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# Deshalogenation of Sovtol-10 using a no-destructive method: pilot plant design

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**Abstract**

A practical and efficient treatment of PCBs (polychlorinated biphenyls) in transformer oil by a chemical dechlorination process has been reported. The transformer oil containing commercial PCB mixtures Sovtol-10 was treated by the required amounts of PEG 400 (polyethylene glycol 400) and powdered potassium hydroxide (KOH), along with different reaction times. The reaction of PEG with PCBs under basic condition produces arylpolyglycols and potassium chlorine. The relative efficiencies of PCB treatment process were assessed in terms of destruction and removal efficiency (DRE, %). Under the experimental conditions of KOH/PEG molar ratio 1.2:1, KPEG/oil 22:1 and three hours of reaction at 90 $^{o}$C, average DRE of PCBs was approximately 99 %, showing completely removal of PCBs containing 5-7 chlorines. In the sample remain the congeners 52 and 44 that are not reported as toxic by the WHO (World Health Organization). With the previously reported conditions the scale up of the process was realized.

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*Keywords:* PCBs; dechlorination; KPEG process; transformers oils; design

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## 1. Introduction

PCBs are chemical substances which are persistent, bioaccumulative, and pose a risk of causing adverse effects to human health and the environment. They can be transported over long distances, and have been detected in the furthest corners of the globe, including places far from where they were manufactured or used. While manufacture of PCBs has reportedly ceased, the potential or actual release of PCBs into the environment has not, since significant quantities of existing PCBs continue in use or in storage. [1]

Until now, no technology for the treatment of electrical equipment containing PCBs is available in Cuba. As a result of the ever increasing stocks of these equipments being taken out of service, the national strategy has been the temporary confinement under specific criteria that ensures the lowest risks possible to health and the environment. [2] The evaluation of source materials indicates that the priority in waste to be treated in Cuba is likely to be PCBs liquid. This is the reason why we will focus on evaluating the chemical deshalogenation technology.

According to an inventory carried out for United Nations Environment Programme (UNEP) about of worldwide PCB destruction capacity, there are 42 facilities from Africa, Asia, Australia, Europe, Latin America and the Caribbean, and North America that dispose PCBs and/or offer PCB destruction technologies and that facilities for PCBs destruction are mainly located in developed countries. [3]

High temperature incineration is the most often used proven process for the destruction of PCBs. Incineration, however, often emits more toxic compounds if is not carefully controlled. Polychlorinated dibenzodioxins and dibenzofurans have both been observed in the combustion of PCBs. [4] For that reason different methods for the destruction of PCBs have been proposed and include wet-air oxidation [5], super or supra-critical oxidation [6, 7], photolysis in the presence of hydrogen donors and oxidants [8], electrolytic reduction [9], biologic treatment [10, 11] and a number of other chemical methods, based on laboratory experiments only. Moreover, these methods typically involve one or more drawbacks, such as the use of expensive reagent, inert atmospheres, extensive temperature control, complex apparatus, substantial energy consumption and the like.

Among non-destructive decontamination processes (selective PCB removal), those based on the reaction between PCBs and PEG alkoxide appear as most promising from an industrial point of view. A group of reagents generically referred to as “APEG” (alkali metal polyethylene glycolate) has been developed.

Brunelle and Singleton [12] carried out an extensive study of Arochlor 1260 dechlorination in such non-polar media as heptane and toluene. They found that PCBs react with polyethylene glycols and potassium hydroxide under mild conditions, following a simple nucleophilic substitution by a polyethylene glycol alkoxide, probably occurring in the glycol phase. De Filippis [13, 14] applied the same chemical process to remove PCBs from contaminated dielectric and lube oils, concluding that the former are easier to dehalogenate. A first-order kinetic was observed for each PCB as well as with respect to the PEG concentration. The reaction was also affected by the KOH/PEG ratio. More recently, the influence of temperature, ultrasounds, polyethylene glycol base (PEG) and base type ware studied for Cafissi [15]. They found that dechlorination of PCBs by chemical treatment is effective at moderate temperature (90-100 ºC) and is strongly dependent on the nature of matrix oil. In addition, the ultrasound can improve the process efficiency by making operation condition less severe.

In previous investigations, the KPEG process using pellet KOH was studied. Average DRE of 93.7 % was obtained under the following conditions: PEG 400, of 30 and KOH/PEG mol ratio 2 for 2 hours of

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