Bench-Test and Pilot-Scale Bioaugmentation of a Hydrocarbons-Contaminated Site by a High Performance Bacteria Consortium

I.J.S. Mello (igor.mello@cpeanet.com) (CPEA, SP/Brazil), L.T.M. Cruz
(leonardo.marquesani.cpeanet.com) and C. Gonçalves (cristina.goncalves@cpeanet.com)

Background/Objectives. The study was developed in two selected areas of an industrial site located in Cubatão, SP, Brazil, contaminated by coal tar. Area#1 (290 m^2) main hydrocarbon contamination is found in retained phase and Area#2 (68 m^2) main contamination is in the dissolved phase. The selected bacteria consortium was Bio Liq HC, a product registered by IBAMA (Federal environmental agency in Brazil) as a hydrocarbon remedy for soil and groundwater. This consortium was composed of six different types of bacteria aiming to facilitate synthetizIng biosurfactants and different enzymes, allowing for a higher efficiency of target contaminants degradation.

Approach/Activities. A bench-test was previously carried out after sampling 20 liters of groundwater and 10 kg of soil from each area. The samples were analyzed for BTXE, PAH, TPH, pH, ORP and microbiological counting. A control sample (no remedy addition) was prepared to be compared to the tested samples. The test lasted 22 days. After this period, control samples and samples + remedy were analyzed for the same parameters described above.

Trenches were prepared for the pilot test in Area#1 and injection wells were installed for the pilot test in Area#2. In both cases, two existing monitoring wells within radius of influence (ROI) were selected for efficiency evaluation.

Baseline samples were collected for comparison after remedy injections. Previous sampling and injections of BioLiq HC® (Superbac) were applied monthly (for 3 months). In Area#1 bioaugmentation was stimulated with addition of nitrogen and carbon sources to potentialize hydrocarbon degradation.

Results/Lessons Learned. Bench test results varied according to the selected area. For Area#1, they indicated favorable conditions for microbiological degradation (pH between 6 and 8 and ORP >0). The number of bacteria increased 10,000 times, degradation of the lighter and naphthenic compounds was observed, varying from 11 to 79% below the obtained results for the control sample; no significant change for medium and heavy TPHs was observed.

For Area#2, pH results were slightly above the ideal range, an oxidizing trend was detected, and the number of bacteria increased only ten times compared to the control sample. Degradation of the lighter compounds varied from 9 to 27% and the medium and heavy TPHs also degraded, from 6 to 40%. Naphthalene concentration increased assuming that the subproducts of degradation converted to these compounds.

The pilot test in Area#1 indicated an increase of bacteria activity (ten times) after the first injection. However, there was a decrease of bacteria counting from the second injection, followed by a significant increase of PAHs. This observation can be justified by the technique selected to test (trenches) once a biosurfactant has the potential to mobilize PAHs from soil to groundwater.

In Area#2, there was an increase of 10 times in bacteria activity after the first remedy injection and the microbiological counting kept at the same level during the whole pilot test. It was observed a decrease of two to three times for benzene concentration as well as other

hydrocarbons. These results indicated an efficient enzymatic action of bacteria consortium for degradation of target contaminants.

Despite of efficiency observed in Area#2, no additional study was accomplished because the permit for bioaugmentation remediation application is still in discussion with Brazilian agencies.