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(54) **Method of decontaminating electro-mechanic apparatus from polychlorobiphenyl.**

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EP 0 098 811 B2

Description

The present invention generally relates to a method of decontaminating from polychlorobiphenyl electro-mechanic apparatus.

As known, for antifire purposes, fluids on the basis of polychlorobiphenyl (PCB) as insulating fluids in electrical apparatus or as hydraulic liquids in mechanical apparatus have been often used in the past. These fluids, generally a mixture of 40% of hexachlorobenzene and 60% of polychlorobiphenyl, exhibit antifire properties which assure a reliable operation of electrical or mechanical apparatus even in environments in which the fire conditions could be promoted.

For example, there are in Italy only tens of thousands of transformators, circuit breakers and other electric apparatus still filled with this fluid and an undefined number of hydraulic apparatus almost certainly still contaminated by PCB.

The suspected cancerous action or at any rate the harmfulness of PCB has caused the use of these fluids in the above mentioned apparatus to be suspended, which fluids are gradually substituted by other less dangerous fluids.

The aggressiveness of fluids on the basis of PCB towards the components of these apparatus is so great that their decontamination becomes an extremely difficult operation and the great harmfulness thereby exhibited causes it to be more convenient to bury all the apparatus into suitably prepared pits than to try a decontamination thereof.

Of course, for economical reasons, this has given rise to the problem of the recovery of these apparatus by trying to decontaminate them as much as possible by reducing the PCB contents at least within limits which are permissible and tolerable from the ecological standpoint.

Recently, attempts have been made to wash the contaminated apparatus with suitable solvents in a liquid phase, however, this method has proved to be difficult, time consuming, expensive and it has not successfully.

In fact, the PCB absorbed by materials such as paper and wood which are normally present in most apparatus and the PCB adsorbed by the inner portion of the magnetic lamination pack or the electric windings cannot be totally removed, at least in a short time, because of its aggressiveness and therefore a portion thereof remains attached to these apparatus so that, with the passing of time, it can be dissolved in the new liquid used in substitution thereof, thereby forming a contaminating element for the latter.

US—A—4,008,729 discloses an apparatus for cleaning articles in volatile solvent wherein the article to be cleaned is placed in a container connected to a solvent collector with siphon and provided with a condenser. The solvent in the container is heated to boiling temperature to generate solvent vapours to bathe the article in solvent vapours and condensate which forms on the condenser and drips into the container to wash impurities from the article.

In this apparatus the article to be cleaned is immersed in the liquid solvent up to the level of the siphon tube extending in the container and therefore the solvent vapours are not in contact with all the article, but only with the portion thereof emerging from the siphon level. Furthermore this treatment is carried out at atmospheric pressure.

It is therefore the main object of the present invention to obviate the above mentioned disadvantages of the known method by providing a new method permitting the above mentioned apparatus to be decontaminated as much as possible, however within ecological acceptable limits so that the apparatus can be reused.

It is another object of the present invention to provide a method of decontaminating from PCB electrical and mechanical apparatus, which can be carried out without the intervention of operators in contact with the PCB.

It is still another object of the present invention to provide a method of the above mentioned kind, which assures in the most absolute way any possibility of environment contaminations.

It is a further object of the present invention to provide a method of the abovementioned kind which provides a quick decontaminating action so as to be inexpensive, and which can be carried out as simply as possible without requiring sophisticated and expensive equipment.

These and other objects of the present invention, which will be more apparent from the following descrption, are attained according to the invention by a method of decontaminating an electrical or mechanical apparatus contaminated with polychlorobiphenyl using a solvent for polychlorobiphenyl which is chemically inert thereto, and has a distillation temperature lower than that of polychlorobiphenyl, which method is characterized by:

introducing the apparatus to be decontaminated in a chamber;

maintaining the apparatus under vacuum submerged in the vapours of said solvent in the sealed chamber; and

controlling the pressure and the temperature of the solvent vapours so as to permit at all times a condensation of the solvent vapours on the surfaces under treatment, the solvent vapours also being condensed at the top of the sealed chamber so as to perform a reflux washing of the apparatus.

According to a feature of the present invention, the solvent vapours are generated by heating means.

According to another feature of the present invention, the solvent vapours are generated in the sealed chamber by associated heating means.

According to a further feature of the present invention, the solvent vapours are generated outside the sealed chamber and then injected therein to wash the apparatus.

The solvent is preferably non-toxic and is also compatible with the apparatus materials.

Advantageously, the distillation temperature of

the solvent is lower than the maximum temperature tolerable by the apparatus to be decontaminated and higher than the room temperature for handling and conservation facility thereof.

Preferably, dearomated heptane or trichloromethane is employed as solvent.

According to still another feature of the invention the temperature of the solvent vapours is increased stepwise as a function of the average temperature of the apparatus to be decontaminated.

According to still another feature of the invention inside the chamber the temperature is controlled by a thermostat controlling a valve which controls the flow of a heationg fluid through the side walls of the chamber.

The invention will be now described in more detail in connection with a preferred embodiment thereof, given by way of example only and therefore not intended in a limiting sense, which is shown in the accompanying drawing, wherein:

Fig. 1 is a diagrammatic sectioned view of a box containing the electric apparatus to be decontaminated, for example a transformer, and provided with the necessary means for carrying out the method of the invention;

Fig. 2 diagrammatically shows the solvent action during the washing step in liquid phase;

Fig. 3 diagrammatically shows the solvent action during the washing step in a vapour phase;

Fig. 4 is a plot of the diagram of the solvent condensation temperature vs. time, during the washing process;

Figs. 5 and 6 show a diagram of the PCB contents in the apparatus under treatment vs. the removal time thereof for the liquid phase washing and the vapour phase washing respectively, showing the more than good results obtained by means of the method of the invention.

As can be seen from Fig. 1, the apparatus under treatment is put in a box B which is heated on the bottom and on the four lateral walls by means of jackets E through which a suitable heating fluid passes, which is fed through an inlet G, through a valve I and is discharged through an outlet H. On the top of the box B a condenser L is arranged through which water flows, the temperature of which is controlled by a thermostat M controlling a water discharge valve N.

Inside the box B the temperature is controlled by a thermostat F controlling the valve I and the pressure is controlled by a vacuostat O controlling a solvent discharge valve P, everything so as to keep constantly the apparatus A submerged in the solvent vapours under vacuum and to cause the solvent vapours to be always condensed on the walls thereof and to flow downwardly thereon therby developing their flooding action according to the plot of Fig. 4, wherein T1 designates the vapour condensation temperature and T2 designates the average temperature of the apparatus A under treatment. Preferably the solvent used in this case is dearomated heptane which exhibits all of the above mentioned features for performing the washing operation.

As can be seen from Fig. 4, the temperature T1 is stepwise controlled as a function of the temperature T2 taken over by the apparatus A, i.e. as the temperature T2 of the apparatus A approaches the vapour condensation temperature T1, the latter is increased of a step ΔT, and this operation is repeated until the washing is ended. The box B is further provided with a solvent inlet S, a thermometer V for measuring the solvent vapour temperature and an inert gas source R connected to the box through a valve Z, a non-return safety valve Q calibrated so as to assure that the pressure inside the box B does not excceed the safety values and a drainage tube D for the gravity discharge of the polychlorobiphenyl.

Once the washing operation is ended it is sufficient to evacuate the box B through the valve P and to condensate the solvent vapours, by recovering all the solvent through the outlet C while the removed PCB is readily discharged through the drainage tube D.

The inert gas source R during the solvent discharge operation is connected to the box B in order to avoid the air to enter therein, which could give rise to possible combustion of the hot solution.

The method could be carried out by providing outside the box B a solvent vapour source and then injecting the solvent vapours into the box D following the requirements for performing the washing operation.

Figs. 2 and 3 diagrammatically show the action of the solvent on the PCB during a liquid phase washing operation and during a vapour phase washing operation, respectively. As can be seen from Fig. 2, the area A is static and therefore there is a poor solvent substitution which when it is saturated, stops its penentration, whereas in Fig. 3 there is a continuous solvent substitution with resulting higher penetrability into the components of the apparatus to be decontaminated.

By means of the method according to the invention an automatic washing without the intervention of operators in contact with the PCB occurs. During the full washing cycle all the necessary equipment does not come into contact with PCB and, once the washing operation is ended, it is fully cleaned and decontaminated, with the exception of the lower PCB collecting zone. Furthermore, any possibility of environmental contamination is avoided since the system does not provide circuits for the PCB containing solvent (pumps, pipes, connectors, etc.), which could give rise to contamination problems. The washing efficiency in very good since the solvent retains always its dissolving capacity without ever reaching the saturation and moreover the solvent can completely penetrate within interstices also of capillary nature.

The decontamination operation is extremely quick. It has been experimentally proved on a tipic series of electric transformators that the PCB embedded in the paper or wood or enclosed in too near walls forming the magnetic core or the

windings thereof, is very difficult to remove (see plot of Fig. 5, wherein the curve shows the PCB decontamination efficiency with liquid phase solvent, where after about three hours of treatment the decontamination rate is about 40% of PCB) whereas, according to this method, the PCB is almost fully removed in the same time (see Fig. 6 wherein the curve shows that in the same time as in Fig. 5 the PCB has been removed in a very high percentage).

From tests effectively carried out it has been proved that the amount of PCB remained on a trasformator containing 200 Kg of insulating liquid is less than 100 gr.

Another advantage of this invention is the very low amount of solvent required for the decontamination and easy recovery thereof since it is sufficient an amount less than 1% of the amount required for carrying out the liquid phase washing, which results in a lower cost of solvent recovery, as this can be recovered by taking advantage of the heat supplied by the heaters by simply evacuating the box once the washing is ended and in the PCB has been separated therefrom.

The so decontaminated apparatus can then be recovered and reused by substituting for the PCB a usual oil or a silicone oil or a liquid usually employed to this end.

From the foregoing it will be readily apparent that the method according to this invention permits a decontamination from PCB with very high yields to be obtained, what could not be obtained till now.

Claims

1. Method of decontaminating an electrical or mechanical apparatus contaminated with polychlorobiphenyl using a solvent for polychlorobiphenyl which is chemically inert thereto, and has a distillation temperature lower than that of polychlorobiphenyl, characterized by:

introducing the apparatus to be decontaminated in a chamber;

maintaining the apparatus under vacuum submerged in the vapours of said solvent in the sealed chamber;

controlling the pressure and the temperature of the solvent vapours so as to permit at all times a condensation of the solvent vapours on the surfaces under treatment, the solvent vapours also being condensed at the top of the sealed chamber so as to perform a reflux washing of the apparatus.

2. Method as claimed in claim 1, characterized in that the solvent vapours are generated by heating means.

3. Method as claimed in claim 2, characterized in that the solvent vapours are generated in the sealed chamber by associated heating means.

4. Method as claimed in claim 1 or 2, characterized in that the solvent vapours are generated outside the sealed chamber and then injected therein to wash the apparatus.

5. Method as claimed in any one of claims 1—4, characterized in that the solvent is non-toxic and is also compatible with the apparatus materials.

6. Method as claimed in any one of claims 1—5, characterized in that the distillation temperature of the solvent is lower than the maximum temperature tolerable by the apparatus to be decontaminated and higher than the room temperature for handling and conservation facility thereof.

7. Method as claimed in any one of the preceding claims, characterized in that dearomated heptane or trichloroethane is employed as solvent.

8. Method as claimed in any one of the preceding claims, characterized in that the temperature of the solvent vapours is increased stepwise as a function of the average temperature of the apparatus to be decontaminated.

9. Method as claimed in any one of the preceding claims, characterized in that inside the chamber the temperature is controlled by a thermostat controlling a valve which controls the flow of a heating fluid through the side walls of the chamber.

Patentansprüche

1. Verfahren zur Dekontamination von mit Polychlorbiphenyl verunreinigten Elektro-Mechanikvorrichtungen unter Verwendung eines Lösungsmittels für Polychlorbiphenyl, das diesem gegenüber chemisch inert ist und eine niedrigere Destilliertemperatur als Polychlorbiphenyl hat, dadurch gekennzeichnet, dass man

die zu dekontaminierende Vorrichtung in eine Kammer einführt;

die Vorrichtung in der adgedichteten Kammer unter Vakuum in die Lösungsmitteldämpfe eingetaucht hält;

den Druck und die Temperatur des Lösungsmitteldämpfe kontrolliert, so das jederzeit eine Kondensation der Lösungsmitteldämpfe an den in Behandlung befindlichen Oberflächen emöglicht wird, wobei die Lösungsmitteldämpfe auch oben in der abgedichteten Kammer kondensiert werden, um eine Rückflusswäsche der Vorrichtung durchzuführen.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, dass die Lösungsmitteldämpfe durch Heizmittel erzeugt werden.

3. Verfahren nach Anspruch 2, dadurch gekennzeichnet, dass die Lösungsmitteldämpfe in der abgedichteten Kammer durch zugeordnete Heizmittel erzeugt werden.

4. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, dass die Lösungsmitteldämpfe ausserhalb der abgedichteten Kammer erzeugt und dann zum Waschen der Vorrichtung in dieselbe eingespritzt werden.

5. Verfahren nach einem Ansprüche 1—4, dadurch gekennzeichnet, dass das Lösungsmittel atoxisch und auch mit den Materialien der Vorrichtung verträglich ist.

6. Verfahren nach einem der Ansprüche 1—5, dadurch gekennzeichnet, dass die Destilliertem-

peratur des Lösungsmittel niedriger als die von der zu dekontaminierenden Vorrichtung verträglichen Höchsttemperatur und höher als die Raumtemperatur für deren Behandlungs- und Aufbewahrungsleichterung ist.

7. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass dearomatisiertes Heptan oder Trichloräthan als Lösungsmittel verwendet wird.

8. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Temperatur der Lösungsmitteldämpfe in Abhängigkeit der Durchschnittstemperatur der zu dekontaminierenden Vorrichtung stufensweise erhöht wird.

9. Verfahren nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, dass die Temperatur im Innern der Kammer über ein Thermostat eingestellt wird, das ein die Strömung einer Heizflüssigkeit in den Kammerseitenwänden der Kammer kontrollierendes Ventil steuert.

Revendications

1. Procédé pour désinfecter un dispositif électro-mécanique de polychlorbiphényl en utilisant un solvant du polychlorobiphényl, qui est chimiquement inerte à celui-ci et qui a une température de distillation inférieure à celle du polychlorobiphényl, caractérisé en ce qu'on

introduit le dispositif à désinfecter dans une chambre;

maintient le dispositif sous vide submergé dans les vapeurs dudit solvant dans la chambre étanche;

contrôle la pression et la température des vapeurs du solvant de façon à permettre toujours une condensation des vapeurs du solvant sur les surfaces en traitement, les vapeurs du solvant étant aussi condensées au sommet de la chambre étanche pour effecteur un lavage à réflux du dispositif.

2. Procédé selon la revendication 1, caractérisé en ce que les vapeurs du solvant engendrées par des moyens de chauffage.

3. Procédé selon la revendication 2, caractérisé en ce que les vapeurs du solvant sont engendrées dans la chambre étanche par des moyens de chauffages associés.

4. Procédé selon la revendication 1 ou 2, caractérisé en ce que les vapeurs du solvant sont engendrées au dehors de la chambre étanche et ensuite injectées dans la même pour laver le dispositif.

5. Procédé selon l'une des revendications 1—4, caractérisé en ce que le solvant est atoxique et aussi compatible avec les matériaux du dispositif.

6. Procédé selon l'une des revendications 1—5, caractérisé en ce que la température de distillation du solvant est inférieure à la température maximum tolérable par le dispositif à désinfecter et supérieure à la temperature ambiante pour la facilité de manipulation et de conservation de celui-ci.

7. Procédé selon l'une des revendications précédentes, caractérisé en ce qu'on emploit comme solvant de l'heptane déaromatisé ou du trichloroéthane.

8. Procédé selon l'une des revendications précédentes, caractérisé en ce que la température de vapeurs du solvant est augmentée par echélons en fonction de la température moyenne du dispositif à désinfecter.

9. Procédé selon l'une des revendications précédentes, caractérisé en ce que la température à l'intérieure de la chambre est contrôlée par un thermostat, qui commande une soupape contrôlant l'écoulement d'un liquide de chauffage à travers les parois latérales de la chambre.