THE LTR-PROCESS FOR DECONTAMINATION OF PCB-CONTAINING ELECTRICAL EQUIPMENT

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ABSTRACT

A new process for the treatment of PCB-transformer and -capacitor carcasses has been developed. The metals can be recycled, no other harmful substances are generated and minimal handling of PCB-material is required. A pilot plant is operating successfully.

INTRODUCTION

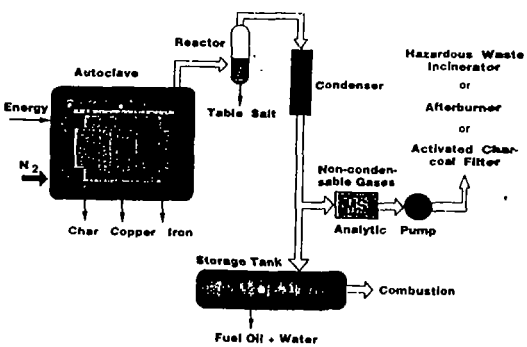
The further usage of PCB-transformers and -capacitors, the methods and the timeframe for their disposal are in most countries strictly regulated. For disposal, the transformers and most power capacitors are drained and the PCB-liquid disposed off in high temperature incinerators. In Western Europe, most of the remaining carcasses are being stored underground in a salt mine, some carcasses are being incinerated as well.

At the ABB Corporate Research Center in Baden, the LTR- (Low Temperature Recycling) process for treatment of theses carcasses has been developed.

EXPERIMENTAL PART

The basic principles of the LTR-process are shown in Fig. 1. The drained transformer or capacitor carcass is put into an autoclave which is then flushed with nitrogen until the oxygen level falls below 2%. At this point, heating of the autoclave starts. The final temperature is 420°C. PCB and other liquids evaporate, the organic components decompose partially. This process gas is led to a chemical reactor containing a sodium hydroxide melt at 400°C. The gas is finely distributed in the melt, the chlorine is completely stripped off forming sodium chloride, which stays in the melt as fine crystals. The chlorine-free gases are then led to a cooler, which they exit at a gas temperature of about 20°C. The condensate can be incinerated. Non-condensable gases (e.g. CH_4, H_2) are passed through an active carbon filter and an afterburner.

FIG. 1 PROCESS DESCRIPTION OF THE LTR-PROCESS



After treatment, all what is remaining of the organic components in the transformer or capacitor is pure carbon. The metals, iron and copper are essentially PCB-free so that they can be recycled. In the reactor, a NaOH-excess has to be maintained in order to keep the melt liquid. This has to be neutralized when the reactor is being regenerated.

The concept of the LTR-process was proven in laboratory-scale experiments. Based on the successful outcome of these tests, a pilot plant was designed and built. A picture of this installation is shown in Fig. 2. The autoclave is large enough to hold the active part of a 125 kVA transformer. The outside of the autoclave is heated electrically. Gas inside the autoclave is circulated by a fan to ensure even and efficient heating of the transformer or capacitor. The reactor is designed such that the residence time of the gas in the melt stays approximately constant, regardless of actual gas flow rate. The cooler is a conventional tube-bundle type design, water cooled. A mass-spectrometer is sampling the gas after the cooler to detect online if any chlorine is getting through the reactor. An active carbon filter and a propane-fired afterburner are treating the offgas before it is vented to the environment.

FIG. 2 LTR PILOT PLANT

The whole process is computer-controlled and incorporates all necessary safety features. Once the autoclave is loaded and the program started, no more operator interference is needed. During heating and outgassing, the system is evacuated to 880 mbar. The gas is pumped out when the pressure has risen to 920 mbar.

This cycling continues until no more gas is produced during a prescribed time. The autoclave is then flushed repeatedly with nitrogen and then cooled down.

RESULTS AND DISCUSSION

The pilot plant went into operation in November 1989. After initial shakedown of the plant several experiments with PCB-contaminated transformer material were performed. These tests proved the validity of the concept also on the larger scale. Next, the complete active part of a 63 kVA PCB-transformer was treated. The core plates of this transformer were compressed with a metal frame. Treated material was analyzed by an outside laboratory for residual PCB-contamination. On the metals, core plates and copper winding, a random wipe test according to US EPA procedures was performed. Insulation material was subjected to solvent extraction and subsequent PCB-determination. Results are listed in Table 1. These values are given per surface area for the metals and per mass of the insulating material for the other materials.

	PCB-content
Core plates	< 1 mg/m2
Copper winding	< 1 mg/m2
Insulating material	0.24 mg/kg

Table 1. Analytical results for treatment of 63 kVA PCB-transformer

These results clearly show that the metals can be recycled directly and that the insulating material can be disposed off safely.

With the LTR-process, a process has been developed allowing an environmentally safe disposal of PCB-transformer and -capacitor carcasses. Definite destruction of PCB's, recycling of the metals, minimal handling of PCB-contaminated parts are the main advantages of this process. No other toxic substances are being generated. The system is compact and cost-effective so that decentralized plants are economical.