The Start of PCB Treatment by the BCD Process

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1. Present Situation of PCB Treatment in Japan

In Japan, manufacturing, import and use of PCB were banned in 1972 because of its toxicity, since then PCB has been required to be stored under strict control. High temperature PCB incineration has been the only PCB treatment process legally allowed until recently. However, there have been concerns with this system that during the incineration process it may produce dioxins and unburned PCB may be emit into the environment. Due to these concerns, there has been no agreement gained from the residents and mandatory storage of PCB has continued, except for one instance. In June of 1999, however, the amended law was enforced (TABLE 1), and the BCD process - having an excellent decomposition performance with a high degree of safety - was approved along with some other chemical dechlorination processes. Because the BCD process has been approved as a PCB disposal technique, we applied for a permission to treat PCB waste we had retained to the authority. We now have the permission and have officially started a PCB treatment facility since January of 2000. In this paper we report on the process until we obtained an approval along with the treatment performance we have obtained.

TABLE1 Present PCB Emission Control Standard in Japan

Waste oil	0.5mg-PCBs/kg
Waste acids&waste alkalis	0.003mg-PCBs/L
Others(e.g.sludge)	0.003mg-PCBs/L-solution
Papers	Undetermined

2. Development Process

The BCD process, developed by EPA in 1989, is a method of chemical treatment that effectively converts persistent chlorinated organic compounds including PCBs into innocuous substances (Fig. 1). The process involves treatment of PCBs with hydrogen donor, alkali, and a catalyst at 300~350°C.

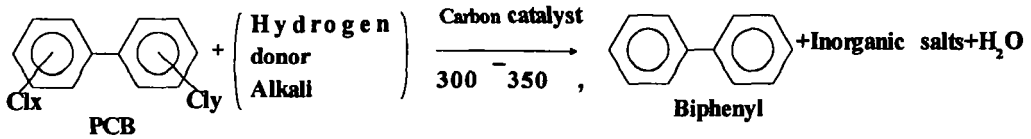

Fig.1 Principle of BCD process

The process offers the following advantages:

- Safely decomposes PCBs to low levels.
- No dioxins produced with limited environmental contamination.
- Relatively easy operation without need for special emergency measures.

We have been developing the following in order to comply with Japanese laws and circumstance since we employed this process in 1993[1].

1) Improving reaction rate
We have made efforts in improving the reaction rate and decomposition efficiency to reduce operation time and the cost of treatment.

2) Recycling treated oil.
The treated oil is seen as a recyclable fuel, and the fuel oils standard is required for the stable operation of incinerators (to help reduce the wear of fire resistant materials).

3. Our PCB Treatment Plan and its Approval Process

Fig. 2 shows the PCB treatment process in accordance with the law. Japanese people have been very sensitive to PCB since the Kanemi oil incident occurred in 1960s. Therefore, the most important issue, to conduct PCB oil treatment, was to build a consensus among the residents. As the first step we had meetings with local residents to describe our plan and provided information. The people were informed that extremely low levels of exhaust gases and water were emitted from the chemical treatment plant, and that resulted in a high degree of safety. This led to a good understanding by the residents. Later, we started official talks with the local government, and in October of 1999 the approval for the BCD process as the treatment of PCB by the chemical decomposition, as well as construction of a treatment facility at Fujisawa site was obtained.

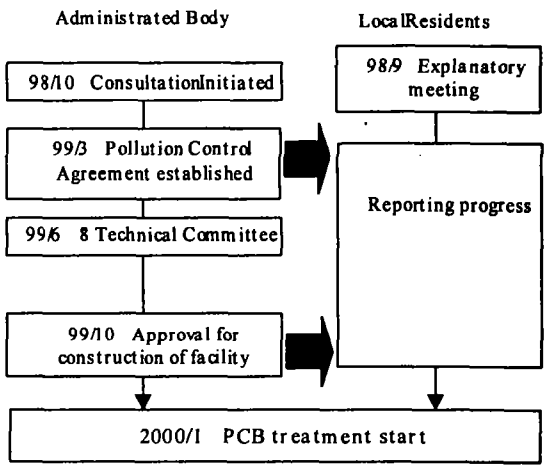

Fig.2 Flow Scheme of PCB Oil Treatment Application

The plan calls for 1 year to treat the entire 600Kg of PCB that Ebara currently retains. PCB is mainly Kanechlor KC-300.

4. Treatment Plant and its Performance

Our plant is being operated by one director, three operators, and one analyst. The BCD treatment plant consists of a reactor, condensers, activated carbon absorber, cooling tank which cools the treated oil coming out from the reactor, and other supporting utilities (Fig. 3). TABLE 2 shows the treatment conditions. The operating sequence includes pumping of 80L of transformer oil into the reactor and feeding of KOH

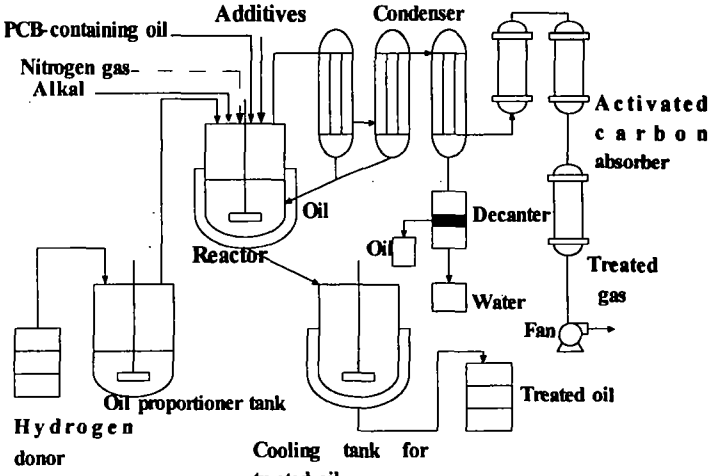

Fig.3 Outline of batchwise treatment plant

and additive, followed by addition of 8kg of PCB. The reactor is then heated only after ensuring that the reactor is being purged with nitrogen and its oxygen content is below 5%, and that all the equipment is running properly. The reaction is allowed to run for 4 hours after the liquid phase temperature of the reactor reaches 300°C. During the reaction, a small negative pressure is maintained inside the reactor by an induction fan to prevent release of PCBs from the system. Volatilized components during the reaction include vaporized oils and water. Oil components are condensed by the first and the second condensers, then the condensates are fed back into the reactor for further decomposition. The water is condensed at the final condenser and collected in a decanter. Oil and water components not removed at the previous condensers are separated at this decanter. The oil is fed back for re-treatment and the water is disposed of as industry waste, after PCB level is checked (<0.03mg-PCBs/L). The exhaust gases from the decanter are allowed to pass through three-stage activated carbon absorber, then released from the system. After 4 hours of reaction, the rapid analysis method[2] employing a quadruple GC/MS is used for the PCB level of the oil. This analysis must be completed within 1.5 hours. If the PCB level of the oil meets Ebara's standard (0.3mg-PCBs/kg-oil), the reaction is allowed to terminate by cooling the reaction mixture (below 70°C), and this is followed by removal of the contents from the reactor. The oil removed from the system is sampled and rapid analysis method is performed to ensure the PCBs were decomposed to below Ebara's standard. Official analysis method is used to determine the PCB level of the treated oil. If it is below the standard of 0.5mg-PCBs/kg-oil, it is then disposed of as industry waste. Because this oil is known to be reusable, recycling is being considered. Gloves and papers contaminated with PCB during the operation are kept until applicable guidelines are established in Japan.

TABLE2 Treatment Conditions

PCB	KC-300□8kg
KOH	12.5kg
Hydrogen donor	80L
Additives	0.8L
Reaction temperature	300□325□□
Reaction time	4hours
Treated oil concentration*	<0.3mg-PCBs/kg

*Determined by the rapid analysis method

Condensers from which PCB has been removed are currently stored at Fujisawa site, but the handling of these vessels are being developed.

5. Environmental Impacts

We have established an environmental pollution control agreement with the local government, and environmental measurements are done (once every three months) by an external analytical institution. Analysis of the process gases after the activated carbon treatment for PCBs and dioxins is regularly performed and the results are reported to the authorities.

During the treatment process, concentrations of PCBs in the environment, dioxins, PCBs in the treated process gases, dioxins, biphenyl, and chlorinated benzenes were low enough and no effects to the surrounding environment were observed (TABLE 3).

TABLE3 Levels under Environmental Pollution Agreement and Actual Levels in Treatment Plant

		Actual level	Agreement level
Treated gas	PCBs	<0.03ƒ g/m³	<0.01mg/m³
	Co-PCBs	0.000075ng-TEQ/m³	<0.01ng-TEQ/m³
	DXNs	0ng-TEQ/m³	<0.02ng-TEQ/m³
	Biphenyl	0.19ƒ g/m³	<1.3mg/m³
	CBz	3.7ƒ g/m³	<46mg/m³
Atmosphere	PCBs	0.44□1.2ng/m³	<500ng/m³
	Co-PCBs	0.011pg-TEQ/m³	0.6pg-TEQ/m³
	DXNs	0.042□0.30pg-TEQ/m³	

6. Safety Measures

The most important issue in handling PCB is accidental release to the environment and the operators' safety. In daily plant management, mandatory inspections are enforced both before the start-up and heating of the reactor. In an event of earthquake or malfunction of equipment during the operation, the following equipment prescribed to avoid leakage into the surrounding environment .

Safety Equipment
• Oil retaining walls with oil impermeable treatment.
• Carbon dioxide fire extinguisher
• Fire alarm system
• Seismic sensor
•TV monitor

On the assumption of emergency situations, emergency drill is regularly conducted, and safety training is done once every three months to enforce the emergency manual to all the operators.

As described here in this report, we operate our treatment plant in an environmentally friendly manner.

7. Conclusion

1) We have obtained the approval for the BCD process as a liquid PCB treatment facility.
2) We have been running the PCB treatment facility safely since its start-up without adverse effects on the surrounding environment.
3) The treatment plant has been designed to cope with emergency situations with installation of required equipment to prevent leakage into the surrounding environment

References

1. Makoto Takada, Ryuji Uchida, Shin Taniguchi, Masaaki Hosomi, **(1997)** Organohalogen Compounds, 31, 435
2. Makoto Takada, Hisayuki Toda, Ryuji Uchida, **(1999)** Organohalogen Compounds, 40, 271