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(54) **DEGREASING COMPOSITION USEFUL FOR
DEGREASING AND/OR
DECONTAMINATING SOLID SURFACES**

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(57) **ABSTRACT**

The invention relates to a degreasing composition in liquid, gel or foam form for degreasing and/or decontaminating solid surfaces.

This composition comprises an aqueous solution of nitric acid including:

at least one first, emulsifying non-ionic surfactant consisting of a polyethoxylated fatty alcohol, and

at least one second, wetting non-ionic surfactant consisting of a copolymer of ethylene oxide and propylene oxide.

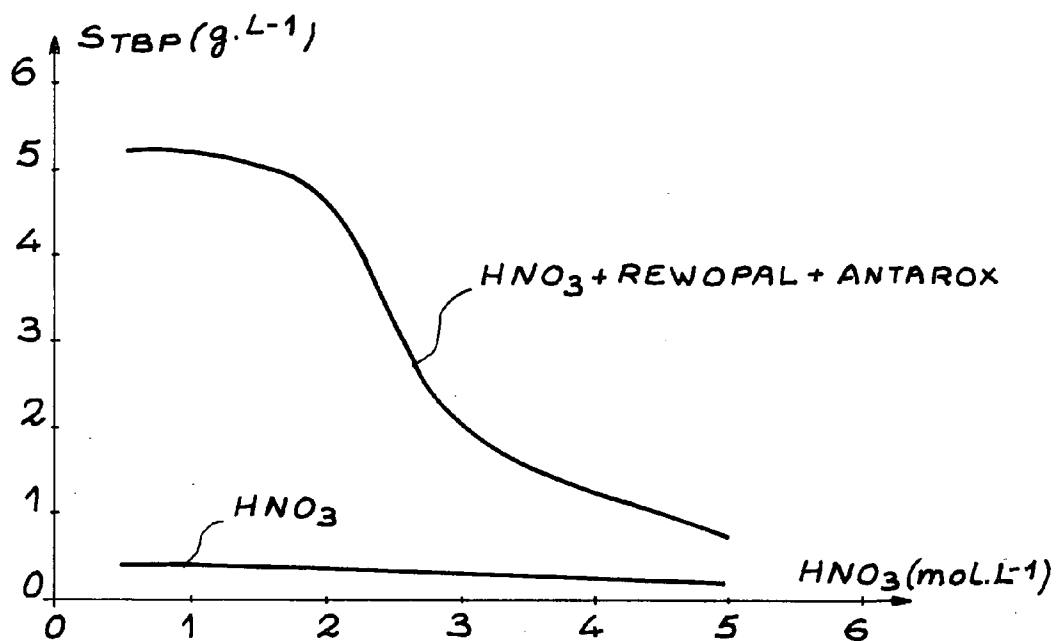


FIG. 1

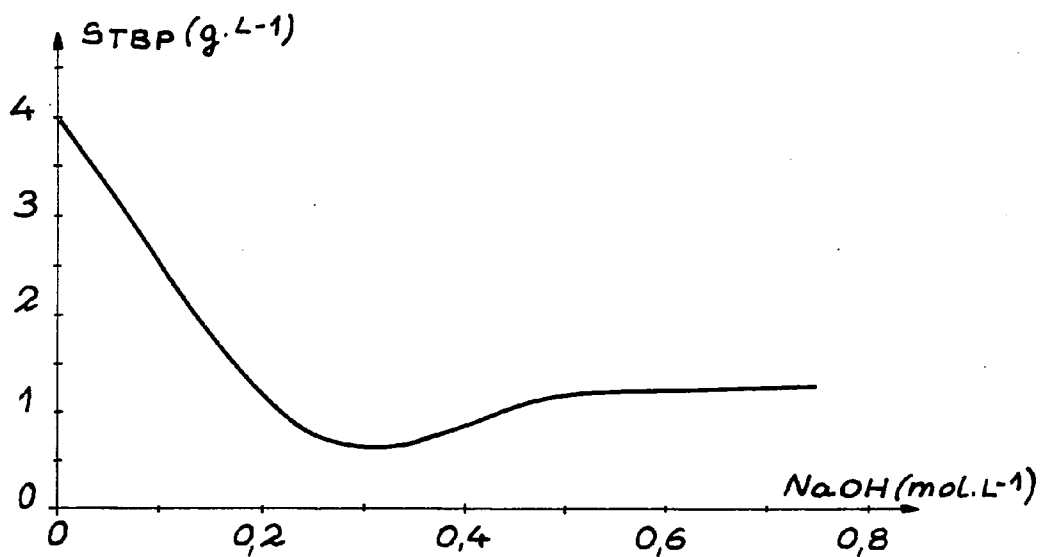


FIG. 2

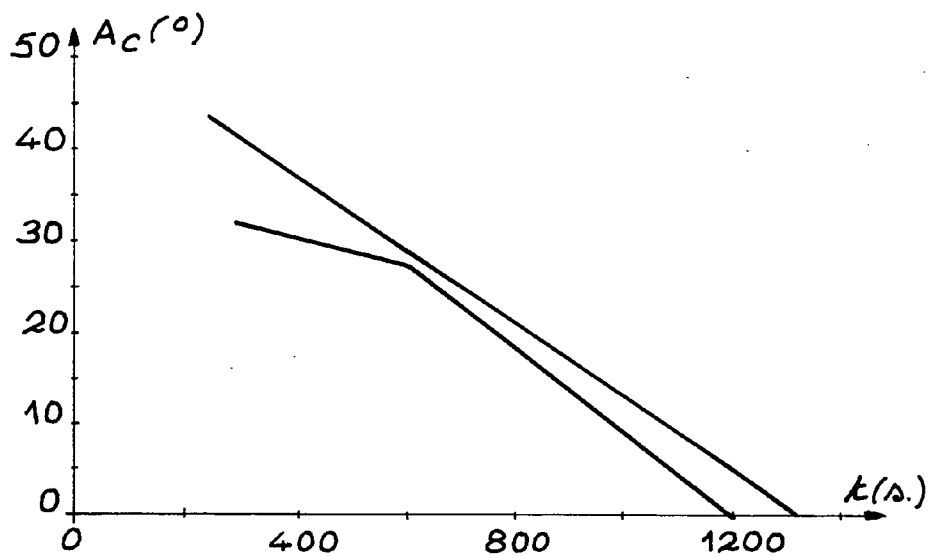


FIG. 3

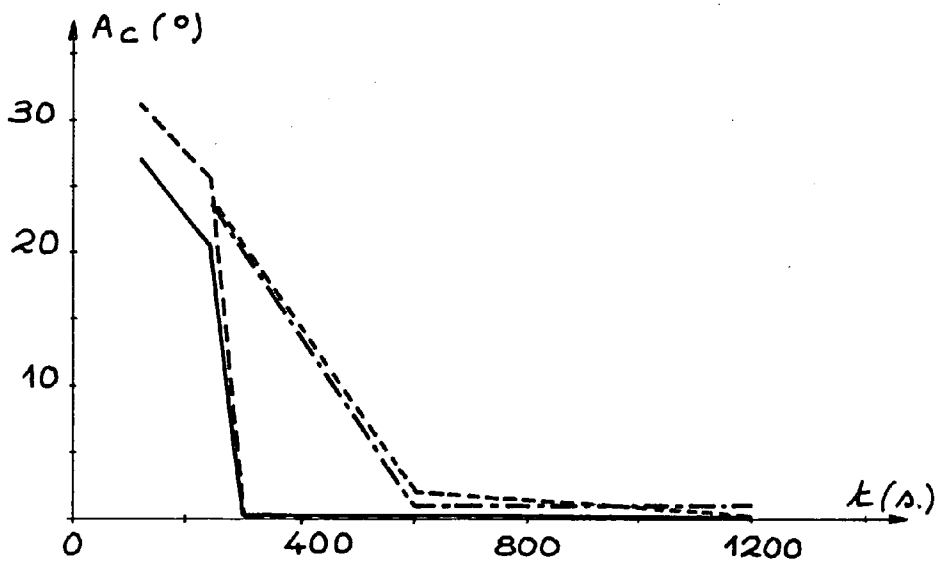


FIG. 4

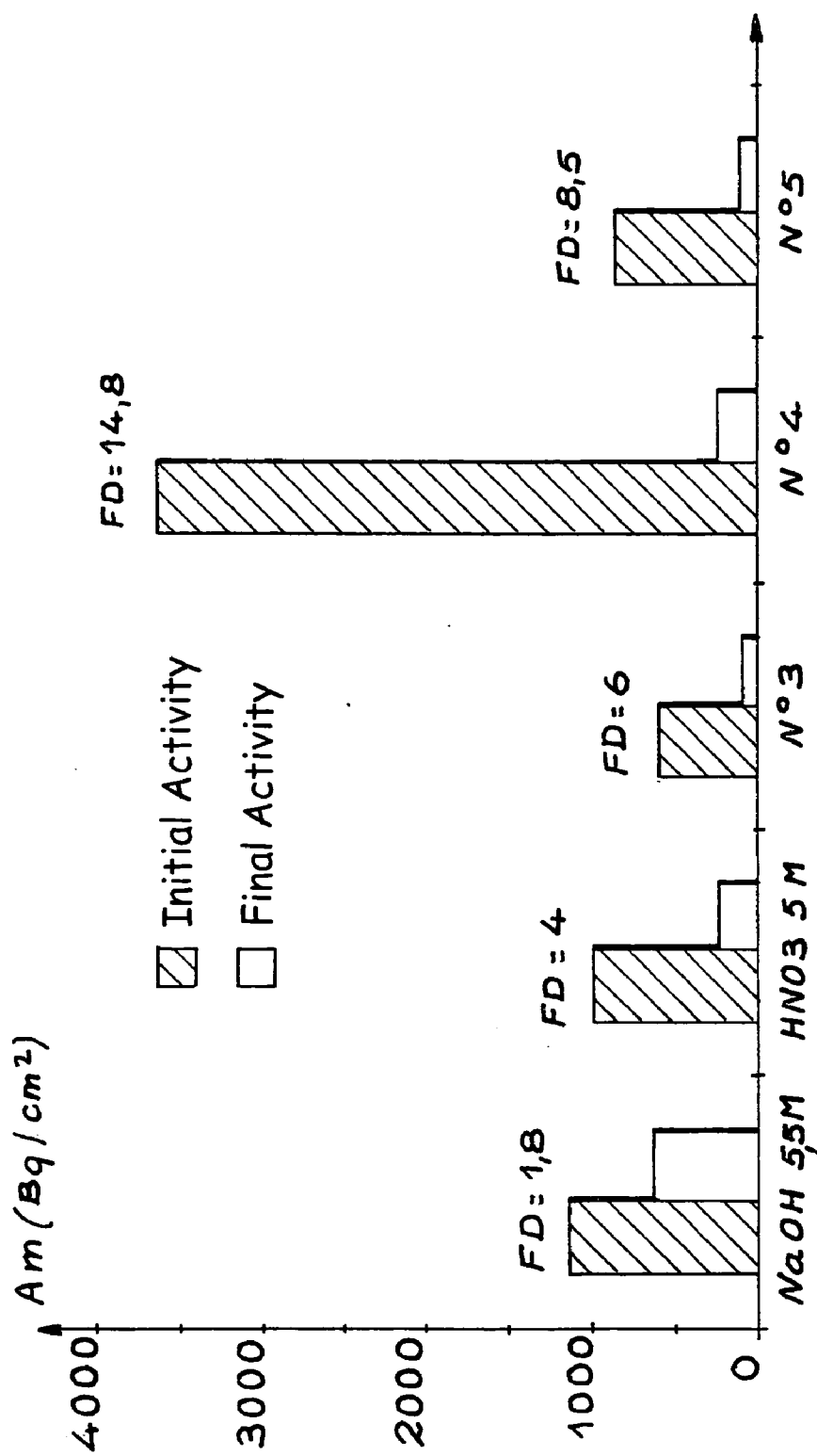


FIG. 5

DEGREASING COMPOSITION USEFUL FOR DEGREASING AND/OR DECONTAMINATING SOLID SURFACES

TECHNICAL FIELD

[0001] The invention relates to a degreasing composition and also to a degreasing foam and gel which comprise the said composition.

[0002] The invention likewise relates to a method of degreasing and/or decontaminating a surface using the said degreasing composition, gel and/or foam.

[0003] The present invention finds application for example, though without being limited thereto, in the degreasing of surfaces, particularly of metallic surfaces such as those of instruments, components, floors, etc., of a plant for reprocessing spent nuclear fuels. These surfaces are or may be in contact with one or more fatty substances, which may be contaminated. It is therefore necessary to clean these surfaces regularly for the purpose of radioactive decontamination and/or sanitation.

[0004] For example, one of these substances is a solvent called tributyl phosphate (TBP), which is used in extraction cycles for radioactive metals such as uranium and plutonium. In the course of these extraction cycles this solvent acquires a particularly high radiochemical activity, since it may contain up to several tens of grams of uranium and/or plutonium per litre. This solvent may then become a high-activity (HA) or very-high-activity (VHA) solvent. The presence of these HA and VHA solvents on some of the components of spent fuel reprocessing plants, such as mixer-settlers, extraction columns, etc., often leads to the formation of particularly organophilic metallic surfaces, which promote subsequent fatty deposits. These fatty deposits are virtually insensitive to rinsing with aqueous solutions conventionally used in reprocessing, and therefore require a specific treatment.

[0005] Other fatty substances which may be present on these surfaces are the breakdown products of TBP obtained by radiolysis of the solvent, such as dibutylphosphoric acid (HDBP), monobutylphosphoric acid (H_2MBP) and the salts and complexes of these acids with metals such as uranium, plutonium and the metal cations which may be present during the reprocessing of nuclear waste and particularly of spent fuels. These surfaces may also be contaminated by uranium oxides and plutonium oxides and also by the nitrate compounds of these elements.

[0006] It is therefore necessary to decontaminate these surfaces in order to remove not only the fatty substances but also the contaminating products, especially the radioactive products.

PRIOR ART

[0007] The document FR-A-2 781 809 [1] describes degreasing compositions which can be used for degreasing a metallic surface having been in contact with a solvent, such as TBP and/or its derivatives, HDBP and H_2MBP , and their salts and complexes, which comprises a basic medium such as sodium hydroxide solution in combination with two non-ionic surfactants.

[0008] This degreasing composition therefore uses a basic medium, which promotes chemical attack on the greases to

be eliminated by the conventional saponification reaction. The presence in this medium of the two surfactants allows the concentration of sodium hydroxide to be reduced and the spreading of the solution to be enhanced.

[0009] However, in the nuclear sector, the use of a basic medium has the drawback of leading to the formation of hydroxides of radioactive metals, especially plutonium hydroxide, for which there is a risk of redeposition on the metallic surface. Consequently it is necessary to carry out complementary treatments to solubilize these hydroxides, for example by means of acid treatments.

[0010] Moreover, the presence of sodium hydroxide in the effluents makes their handling more awkward and leads to an increase in the volumes of solution required for the sanitation of nuclear equipment.

[0011] Moreover, sodium hydroxide has the drawback of low compatibility with the glassy matrices for conditioning the ultimate waste obtained from the reprocessing of nuclear fuels.

DESCRIPTION OF THE INVENTION

[0012] The present invention specifically provides a degreasing composition which allows the drawbacks mentioned above to be removed, by virtue of the use of an acidic medium.

[0013] According to the invention the liquid degreasing composition comprises an aqueous solution of an inorganic acid including:

[0014] at least one first, emulsifying non-ionic surfactant consisting of a polyethoxylated fatty alcohol, and

[0015] at least one second, wetting non-ionic surfactant consisting of a copolymer of ethylene oxide and propylene oxide.

[0016] The novelty of this composition therefore lies in the use of an inorganic acid, a solvent which is used little, if at all, in detergency.

[0017] In this composition it is preferred to use as the inorganic acid nitric acid, which is one of the acids used in nuclear fuel reprocessing installations. The nitric acid concentration of the aqueous solution is selected such as to allow the dissolution therein of sufficient amounts of the first and second non-ionic surfactants. In general the nitric acid concentration of the aqueous solution is from 0.1 to 5 mol.L⁻¹.

[0018] The surfactants used are soluble in the nitric acid solution and are selected so as to allow a high level of solubilization of the TBP while at the same time resulting in a solution which has an appropriate cloud temperature and a controlled foaming effect.

[0019] The first, emulsifying non-ionic surfactant is a polyethoxylated fatty alcohol having, for example, the formula:



[0020] in which n is an integer ranging from 2 to 20 and R¹ is a saturated or unsaturated hydrocarbon chain having 9 to 18 carbon atoms.

[0021] Preferably n is an integer ranging from 6 to 15 and R^1 is an alkyl group of 11 to 13 carbon atoms.

[0022] As an example of a surfactant of this type mention may be made of the product sold by Goldschmidt (France) under the name Rewopal X 1207 L. It contains statistically from 6 to 15 oxyethylenated units per molecule and a carbon chain containing statistically 11 to 13 carbon atoms. This non-ionic surfactant possesses a high hydrophilic-lipophilic balance (HLB), of 12.5.

[0023] In 5 M nitric medium its solubility is several tens of grams at 25° C., for example of the order of 80 g.L⁻¹. In a more concentrated nitric medium, 15 M for example, the solubility is lower, of the order of 10 g.L⁻¹.

[0024] The second, wetting non-ionic surfactant used in the composition of the invention allows the foamability of the surfactant system to be reduced and the micellization capacity of the surfactant system to be increased; it is selected from the class of block copolymers of ethylene oxide and propylene oxide. These non-ionic surfactants are known for their good wetting properties and additionally they exhibit a cloud point, which makes it possible to set a cloud temperature above which the system becomes perfectly non-foaming, by adjusting their concentration in the composition. This property is of advantage in safety terms, since it provides a simple means of controlling untimely foaming in the course of application on the industrial scale.

[0025] The degreasing of a surface consists in particular in solubilizing the substance or substances present on the surface to be degreased in micelles, which are formed by the combination of the surfactants in the aqueous solution. These micelles are formed in particular with the saturated or unsaturated, polyethoxylated fatty alcohol and contain the dissolved fatty substance(s).

[0026] The micelles are dynamic particles which form and disaggregate continuously in the solution. When the concentration of one of the surfactants of the composition according to the invention is too low, in particular in relation to the amount of fatty substance(s) to be dissolved, the micelles are able to undergo dissociation and to release the fatty substance(s), which is (are) then redeposited on the degreased surfaces. The dissociation of the micelles is visible and is manifested in the formation of clouding within the solution. This dissociation may take place when the composition according to the invention is saturated with fatty substance(s), and/or above a certain temperature.

[0027] The saturation of the composition according to the invention by a fatty substance may be demonstrated by measuring the "cloud point" of this composition. The cloud point is expressed in degrees Celsius (° C.). The cloud point of a non-ionic surfactant corresponds to partial dehydration of the hydrophilic chain, which is manifested, when the cloud point temperature is reached, in phase separation, in other words the segregation of the surfactant.

[0028] If the cloud point occurs at ambient temperature, this may give rise to redeposition of the fatty substance on the degreased surfaces, at ambient temperature. It is therefore preferable for the cloud point of the composition to be higher than the temperature used for degreasing, for example approximately 20° C., when degreasing is performed at ambient temperature or a temperature greater than 20° C. A high cloud point, moreover, translates into a high capacity

for dissolution of a fatty substance. Measurement of the cloud point therefore makes it possible in particular to measure the degreasing efficiency of the composition according to the invention. This degreasing efficiency may also be measured by measuring the wettability of this surface.

[0029] In accordance with the invention the concentration of the second, wetting surfactant of the composition is selected to give a cloud point higher than the temperature at which degreasing will be performed.

[0030] In accordance with the invention the second, wetting surfactant is preferably made of a block copolymer of ethylene oxide and propylene oxide containing from 1 to 8 ethylene oxide units and from 3 to 12 propylene oxide units.

[0031] As an example of a block copolymer of this type useful in the invention mention may be made of the product sold by Rhodia under the name Antarox FM 33. This product has a solubility in concentrated (15 M) nitric acid, at 20° C., of from 3.0 to 3.5 g.L⁻¹.

[0032] In the degreasing composition of the invention the proportion of each of the surfactants is determined as a function of the following criteria:

[0033] the cloud temperature of the composition,

[0034] the wettability of the composition, and

[0035] the TBP solubilization capacity.

[0036] Furthermore, it is preferred to select concentrations such that the total surfactant concentration of the composition is situated in the range from 1 to 20 g.L⁻¹.

[0037] It is also preferable for the amount of the first surfactant(s) to be greater than that of the second surfactant(s). In general, the mass ratio of the first, emulsifying surfactant(s) to the second, wetting surfactant(s) is from 2 to 10, preferably around 4.

[0038] In certain cases it is possible to add a third surfactant to the degreasing composition of the invention, this surfactant being composed, for example, of a phosphoric ester, for the purpose of reducing the foamability of the surfactant system.

[0039] This phosphoric ester may be of the formula C₃H₁₇OOP(OR²)₂, in which R² is a hydrocarbon group of 4 to 10 carbon atoms.

[0040] As an example of a third surfactant of this type mention may be made of the product sold by Quarré Chim under the name Victawet 12. It may be present in the composition at a concentration of from 0.1 to 3 g.L⁻¹, for example 0.5 g.L⁻¹.

[0041] In accordance with the invention it is also possible to reduce the foamability of the surfactant system by adding from 0 to 0.5 g.L⁻¹ of tributyl phosphate (TBP) to the composition in order to benefit from the high antifoaming power deriving from the hydrophobicity of the TBP molecule.

[0042] Indeed, the maximum antifoaming effect of TBP is observed for values very much lower than the maximum concentration of TBP that can be dissolved in the composition of the invention.

[0043] It is therefore possible to use TBP at very low concentrations as an antifoam for highly selective applications associated with untimely foaming during the application of the treatment, especially during the transfer of the liquid compositions into the pumping elements of the plant. It may also be integrated at the point when the composition is manufactured. This solution has the advantage, in the case of application to nuclear reprocessing, of not necessitating the addition of a chemical additive whose composition is different from those already present in the equipment.

[0044] The liquid degreasing composition of the invention is particularly advantageous since it provides solubilization both of the greases (TBP, HDBP and H₂MBP and also, a priori, the U and Pu complexes of DBP and MBP) and of oxides, especially the oxides of uranium or of plutonium, and also of nitrate compounds which are obtained from these elements and are insoluble in a sodium hydroxide medium. It also provides for the solubilization of any corrosion products of the metallic surface, by carrying out treatment in a single step.

[0045] The liquid degreasing composition of the invention may be used in this form and employed in a variety of ways, for example in the form of soak baths or by spraying.

[0046] It is also possible to use the liquid degreasing composition of the invention in the form of a foam, by combining it with a gas phase. In this case it is possible to add to the foam one or more additives selected from those described in FR-A-2 679 458 [2]. Both the foam and the degreasing liquid can be used for degreasing and/or decontaminating a surface by contacting the surface with the foam or liquid in order to extract into the latter the products contaminating this surface.

[0047] The formulation may be used in the form of a foam and be circulated for containment cleaning. It may also be atomized by means of an applicator, for example a foam gun. The formulation proposed and the proportions indicated are compatible with use of the product in foam form. Such use will take place, however, in the upper range of the concentrations indicated for the two principal surfactants. The foamability of the system may also be enhanced or altered by adding other products like, for example, those described in reference [2]. Thus destabilization can be obtained by adding Amonyl 675 SB, which is sold by SEPPIC (sulfo betaine) at up to 1.5% by mass. Conversely, the stability of the foam can be reinforced by adding a viscosity enhancer, for example xanthan gum, in proportions by mass of less than 0.2%. The foam may also be employed as described in references [2] and [3].

[0048] In the case of a foam, contacting may be performed by circulating the foam within the containment. It is also possible to atomize the foam using an applicator, for example a foam gun, or else to use the techniques described in documents FR-A-2 679 458 [2] and FR-A-2 773 725 [3] in order to generate and apply the foam.

[0049] In accordance with the invention it is also possible to use the degreasing composition in the form of a gel, by adding thereto a suitable inorganic viscosity enhancer such as alumina or silica.

[0050] In this case the gel may be applied to the surface to be decontaminated by means of an applicator, for example by brush or by atomization by means of a lance. It is also possible to use the techniques of decontamination described in documents FR-A-2 695 839 [4], FR-A-2 656 949 [5] and FR-A-2 717 709 [6].

[0051] Thus the gel can be applied to the surface to be decontaminated by spraying with a gun, by soaking and allowing to drip dry, by packing or else using a brush. It can be subsequently removed from the surface by detaching it by simple rinsing with water, for example by means of a jet of water. Preferably the gel is applied by spraying with a gun, for example under a pressure (Airless compressor) in the injector ranging from 500 to 1000 N.cm⁻³.

[0052] Additionally the invention likewise provides a method of decontaminating and/or degreasing a surface, which consists in contacting the surface with a liquid composition, a foam or a gel in accordance with the invention in order to extract the products contaminating this surface into this composition, foam or gel.

[0053] These contaminating products may be one or more of the following products: tributyl phosphate (TBP), dibutyl phosphoric acid (HDBP), monobutyl phosphoric acid (H₂MBP) and their salts and complexes with uranium, plutonium and radioactive metals, and the oxides and nitrates of uranium and of plutonium.

[0054] Other features and advantages of the invention will appear more clearly on reading the description which follows of working examples, which are given of course by way of illustration and not of limitation, with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0055] FIG. 1 is a diagram illustrating the change in the apparent solubility of TBP, S_{TBP} (in g.L⁻¹), as a function of the nitric acid concentration of the medium (mol.L⁻¹), in the case of a nitric acid solution alone and in the case of a degreasing composition in accordance with the invention, composed of HNO₃ containing 8 g.L⁻¹ of Rewopal and 2 g.L⁻¹ of Antarox.

[0056] FIG. 2 is a diagram illustrating, for comparison, the change in the apparent solubility of TBP; S_{TBP} (in g.L⁻¹), as a function of the NaOH concentration (mol.L⁻¹) of a composition comprising the same surfactants in the same concentrations as the composition of FIG. 1, HNO₃ being replaced by NaOH.

[0057] FIGS. 3 and 4 are curves illustrating the degreasing kinetics of a degreasing composition of the invention in a 1 M nitric medium (FIG. 3) and of a degreasing composition of the invention in a 5 M nitric medium (FIG. 4), i.e. the change in contact angle A_c (°) as a function of the soak time t(s).

[0058] FIG. 5 is a histogram illustrating the effect of the degreasing compositions of the invention and the effect of a pure nitric acid solution or of a pure sodium hydroxide solution on the decontamination from americium of metallic surfaces, expressed in terms of ²⁴¹Am surface activity (Bq/cm²) before and after decontamination.

EXAMPLE 1

Apparent Solubilization of TBP

[0059] This example studies the influence of the nitric acid concentration of a degreasing composition of the invention containing 8 g.L⁻¹ of the first surfactant, Rewopal X1207 L, and 2 g.L⁻¹ of the second surfactant, Antarox FM 33.

[0060] TBP solubilization tests are therefore carried out in nitric acid solutions whose nitric acid concentrations vary

from 0.5 to 5 M, containing the amounts of surfactants indicated above, by adding TBP to the composition until persistent clouding appears.

[0061] For comparison, the same TBP solubilization test is conducted in solutions of nitric acid alone, having HNO_3 concentrations ranging from 0.5 to 5 mol.L⁻¹.

[0062] The results obtained are shown in FIG. 1, which illustrates the change in apparent solubility S_{TBP} (in g.L⁻¹) as a function of the HNO_3 concentration (in mol.L⁻¹).

[0063] Thus it is noted that in both cases the maximum apparent solubility is observed for an acid concentration of the order of 1 mol.L⁻¹, and that the increase due to the provision of the surfactants in the composition of the invention is of a factor of 12 relative to the nitric medium alone.

[0064] The level at which the surfactants are introduced is that of their capacity to remove hydrophobic deposits from solid surfaces, by virtue of their wetting and emulsifying properties. The presence of these deposits of organic origin, even in a small quantity, may detract considerably from the conventional, hydrophilic-type treatments, by preventing their access to the entirety of the contaminated surfaces. The choice of TBP as reference is justified because it constitutes the most hydrophobic deposit likely to be encountered in a nuclear fuel reprocessing plant.

[0065] TBP is solubilized in the micelles formed by the combination of surfactants in the composition. These micelles appear at surfactant concentrations greater than the critical micelle concentration (CMC). The hydrophobic core of the micelle acts as a micro-reactor, allowing the solubilization of organic solvents. The apparent solubility resulting from the incorporation of the organic material in the micelles is thus very much greater than the true solubility of TBP in the reference medium, as evident from FIG. 1.

[0066] In FIG. 2, for comparison, the results obtained when the same surfactants are used in a basic medium consisting of sodium hydroxide have been shown, the concentration of Rewopal being 8 g.L⁻¹ and the concentration of Antarox being 2 g.L⁻¹.

[0067] In this FIG. 2 the change in the apparent solubility of TBP, S_{TBP} (in g.L⁻¹), has been shown as a function of the concentration of NaOH (in mol.L⁻¹).

[0068] In this case it is seen that the apparent solubility of TBP is much higher than in the case of the nitric acid medium; the surfactants used do not, therefore, make it possible, in an NaOH medium, to improve the apparent solubility of TBP relative to that obtained in a neutral medium (pure water). This example conveys the specificity of the surfactant formulation in acidic medium.

EXAMPLE 2

Surface Degreasing Kinetics with Two Degreasing Compositions in Accordance with the Invention

[0069] In this example the following two degreasing compositions are used:

[0070] Composition no. 1: 1 M nitric acid, 8 g.L⁻¹ Rewopal and 2 g.L⁻¹ Antarox

[0071] Composition no. 2: 5 M nitric acid, 8 g.L⁻¹ Rewopal and 2 g.L⁻¹ Antarox.

[0072] In this example an initially clean plate of 304 L stainless steel is covered with a deposit composed of a

mixture of TBP, HDBP and H₂MBP in the following proportions by mass: TBP 70%, HDBP 18%, H₂MBP 12%. An indirect measurement of the initial contact angle is then carried out using a Krüss K12 plate tensiometer. The change in contact angle is subsequently followed after the plate has been soaked in the degreasing composition. A zero contact angle corresponds to ideal degreasing.

[0073] FIG. 3 illustrates the change in contact angle A_c (in°) as a function of the soak time t (in s) of two plates in composition no. 1.

[0074] FIG. 4 illustrates the change in contact angle A_c (in degrees) as a function of the soak time t (in seconds) for a number of tests conducted with composition no. 2.

[0075] In all cases the initial mass of the deposit was 45±4 mg.

[0076] In these figures it is noted that total degreasing of the plates is obtained after 22 minutes of soaking for composition no. 1 in nitric acid medium at a concentration of 1 M. This time is substantially shorter for composition no. 2, where the nitric acid medium is at a concentration of 5 M. The time necessary to obtain total degreasing is then taken to approximately 5 minutes. The degreasing times are substantially shorter than those obtained in sodium hydroxide medium with the compositions described in document [1].

EXAMPLE 3

Reduction in Foaming by Addition of Another Product

[0077] The presence of TBP has a high antifoaming power owing to the hydrophobicity of this molecule. The antifoaming power of TBP is evaluated in the case of the compositions of the invention in a nitric acid medium. This evaluation is performed using a column filled with solution into which air is introduced through a frit in order to form a foam. The experiment is stopped when a predetermined maximum duration has elapsed (in this case 280 seconds) or when the maximum available height on the column has been reached (in this case 26 cm). A determination is made of the maximum height of foam obtained or the time required to obtain it (Table 1, column 3) and of the time taken by the foam to fall by height equal to half the maximum height attained (Table 1, column 4). These tests are carried out with compositions no. 1 and no. 2 from the preceding example, by adding to them 0.6 or 0.05 g.L⁻¹ of TBP.

[0078] Table 1 below gives the results obtained. In any case, the foaming powers observed are those of a very low foamability range.

TABLE 1

Antifoaming effect of TBP on the composition			
Composition	Concentration of TBP (g · L ⁻¹)	Max. height (cm)/time (s)	Half-life (1) (s)
Rewopal 8 g · l ⁻¹ + Antarox 2 g · l ⁻¹ [HNO ₃] 1 M (no. 1)	0	26/126	320
Rewopal 8 g · l ⁻¹ + Antarox 2 g · l ⁻¹ [HNO ₃] 5 M (no. 2)	0	12.5/280	66

TABLE 1-continued

Antifoaming effect of TBP on the composition			
Composition	Con- centration of TBP ($\text{g} \cdot \text{L}^{-1}$)	Max. height (cm)/time (s)	Half-life (1) (s)
Rewopal $8 \text{ g} \cdot \text{L}^{-1}$ + Antarox $2 \text{ g} \cdot \text{L}^{-1}$ [HNO ₃] 1 M (no. 1)	0.6	13/280	64
Rewopal $8 \text{ g} \cdot \text{L}^{-1}$ + Antarox $2 \text{ g} \cdot \text{L}^{-1}$ [HNO ₃] 5 M (no. 2)	0.05	5/280	22

(1) Time taken for the foam to fall by a height equal to half the maximum height attained.

[0079] Thus it is observed that a significant antifoaming effect of the TBP is found for values very much lower than the maximum concentration of TBP which can be dissolved in the two compositions.

EXAMPLE 4

Decontamination of Metal Items Contaminated with Americium²⁴¹

[0080] In these tests items contaminated with americium-241 are immersed in the following degreasing compositions:

[0081] Composition no. 3: HNO₃ 5 M, Antarox $2 \text{ g} \cdot \text{L}^{-1}$, Rewopal $8 \text{ g} \cdot \text{L}^{-1}$

[0082] Composition no. 4: HNO₃ 0.5 M, Antarox $2 \text{ g} \cdot \text{L}^{-1}$, Rewopal $8 \text{ g} \cdot \text{L}^{-1}$

[0083] Composition no. 5: HNO₃ 0.5 M, Antarox $2 \text{ g} \cdot \text{L}^{-1}$, Rewopal $8 \text{ g} \cdot \text{L}^{-1}$

[0084] for 6 hours at 40° C.

[0085] The tests are conducted with different initial levels of ²⁴¹Am activity.

[0086] A determination is then made of the final ²⁴¹Am surface activity (in Bq/cm²) of the items after this treatment.

[0087] The results obtained are given in the form of a histogram in FIG. 5, which also indicates the initial ²⁴¹Am surface activity (in Bq/cm²) of the items.

[0088] On the basis of these results a determination is made of the decontamination factor DF, i.e. ratio of the initial activity to the final activity of the items. The values obtained are given in FIG. 5.

[0089] Also shown in this Figure, for comparison, are the results obtained when 5.5 M NaOH and 5 M HNO₃ are used at 40° C. for 6 hours.

[0090] Thus it is noted that the efficiency of the compositions of the invention is markedly superior to that of a concentrated nitric acid solution or a concentrated sodium hydroxide solution.

[0091] The items treated were from equipment used in a nuclear fuel reprocessing operation. They were in contact with TBP and its breakdown products.

References Cited

[0092] [1] FR-A-2 781 809

[0093] [2] FR-A-2 679 458

[0094] [3] FR-A-2 773 725

[0095] [4] FR-A-2 695 839

[0096] [5] FR-A-2 656 949

[0097] [6] FR-A-2 717 709

1. Liquid degreasing composition comprising an aqueous solution of an inorganic acid, including:

at least one first, emulsifying non-ionic surfactant consisting of a polyethoxylated fatty alcohol, and

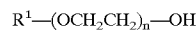
at least one second, wetting non-ionic surfactant consisting of a copolymer of ethylene oxide and propylene oxide.

2. Composition according to claim 1, wherein the inorganic acid is nitric acid.

3. Composition according to claim 2, wherein the nitric acid concentration of the aqueous solution is from 0.1 to 5 mol.L⁻¹.

4. Composition according to any one of claims 1 to 3, wherein the total surfactant concentration is from 1 to 20 g.L⁻¹.

5. Composition according to any one of claims 1 to 4, wherein the first, emulsifying surfactant is a polyethoxylated fatty alcohol of formula:



in which n is an integer ranging from 2 to 20 and R¹ is a saturated or unsaturated hydrocarbon chain having 9 to 18 carbon atoms.

6. Composition according to claim 5, wherein n is an integer ranging from 6 to 15 and R¹ is an alkyl group of 11 to 13 carbon atoms.

7. Composition according to any one of claims 1 to 6, wherein the copolymer of ethylene oxide and propylene oxide is a block copolymer containing from 1 to 8 ethylene oxide units and from 3 to 12 propylene oxide units.

8. Composition according to any one of claims 1 to 7, wherein the mass ratio of the first, emulsifying surfactant(s) to the second, wetting surfactant(s) is from 2 to 10, preferably around 4.

9. Composition according to claims 6 and 7, containing 8 g.L⁻¹ of the first, emulsifying surfactant and 2 g.L⁻¹ of the second, wetting surfactant.

10. Composition according to any one of claims 1 to 9, further comprising a third surfactant consisting of a phosphoric ester.

11. Composition according to claim 10, wherein the phosphoric ester is of the formula: C₃H₁₇OOP(OR²) in which R² is a hydrocarbon group of 4 to 10 carbon atoms.

12. Composition according to either of claims 10 and 11, wherein the concentration of the third surfactant is from 0.1 to 3 g.L⁻¹, preferably 0.5 g.L⁻¹.

13. Composition according to any one of claims 1 to 9, further comprising from 0 to 0.5 g.L⁻¹ of tributyl phosphate as antifoam.

14. Degreasing foam comprising a gas phase and a composition according to any one of claims 1 to 13.

15. Foam according to claim 14, further comprising one or more additives.

16. Degreasing gel comprising a degreasing composition according to any one of claims 1 to 13 and an inorganic viscosity enhancer.

17. Gel according to claim 16, wherein the viscosity enhancer is alumina or silica.

18. Method of degreasing and/or decontaminating a surface, which comprises contacting the surface with a composition according to any one of claims 1 to 13 in order to extract the products contaminating this surface into this composition.

19. Method of degreasing and/or decontaminating a surface, which comprises contacting the surface with a foam according to either of claims 14 and 15 in order to extract the products contaminating this surface into this foam.

20. Method of degreasing and/or decontaminating a surface, which comprises contacting the surface with a gel according to either of claims 16 and 17 in order to extract the products contaminating this surface into this foam.

21. Method according to any one of claims 18 to 20, wherein the products contaminating the surface are one or more of the following products: tributyl phosphate (TBP), dibutylphosphoric acid (HDBP), monobutylphosphoric acid (H₂MBP) and their salts and complexes with uranium, plutonium and radioactive metals, and the oxides and nitrates of uranium and of plutonium.

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