Polychlorinated Biphenyls (PCBs) in Japan

Removal Efficiency (%)

Cyclodextrins (CDs)

- The nanoevironment of CD cavity is comparable to that of 1,4-dioxane.
- The shape and size of PCBs are suitable to be incorporated into the CD cavity.

Preparation of Channel-Type γ-CD Assembly

Strategies

CDs have a hydrophobic cavity into which compounds of an appropriate size and shape can be incorporated.

Inclusion of Guest Compounds by CD in Aqueous Media

Natural γ-CD (Cage Type)

Channel-Type γ-CD

Removal Efficiency of Various Chlorinated Aromatics from Insulating Oil

Removal Efficiency (%)

Chlorinated Aromatics

- 1,2,4-TrCBz
- 1,3,5-TrCB
- 1,3,5-TrCBz
- 3,4,4'-TrCB
- 2-MCB
- 4-MCB
- 4,4'-DiCB
- 4,4'-DiCB

- 3,4,4'-TrCB increased with an increase in the amount of added γ-CD. These chlorinated aromatics (100 ppm) were completely removed from insulating oil by the addition of 150 mg of channel-type γ-CD.

Competitive Adsorption Experiments Using a Mixture of Different Chlorinated Aromatics

Removal of Chlorinated Compounds

- 1,2,4-TrCBz
- 1,3,5-TrCB
- 3,4,4'-TrCB
- 2-MCB
- 4-MCB
- 4,4'-DiCB
- 4,4'-DiCB

- The channel-type assembly of γ-CD functioned as an effective adsorbent for the removal of chlorinated aromatics from insulating oil.

Conclusions

Removal Efficiency of Chlorinated Aromatics as a Function of the Amount of Channel-Type γ-CD

Disadvantages

- High reaction temperature and/or prolonged reaction times were required.

Removal of Chlorinated Aromatics in Japan

Treatment of PCB-contaminated Oils in Japan

- Removal efficiency (removal percentage) of 1,2,4-TrCBz and 1,3,5-TrCB increased with an increase in the amount of added γ-CD. These chlorinated aromatics (100 ppm) were completely removed from insulating oil by the addition of 150 mg of channel-type γ-CD.

Conclusions

- The channel-type assembly of γ-CD functioned as an effective adsorbent to remove chlorinated aromatics from insulating oil.

- Competitive adsorption experiments revealed that selective adsorption based on the shape and size of the chlorinated aromatics was achieved by the channel-type γ-CD assembly, implying that inclusion into the cavity of the channel-type γ-CD was responsible for the removal of chlorinated aromatics from insulating oil.

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- Cyclodextrins (CDs)
- Polychlorinated Biphenyls (PCBs) in Japan
- Removal of Chlorinated Aromatics from Insulating Oils by Channel-Type Cyclodextrin Assembly
- Removal Efficiency of Various Chlorinated Aromatics from Insulating Oil
- Competitive Adsorption Experiments Using a Mixture of Different Chlorinated Aromatics
- Conclusions
- Acknowledgments

INTRODUCTION

PCBs were widely used as insulating fluids in capacitors and transformers. Although their manufacture and commercial use have been prohibited in many countries since the 1970s because of their strong toxicity, environmental persistence, and bioaccumulation, large amounts of insulating oils contaminated with PCBs are still being used or are kept without being appropriately treated in many countries, including Japan. In the Stockholm Convention on Persistent Organic Pollutants, more than 150 countries have agreed to destroy PCBs until 2020. Thus, the efficient and safe treatment of PCB-contaminated insulating oils is a crucial problem from a global viewpoint.

We report herein that a channel-type γ-CD assembly, in which γ-CD molecules are stacked in a head-to-head or head-to-tail orientation to form a column in the crystal, can function as an effective adsorbent to remove chlorinated aromatic compounds (including PCBs) from insulating oil via inclusion complex formation.