嘉南藥理科技大學專題研究計畫成果報告

計畫名稱

利用污水廠之有機污泥為添加碳源進行環境基質中多氯聯苯之還原性脫氯降解研究

計畫類別：□個別型計畫　　■整合型計畫
計畫編號：CNEM93-02-(5)
執行期間：93 年 1 月 1 日至 93 年 12 月 31 日

計畫主持人：陳意銘
共同主持人：
計畫參與人員：

執行單位：嘉南藥理科技大學環境資源管理系

中華民國九十四年二月二十一日

嘉南藥理科技大學專題研究計畫成果報告

利用污水廠之有機污泥為添加碳源進行環境基質中多氯聯苯之還原性脫氯降解研究

Reductive dechlorination of polychlorinated biphenyls by using activated sludge from wastewater treatment plant as sole nutrient supplement

計畫編號：CNEM93-02-(5)

執行期限：93 年 1 月 1 日至 93 年 12 月 31 日

主持人：陳意銘　　嘉南藥理科技大學環境資源管理系

一、　中英文摘要

還原性脫氯作用對於環境中多氯聯苯之去除十分重要，本計畫擬對台南市灣裡地區二仁溪下游底泥中的多氯聯苯污染之環境中自發性脫氯作用進行為期一年的研究，研究重心在於建立環境復育之方法，亦即利用天然底泥厭氧微生物對於多氯聯苯進行脫氯作用，底泥生物所需之養分物質來自活性有機污泥。實驗結果顯示，未添加污泥之底泥微生物，在經 160 天之培養期後，仍無脫氯作用產生，然而添加污泥之組別則在 90 天後開始進行脫氯作用，實驗證明二仁溪中廣泛存在著多氯聯苯脫氯微生物，此外，當環境適合甲烷生成菌發展時，便有顯著之脫氯作用產生。

關鍵詞：多氯聯苯、還原性脫氯作用、脫氯微生物

Abstract

Reductive dechlorination is of important in the degradation of PCBs in the environments. This study is dedicated to understand the reductive dechlorination of 2,3,4-trichlorobiphenyl (2,3,4-CBp) in Erh-Jen River. Therefore, microorganisms from ten river sediments were collected and applied to dechlorination experiments. By using natural sediment-extracted waters as cultural media, when amended with 10 g/L of dewatered sludge, all ten sets of sediment microorganisms initiated 2,3,4-CBp dechlorination after 90 days. However, without yeast extract, no set showed dechlorinating activity during a period of 160-day incubation. The results suggested that there were 2,3,4-CBp-dechlorinating consortia widespread in Erh-Jen River sediments. It also indicated that the dechlorination of 2,3,4-CBp could occur when the environmental conditions were suitable for the methanogens to be enriched.

Keywords： Polychlorinated biphenyls, Reductive dechlorination, Dechlorinating consortia

二、 緣由與目的

Polychlorinated biphenyls (PCBs) were widely used in capacitors and transformer in last century. Most of the PCBs pollution were directly deposited on soil or water surface, and PCBs may be volatilized, buried, or transport to the aquatic system. Because PCBs are less degradable and persistent in environment, they are still an important worldwide contaminant after their production has been banned for several decades (Quensen et al. 1988, Sugiura et al. 1986).

This study is dedicated to characterize PCB dechlorination in Er-Jen River sediments. And for the purpose of simulating environmentally happened dechlorination, microorganisms from sediments were first incubated in collected natural waters without any additive. Afterward, dewatered sludge was introduced as nutrient supplement in 2,3,4-trichlorobiphenyl (2,3,4-CBp) dechlorination. The transformation of incubation condition for initializing 2,3,4-CBp dechlorination was studied by measuring the production of methane, the change of ORP values and pH values.

三、 結果與討論

1. Sediments and Chemicals

Ten Sediments from Erh-Jen River were sampled. Seven of them were collected in the upper area of the Nan-Ding Bridge located in the down stream, and the other three were collected beneath the Erh-Tsen-Sing Bridge located in the middle stream. The sediments have been contaminated by polychlorinated biphenyls and heavy metals. PCB congeners including 2,3,4-CBp, 2,3-CBp, 2,4-CBp and 2-CBp were purchased from Accustandard Co. (New Haven, CT, USA).

2. 2,3,4-CBp dechlorination in sediment waters

After 160 days of incubation in sediment waters, no set of sediment microbes showed 2,3,4-CBp-dechlorination ability. In these sets, there were no massive methane production period and the concentrations of methane remained at low level. Increasing the organic contents by amending 10 g/L of Dewatered sludge (DS) in SW media made sediment microorganisms more vigorous in consuming oxygen, and turned the incubating condition into strictly anaerobic. After 60 days of incubation, methane was massively produced, and dechlorination was initiated in the sets of S1, S2, S3, S4, S6 and S7 (Table 1). Although the lag phase for the sets of S5, S8, S9 and S10 was 15 ~ 30 days longer than that for the others, all the ten sets showed

effective 2,3,4-CBp-dechlorination and complete transformation before day 160.

Anaerobic consortium from the S1 and S2, S4 site, with DS amended, completed dechlorination before the 90th day. In these sets, the same final products 2,4-dichlorobiphenyl (2,4-CBp), and almost equal amount of highest methane concentrations were produced. In addition, the similar lowest ORP values were also observed.

3. 2,3,4-CBp dechlorination in mineral media amended with dewatered sludge

Using MM with 10 g/L of dewatered sludge as media, 2,3,4-CBp was dechlorinated in similar lag phases with using SW with DS, but the completing dechlorination periods were a little shorter than SW sets (Table 2). However, the same final products 2,4-dichlorobiphenyl (2,4-CBp) was found in all sets.

五、參考文獻

Chen I.M., Chang F.C. and Wang Y.S. (1997) Reductive dechlorination of hexachlorobenzene and polychlorinated biphenyls in anaerobic sediments from tropical rivers with enrichment. Proceedings of the Symposium on Chlorinated Dioxins and Related Compounds. 17th, 33, 189. Indianapolis, Indiana, USA.

Chen, I. M., Chang, F. C., Chang, B. V., and Wang, Y. S. (2000) Specificity of the microbial activities in the reductive dechlorination of chlorinated benzenes. Water Environ. Res. 72(6), 675-679.

Chen, I.M., Chang, B. V., Yuan, S. Y., and Wang, Y. S. (2002) Reductive dechlorination of hexachlorobenzene under various additions. Water, Air, and Soil Poll. 139, 61-74.

Quensen, J.F.Ⅲ, Tiedje J.M., and Boyd. S.A. (1988) Reductive dechlorination of polychlorinated biphenyls by Anaerobic microorganisms from sediments. Science. 242: 752-754.

Sugiura, K., M.Kitamura, E.Matsumoto, and M.Goto. (1986) Polychlorobiphenyls (PCBS) in sediments of Tokyo Bay, Japan. Arch. Environ. Contam.Toxicol. 15:69-76

Table 1. 2,3,4-CBp Dechlorination by Erh-Jen River sediment microorganisms in sediment waters with dewatered sludge

Inoculum source	Medium	Dewatered Sludge amendment (g/L)	Lag phase (day)	Dechlorination completing day	Final products in Dechlorination
S1	SW	10	60	90	2,4-CBp
S2	SW	10	60	90	2,4-CBp
S3	SW	10	60	105	2,4-CBp
S4	SW	10	60	90	2,4-CBp
S5	SW	10	75	120	2,4-CBp
S6	SW	10	60	120	2,4-CBp
S7	SW	10	60	105	2,4-CBp
S8	SW	10	75	120	2,4-CBp
S9	SW	10	75	120	2,4-CBp
S10	SW	10	90	160	2,4-CBp

Table 2. 2,3,4-CBp Dechlorination by original sediment microorganisms in synthetic media

Inoculum source	Medium	Dewatered sludge amendment (g/L)	Lag phase (day)	Dechlorination completing day	Final products in Dechlorination
S1	MM	10	60	75	2,4-CBp
S2	MM	10	60	75	2,4-CBp
S3	MM	10	75	90	2,4-CBp
S4	MM	10	60	90	2,4-CBp
S5	MM	10	75	105	2,4-CBp
S6	MM	10	60	90	2,4-CBp
S7	MM	10	60	75	2,4-CBp
S8	MM	10	75	105	2,4-CBp
S9	MM	10	90	120	2,4-CBp
S10	MM	10	90	160	2,4-CBp