

Transformers with PCB-contaminated mineral oil: myth or reality?

By Luciano A. Gonzalez

Although the quantification of PCB contaminated mineral oil in electrical transformers may seem simple, based on the limited information gathered and published in the National Implementation Plans already submitted by Parties to the Stockholm Convention, the number of transformers, particularly small distribution units, is so significantly high and their location in the electrical network so wide that unless there is a concerted effort to identify and properly handle them, most countries will not be able to meet their obligation by the targeted date of 2025 for cessation of use.

Unfortunately, the only way to identify PCB contaminated transformers is by carrying out sampling and analysis of the dielectric fluids. This task however, if completed for all transformers in any country's electrical network, would be extremely costly. In addition, as sampling of pole-mounted transformers cannot be carried out without opening the unit, the transformers must be disconnected to take the sample of the dielectric system. As opening up of the transformers would require interruption of the electrical supply, most companies are not prepared to face the discontent amongst the electrical users that would result from disruption of the power supply.

Usually, a small number of power transformers contain about one third of the oil in all electrical transformers. As power transformers are usually built with a sampling valve, sampling of the oil from these transformers can be carried out in energized transformers, without the need to interrupt the electrical supply.

Another important aspect to consider in this analysis is the issue of PCB-filled transformers. In general the number of PCB-filled transformers is relatively small compared to the whole population of transformers in any given country. The dielectric PCB fluid was a premium material, more expensive than mineral oil or other dielectric liquids. Because mainly of the price, the use of PCB transformers was restricted to locations where potential fires due to electrical transformer failures had to be avoided. This reasoning led to the use of PCB transformers in confined spaces such as underground electrical public transportation systems, hospitals, schools, mines and electrical generating stations.

In many countries, the electrical supply system is owned by different companies or agencies. Thus, different companies may own generating stations that supply their product to other companies owning the transmission lines. The transmission lines bring the power to transmission stations and from there to smaller substations from where the electricity is distributed to end-users. Such distribution network is also frequently owned and/or operated by different companies as well. Under such complex scenario, it is quite often a significant challenge to determine the actual inventory of PCBs in any given jurisdiction.

In order to estimate the potential number of PCB contaminated transformers one could use the installed electrical generating capacity. For example, a country with only 11,000 mega watts of electrical generating capacity, the total number of transformers would be in the order of 350,000 units.

The fundamental question is how many of the transformers are contaminated with PCBs above the threshold limit of 50 ppm as directed by the Stockholm Convention. The answer is that nobody knows and that there are several factors that affect this. These factors may be related to manufacturers and to transformer maintenance practices in the different utilities.

A study by Elizabethton Electric System (USA), prepared in 1998 and updated in 2006 on "Distribution Transformer Manufacturers and available Polychlorinated Biphenyl (PCB) Information" provides statistical results linking PCB contamination to transformation manufacturers. Their study shows that although transformers from some manufacturers did not have any PCBs, the incidence rate for others was in the order of 25 to 32%. Unfortunately, although these studies could give a good indication of contamination for suppliers of transformers in a given country, they cannot be used for PCB equipment.

In a separate study carried out by Sapertein et al., the authors found about 3.3% of all transformers were contaminated with PCBs above the 50 ppm limit. Data from the Canadian PCB inventory published in 1989 suggested that in addition to the 6 million litres of PCB contaminated mineral oil already treated, Canada has about 40 million litres of PCB contaminated oil above 50 ppm, contained in 300,000 to 350,000 transformers.

Maintenance practices in power transformers require that the dielectric fluid is to be cleaned from time to time to remove water and other impurities accumulated in the transformers. If the same machines are used to clean PCB contaminated oil and PCB-free oil, cross contamination of the clean oil would occur causing the clean transformer also to become PCB contaminated. PCB contaminated mineral oil, stored in bulk storage tanks could have been also used to re-fill failed pole mounted transformers that have been taken to machine shops for repairs thereby cross contaminating the original PCB-free transformers.

PCB inventory data from Ontario Hydro in the early 1980's shows that the company had about 1000 metric tons of high level PCB liquid (Askarel) and near 10,000 metric tons of PCB contaminated mineral oil distributed in a large number of transformers. The significant inventory of PCB contaminated mineral oil led this company to develop its own dechlorination system for PCB contaminated mineral oil.

Preliminary studies carried out in Mongolia for the preparation of their National Implementation Plan indicated that about 7.5% of their mineral oil transformers were contaminated with PCBs above the 50 ppm level.

Based on the limited data available, it is not possible to draw conclusions about the number of mineral oil transformers contaminated with PCBs over the 50 ppm level and the cause of the PCB contamination. The fact is that a large number of transformers filled with mineral oil containing PCBs above the 50 ppm were found in electrical companies with good maintenance practices and that many pole-mounted transformers without maintenance and still with the original dielectric fluid may suggest that these transformers were contaminated at the original manufacturer's site.

It is also known however that the lack of awareness of the PCB problem prevented many companies to take precautions to avoid further cross contamination.

It is expected that in developing countries or countries with economies in transition, the PCB contaminated mineral oil filled transformers would be a significant problem and that in order to facilitate these countries to fulfill their obligations under the Stockholm Convention to achieve environmentally sound waste management of PCBs by year 2028, assistance for transferring technologies to properly decontaminate and reclaim the mineral oil may be more suitable than just providing support to export their PCB wastes for destruction.

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