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DGG-B™

DGG-B Anaerobic Benzene Bioaugmentation Culture

Benzene

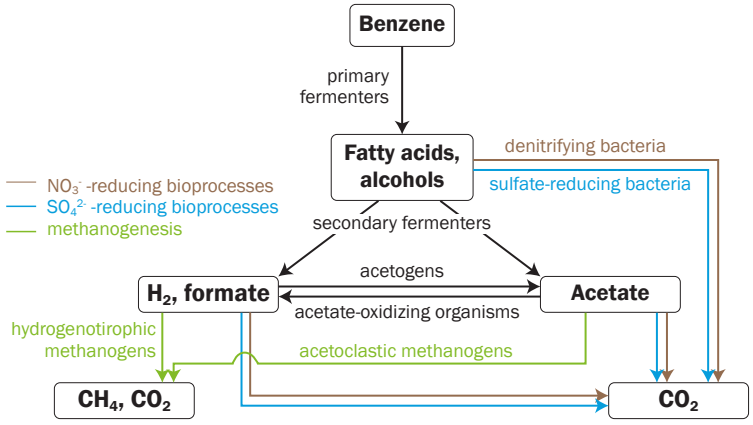
Benzene is found naturally in petroleum, and is used extensively in the synthesis of a wide range of materials and chemicals. It is also a frequent groundwater contaminant that is highly toxic and carcinogenic and thus a top priority for remediation efforts.

- Benzene is a specific problem – as it is more toxic and less biodegradable than other TEX (toluene, ethylbenzene and xylenes) compounds (particularly under anaerobic conditions)
- Benzene is also produced from the dechlorination of pesticides (lindane) and chlorobenzenes
- Under anaerobic conditions, **benzene is a substantial bottleneck** to achieving site cleanup goals.

Aerobic benzene biodegradation occurs readily; however, injection of sufficient oxygen into the subsurface is often prohibitively expensive. **Anaerobic microbial transformation processes offer an attractive remediation alternative** and have been successfully applied to chlorinated solvents. Why not benzene and other monoaromatic hydrocarbon compounds?

Closely related compounds, like toluene, ethyl benzene and xylenes, are also readily degraded anaerobically and the microbes that biodegrade these compounds are widely distributed.

The DGG-B benzene-degrading culture is currently available for testing in laboratory treatability studies and pilot testing.



Introducing DGG-B

At the University of Toronto, Elizabeth Edwards' lab has been studying anaerobic degradation of aromatic compounds for decades. A benzene-utilizing methanogenic culture was derived from an oil refinery site and couples benzene oxidation with methanogenesis. The culture consistently converts benzene to methane and carbon dioxide (CO_2), at a rate between 0.4 to 1.0 milligrams per liter per day (mg/L/day) and has a doubling time of 30 days. The DGG-B culture can promote benzene degradation under methogenic or sulfate reducing conditions. Methanogenic benzene degradation occurs syntrophically by benzene degraders, fermentative bacteria and methanogens. A *Deltaproteobacterium*, designated ORM2, has been identified as the key benzene degrading organism.

Quantitative PCR (qPCR) tools are available to track the abundance of the primary benzene-degrading strain ORM2

qPCR tools have been developed for potential biomarker genes for anaerobic benzene biodegradation. A variety of biomarkers including Gene-Trac® ORM2 and SRB, can be used to assess the potential benzene degrading populations that may be present in the environment, either naturally occurring or as a result of biostimulation or bioaugmentation. Contact SiREM for the most current list of applicable biomarkers to test.

Additionally if benzene is attenuating under nitrate electron acceptor conditions, SiREM has a Gene-Trac® test to quantify the presence of *Peptococcaceae*, the microbes that have been associated with this degradation pathway.

Contact SiREM for more information on our anaerobic benzene cultures and treatability testing options.

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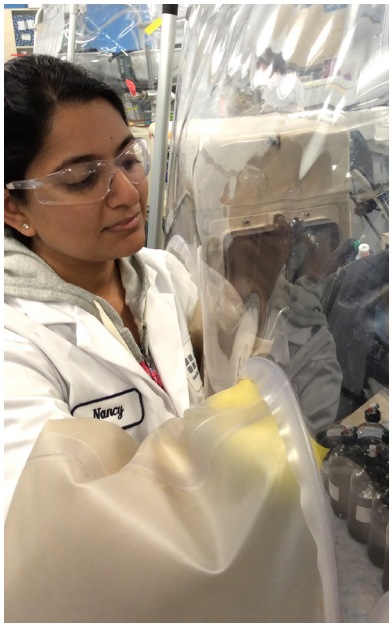
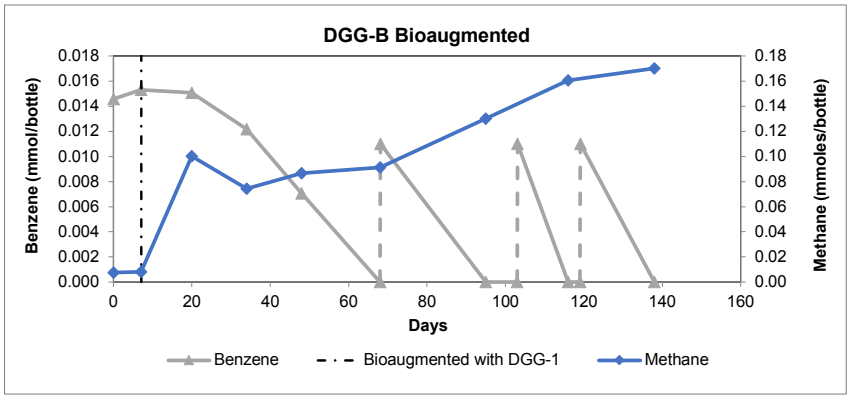
treatability studies

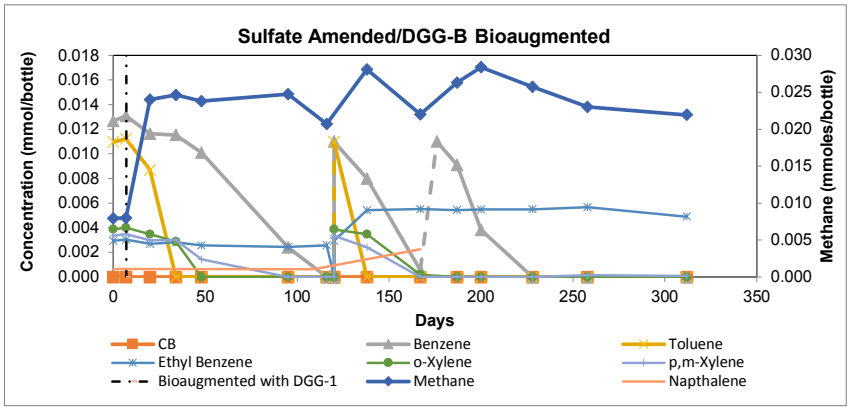
Anaerobic Benzene Biodegradation

Anaerobic treatability studies are routinely conducted under a variety of conditions using site materials impacted with petroleum hydrocarbons. Degradation of BTEX can be monitored with and without DGG-B bioaugmentation culture, and under various electron acceptor conditions. Samples from the original groundwater materials, as well as microcosm samples can be taken to quantify the potential benzene degraders via qPCR biomarkers. The time frame for each treatability study is typically 8-12 months.

For evaluation of remedial technology performance variables







The figures above show the activity of the DGG-B culture in microcosms; repeated spikes of benzene were degraded under methanogenic conditions in the top figure. Benzene, toluene and xyylene were degraded under sulfate reducing conditons in the lower figure.

To date bioaugmentation with the DGG-B culture has promoted benzene degradation under both methanogenic and sulfate-reducing conditions in a number of studies, while in another experiment, no benzene degradation was observed despite bioaugmentation. In this case, the total petroleum hydrocarbons (TPH) decreased from 30 to 7 mg/L over the first 200 days, suggesting that degradation of petroleum hydrocarbons is ongoing; however, the presence of other organic carbon may inhibit benzene degradation.

Contact SiREM for a quotation or more information on treatability services for BTEX sites.

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