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Small boost of electricity aids natural clean-up of PCB contaminants

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Contact: mayh@musc.edu

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Applying a low voltage to polluted river sediment can boost microbes' natural ability to degrade harmful polychlorinated biphenyl (PCB) contaminants, according to a new study. The approach could be a cost-effective, sustainable strategy to bioremediate polluted sites.

PCBs are persistent contaminants as they remain for long periods in the environment, particularly in water, soil and sediment. They were manufactured on a wide scale in 1970s-1980s for uses such as cooling and insulating fluids, plasticisers and stabilisers, but they became heavily restricted in many countries in the late 1970s after they were found to be toxic to humans and other animals, and suspected to be carcinogenic.

However, PCBs are still widely found in the environment. The European Council Directive 96/59/EC of 1996[1] on the disposal of PCBs and PCTs, aims to dispose completely of PCBs and equipment containing PCBs as soon as possible.

'Bioremediation' exploits the natural ability of microorganisms to remove pollutants from the environment. The study attempted to encourage PCB degradation by applying a small voltage of electricity to polluted river sediment. This process provides a continuous supply of electrons that not only increases microbial degradation of PCBs, but also helps prevent toxic breakdown products from building-up.

The researchers passed an electric current through bioelectrochemical reactors containing sediment from a PCB-contaminated river in Wisconsin, USA. They tested different voltages, passed through titanium electrodes spaced 2cm apart.

Results showed that approximately 60% of PCB contamination could be removed in 88 days, using a low voltage of just 1.5V. This approach was also effective at decontaminating sediment that had been artificially contaminated with PCBs at 10 times the normal concentration found in the river. Voltages of up to 3.0V were most effective on these samples. The combined results showed that a mixture of PCBs (rather than specific types) were degraded using this approach.

One hypothesis for such efficient PCB degradation is that low voltages stimulate the movement of aquatic worms. This movement would mix oxygen into the sediment making it more readily available for PCB-degrading bacteria. Genetic tests confirmed that application of voltage did not reduce the numbers of microbes responsible for PCB degradation.

The researchers suggest that electrically-stimulated bioremediation could be a cost-effective, environmentally sustainable strategy to clean up PCB-contaminated sites, and can be carried out at the site itself. This avoids the negative environmental impact of dredging rivers to recover sediment for treatment offsite.

The size and location of the decontamination zone can be controlled by the level of voltage and the time it is applied for, as well as the location of the electrodes. Furthermore, the low voltage required could easily be provided by a solar panel or a microbial fuel cell at the site.

1. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1996:243:0031:0035:EN:PDF