Bacterial Degradation of DNT and TNT Mixtures

Background:
Many sites at Department of Defense (DoD) installations are contaminated with explosives related compounds as a result of the manufacture, handling and storage of munitions. 2,4,6-Trinitrotoluene (TNT), along with the dinitrotoluenes (DNT), are the major contaminants at these sites. A considerable amount of work has been done to excavate and treat the most heavily contaminated soil at many of the sites. The most common technologies involve incineration or composting, both of which are expensive and do not result in the complete degradation of the TNT molecule. Because there is no cost effective strategy for elimination of DNT and TNT from water and soil that has not been excavated, the majority of contaminated soils and groundwater have not been treated.

Objective:
The major objective of this research project is to characterize bacterial strains with the ability to efficiently degrade mixtures of DNT isomers and to expand their degradative capability to TNT. Because most contaminated sites contain mixtures of nitroarene compounds, such strains would have potential for use in bioremediation of field sites.

Summary of Process/Technology:
Strains with the ability to grow on both DNT isomers have the potential to remediate soil and water contaminated with mixtures of DNT isomers. The combined use of 2,4- and 2,6-DNT-degrading bacteria yields simultaneous degradation of mixtures of DNT isomers in bench scale fluid bed reactors. However, in field scale reactors, 2,4-DNT was degraded readily while 2,6-DNT degraded unpredictably or only after the disappearance of 2,4-DNT. Thus, it seems that 2,4-DNT inhibits the degradation of 2,6-DNT. Recently, strains have been isolated with the ability to degrade both isomers of DNT. The proposed work will increase the fundamental understanding of the microbial processes involved in the degradation of mixtures of DNT. Bacteria that grow on both isomers of DNT are able to remove nitro groups in both the 2- and 4- positions. They should therefore be able to remove similar nitro groups from TNT. Metabolic engineering will be used to modify the substrate range of the DNT-oxidizing enzymes to include TNT. Novel degradation strategies will be optimized in microcosms to provide the basis for in situ applications for the cleanup of soil and groundwater contaminated with DNT/TNT mixtures.

Benefit:
Extensive DNT contamination exists at Badger and Volunteer Army Ammunition Plants. A current pilot-scale bioremediation project involves bioaugmentation with isolates adapted to the conditions at Badger. The new fundamental understanding about the degradation of DNT developed under this project will be incorporated immediately into the ongoing strategy for cleanup at Badger. It will also be an enabling technology for the eventual cleanup at Volunteer where soil and groundwater are extensively contaminated with mixtures of TNT and DNT. Cleanup of soil and groundwater, both in the U.S. and abroad, would benefit considerably from novel microbial strategies for TNT and DNT degradation.

Accomplishments:
This is an FY 2001 New Start project.

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