indicator is added into an ethanol solution with a certain ratio and is added into the decontamination gel to obtain a decontamination gel having at least one colorimetric indicator. Therein, the decontamination gel is a mixture of at least one first compound, an inorganic acid and water; the first compound is diethylene triamine pentaacetic acid (DTPA), ethylene diamine tetraacetic acid (EDTA), apple pectin, prussian blue, ammonium phosphomolybdate (AMP), Ce^{4+}/Ce^{3+} , hydrogen peroxide or ferrocyanide; the inorganic acid is phosphoric acid, hydrochloric acid, formic acid or sulfuric acid; the plasticizer is tetrahydrofuran (THF), N-methyl formamide (NMF), N,N-dimethyl formamide (DMF), glycerin or phthalate ester; the colorimetric indicator is a mixture of at least one second compound and an ethanol solution; and the second compound is alizarin, phenol red (PR), arsenazo III or 2-(5-bromo-2-pyridylazo)-5-dimethylaminophenol (BrPADAP).

(c) Decontaminating contamination [13]: Pasting the decontamination gel on the contaminated surface of the material by a brush or a spraying tool. A film is thus naturally formed at a temperature between 10 and 40°C after 3 to 24 hours (hrs). The film shows contaminated areas on the surface and contamination is soaked in the film by physical absorbing and chemical chelating. Hence, the contamination is decontaminated by removing the film. Therein, the material is stainless steel, carbon steel, aluminum, copper, plastics or glass.

[0021] Accordingly, a novel decontamination method of a metal surface contaminated by radioactive element is obtained.

[0022] Please refer to FIG. 2, which is a flow view showing fabricating a gel fluid. As shown in the figure, on using the present invention, a mixed solution with a physical ratio of water to an evaporable organic solution [21] between 1 and 5 is obtained in a reactor. Then a first polymer [22], such as methylcellulose, is added to obtain a proper weight ratio. The methylcellulose is blended to be fully solved with temperature heated up. A condenser is then further used to prevent an evaporation of the organic solution and water. Then a second polymer [23], such as PVA, is gradually added with blending under 85°C during 4 to 5hrs to be fully solved into water for obtaining a proper weight ratio of the first polymer to the second polymer. Then a plasticizer [24], such as glycerin, is added at a temperature between 80°C and 95°C to obtain a proper volume ratio of glycerin to water. Thus, a gel fluid [26] is obtained after a continuous blending [25].

[0023] Please refer to FIG. 3, which is a flow view showing a decontamination gel. As shown in the figure, on fabricating a decontamination reagent solution, a decontamination reagent [27], such as DTPA, is solved into a solution of phosphoric acid and water [28] to be fully blended for obtaining a molar ratio of 1:8:175 for DTPA to phosphoric acid to water in the decontamination reagent.

gent solution [29]. Then 6500 volumes of gel fluid [26] is added with 200 volumes of the decontamination reagent solution [29] to obtain a ratio of 33 to 1. Then the solution is blended [31] under 85°C [30] in the reactor. Thus, the decontamination reagent solution [34] is obtained after being placed still [32] for 1hr to be cooled down [33] to room temperature.

[0024] Please refer to FIG.4, which is a flow view showing a colorimetric decontamination gel. As shown in the figure, a colorimetric indicator [35], such as alizarin, is added into an ethanol solution [36] to obtain a colorimetric indicator solution [37] with a ratio of alizarin to the ethanol solution between 0.01 and 0.03. Then, 50 volumes of the colorimetric indicator solution [37] are mixed with 4800 volumes of a decontamination reagent [34] to obtain a proper ratio. Then the solution is blended [38] and then is placed still [39] to obtain a colorimetric decontamination gel [40].

[0025] Then, the decontamination gel is sprayed on a surface of a material. After the decontamination gel is dried up, a film is formed and radioactive substances like cobalium (Co), cesium (Cs) and strontium (Sr) are soaked in the film and are shown by the colorimetric indicator with different colors. In this way, positions of the contaminations are observed and are cleaned by removing the film. In addition, densities of the contamination are recognized by the colors.

Color reaction of decontamination gel having single colorimetric indicator

[0026] Please refer to FIG.5, which is a view showing colors of a first state of use. As shown in the figure, different colorimetric indicators have different color reactions. At first, decontamination gels separately having colorimetric indicators are obtained. And materials of stainless steel are used to be sunk in a cleanser. Then the materials are cleansed with ultrasound before being hot-dried in an oven. After the temperature is cooled down to room temperature, solutions separately having contaminations of Co, Cs and Sr are obtained and dropped on glasses to be hot-dried. After the temperature is cooled down to room temperature, the decontamination gels separately having colorimetric indicators are sprayed on the glasses having contaminations of Co, Cs and Sr to show different colors.

[0027] As a result, the glasses having the contaminations of Co show obvious colors by the decontamination gels having alizarin and BrPADAP; and the glasses having the contaminations of Cs and Sr show obvious colors by the decontamination gels having alizarin and arsenazo III. Hence, different decontamination gels separately having different colorimetric indicators detect materials separately having contaminations of Co, Cs and Sr for preventing pollution dispersion and protecting environment.

Color reaction of decontamination gel having mixed colorimetric indicators

[0028] Please refer to FIG.6, which is a view showing colors of a second state of use. As shown in the figure, a decontamination gel having more than two colorimetric indicators is used to show colors of materials having contaminations of Co, Cs and Sr. At first, two different colorimetric indicators are solved in an ethanol solution. The mixed colorimetric indicators are added to a decontamination gel. Then solutions separately having contaminations of Co, Cs and Sr are obtained and the mixed colorimetric indicators are dropped on glasses to be hot-dried to show different colors. Therein, the colorimetric indicators are BrPADAP and arsenazo III; PR and alizarin; PR and arsenazo III; or alizarin and arsenazo III.

[0029] As a result, the glasses having the contaminations of Co, Cs and Sr show obvious colors by the decontamination gel having the colorimetric indicators. Hence, the decontamination gel having the colorimetric indicators detects materials having contaminations of Co, Cs and Sr for preventing pollution dispersion and protecting environment.

Decontamination effect of the decontamination gel to materials having contaminations of Co, Cs and Sr

[0030] For removing contaminations of Co, Cs and Sr, a decontamination gel according to the present invention is obtained. Solutions having contaminations of Co, Cs and Sr are obtained and dropped on a glass to be hot-dried. After the temperature is cooled down to room temperature, the decontamination gel is sprayed on a glass having contaminations of Co, Cs and Sr to form a film after being dried up naturally. Thus, the contaminations of Co, Cs and Sr are cleaned by removing the film. By sinking the glass in an acid solution and analyze the acid solution afterward, a decontamination effect of the decontamination gel to materials having contaminations of Co, Cs and Sr is shown. As a result, it is shown that the decontamination gel has decontamination effects of 99%, 96% and 97% to Co, Cs and Sr separately.

[0031] To sum up, the present invention is a decontamination method of a metal surface contaminated by radioactive element, where a blend of polymers, characteristic additives and a decontamination reagent are mixed to obtain a decontamination gel for indicating contaminations of Co, Cs and Sr and to obtain good decontamination effect by cleaning the contaminations by removing a film of the decontamination gel dried-up.

[0032] The preferred embodiment herein disclosed is not intended to unnecessarily limit the scope of the invention. Modifications or variations belonging to the scope of the claims are all within the scope of the present invention.

Claims

1. A decontamination method for decontamination of a metal surface contaminated by radioactive elements, comprising steps of:

(a) mixing an organic solvent, more than one polymer and water to obtain a gel fluid;
 (b) adding a decontamination reagent and a plasticizer into said gel fluid to be fully blended then adding a solution of at least one colorimetric indicator to obtain a colorimetric decontamination gel; and
 (c) pasting said decontamination gel on a contaminated surface of a material to obtain a film and removing said film to decontaminate said surface;

wherein

said organic solvent is selected from a group consisting of acetylene acetone, acetonitrile and ethanol;

said plasticizer is selected from a group consisting of tetrahydrofuran, N-methyl formamide, N,N-dimethyl formamide, glycerin and phthalate ester; and
 said colorimetric indicator is a mixture of an ethanol solution and at least one selected from a group consisting of alizarin, phenol red, arsenazo III and 2-(5-bromo-2-pyridylazo)-5-dimethylaminophenol.

2. The method according to claim 1, wherein said gel fluid has a temperature between 80 °C and 95°C.
3. The method according to claim 1 or 2, wherein said water and said organic solvent has a physical ratio between 1 and 5.
4. The method according to one of claims 1 to 3, wherein said polymer is selected from a group consisting of polyethylene oxide, polyacrylonitrile, polyvinyl alcohol, polyvinyl pyrrolidone, polyvinyl acetate, carboxymethyl cellulose, polyethylene oxide, polyethylene glycol, gelatin, apple pectin and arabic gum.
5. The method according to one of claims 1 to 4, wherein said plasticizer is mixed with said polymer at a temperature between 80°C and 95°C.
6. The method according to one of claims 1 to 5, wherein said decontamination reagent is a mixture of at least one first compound, an inorganic acid and water; and
 wherein said first compound is selected from a group consisting of diethylene triamine pentaacetic acid, ethylene diamine tetraacetic acid, apple pectin, prussian blue, ammonium phosphomolybdate,

Ce4+/Ce3+, hydrogen peroxide and ferrocyanide.

7. The method according to one of claims 1 to 6, wherein said inorganic acid is selected from a group consisting of phosphoric acid, hydrochloric acid, formic acid and sulfuric acid.
8. The method according to claim 6, wherein a molar ratio of said decontamination reagent to said inorganic acid to water is 1 to 8 to 175.
9. The method according to one of claims 1 to 8, wherein said colorimetric indicator and said ethanol solution is mixed to obtain a ratio between 0.01 and 0.03.
10. The method according to one of claims 1 to 9, wherein said decontamination gel is exposed in air for 3 to 24 hours at a temperature between 10°C and 40°C to obtain said film.
11. The method according to one of claims 1 to 10, wherein said film has a decontamination efficiency, which is greater than 96%, to a contamination containing an element selected from a group consisting of cobaltum, cesium and strontium; and
12. The method according to one of claims 1 to 11, wherein said material is selected from a group consisting of stainless steel, carbon steel, aluminum, copper, plastics and glass.
13. The method according to one of claims 1 to 12, wherein said colorimetric indicator colorizes contaminations on said surface of said material and thus shows positions of said contaminations.
14. The method according to one of claims 1 to 13, wherein a physical ratio of said decontamination reagent to said gel fluid in a mixed solution is 1 to 33.
15. Decontamination gel for decontamination of a metal surface contaminated by radioactive elements, consisting of:

(a) an organic solvent, more than one polymer and water mixed to form a gel fluid; and
 (b) a decontamination reagent, a plasticizer and at least one colorimetric indicator in said gel to form a colorimetric decontamination gel; and
 (c) that is suitable for being pasted on a contaminated surface of a material to obtain a film and removing said film to decontaminate said surface

wherein

said organic solvent is selected from a group consisting of acetylene acetone, acetonitrile and etha-

nol;
said plasticizer is selected from a group consisting of tetrahydrofuran, N-methyl formamide, N,N-dimethyl formamide, glycerin and phthalate ester; and said colorimetric indicator is a mixture of an ethanol solution and at least one selected from a group consisting of alizarin, phenol red, arsenazo III and 2-(5-bromo-2-pyridylazo)-5-dimethylaminophenol.

Patentansprüche

1. Dekontaminationsverfahren zur Dekontamination einer mit radioaktiven Elementen kontaminierten Metalloberfläche, das folgende Schritte umfasst:

(a) Mischen von einem organischen Lösungsmittel, mehr als einem Polymer und Wasser, um ein Gelfluid zu erhalten;
(b) Hinzufügen eines Dekontaminations-Reagens und eines Weichmachers in das Gelfluid bis zur vollständigen Vermischung und anschließendes Hinzufügen einer Lösung aus mindestens einem kolorimetrischen Indikator, um ein kolorimetrisches Dekontaminationsgel zu erhalten; und
(c) Aufbringen des Dekontaminationsgels auf eine kontaminierte Oberfläche eines Materials, damit ein Film entsteht, und Entfernen des Films, so dass die Oberfläche dekontaminiert wird;

wobei

das organische Lösungsmittel aus einer Gruppe gewählt wird, die aus Acetylaceton, Acetonitril und Ethanol besteht;

der Weichmacher aus einer Gruppe gewählt wird, die aus Tetrahydrofuran, N-Methylformamid, N,N-Dimethylformamid, Glycerin und Phthalatsäureester besteht; und der kolorimetrische Indikator eine Mischung aus einer Ethanolösung und mindestens einem Stoff ist, der aus einer Gruppe gewählt wird, die aus Alizarin, Phenolrot, Arsenazo III und 2-(5-Bromo-2-Pyridylazo)-5-Dimethylaminophenol besteht.

2. Verfahren nach Anspruch 1, wobei das Gelfluid eine Temperatur zwischen 80°C und 95°C aufweist.
3. Verfahren nach Anspruch 1 oder 2, wobei das Wasser und das organische Lösungsmittel ein physikalisches Verhältnis zwischen 1 und 5 haben.
4. Verfahren nach einem der Ansprüche 1 bis 3, wobei das Polymer aus einer Gruppe gewählt wird, die aus Polyäthylenoxid, Polyacrylnitril, Polyvinylalkohol, Polyvinylpyrrolidon, Polyvinylacetat, Carboxymethylcellulose, Polyäthylenoxid, Polyäthylen-

glycol, Gelatine, Apfelpektin und Gummi arabicum besteht.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei der Weichmacher bei einer Temperatur von 80°C bis 95°C mit dem Polymer gemischt wird.
6. Verfahren nach einem der Ansprüche 1 bis 5, wobei das Dekontaminationsreagens eine Mischung aus mindestens einer ersten Verbindung, einer anorganischen Säure und Wasser ist; und wobei die erste Verbindung aus einer Gruppe gewählt wird, die aus Diäthylentriaminpentanessigsäure, Äthylendiamintetraessigsäure, Apfelpektin, Preußisch-Blau, Ammoniumphosphomolybdat, Ce4+/Ce3+, Wasserstoffperoxid und Ferrocyanid besteht.
7. Verfahren nach einem der Ansprüche 1 bis 6, wobei die anorganische Säure aus einer Gruppe gewählt wird, die aus Phosphorsäure, Chlorwasserstoffsäure, Ameisensäure und Schwefelsäure besteht.
8. Verfahren nach Anspruch 6, wobei ein Molverhältnis des Dekontaminationsreagens zu der anorganischen Säure zu Wasser 1 zu 8 zu 175 beträgt.
9. Verfahren nach einem der Ansprüche 1 bis 8, wobei der kolorimetrische Indikator und die Ethanolösung zu einem Verhältnis zwischen 0,01 und 0,03 gemischt werden.
10. Verfahren nach einem der Ansprüche 1 bis 9, wobei das Dekontaminationsgel 24 Stunden lang bei einer Temperatur zwischen 10°C und 40°C der Luft ausgesetzt wird, damit der Film gebildet wird.
11. Verfahren nach einem der Ansprüche 1 bis 10, wobei der Film eine Dekontaminationseffizienz größer 96% bei einer Kontamination aufweist, die ein Element aus der Gruppe Kobalt, Cäsium und Strontium enthält.
12. Verfahren nach einem der Ansprüche 1 bis 11, wobei das Material aus einer Gruppe gewählt wird, die aus Edelstahl, Kohlenstoffstahl, Aluminium, Kupfer, Kunststoff und Glas besteht.
13. Verfahren nach einem der Ansprüche 1 bis 12, wobei der kolorimetrische Indikator Kontaminationen an der Oberfläche des Materials färbt und so die kontaminierten Stellen anzeigt.
14. Verfahren nach einem der Ansprüche 1 bis 13, wobei ein physikalisches Verhältnis des Dekontaminationsreagens zu dem Gelfluid in einer Lösungs-

schung 1 bis 33 beträgt.

15. Dekontaminationsgel zur Dekontamination einer mit radioaktiven Elementen kontaminierten Metalloberfläche, das aus Folgendem besteht:

(a) einem organischen Lösungsmittel, mehr als einem Polymer und Wasser, die zu einem Gel-fluid gemischt werden; und
(b) einem Dekontaminationsreagens, einem Weichmacher und mindestens einem kolorimetrischen Indikator in dem Gel, damit ein kolorimetrisches Dekontaminationsgel entsteht; und
(c) das dazu geeignet ist, auf eine kontaminierte Oberfläche eines Materials aufgebracht zu werden, damit ein Film gebildet wird, der zum Zwecke der Dekontamination von der Oberfläche entfernt wird, wobei

das organische Lösungsmittel aus einer Gruppe gewählt wird, die aus Acetylaceton, Acetonitril und Ethanol besteht;

der Weichmacher aus einer Gruppe gewählt wird, die aus Tetrahydrofuran, N-Methylformamid, N,N-Dimethylformamid, Glycerin und Phthalatsäureester besteht; und der kolorimetrische Indikator eine Mischung aus einer Ethanol-Lösung und mindestens einem Stoff ist, der aus einer Gruppe gewählt wird, die aus Alizarin, Phenolrot, Arsenazo III und 2-(5-Bromo-2-Pyridylazo)-5-Dimethylaminophenol besteht.

Revendications

1. Procédé de décontamination pour la décontamination d'une surface de métal contaminée par des éléments radioactifs comprenant les étapes de:

(a) mélange d'un solvant organique, de plus d'un polymère et de l'eau pour obtenir un fluide en gel;
(b) ajout d'un agent réactif de décontamination et d'un plastifiant dans ledit fluide en gel pour être entièrement mélangés puis ajout d'une solution d'au moins un indicateur colorimétrique pour obtenir un gel de décontamination colorimétrique et
(c) collage dudit gel de décontamination sur une surface contaminée d'un matériau pour obtenir une pellicule et enlèvement de ladite pellicule pour décontaminer ladite surface,

dans lequel

ledit solvant organique est sélectionné dans un groupe comprenant l'acétone d'acétylène, l'acétonitrile et l'éthanol,

ledit plastifiant est sélectionné dans un groupe comprenant le tétrahydrofurane, le N-méthylformamide,

le N,N-diméthylformamide, la glycérine et l'ester de phtalate et

ledit indicateur colorimétrique est un mélange d'une solution d'éthanol et d'au moins l'une des substances sélectionnées dans un groupe comprenant l'alizarine, le rouge de phénole, l'arsenazo III et le diméthylaminophénol-5-bromo-5-pyridylazo.

2. Procédé selon la revendication 1 dans lequel ledit gel fluide a une température entre 80° C et 95° C.
3. Procédé selon la revendication 1 ou 2 dans lequel ladite eau et ledit solvant organique a un rapport physique entre 1 et 5.
4. Procédé selon l'une des revendications 1 à 3 dans lequel ledit polymère est sélectionné dans un groupe comprenant l'oxyde de polyéthylène, le polyacrylonitrile, l'alcool de polyvinyle, le pyrrolidone de polyvinyle, l'acétate de polyvinyle, la carboxyméthylcellulose, l'oxyde de polyéthylène, le polyéthylène-glycol, la gélatine, la pectine de pomme et la gomme arabique.
5. Procédé selon l'une des revendications 1 à 4 dans lequel ledit plastifiant est mélangé avec ledit polymère à une température entre 80° C et 95° C.
6. Procédé selon l'une des revendications 1 à 5 dans lequel ledit agent de réaction de décontamination est un mélange d'au moins un premier composé, un acide inorganique et de l'eau et dans lequel ledit premier composé est sélectionné dans un groupe comprenant l'acide diéthylène triamine pentaacétique, l'acide éthylène diamine tétraacétique, la pectine de pomme, le bleu de Prusse, le phosphomolybdate d'ammonium, le Ce4+/Ce3+, le peroxyde d'hydrogène et le ferrocyanide.
7. Procédé selon l'une des revendications 1 à 6 dans lequel ledit acide inorganique est sélectionné dans un groupe comprenant l'acide phosphorique, l'acide hydrochlorique, l'acide formique et l'acide sulfurique.
8. Procédé selon la revendication 6 dans lequel un rapport molaire dudit réactif de décontamination à l'acide inorganique et l'eau est de 1 à 8 à 175
9. Procédé selon l'une des revendications 1 à 8 dans lequel ledit indicateur colorimétrique et ladite solution d'éthanol sont mélangés pour obtenir un rapport entre 0,01 et 0,03.
10. Procédé selon l'une des revendications 1 à 9 dans lequel ledit gel de décontamination est exposé

à l'air pendant 3 à 24 heures à une température entre 10° C et 40° C pour obtenir ladite pellicule.

11. Procédé selon l'une des revendications 1 à 10 dans lequel ladite pellicule a une efficacité de décontamination qui est supérieure à 96% pour une contamination contenant un élément sélectionné parmi un groupe comprenant le cobalt, le césium et le strontium. 5
10
12. Procédé selon l'une des revendications 1 à 11 dans lequel ledit matériau est sélectionné dans un groupe comprenant l'acide inoxydable, l'acide de carbone, l'aluminium, le cuivre, le plastique et le verre. 15
13. Procédé selon l'une des revendications 1 à 12 dans lequel ledit indicateur colorimétrique colore les contaminations sur ladite surface dudit matériau et montre ainsi les positions de ces contaminations. 20
14. Procédé selon l'une des revendications 1 à 13 dans lequel un rapport physique dudit agent réactif de décontamination audit gel fluide dans une solution mélangée est de 1 à 33. 25
15. Gel de décontamination pour la décontamination d'une surface de métal contaminée par des éléments radioactifs composé : 30
 - (a) d'un solvant organique, plus d'un polymère et d'eau mélangés pour former un gel fluide et
 - (b) un agent réactif de décontamination, un plastifiant et au moins un indicateur colorimétrique dans ledit gel pour former un gel de décontamination colorimétrique et 35
 - (c) qui est approprié pour être collé sur une surface contaminée d'un matériau pour obtenir une pellicule et pour enlever ladite pellicule pour décontaminer ladite surface 40

dans lequel

ledit solvant organique est sélectionné dans un groupe comprenant l'acétone d'acétylène, l'acétonitrile et l'éthanol, 45

ledit plastifiant est sélectionné dans un groupe comprenant le tétrahydrofurane, le N-méthylformamide, le N,N-diméthylformamide, la glycérine et l'ester de phtalate et

ledit indicateur colorimétrique est un mélange d'une solution d'éthanol et d'au moins l'une des substances sélectionnées dans un groupe comprenant l'alizarine, le rouge de phénole, l'arsenazo III et le diméthylaminophénol-5-bromo-5-pyridylazo. 50
55

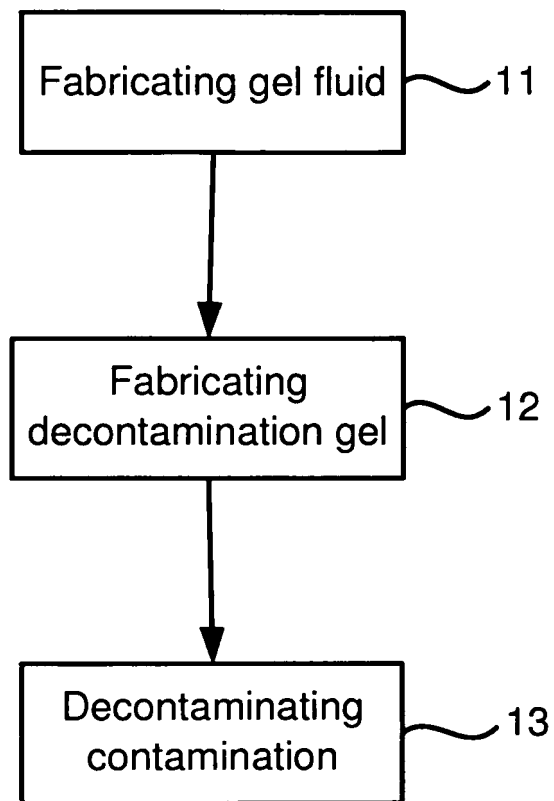


FIG.1

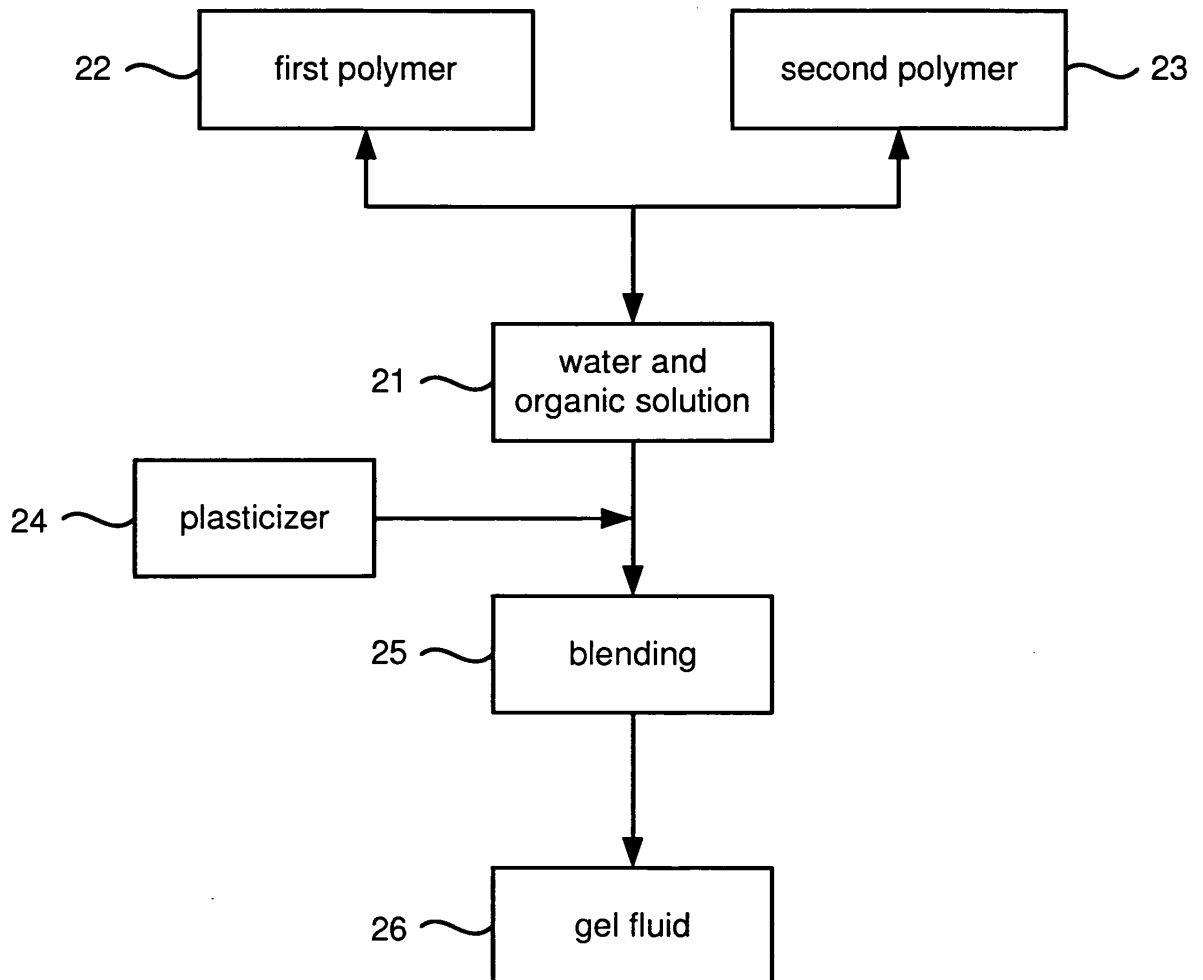


FIG.2

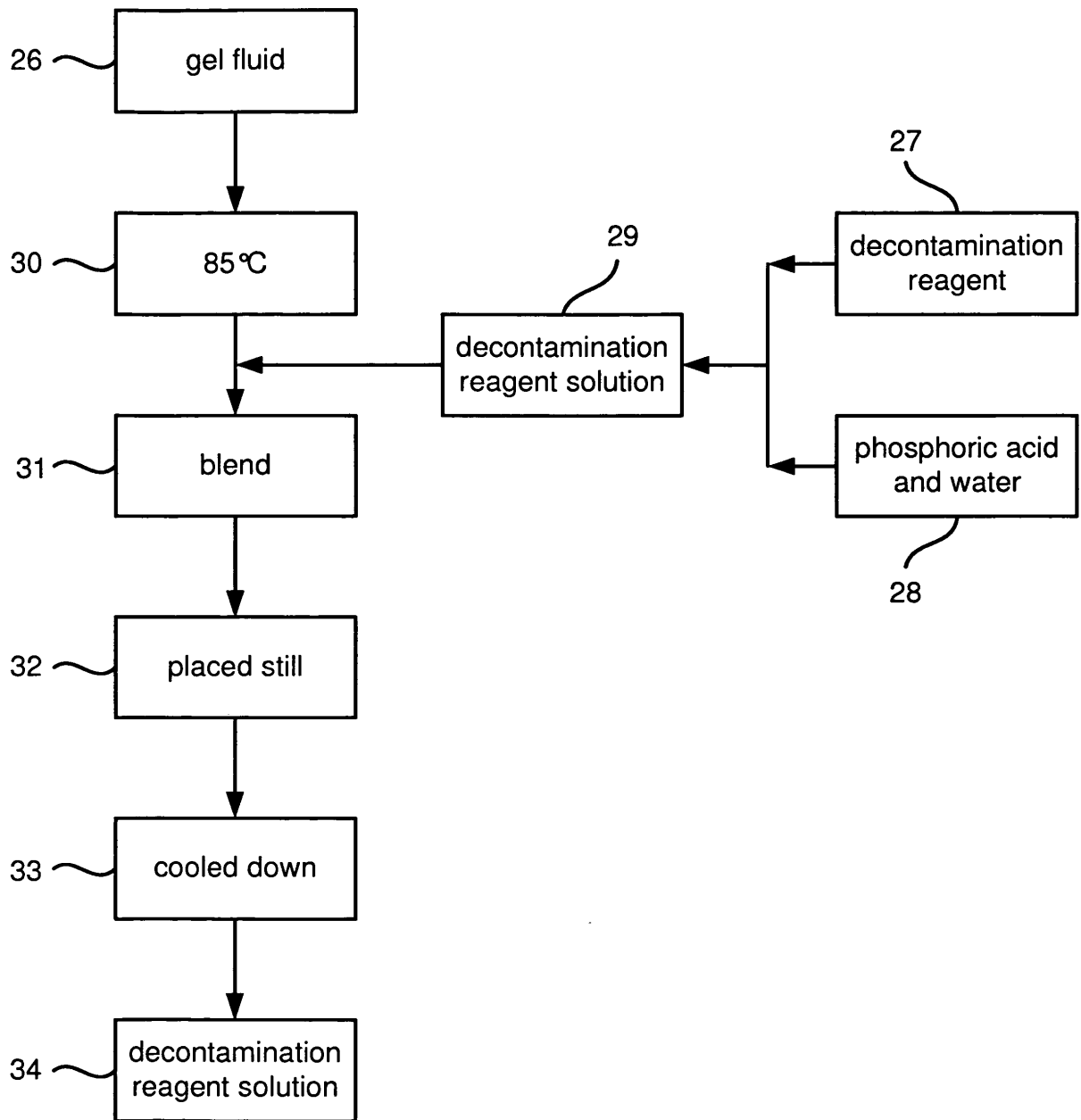


FIG.3

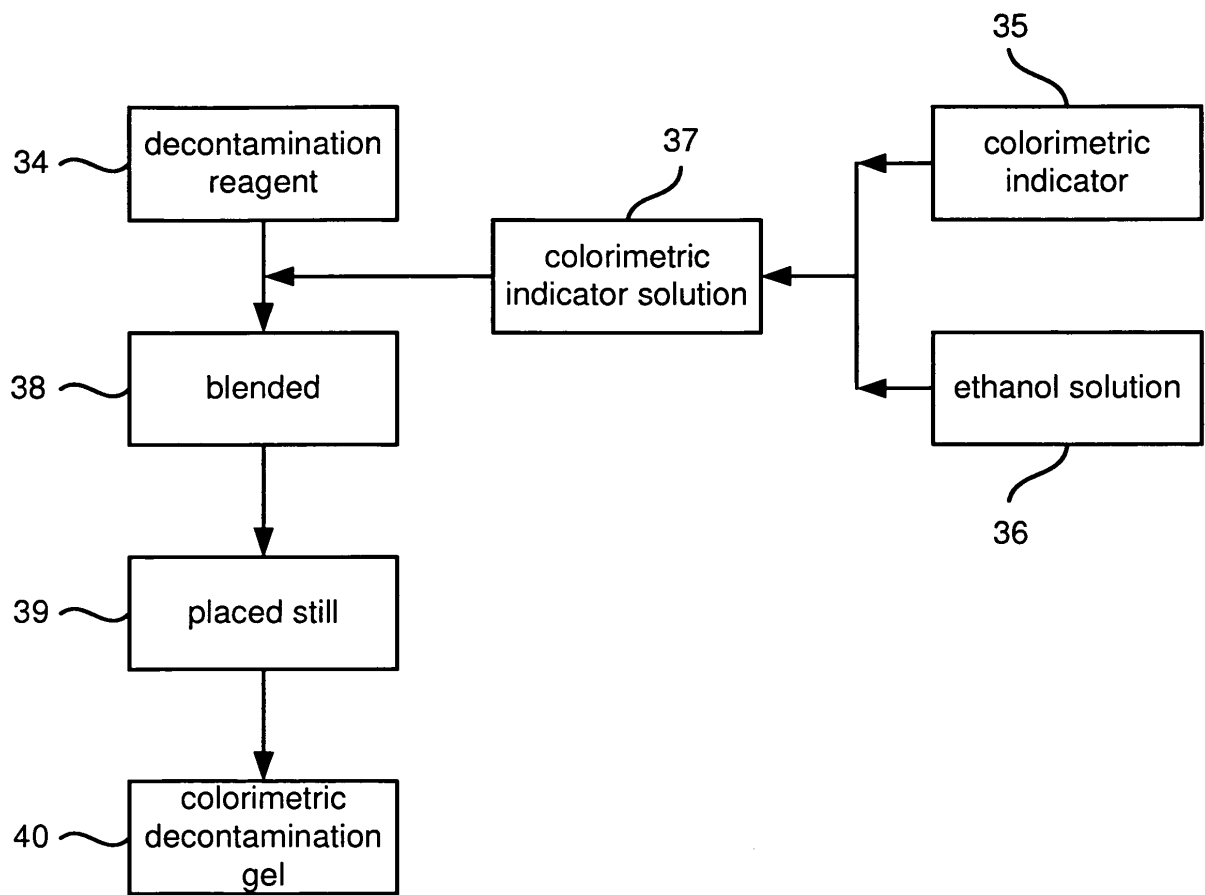


FIG.4

colorimetric indicator	color of decontamination gel	color of contamination		
		Co	Cs	Sr
alizarin	titian	none	light purple	light purple
PR	titian	saffron	saffron	saffron
Arsenazo III	light blue	light blue	light blue	blue
BrPADAP	orange	light blue	—	—

FIG.5

colorimetric indicator	color of decontamination gel	color of contamination		
		Co	Cs	Sr
BrPADAP+ arsenazo III	chocolate	dark pruple	claret	green
PR+alizarin	titian	yellow	dark red	dark red
PR+ arsenazo III	claret	yellow	purplish grey	olivine
alizarin+ arsenazo III	claret	gray	blue	blue

FIG.6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4511488 A [0002]
- US 5660641 A [0002]
- US 5891261 A [0006]
- US 2003172959 A1 [0008]
- US 5763734 A [0009]
- US 6689226 B1 [0010]
- US 6203624 B1 [0011]