Recent Developments In Bioremediation Of Recalcitrant Organics In Dredged Material

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Abstract: Bioremediation of recalcitrant organics was investigated in laboratory, pilot, and demonstration scale studies. The efforts focused on demonstrating bioremediation potential for dredged material in confined disposal facilities. Random samples collected over time (3 months to 1 year) were chemically analyzed (3 to 5 replicates) using standard U.S. Enviromental Protection Agency procedures. Signifcance was determined using ANOVA techniques. Laboratory scale studies were limited to land treatment technology. The laboratory results showed significant removal of polychlorinated biphenyls (PCBs) and no removal of polychlorinated dioxins and furans using land treatment technology. These results were confirmed in pilot scale studies at the Saginaw confined disposal facility for dredged material in Bay City, MI where PCB concentrations were reduced by as much as 70 per cent. Demonstration scale composting of PCBs and polynuclear aromatic hydrocarbons (PAHs) in dredged material was conducted at the Milwaukee and Green Bay, WI confined disposal facilities. Composting with wood chips lowered PCB but not PAH concentrations. Composting with wood chips and biosolids was ineffective for both PCBs and PAHs. PAHs and polychlorinated dioxins and furans resist treatment, and PCBs tend to disappear as long as no readily degradable carbon source is present.

Many dredged material confined disposal facilities (CDFs) are nearing capacity, and it is expensive to site, design, and construct new CDFs. Alternatives to traditional disposal of dredged material that is unsuitable for open-water disposal are therefore needed. One promising alternative is to find beneficial uses for the material presently stored in CDFs. It is expected that States will require cleanup of the material before allowing beneficial uses, such as top soil. If contaminated dredged material can be cost-effectively cleaned to satisfy requirements for beneficial use, perhaps the service life of CDFs can be extended by treating, removing, and beneficially using dredged material.

Land treatment of dredged material from the New York/New Jersey Harbor and the Saginaw River, Bay City, MI was investigated at laboratory scale in glass aquariums (64 cm x 64 x cm x 25cm) at ambient laboratory temperature, 20^{o} C. The effects of tilling, water addition, and light were investigated in separate aquariums. The New York/New Jersey study showed about 40% reduction in total PCB (initially 0.97 mg/kg) over a period of 5 months (Tang and Myers 2001). ANOVA treatment of the data showed that

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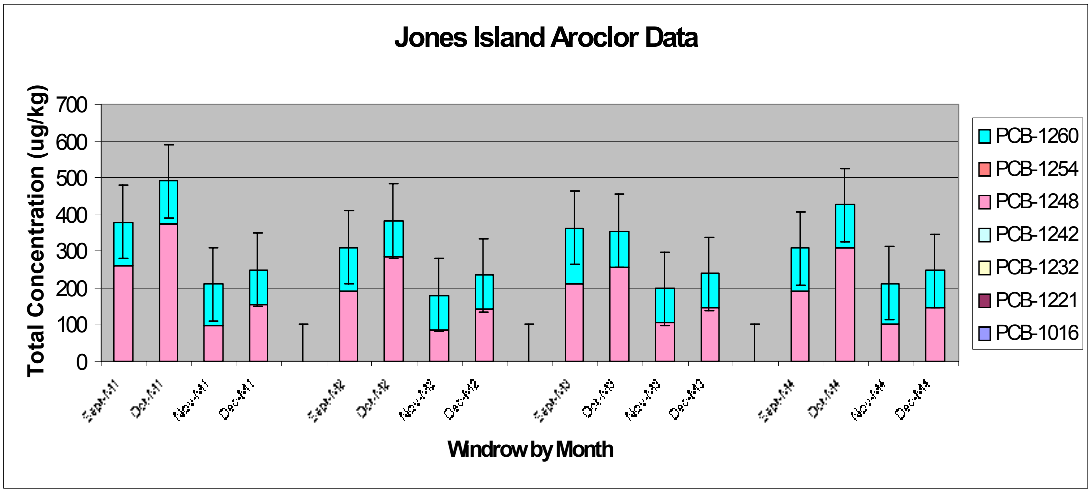
tilling produced a tangible effect on PCB disappearance. The other treatment effects (light, water, etc.) were not significant. The Saginaw River study also showed PCB disappearance, about 20% (initially 0.32 mg/kg) over a period of 4 months (Tang and Myers 1998). Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were also monitored in the Saginaw River study. PCDF concentrations declined about 20%, but PCDD concentrations did not significantly change. ANOVA treatment of the data, however, showed that tilling did not significantly affect PCB or PCDF loss.

A pilot-scale study was conducted in field cells at the Saginaw Bay CDF, Bay City MI as a further step toward confirming and applying the laboratory results on land treatment technology. Each cell was 9.1 m diameter and 1 m depth. One cell served as the control, one was tilled, and one was tilled and periodically flooded. The pilot-scale study generally confirmed the previous laboratory results. Pilot-scale data showed TCDDs and TCDFs to be stable and resist treatment. Total PCB concentrations were reduced by about 70% (initially 0.83 mg/kg) over a period of 1 year (Tang et al. 2000). ANOVA treatment of the data again showed that tilling and water addition had no significant effect on PCB disappearance.

At first, dredged material composting at the Jones Island CDF (Milwaukee, WI) was conducted with a mixture of wood chips and dredged material from the CDF. PCB concentrations decreased over the two-month study, but PAH concentrations remained unchanged (US Army Engineer District, Detroit 1999). Subsequent to the first study, an expanded composting study using mixtures of wood chips, biosolids, and dredged material was conducted at the Jones Island CDF and the Bay Port CDF, Green Bay, WI. At each study site, the mixtures were placed in windrows that were generally 2 – 4 m wide at the base, 0.5 - 1 m high, and 50 – 60 m long. The windrows were periodically turned with a SCAT 481 Turner (Myers and Bowman 1999) and watered with onsite water. Each compost study lasted about 3 months. The inclusion of biosolids in the compost mixtures had no effect on PAH concentrations at either site and appeared to adversely affect PCB disappearance at the Milwaukee site. Selected data are shown in the figure below.

The four groups of vertical bars represent separate windrows and within each group are four bars. The first bar in each group shows the initial contaminant concentration. The other three bars show contaminant concentrations in samples collected at approximately one-month intervals.



The various studies discussed in this paper show that recalcitrant organic compounds in dredged material from Federal navigation channels are very difficult to bioremediate. PAHs, PCDDs, and PCDFs have thus far resisted efforts to bioremediate. PCBs tend to disappear, but the conditions that maximize treatment effectiveness are not well understood.

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