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METHOD OF CLEANING RADIOACTIVE ARTICLES

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This invention relates to methods of removing radioactive material adhering to articles, an operation usually termed decontamination, and is especially directed to a process utilizing ultrasonic waves for that purpose.

The removal of such radioactive material presents serious problems. Substantially complete removal is necessary, since even a small amount of radioactive residue may have harmful cumulative effects. Mechanical removal by scrubbing or the like, a method widely used, requires relatively long and vigorous treatment, and even then is ineffective where the article to be decontaminated has recesses or interstices that cannot be effectively reached in this manner. Such articles must be disposed of in such a way that radiation from them will not be harmful, a wasteful and troublesome operation.

An object of the invention is to provide a novel decontamination method that will remove substantially all adherent radioactive material, substantial removal being intended to mean that, if there should be any residue of such material, its effects will be negligible and inconsequential. A further objective is to provide such a method that will not involve scrubbing or other abrasive operations, and which will be basically mechanical and not manual.

These objects are accomplished in general by the use of ultrasonic cleaning in liquid, since this method has been found to be uniquely effective in separating substantially all of the radioactive material from even the most inaccessible areas of an article, as long as the liquid can penetrate to such areas, and placing such material in suspension in the liquid, so that the decontaminated article can be withdrawn from the liquid substantially free from radioactivity. This decontamination method can be carried out in a small fraction of the time now necessary for scrubbing methods, removes radioactive material more thoroughly, and can clean articles that now must be discarded and buried.

However, it has been found in practice that when this decontamination method is used radioactive particles are adsorbed from the liquid by the metal container forming part of the ultrasonic cleaning apparatus, requiring decontamination of the container, as by scrubbing. Moreover, special precautions must be taken in disposing of the cleaning liquid carrying radioactive particles. For instance, if such liquid is poured into a pit in the ground which is thereafter filled, a common expedient for disposing of radioactive material, there may be danger that the contaminated liquid will seep down to the water table and contaminate wells or streams.

An object of the invention is to provide a method of preventing contamination of the container during ultrasonic decontamination of articles in liquid. A related purpose is to accomplish this object by a simple, inexpensive and readily operated procedure.

A further purpose is to provide a novel and improved method of facilitating the disposal of liquid carrying radioactive material.

Another purpose is to prevent the contamination of the indicated container and also facilitate disposal of contaminated liquid by a single method.

These objects and purposes are in general accomplished by providing an inner container for liquid in which the contaminated articles are placed, and which is inserted in the metal container or bowl of a standard ultrasonic cleaner which ordinarily contains the liquid in which articles are ultrasonically cleaned. A suitable example of such apparatus is the ultrasonic cleaner manufactured by Bendix Aviation Corporation, Davenport, Iowa and described in the September 1954 issue of "Production Equipment," published by Wilson-Carr, Inc., Chicago, Ill.

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The material of which the inner container is made, and the thickness of such material, must be selected so that the ultrasonic waves will pass through the inner container into the liquid therein with sufficient energy to produce adequate cavitation therein. Materials having relatively low impedance to ultrasonic waves and low reflectance at an interface with liquids are required, among them being glass, metals and synthetic resins, comprising metal foils, especially aluminum and copper, and synthetic resin sheet material, particularly polyethylene and polyvinyl resins.

The thickness of the container material must also be selected between a maximum at which the transmittal of ultrasonic waves at normal ultrasonic cleaner energies is impeded to the point where cavitation within the inner container is insufficient for adequate cleaning, and a minimum at which the material is ruptured by the waves and cavitation. These limits necessarily vary, not only with different types of material but with different kinds of each material; but for any given species of material for use in a particular ultrasonic cleaner a suitable thickness can be selected.

An important feature of the invention is the use of flexible material for the inner container, since the latter can be readily closed and sealed after the cleaned articles are removed, greatly facilitating safe disposal of the contaminated liquid.

Flexible sheets of synthetic resins and of metal foils have been found to be especially suitable for the inner container, and standard commerical polyethylene has been successfully used. The minimum thickness of such synthetic resins is determined by the ability to support the liquid without breaking, this limit being above that at which the resin would be affected by cavitation, since flexible material of this type is not readily ruptured by cavitation. However, it has been found that with thicknesses over one-sixteenth of an inch the loss of ultrasonic energy is appreciable, and the thickness of the inner container material should be below that figure.

Inner containers of this type can be supported in the container or bowl of the cleaner in various ways, one simple arrangement being to use an inner container of about the same top circumference as the outer container top, and bend the margin of the inner container outwardly over the top of the outer container. This is especially effective when the inner container material is somewhat elastic.

When metal foil is used, its thickness likewise should not be greater than one-sixteenth of an inch in order to avoid objectionable loss of energy. With foil there is more danger of rupture by cavitation; and when standard commercial aluminum foil is used, a thickness greater than five thousandths of an inch should be used. Other metal foils that may be employed include lead, copper and tin foils. The tin or copper foil should not be less than one-thousandth of an inch thick, and neither should be more than one-sixteenth of an inch thick. Ordinary commercial grades of these foils may be used. However, the foil thickness will of course be adequate to avoid rupture by the inserted articles or by handling during disposal.

It is advantageous when using flexible inner containers to have them conform generally in size and shape to the inner face of the outer container, so that during the decontamination operation they may be supported where necessary by the outer container. However, it has been found that attenuation of the ultrasonic waves passing from the outer container to the liquid in the inner container will be greatly reduced if the space between the containers is filled with liquid.

The liquid detergent will be selected in accordance with the character of the contaminants following established practice in ultrasonic cleaning in liquids. It may be water, an aqueous solution of detergent substances, or a liquid of a different character, which may be basically a petroleum derivative.

In carrying out the process the inner container is inserted in the outer container or bowl of the ultrasonic cleaner, filled with liquid and the articles to be decontaminated are submerged in the liquid. The space between the containers will also be filled with liquid. The cleaning apparatus will then be operated until the ultrasonic waves traveling from the outer container into the liquid in the inner container, and the resulting cavitation, have removed substantially all radioactive material from the articles. Such articles are then taken out and rinsed, and the inner container with the liquid therein is safely disposed of. This may be done by sealing the open top of the inner container and placing such container with its contents in a place where it can do no harm, as by burying it. Even if the buried container should leak, the relatively slow rate of discharge, and the increased time allowed for decay of the radioactive material, will minimize and usually eliminate any danger of appreciable contamination of ground water. The use of such inner containers likewise greatly facilitates safe handling and transportation of the radioactive material removed from the contaminated articles.

An additional step which constitutes a further feature of the invention greatly reduces, and in practice substantially eliminates, any material danger of objectionable effects from the radioactive particles in the cleaning liquid. This is accomplished by mixing with the liquid a material which adsorbs such particles. Such material is advantageously in finely divided form and is added after the cleaned articles are removed from the inner container. The liquid containing the adsorptive material may be agitated, as by shaking the container or stirring, to obtain uniform distribution and the consequent removal from the liquid of the greater part of the radioactive substance. When an inner container with the contaminated liquid therein is buried, leakage is unimportant, since the proportion of contamination in the liquid is so low that its effect in practice will be negligible.

It has been found that a relatively small proportion of the adsorptive material will be adequate for ordinary purposes, a proportion as low as one percent of the amount of liquid by volume having been found to be effective, though larger amounts up to ten percent may be used. Substances that have been found suitable for use as such adsorptive material include colloidal sulfur, iron oxides, activated charcoal, halogen salts, manganese dioxide and clays, especially fuller's earth. These substances are of course most effective when introduced in very fine or pulverulent form. The adsorbent used should be selected on the basis of the particular radioactive substance or substances that produce the contamination, since each radioactive substance is adsorbed more rapidly and effectively by certain adsorbents. For instance, radioactive cesium is adsorbed with unexpected efficiency by clay, and especially fuller's earth. A brief period of agitation sufficient to maintain complete dispersion, normally substantially less than a minute, is adequate for effective adsorption; and with proper selection of the adsorbent, contamination can be substantially removed from the liquid in this manner.

The following examples are given by way of illustration and are not to be considered as restrictive.

Example 1

An inner container formed of aluminum foil, 0.01 inch thick and shaped to fit the bowl of an ultrasonic cleaner, is inserted in the bowl with the upper edge of the container bent outwardly over the margin of the bowl. Detergent liquid is poured into the foil container and liquid, which may be water or detergent liquid, is poured between the foil container and the bowl. Articles to be cleaned are placed in the liquid in the container and the cleaner is operated to produce cavitation in such liquid around the articles. When the cleaning of the articles is complete they are removed and rinsed, the upper edge of the foil container is pulled together and bent over to seal the container, and the container is then buried.

Example 2

An inner container formed of copper foil 0.01 inch thick is inserted in an ultrasonic cleaner bowl in contact with the inner face of the bowl. Detergent liquid is poured into the container and liquid, which may be detergent or water, is poured between the container and the bowl, contaminated articles are placed in the liquid in the container and the ultrasonic cleaner is operated to produce cavitation around such articles. After the articles are cleaned they are removed from the liquid and rinsed, and an amount of clay equal in volume to five percent of the liquid in the container is introduced into the liquid and stirred. The top edge of the container is brought together and bent over to form a seal, after which the container is buried.

Example 3

The procedure of Example 1 is followed to clean articles contaminated with radioactive cesium. After the articles are removed from the liquid an amount of fuller's earth equal in volume to one percent of the liquid in the container is introduced into the liquid and stirred. The container is then sealed and buried.

Example 4

A container formed of a flexible sheet of polyethylene plastic, 0.01 inch thick, is placed in the bowl of an ultrasonic cleaner and the upper edge of the container is turned outwardly around the bowl margin with the container bottom in contact with the bottom of the bowl. A detergent liquid is poured into the container, contaminated articles are placed in the liquid and the ultrasonic cleaner is operated to produce cavitation on the surfaces of the articles. When cleaning is completed the articles are removed, the upper margin of the plastic container is brought together and tied or clamped to form a seal, and the container is buried.

While preferred forms of the invention, with variations and examples, have been given, the specific features of the disclosure have been given by way of illustration and not to indicate the full scope of the invention, which is set forth in the claims.

As it is used herein, the word "ultrasonic" refers to mechanical wave action and does not refer to a wave action limited to any frequency or frequency range within or above the range of audible frequencies.

I claim:

1. The method of removing radioactive material from a contaminated article by the action of ultrasonic waves in cleaning apparatus provided with a bowl containing liquid which comprises inserting in the bowl and liquid an inner container, placing detergent liquid in such container, submerging the article in the detergent liquid, transmitting ultrasonic waves from the bowl into the detergent liquid to produce cavitation at the surface of the article, removing the article from the detergent liquid after removal of such material therefrom, and sealing the detergent liquid in the container in condition for disposal.

2. The method set forth in claim 1 in which the container is made of flexible material, and the sealing comprises folding together the open top portion of the container.

3. The method set forth in claim 1 in which the container is made of flexible material with an open top simi-

lar in size to the bowl top, and is held in place during the ultrasonic wave transmission by deflecting such top outwardly across the top of the bowl.

4. The method set forth in claim 1 in which the container is formed of metal foil.

5. The method set forth in claim 1 in which the container is formed of aluminum foil.

6. The method set forth in claim 1 in which the container is formed of copper foil.

7. The method set forth in claim 1 in which the container is formed of flexible sheet synthetic resin material.

8. The method set forth in claim 1 in which the container is formed of flexible sheet polyethylene.

9. The method set forth in claim 1 in which the container is formed of flexible sheet polystyrene.

10. The method of removing radioactive material from a contaminated article by the action of ultrasonic waves in cleaning apparatus provided with a bowl which comprises inserting in the bowl an inner container, placing detergent liquid in such container, submerging the article in the liquid, transmitting ultrasonic waves from the bowl into the liquid to produce cavitation at the surface of the article, removing the article from the liquid after removal of such material therefrom, mixing with the liquid a finely divided adsorbent of the radioactive material, and sealing the liquid in the container in condition for disposal.

11. The method set forth in claim 10 in which the adsorbent is used in proportions of between one and ten percent of the liquid by volume.

12. The method set forth in claim 10 in which the adsorbent is a clay.

13. The method set forth in claim 10 in which the radioactive material is cesium and the adsorbent is fuller's earth.

References Cited in the file of this patent

UNITED STATES PATENTS

1,707,655	Cohn	Apr. 2, 1929
1,709,701	Althoff	Apr. 16, 1929
2,131,855	Hummel	Oct. 4, 1938
2,174,425	Schlumbohm	Sept. 26, 1939
2,468,550	Fruth	Apr. 26, 1949
2,496,684	Upchurch	Feb. 7, 1950
2,574,931	Nason	Nov. 13, 1951
2,629,244	Rand	Feb. 24, 1953
2,748,673	Winstead	June 5, 1956
2,779,695	Brown	Jan. 29, 1957

OTHER REFERENCES

U.S. Atomic Energy Comm. WASH–408 Disposal of Radioactive Wastes in the U.S. Atomic Energy Program, May 17, 1956, pages 1–5.

U.S. Atomic Energy Comm. WASH–275, "Sanitary Engineering Conference, Baltimore, Md., April 15–16, 1954," August 1955, pages 215–219, 230–245.