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RECLASSIFICATION OF ELECTRICAL APPARATUS CONTAMINATED WITH PCB.

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EP-A- 0 037 280
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US-A- 4 425 949

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Description

This invention relates to an apparatus and method for cleaning or reclassifying electrical apparatus, such as transformers and capacitors, designed to use as a liquid dielectric fluid polychlorinated biphenyls, and a porous internal construction. Such apparatus is characterized by the adsorption of the liquid into the pores of structural support media, thereby rendering difficult the complete removal of said liquid.

For many years polychlorinated biphenyls (PCB or PCB's) have been used as an insulation or dielectric fluid in the electrical apparatus industry as a safe, fire resistant material. Dielectric fluids containing such PCB's have often been generically called askarels where the PCB is often present as a mixture in a chlorinated benzene solvent. In the late 60's and early 70's it was discovered that PCB's were hazardous environmental contaminants and their use was discontinued; however, by that time many pieces of electrical apparatus had been built using the PCB's as an insulation media. A primary use of PCB is an electrical transformers and electrical capacitors as a coolant dielectric fluid. This invention relates to cleaning PCB'S from such apparatus and eventual reclassification of it as non-PCB equipment. For reclassification it is presently necessary that tests demonstrate a contamination of less than 50 ppm of PCB in the dielectric fluid after three months of operation succeeding the completion of cleaning.

Transformers designed for PCB use all have a major similarity in that they contain a cellulosic material as insulation, usually a paper wrap, on the wire comprising the core of the transformer. Included in the transformer may be wooden structures acting as insulators. Because of these two major items, the interior of the transformer acts somewhat like a sponge and PCB's become impregnated into these materials. They are contained in such a manner that simple washing will not remove them, and that, over a period of time, the PCB's will leach out of the cellulosic material and come to an equilibrium level in the transformer even if it had been filled with clean, non-PCB, oil. Transformers which use a mineral oil dielectric are different and the invention does not apply.

A similar problem is encountered in the disposal of transformers and capacitors which are impregnated with more than 500 ppm PCB or PCB contaminated liquids which are understood to be liquids containing from 50 to 500 ppm PCB. Regulations imposed by the United States Environmental Protection Agency prohibit the recovery and recycling of the equipment unless the equipment can be certified as non-PCB equipment under those regulations.

Several methods are used or have been proposed for the cleanup, or reclassification, of transformers. Complete flushings have been proposed with several classes of fluids thereby generating large volumes of PCB contaminated, or PCB, material by the United States Environmental Protection Agency (EPA) definitions. These methods involve vacuum extraction and condensation of vaporized solvents but have been found lacking for a number of reasons.

The major problem with prior methods is that they either generate a very large volume of contaminated fluid, with more than 500 ppm of PCB, and require long periods of time to successfully complete cleaning or they include complicated process steps during which the equipment must be kept out of service or service is frequently interrupted. Several discussions of the problem of cleaning PCB and PCB contaminated electrical apparatus, particularly transformers, are found in U. S. Patent Nos. 4,483,717, 4,425,949 and 4,312,794 and a literature reference ("Transformer Askarel Removal to an EPA Clean Level," J.H. Olmstead. Proceedings IEEE, 1 AS 79: 34, See pages 1053 through 1055), which describe the cycling of transformer dielectric fluid through a filtration system to scavenge PCB.

Other methods suffer from high labor requirements, the necessity of hauling of contaminated fluids to separation equipment, often over public roads to off site locations, or employ complicated separation techniques. EP-A-0-188,698, for example, describes apparatus for removing PCB's from contaminated leaching fluid off site. Up to now simple, onsite and unattended apparatus and methods for cleaning, or reclassifying, transformers designed for PCB dielectric fluid while maintaining the transformer on line and energized, or under a power load, have been wanting. With this invention such problems have been solved.

The present invention relates to apparatus for cleaning and reclassifying liquid filled electric apparatus designed to use PCB dielectric fluid to meet at least the present U.S. government EPA standards as "non-PCB" equipment.

According to the present invention, there is provided an apparatus for cleaning fluids contaminated with polychlorinated biphenyls from an electrical apparatus preferably with minimal interruption in the operation of said electrical apparatus prior to reclassification thereof, characterized in that for ease of operation in a simplified, unattended manner said cleaning apparatus includes means connectible to said electrical apparatus for removing and conducting a leaching fluid contaminated with polychlorinated biphenyls from said electrical apparatus to a first single-stage distillation column, said first single-stage column being configured to form an overhead vapor stream consisting essentially of the leaching fluid and a bottoms stream contaminated with

polychlorinated biphenyls, condensing means receiving said overhead stream for condensing the vapor therein consisting essentially of the leaching fluid from said first single-stage column, means for returning the condensed leaching fluid to the electrical apparatus, means for withdrawing the bottoms stream from said first single-stage column and conducting said bottoms stream to a second single-stage column, said second single-stage column being configured to form a second overhead vapor stream including the leaching fluid and a second bottoms stream containing polychlorinated biphenyls, second condensing means receiving the second overhead vapor stream for condensing the vaporized leaching fluid in said overhead stream, and means for conducting the condensed leaching fluid from said condenser to said first single-stage column. The means for conducting leaching fluid from the electrical apparatus may comprise a loop including a siphon breaker means between the electrical apparatus and the first single-stage distillation column. The condensing means which receives the overhead stream from the first single-stage column may be an atmospheric condenser as may the second condensing means.

This invention allows cleaning of electrical apparatus designed for PCB use, such as a transformer, while the apparatus is energized and operating on line. Normally only a single discontinuance of service of the electrical apparatus is necessary, and occurs to initially drain a PCB, or PCB contaminated, fluid from the electrical apparatus. Maintenance can then be performed. During this time the apparatus can be modified if necessary and connected to the cleaning apparatus, which includes a distillation arrangement. In carrying out a preferred aspect of the invention the apparatus is filled with a leaching fluid chosen both to leach PCB's from the core, or cellulosic material insulation on the core wiring of a transformer and to serve as the insulating dielectric fluid coolant for maintaining the electric apparatus on line and energized while the method of reclassification is being performed. Leaching fluid is circulated from the electric apparatus through the distillation unit, where it is separated from PCB's being removed from the electrical apparatus, and recirculated back through the transformer. The concentrated PCB's are accumulated on site for disposal. These steps are repeated until the electrical apparatus is capable of reclassification, at which time the transformer is either reclassified with the leaching fluid left in the transformer or the leaching fluid is removed from the transformer and replaced with an alternative permanent dielectric fluid, such as mineral oil, silicones, mixtures thereof or the like and then the reclassification test, ninety (90) days of operation is performed. The leaching fluid can be replaced while continuing in service, however it is preferable that this substitution of fluids be performed during a brief interruption of operation of the electric apparatus.

Detailed Description with Reference to the Drawing

The figure shows apparatus embodying the present invention which is being applied to an electrical power transformer. The transformer was previously insulated with a PCB coolant fluid.

It will be understood that other liquid materials including chlorinated benzene which are often found accompanying PCB's in electrical apparatus like power transformers may be removed along with the PCB's.

The primary advantage of the present invention is that it allows onsite, unattended reclassification of electrical apparatus in a manner which is capable of being conducted without substantial periods of interruption of operations of such equipment. This can be done either continuously or in a periodic, batch mode as described herein where operation is not continuous but is positioned in a batch mode and carried out in such a manner that operation of the apparatus could proceed without interruption. In the batch mode the equipment may also be placed near the electrical apparatus the contaminated fluid may be transported to the equipment.

The equipment, here a transformer, is first drained to remove the bulk of the PCB's therefrom. The transformer is then preferably washed with an amount of solvent, or leaching fluid, of from about one to about ten percent of its volume to remove any major gross puddles of PCB's. The liquid solvent, or leaching fluid, is dispersed throughout the case to flush out radiators and other parts of the transformer. This solvent is then either removed from the transformer and stored for further processing at the site or run through the distillation unit as hereinafter described in the practice of the invention to separate it from the PCB's. Maintenance would be preferably performed on the apparatus to change gaskets and the like during this period.

At this point the electrical apparatus, here a transformer, has been processed in the manner which is normal to the industry in preparation for refilling with a non-PCB liquid. Bulk liquid has been drained, and significant pools have been removed so that the residual PCB's available for contaminating the new fluid amounts to small amounts relative to the total liquid capacity of the transformer. However, significant amount of PCB's remain absorbed in the core of the transformer, available to leach out once the transformer is refilled with dielectric fluid and placed back-on-line.

During this initial drain, rinse time and maintenance, the transformer may be conveniently fitted with means for removing the fluid, connections and valves and the like, to provide for conducting leaching fluid in and out of the transformer without interrupting on-line, energized cleaning and reclassification in accordance with this

invention. The added valves allow the possibility of refilling of the transformer with a dielectric fluid different from the leaching fluid with a minimum of interruption, if any, of the operation of the transformer. A distillation unit as described herein is attached to fittings, hereinafter described, on the transformer which, for purposes of this discussion, is filled with a liquid leaching fluid. The liquid leaching fluid may be any fluid which is a solvent for the PCB and which has a boiling point sufficiently distant from that of the PCB to be easily separated by distillation; i.e., having a boiling point sufficiently below that of the PCB to form a sharp separation.

The PCB compounds normally used for electrical apparatus, particularly transformers, are usually a wide range of congeners which boil within the range of about 250° to about 500°C. Commonly used PCB containing fluids were called askarels which were often mixtures of biphenyls having differing degrees of chlorination in a trichlorobenzene (TCB) solvent; for example, common mixtures contained from about 50% to about 85% mixed PCB's and corresponding from about 15% to about 50% TCB.

Preferably the leaching fluid will also have a boiling point sufficiently high to avoid special equipment requirements for condensation of vapors that are generated. The leaching fluid should have the essential properties of a coolant dielectric fluid and be compatible with the internal core of the transformer such that energized operation of the transformer is possible during the steps of the cleaning and reclassification process. In addition to keeping the core submerged during operation, it is important, as is well known to those skilled in the art, to avoid exposure of the core to oxygen and moisture. During operation this is assured by including a siphon leg equipped with a siphon breaking means which controls flow from the transformer to the distillation apparatus which will stop flow of leaching fluid and cause the distillation to stop in the event of danger of the core becoming exposed.

A preferred leaching fluid for use in the practice of this invention is perchloroethylene, boiling point about 121°C, either the pure substance having less than about 100 ppm halohydrocarbon contaminants as described in U. S. Patent No. 4,312,794 or an inhibited perchloroethylene as described in U. S. Patent No. 4,293,433, both of which are incorporated herein by reference for all purposes for the disclosure therein made. Another preferred leaching liquid would be an inhibitor stabilized perchloroethylene containing from 200 ppm to about 500 ppm of trichloroethylene. Any of the leaching fluid containing perchloroethylene as described above may be used alone or in conjunction with a hydrocarbon diluent, preferably from about 1% to about 30% by weight thereof, preferably boiling within about 10°C of the perchloroethylene in order to provide an easy separation by distillation from the PCB's. The hydrocarbon diluent preferably would be selected to preserve the non-flammable nature of the perchloroethylene fluid.

A distillation system can be attached on site as hereinafter described, to the transformer and operated either continuously or periodically, circulating the leaching fluid from the transformer through the distillation unit where PCB's are removed from the fluid and cleaned leaching fluid is circulated back to the transformer.

Referring to the drawing an especially preferred embodiment of the practice of this invention, after initial draining and cleaning a transformer T2 is connected to a combination of two interconnected single stage distillation columns substantially as schematically shown. The transformer T2 with the core W2 is filled with a leaching fluid F such as perchloroethylene. The leaching fluid F is withdrawn from transformer T2 through nozzle 202 at or near the bottom of transformer T, line 204, valve 206 and loop 208 (the purpose of which is explained below) to line 210 through which it is introduced into a first distillation column D2. Distillation column D2 preferably has a single stage distillation zone in still 214 and is operated at substantially zero reflux except for such concentration as might occur in exit overhead line 218. The leaching fluid F in first distillation column D2 is heated in still 214 through the introduction of heat, shown as coils 216 preferably electric or with steam or one of any other well known heating fluids as an alternative, to a temperature sufficient to boil the leaching fluid from the PCB's. When perchloroethylene is used as the leaching fluid, this temperature will be from about 120°C to about 180°C, more preferably from about 120°C to about 150°C.

The overhead stream produced from first distillation column D2 will preferably be substantially free of PCB's at later stages of transformer cleaning, more preferably about 2 ppm by weight PCB's or less. To accomplish such, the PCB concentration in the bottoms 215 should be kept below about 20% by weight, preferably below about 10% by weight, still more preferably below 5% by weight.

Due to the relatively low temperatures utilized within first distillation column D2, bottoms 215 must be periodically drained or, preferably, discharged to a second distillation column D2a, where the bottoms stream is further distilled, usually at a higher temperature (as detailed below), to remove a substantial portion of the remaining leaching fluid from the PCB's. This leaching fluid is then condensed and recycled back to distillation column D2, while the remaining PCB's are initially accumulated within the distillation column D2 and eventually discharged to a second distillation column D2a.

The level of bottoms 215 will be monitored by a level controller 230. Level controller 230 may optionally actuate valve 206 to change the rate of flow from transformer T2 or heat coil 216 to raise the temperature of still 214 and reduce the volume of bottoms 215 by increased distillation until the PCB concentration in the bottom

of D2 reaches about 20%, preferably about 10% or less, and more preferably about 5% or less. It is preferable to actuate valve 206 for the circulation of additional fluid from the transformer T2 to the first distillation unit D2. Other schemes for accomplishing basic control of D2 will be appreciated by one skilled in the art.

Periodically, bottoms 215 are preferably drained through line 234, valve 232 and line 236 into a second distillation column D2a. Distillation column D2a, like distillation column D2, preferably has a single stage distillation zone and is operated as set forth above. The bottoms 215 in distillation column D2a is heated in a still 214a through the introduction of heat, shown as coils 216a preferably electric or with steam or one of any other well known heating fluids as an alternative, to a temperature sufficient to boil a substantial amount of the leaching fluid from the PCB's. When perchloroethylene is used as the leaching fluid, this temperature will be from about 120°C to about 210°C, more preferably from about 150°C to about 180°C. While the overhead of second distillation column D2a does not carry a specific PCB concentration restriction, it should be successful operation remain less than the concentration in the still 214. The leaching fluid is vaporized from the bottoms stream 215a to produce a PCB concentration of from about 70% to about 95%, more preferably from about 80% to about 95%, in the bottoms 215a. Such concentrations reduces the volume of waste for ultimate disposal to about one forth to one tenth of what it would be with only a single stage.

The level of bottoms 215a will be monitored and controlled by a controller (not shown) operating heater 216a or valve 232a. The bottoms 215a rich in PCB's may be either accumulated throughout the cleaning period or removed periodically to purge the PCB's from distillation column D2a through line 234a, valve 232a and line 236a to storage and/or further disposal.

In one embodiment of D2a operation, bottoms from D2 are fed to D2a through valve 232 and line 236 until the controller 230a signals that D2a is full through its high level switches (HLS). Valve 232 is then closed and heat is applied to D2a to boil leaching fluid away from PCB's. This proceeds until the level of liquid in the bottom of second column D2a falls enough to trigger the low level switch (LLS). At this point, the controller optionally can open valve 232 to receive more fluid from first column D2 or temporarily turn off the heat source to second column D2a. Thus, the majority of the PCB's in the bottom of first column D2 is transferred to second column D2a. If the quantity of PCB's to be accumulated in second column D2a exceeds the capacity of the unit part of the contents of second column D2a can be discharged to a separate storage tank. Second distillation zone D2a can be designed to accommodate up to about 50% PCB's and chlorinated benzenes (i.e., TCB solvent) preferably up to about 80% PCB's and chlorinated benzenes, and more preferably up to about 90% PCB's and chlorinated benzenes.

The overhead stream produced by distillation column D2a exits through line 218a as a vapor and proceeds to a condensing means C2a, where the vapor is condensed into liquid through heat exchange, preferably in a finned heat exchanger exposed to atmospheric air for reducing the temperature of the overhead stream. The condensate exits condenser C2a through line 220a and is recycled into the bottom of distillation column D2 wherein it commingles with bottoms 215 and fluid entering from line 210 for further treatment therein.

The overhead stream produced by distillation column D2 exits through line 218 as a vapor and proceeds to a condenser C2, where the vapor is condensed into liquid through heat exchange, preferably in a finned heat exchanger exposed to atmospheric air for reducing the temperature of the overhead stream. The condensate exits condenser C2 through line 220 and valve 222 and proceeds through line 224 for return through valve 226 and nozzle 228 to the transformer T2.

To compensate for any removal of leaching fluid from still 214a, leaching fluid make-up may be added, for example, through line 240, valve 242 and line 244 into line 224 and thus to transformer T2 as previously described. Very little leaching fluid will be removed from still 214a, however, due to the high PCB concentration and low volume of bottoms 215a. Leaching fluid can additionally be removed, if desired, from line 220 through line 252, valve 250 and line 254. When draining transformer T2 for the replacement of the leaching fluid with a permanent fluid, the leaching fluid can be drained from line 210 through line 258, valve 256 and line 266.

As previously indicated, it is imperative during the cleaning process that the level of leaching fluid within transformer T2 remain above core W2. As depicted in Fig. 6, a loop 208 is preferably installed between line 204 and 210, and a siphon breaker 272 is installed above fluid level at nozzle 268 and valve 270 (optional) in loop 208 which operators to open if fluid F drops below the limits of level controller 273.

Loop 208 is an arched section between lines 204 and 210, with the apex 209 of the arch being higher in elevation than the top of core W2 and below the surface of fluid F normally present in transformer T2. The entrance of line 210 into first distillation zone D2 is usually below the level fluid F in transformer T2 to provide gravity feed. When leaching fluid level drops in transformer T2 exposing the apex 209 of loop 208 to a liquid free void in transformer T2 a potential siphon is broken. This stops the draining of transformer T2 and protects the core W2. When the level of fluid in transformer T2 exceeds the level of the apex 209 the flow of fluid F again starts to the first distillation unit D2. Since transformer often have sediment which invades the leaching fluid F the siphon breaker is a protection against the consequences of valve 206 becoming stuck in the open

position.

The embodiment as depicted in the drawing 1 and discussed above provides several operational advantages. The dual distillation zones provide the effectiveness of multistage distillation without the process complications attendant to such. The apparatus of shown in the drawing requires no more than on/off process control, whereas a multistage unit would require substantially more and complex proportional or proportional/integral controls, as well as additional equipment in the form of reflux tanks, reflux pumps, flow monitors and controls. Many situations can arise during the operation of this equipment which would require an automatic pause or temporary shutdown of the equipment. Due to the simplified process control of the system of the preferred embodiment, these interruptions in service are easily handled by the on/off nature of the process control. Achievement of such control with a multistage unit is, as is well known by one skilled in the art, at best costly and complicated.

EXAMPLE

Table 1 shows results comparing a single stage processor without a second distillation zone and a first single stage distillation zone combined with a second bottom distillation zone as depicted in the drawing. The combination includes the ability to concentrate PCB's in second bottoms D2a, stream, control PCB concentration in column D2 at desired range and ability to control PCB accumulation at less than 2ppm in the holding tank for recycle to the first distillation zone.

To simulate a contaminated transformer, a vessel was filled with perchloroethylene based leaching fluid. Into this simulated transformer, an askarel containing 50% trichlorobenzene and 50% mixed PCB's, was added in the amounts shown and at the times indicated in Table 1. The apparatus of this stage distillation unit (D2) and later as a combination of two single stage distillation units (D2 and D2a).

The first distillation unit D2 was configured to draw fluid from the simulated transformer periodically as fluid boiled, thereby lowering the liquid level in the still 214. The temperature in the still 214 varied with the concentration of PCB's, ranging from about 121°C (minimal PCB content) to about 135 to 140°C (40% to 50% PCB's). Condenser leaching fluid was accumulated in holding tank 119 not shown and recirculated to the transformer. As shown in Table 1, over a period of 10 days, regular increments of askarel were added to D2. Due to the boiling and clean recycle action of D2, the level of PCB's in the still 214 rose rapidly, leveling out when additions of askarel to the transformer were stopped and rising again when additions of askarels resumed.

On day 38, the second single stage distillation unit D2a was connected to first distillation unit D2 and portions of the contents of the first still 214 were periodically fed to second distillation zone D2a where they concentration of PCB's, ranging from about 125°C (about 10% PCB's) to about 190 to 210°C (about 90% PCB's). PCB's were accumulated in second distillation zone D2a and boiled fluids were recycled to the boiling chamber of first distillation zone D2. As shown in Table 1, immediately following the startup of second distillation zone D2a, the PCB concentration of the boiling chamber in D2 begins to fall while PCB concentration of the still 214a begins to rise. The decline in PCB concentration in the still 214 occurs despite the steady addition of PCB's to the transformer. As the concentration of PCB's in the still 214 falls, the residual PCB content of condensed fluid in the holding tank 119 rapidly falls to less than 2 ppm and remains there. At the same time, the concentration of PCB's in the still 214a rises rapidly. At steady state, with no addition of PCB's to the transformer, the concentration of PCB's in the first distillation zone D2 falls to about 0.1% and all of the PCB's collect in the still 214a.

TABLE 1

PERFORMANCE OF PROCESSOR ALONE AND
WITH SECOND DISTILLATION ZONE

Contents of Processor

	Cumulative Askarel to Transformer PCB mls	PCB in Distillation Zone One 215 mg/l	PCB in Hold Tank* 119 mg/l	PCB in Distillation Zone Two 215a mg/l	Test Day No.
A. Operation of Processor Only					
	0	<2	<2	-0-	0
	1,800	43,010	<2	-0-	1
	3,000	74,547	4	-0-	2
	4,500	117,072	3	-0-	2
	6,000	142,731	5	-0-	7
	7,800	205,684	7	-0-	8
	9,400	251,715	6	-0-	8
	9,400	249,164	8	-0-	9
	9,400	251,104	7	-0-	9
	9,400	235,675	9	-0-	10
	9,400	235,514	9	-0-	10
	11,000	273,162	7	-0-	11
	11,000	282,358	11	-0-	11
	11,000	271,725	8	-0-	11
	12,500	308,228	10	-0-	14
	14,100	411,971	13	-0-	16
B. Processor Plus Bottoms Processor					
	19,500	10,857	<2	422,433	38
	20,500	12,708	<2	482,746	39
	21,500	1,231	<2	519,531	45
	23,100	13,784	<2	536,480	47
	25,100	17,538	<2	600,081	52
	26,100	26,694	<2	655,546	52

* Not shown

Claims

1. Apparatus for cleaning fluids contaminated with polychlorinated biphenyls from an electrical apparatus preferably with minimal interruption in the operation of said electrical apparatus prior to reclassification thereof, characterized in that for ease of operation in a simplified, unattended manner said cleaning apparatus (D₂, D_{2a}, C₂, C_{2a}) includes means (204, 208, 210) connectible to said electrical apparatus (T) for removing and conducting a leaching fluid contaminated with polychlorinated biphenyls from said electrical apparatus (T) to a first single-stage distillation column (D₂), said first single-stage column (D₂) being configured to form an overhead vapor stream (218) consisting essentially of the leaching fluid and a bottoms stream (215) contaminated with polychlorinated biphenyls, condensing means (C₂) receiving said overhead stream (218) for condensing the vapor therein consisting essentially of the leaching fluid from said first single-stage column (D₂), means (220, 224) for returning the condensed leaching fluid to the electrical apparatus (T), means (232, 234, 236) for with-

drawing the bottoms stream (215) from said first single-stage column (D_2) and conducting said bottoms stream (215) to a second single-stage column (D_{2a}), said second single-stage column (D_{2a}) being configured to form a second overhead vapor stream (218a) including the leaching fluid and a second bottoms stream (215a) containing polychlorinated biphenyls, second condensing means (C_{2a}) receiving the second overhead vapor stream (218a) for condensing the vaporized leaching fluid in said overhead stream (218a), and means (220a) for conducting the condensed leaching fluid from said condenser (C_{2a}) to said first single-stage column (D_2).

2. The apparatus of claim 1, characterized in that the means for conducting leaching fluid from the electrical apparatus comprise a loop (208) including a siphon breaker means (272) between the electrical apparatus and the first single stage distillation column (D_2).

3. The apparatus according to Claim 1 or 2, characterized in that the condensing means (C_2) which receives the overhead stream (218) from the first single stage column (D_2) is an atmospheric condenser.

4. The apparatus of any preceding claim, characterized in that the second condensing means (C_{2a}) is an atmospheric condenser.

5. The use of the apparatus of any preceding claim for cleaning a transformer.

Patentansprüche

1. Vorrichtung zum Reinigen von mit polychlorierten Biphenylen verunreinigten Fluiden, die von einer elektrischen Vorrichtung stammen, vorzugsweise mit minimaler Unterbrechung des Betriebes der elektrischen Vorrichtung vor ihrer Umklassifizierung, dadurch gekennzeichnet, daß die Reinigungsvorrichtung (D_2 , D_{2a} , C_2 , C_{2a}) zum Erleichtern und Vereinfachen ihres bedienungsfreien Betriebes eine Einrichtung (204, 208, 210) aufweist, die mit der elektrischen Vorrichtung (T) verbindbar und geeignet ist, ein mit polychlorierten Biphenylen verunreinigtes Laugungsfluid von der elektrischen Vorrichtung (T) abzuziehen und einer ersten einstufigen Destillierkolonne (D_2) zuzuleiten, die so ausgebildet ist, daß sie einen im wesentlichen aus dem Laugungsfluid bestehenden Kopfdampfstrom (218) und einen mit polychlorierten Biphenylen verunreinigten Bodenstrom (215) erzeugt, ferner eine den Kopfstrom (218) empfangende Kondensationseinrichtung (D_2) zum Kondensieren des in dem Kopfstrom enthaltenen Dampfes, der im wesentlichen aus dem von der ersten einstufigen Kolonne (D_2) kommenden Laugungsfluid besteht, eine Einrichtung (220, 224) zum Zurückführen des kondensierten Laugungsfluids zu der elektrischen Vorrichtung (T), eine Einrichtung (232, 234, 236) zum Abziehen des Bodenstroms (215) von der ersten einstufigen Kolonne (D_2) und zum Zuleiten des Bodenstroms (215) zu einer zweiten einstufigen Kolonne (D_{2a}), die so ausgebildet ist, daß sie einen das Laugungsmedium enthaltenden zweiten Kopfdampfstrom (218a) und einen polychlorierte Phenyle enthaltenden zweiten Bodenstrom (215a) erzeugt, eine den zweiten Kopfdampfstrom (218a) empfangende zweite Kondensationseinrichtung (C_{2a}) zum Kondensieren des verdampften Laugungsfluids in dem Kopfstrom (218a) und eine Einrichtung (220a) zum Zuleiten des von dem Kondensator (C_{2a}) kommenden kondensierten Laugungsfluids zu der ersten einstufigen Kolonne (D_2).

2. Vorrichtung nach Anspruch 1, dadurch gekennzeichnet, daß die Einrichtung zum Abziehen von Laugungsmedium von der elektrischen Vorrichtung eine Schleife (208) aufweist, die einen zwischen der elektrischen Vorrichtung und der ersten einstufigen Destillationskolonne (D_2) angeordneten Trennsiphon (272) enthält.

3. Vorrichtung nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die den von der ersten einstufigen Kolonne (D_2) kommenden Kopfstrom (218) empfangende Kondensationseinrichtung (C_2) ein unter atmosphärischem Druck arbeitender Kondensator ist.

4. Vorrichtung nach einem der vorhergehenden Ansprüche, dadurch gekennzeichnet, daß die zweite Kondensationseinrichtung (C_{2a}) ein unter atmosphärischem Druck arbeitender Kondensator ist.

5. Verwendung der Vorrichtung nach einem der vorhergehenden Ansprüche zum Reinigen eines Transformators.

Revendications

1. Appareil de nettoyage pour débarrasser un appareil électrique des fluides contaminés par les polychlorobiphényles, avec de préférence une interruption minimum du fonctionnement dudit appareil électrique, préalablement à sa requalification, caractérisé en ce que, pour faciliter le fonctionnement d'une manière simplifiée et sans surveillance, ledit appareil de nettoyage (D_2 , D_{2a} , C_2 , C_{2a}) comprend des moyens (204, 208, 210) raccordables audit appareil électrique (T) pour enlever et conduire un fluide de lessivage contaminé par les polychlorobiphényles depuis ledit appareil électrique (T) jusqu'à une première colonne de distillation (D_2) à un

étage, ladite première colonne de distillation à un étage (D_2) étant agencée pour former un courant de vapeur (218) en tête de colonne constitué essentiellement du fluide de lessivage et un courant de pied de colonne (215) contaminé par les polychlorobiphényles, des moyens de condensation (C_2) recevant ledit courant de tête (218) pour y condenser la vapeur constituée essentiellement par le fluide de lessivage provenant de ladite première colonne (D_2) à un étage, des moyens (220, 224) pour renvoyer le fluide de lessivage condensé vers l'appareil électrique (T), des moyens (232, 234, 236) pour extraire le courant de pied (215) de ladite première colonne (D_2) à un étage et conduire ledit courant de pied (215) vers une seconde colonne (D_{2a}) à un étage, ladite seconde colonne (D_{2a}) à un étage étant agencée pour former un second courant de vapeur de tête (218a) comportant le fluide de lessivage et un second courant de pied (215a) contenant les polychlorobiphényles, des seconds moyens de condensation (C_{2a}) recevant le second courant de vapeur de tête (218a) pour condenser le fluide de lessivage qui se trouve à l'état de vapeur dans ledit courant de tête (218a) et des moyens (220a) pour conduire le fluide de lessivage dudit condenseur (C_{2a}) vers ladite première colonne à un étage (D_2).

2. Appareil selon la revendication 1, caractérisé en ce que les moyens pour conduire le liquide de lessivage à partir de l'appareil électrique comprennent une boucle (208) comportant des moyens interrupteurs à siphon (272) entre l'appareil électrique et la première colonne de distillation (D_2) à un étage.

3. Appareil selon la revendication 1 ou 2, caractérisé en ce que les moyens de condensation (C_2) qui reçoivent le courant de tête (218) venant de la première colonne à un étage (D_2) sont un condenseur atmosphérique.

4. Appareil selon l'une quelconque des revendications précédentes, caractérisé en ce que les seconds moyens de condensation (C_{2a}) consistent en un condenseur atmosphérique.

5. Utilisation de l'appareil selon l'une quelconque des revendications précédentes pour nettoyer un transformateur.

