Bioaugmentation as a Strategy for in-situ Bioremediation : When does it Work?

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Microorganisms are capable of degrading an impressive range of organic pollutants including hazardous molecules of anthropogenic origin, thanks to their metabolic machinery and their capacity to adapt to adverse environments. These features make microorganisms key players in remediation and site restoration, but their efficiency depends on many factors, including, amongst others, the chemical nature of the target pollutants (structure and concentration), their availability to the microorganisms, and the physicochemical characteristics of the environment.

The intrinsic capacity of a microbial population to degrade pollutants within an environmental matrix (soil, sediment, sludge, wastewater, etc.) can be reinforced either by a stimulation of the autochthonous population (biostimulation) or by the addition of microorganisms (bioaugmentation). The former usually involves the addition of nutrients or electron acceptors to the indigenous microorganisms, while the latter consists of introducing specific competent microorganisms to the local population, thus augmenting it. Although not new and already practiced in agriculture for many years as well as in some wastewater treatment sequences, bioaugmentation as a means of increasing the efficiency of biodegradation in the environment is much discussed and remains a largely experimental methodology. A number of both biotic and abiotic factors conspire against bioaugmentation as a successful strategy of bioremediation, including predation, competition, sorption, etc.

The addition of non-autochthonous microorganisms may be justified for the treatment of highly recalcitrant compounds in biotopes devoid of significant populations of biodegrading microorganisms. Field practice shows that under optimal local environmental conditions the rate of pollutant degradation may increase upon addition of an exogenous inoculant to remediate a chemical spill, however the most successful cases of bioaugmentation occur in confined systems, such as bioreactors in which the conditions can be controlled to favour survival and prolonged activity of the exogenous microbial population. These issues will be emphasized based on the critical appraisal of examples from laboratories worldwide (El Fantroussi & Agathos, 2005; Lyon & Vogel, 2011).

References

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