



PROPRIETARY BLEND OF BACILLUS BACTERIA TO DEGRADE MANUFACTURED GAS PLANT COAL TAR RESIDUE

ENVIRO-BAC BENCHTOP STUDY APPLICATION

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ABSTRACT

Coal tar residue resulting from the historic operation of Manufactured Gas Plants (MGPs) are traditionally removed from environmental media using presumptive remedial technologies that include excavation, dredging, chemical oxidation, pump and treat, and/or total fluid extraction; or are immobilized by in-situ stabilization or capping.

While these methods are known to be effective, they can result in high lifecycle costs, long remedial timeframes, significant intrusive disturbances, and/or high long-term OM&M. Additionally, a typical MGP remediation program may require the use of multiple remediation methods to achieve non-aqueous phase liquid (NAPL) containment and/or regulatory closure.

One remedial technology that has not played a significant role in MGP remediation is in-situ bioremediation through bioaugmentation. To further evaluate bioaugmentation as a remedial technology for MGPs, a benchtop study was completed using a proprietary blend of Bacillus Bacteria known as **Enviro-BAC** that is patent pending.

Enviro-BAC is a blend of non-pathogenic, non-genetically modified microbial organisms. The particular strains in **Enviro-BAC** are all naturally occurring, facultative anaerobes and are blended at a high concentration for optimum performance in the application.


Enviro-BAC has undergone extensive testing and product application under various conditions and environments including laboratory benchtop trials, pilot studies, and numerous remedial field applications at petroleum sites. Its proven track record at petroleum sites made it an ideal candidate for potential application at MGPs.

To evaluate the potential benefits of in-situ bioremediation of MGP related coal tar residues, HRP Associates, Inc. contracted Prima Environmental to complete a series bench test studies.

TEST METHODOLOGY

Bench testing completed using the **Enviro-BAC** included three separate setups. Details on each of the testing setups and the objectives are summarized below.


TEST ONE



Fifteen 500mL glass separatory funnels were filled with 25 mL of NAPL and deionized water for each test. **Enviro-BAC** was added to four of the test groups at concentrations ranging from 5 g/L to 20 g/L with 5 g/L increases between sets.

The objectives of this test were to a) visually monitor the NAPL levels for signs of reduction, and b) measure the concentrations in water as the **Enviro-BAC** reacted with the product. The setup of the separatory funnels is shown above.


TEST TWO



Five 500 mL flasks were mixed using a control and **Enviro-BAC** concentrations that matched those used during Test 1. Each flask was connected to an inverted graduated cylinder filled with water.

This test was used to determine if the biological activity caused by the addition of **Enviro-BAC** resulted in the generation of off-gases. Any off-gas generated would displace the water in the cylinder and were monitored throughout the test. No off gas was observed in the graduated cylinders and no samples were collected.

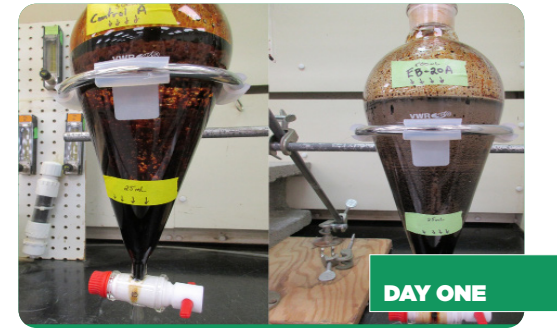
TEST THREE



Test 3 used 500 mL Erlenmeyer flasks mixed with NAPL and deionized water. One flask was used as a control and the other two flasks had **Enviro-BAC** and 10 g/L and 20 g/L. The flasks were used to provide more surface area for contact between the water and the NAPL.

After 30 days, the NAPL was collected and analyzed to determine the change in chemical properties as a result of the **Enviro-BAC**.

RESULTS



CONCLUSIONS

- All tests showed a clear change in the physical properties of the MGP NAPL when the **Enviro-BAC** was introduced.
- Loss of cohesion to the glass surfaces
- LNAPL not present outside of control samples
- NAPL appeared to have reduced interfacial tension (to be lab verified)
- Microbial populations thrived in the test reactors, indicating the MGP NAPL is an excellent food source for the microbes
- The results from the water samples indicate that the **Enviro-BAC** at lower concentrations (5 g/L) was behaving as a surfactant in targeting the NAPL with limited capacity to treat the dissolved concentrations in water.
- At the higher **Enviro-BAC** concentrations, the **Enviro-BAC** targeted both the NAPL and the dissolved phase PAHs, resulting in mass destruction not reallocation.
- The **Enviro-BAC** concentrations were successful in reducing the Total PAH Concentrations by 41 to 45% over a 30-day period at the 10 g/L and 20 g/L doses, respectively.

RESULTS

Results from Test one indicated a visual response in the NAPL properties. The photos show the control and the 20 g/L **Enviro-BAC** at Day one and Day seven.

