United States Patent Office 3,515,655 Patented June 2, 1970



3,515,655

# ELECTROLYTIC DECONTAMINATION OF RADIOACTIVELY CONTAMINATED EQUIPMENT

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No Drawing. Filed Sept. 15, 1967, Ser. No. 668,224
Int. Cl. C23b 1/00, 3/02
U.S. Cl. 204—141 3 Claims

## ABSTRACT OF THE DISCLOSURE

Removal of radioactive contamination from various equipment. The equipment is connected as cathode into an electrolytic circuit in which the electrolyte is an aqueous 1 to 9 N nitric acid solution.

The present invention concerns the decontamination of equipment, vessels, apparatus and quite generally metallic objects that have been in contact with and therefore contaminated by radioactive material. All the objects liable to get radioactively contaminated and with whose decontamination the present invention is concerned will be referred to hereinafter for short as "equipment."

The decontamination of equipment from radioactive contamination constitutes a very serious maintenance problem. The equipment used for processes which involve the use and handling of radioactive material, e.g. in nuclear reactors, is made from a non-corrosive metal such as stainless steel, aluminum and its alloys, zirconium and its alloys, Inconel (trade name for an alloy of 78% nickel; 15% chromium and 7% iron), platinum. All these metals and metal alloys, while being basically chemically inert to the reactants with which they come in contact have nevertheless the capacity of adsorbing certain amounts of radioactive material. While the absolute quantities of the adsorbed material are of course very small, they cause nevertheless a considerable radioactivity of the surface. Consequently where the equipment has to be serviced it has first of all to be decontaminated in order to make it accessible without endangering the operators.

Conventionally radioactively contaminated equipment is decontaminated by flushing with various aqueous solutions, involving as a rule the successive use of different solutions. Examples of solutions conventionally used for this purpose are 10% nitric acid, 10% citric acid, 10% sodium hydroxide—2.5% tartaric acid, 10% oxalic acid, 0.003 M periodic acid and 3% sodium fluoride—20% nitric acid. These solutions are normally used in the order listed with a 10% nitric acid flush usually repeated after each use of each of the other solutions. The use of each solution is continued until it no longer proves effective.

In accordance with these conventional flushing methods the vessels of the equipment are filled to slightly over normal working volume with the decontaminating solution, if desired heated up to boiling, and also if desired agitated during the contact period. The solutions are usually held in the vessels for several hours at boiling or near boiling temperature with the exception of oxalic acid solution which is heated to a maximum of 75° C., and sodium fluoride-nitric acid solution which is left in contact with the vessels for a maximum time of about 1 hour at room temperature. The solutions are transferred between vessels during the operations to decontaminate the transfer lines. Spent decontamination solutions have to be disposed of to a waste system.

The decontamination of equipment in accordance with these conventional flushing methods down to a non-dangerous degree of radioactivity is a highly time consuming operation which may last between 6 and 30 days. This in itself is a serious drawback. When considering in addition the fact that very substantial amounts of liquids are involved which have to be handled and disposed, it is easily understood that all the conventional methods for the decontamination of radioactively contaminated equipment are highly unsatisfactory.



It is the object of the present invention to provide an improved method for the decontamination of radioactively contaminated equipment.

The invention consists in a method for the decontamination of radioactively contaminated equipment comprising covering the contaminated surfaces with a 1–9 N aqueous nitric acid solution, connecting the so covered equipment as cathode into an electrolytic circuit and allowing electric current to flow until the desired decontamination is achieved.

It has been observed that non-contaminated metals of which the equipment is made may be dissolved under the conditions specified (see Israel patent specification No. 26,224 filed on July 26, 1966). It has, however, surprisingly been found in accordance with the present invention that as long as the surfaces exposed to the treatment are contaminated the decontamination, that is the desorption of the adsorbed radioactive material, is overriding and the surface itself is only insignificantly attacked if at all.

This selectivity of the process may be enhanced by using current densities and/or nitric acid concentrations that are below the optimum values for cathodic dissolution as described in the abovementioned Israel Pat. No. 26,224. Moreover, any corrosive attack of the metal surface in addition to being quantitatively insignificant, is completely homogeneous and does therefore not impair the quality of the surface.

The decontamination according to the invention is best carried out at room temperature, that is at temperatures between 20 and 30° C. and the decontamination is completed within periods of the order of minutes, e.g. 10 to 60 minutes.

The preferred concentration for the nitric acid and the current densities on the cathode for the decontamination in accordance with the present invention for some metals and metal alloys is indicated in the following Table I.

| Metal or alloy | Current density on the cathode, amp/dcm.² | $HNO_3$ (N) |
|---|---|---|
| Stainless steel 18/8 | 20-30 | 2-8 |
| | 40 | 8 |
| Aluminium | 40-60 | 8 |
| Zirconium and its alloys | 40-50 | 8 |
| Inconel | 20-30 | 2 |
| | 40-50 | 8 |
| Platinum | 40 | 8 |

After the treatment according to the invention the treated surface must be re-passivated which is done in a conventional manner.

The advantages of the decontamination method according to the present invention over conventional methods are striking. Thus while in the conventional method periods of time of the order of days or even weeks are required, the required periods of time in accordance with the present invention are of the order of minutes. Moreover the amount of liquid that has to be handled for the decontamination process according to the invention is a small fraction of that required in conventional processes so that the handling and disposal problems are incomparably simpler.

In many cases the equipment during operation is inherently in contact with a nitric acid solution of the above specified concentration. In such cases all that is required

is to connect the equipment as cathode into an electrolytic circuit leaving the original, contaminated $HNO_3$ solution in contact with the equipment and letting a current flow for the required duration of time. Thereafter the original nitric acid solution is discharged, as it would have been anyhow, and at the same time the equipment is already decontaminated. The great advantages gained in this manner are quite self-evident.

The end of the decontamination treatment according to the invention can be established by ordinary measurements of radioactivity. Moreover, the approximate periods of time required for the decontamination of a certain type of equipment under given conditions of concentration and current density can be established empirically.

The invention is illustrated by the following example to which it is not limited:

EXAMPLE

A plate of A.I.S.I. 304 stainless steel 20 $cm.^2$ in size was radioactively contaminated by immersion for 4 hours into 400 cc. of a boiling 4 N $HNO_3$ solution contaminated by Ce137 0.4 $\mu$ci./cc. on each face.

The contamination of the plate at the end of 4 hours was $1.5.10^{-3}$ $\mu$ci on each face.

The plate was then decontaminated by immersion into a 2 N $HNO_3$ solution at 30° C. and connecting it as cathode into an electrolytic circuit to a D.C. source, the anode being of platinum. The current density on the cathode was 30 amp/$dcm.^2$. After a treatment of 20 minutes the decontamination was complete.

We claim:

**1.** A method for the decontamination of radioactively contaminated equipment of non-corrosive metals comprising covering the contaminated non-corrosive metal surfaces with an aqueous 1–9 N nitric acid solution, connecting the so covered equipment as cathode into an electrolytic circuit and allowing electric current to flow until the desired decontamination is achieved.

**2.** Method for the decontamination of equipment that is, during normal operation, in contact with a nitric acid solution, wherein said solution is employed, prior to its evacuation, for the decontamination treatment according to claim **1**.

**3.** A method in accordance with claim **1** wherein said non-corrosive metal is stainless steel, aluminum, aluminum alloys, zirconium, zirconium alloys, platinum or an alloy of 78% nickel, 15% chromium and 7% iron.

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