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SUPERFUND INNOVATIVE TECHNOLOGY EVALUATION

Demonstration Bulletin

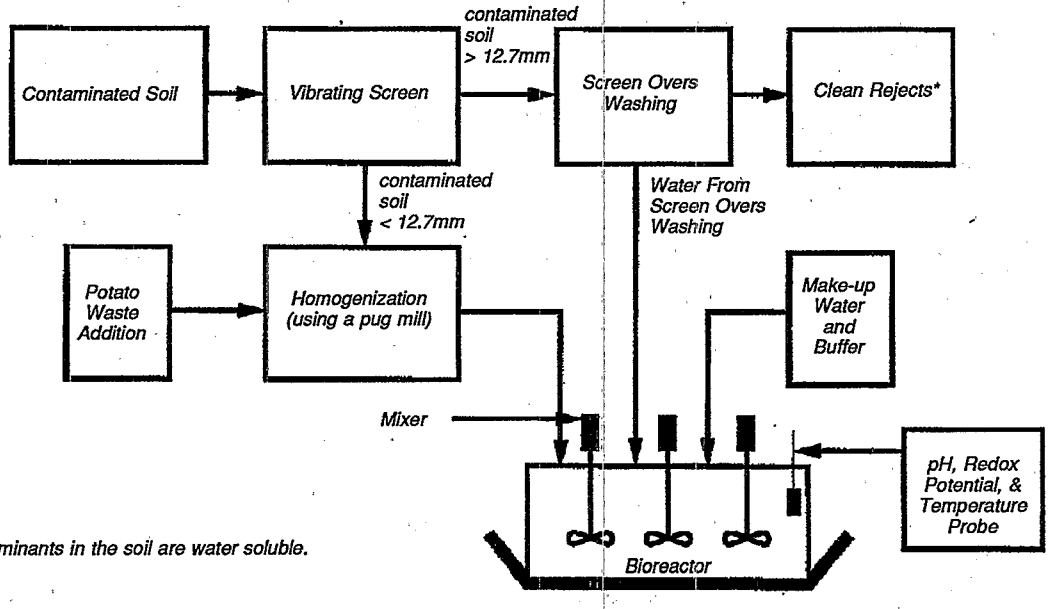
Ex-Situ Anaerobic Bioremediation System: Dinoseb

J.R. Simplot Company

TECHNOLOGY DESCRIPTION: The J.R. Simplot Ex-situ Anaerobic Bioremediation System is a technology designed to destroy nitroaromatic compounds without forming any toxic intermediates. The nitroaromatic compound of interest during this demonstration was dinoseb (2-sec-butyl-4,6-dinitrophenol) an agricultural herbicide used to defoliate potatoes and other legumes. (NOTE: A separate demonstration of this technology is being undertaken with 2,4,6-trinitrotoluene (TNT) as the contaminant of interest. The results of this demonstration will be reported independently.) The theory of operation behind the J.R. Simplot bioremediation process is that dinoseb-contaminated soils (or liquids) can be treated using an anaerobic consortium of soil microorganisms. Under aerobic conditions, degradation of dinoseb forms polymerization products that are potentially toxic. Anaerobic degradation of dinoseb takes place without the formation of these polymerization products. The J.R. Simplot technology mixes a carbon source with contaminated soil and then adds water and a phosphate buffer to create a slurry. This prompts aerobic microorganisms to consume the carbon source and oxygen, thus lowering the redox potential (E_h) of the slurry and creating anaerobic conditions. Anaerobic microorganisms are then stimulated to consume toxins present in the slurry.

Figure 1 presents a schematic flow diagram of the J.R. Simplot bioremediation system. Initially, excavated soil is sent through a vibrating screen to remove large rocks and other debris. The rocks and debris are washed to remove surface contamination. This rinse water is combined with make-up water and added to the bioreactor. Sufficient water is added until the bioreactor contains an amount of water sufficient to provide 1 liter of water for each kg of soil to be treated. A phosphate buffer is added to the system to control the pH. Batches of soil and potato starch (2% by weight) are homogenized together and added to the bioreactor until the system is 75% full. Optimum conditions for the degradation of dinoseb are a temperature of 30 to 35°C and a pH between 7 and 7.5.

WASTE APPLICABILITY: This technology is suitable for soils and liquids contaminated with nitroaromatic compounds. However, the medium to be treated must be free of toxic metals or



* Clean rejects if contaminants in the soil are water soluble.

Figure 1. *Schematic flow diagram of the J.R. Simplot Ex-Situ Anaerobic Bioremediation Process - Dinoseb.*

any other compounds that may be detrimental to the appropriate microorganisms.

DEMONSTRATION RESULTS: Two demonstrations of the J.R. Simplot Ex-Situ Anaerobic Bioremediation System has been performed under the Superfund Innovative Technology Evaluation (SITE) Program. The first demonstration occurred in June/July 1993 at Bowers Field, a municipal airport in the Ellensburg, Washington area. The source of the contamination can be traced to crop dusters in Central Washington during the agricultural season.

During the demonstration 30 m^3 (40 yd^3) of soil contaminated with dinoseb at an average level of 28 mg/kg was placed in the bioreactor. If a larger volume of soil or a molecular bioreactor was to be used for the Demonstration Test, then a lined pit would have been more appropriate than a molecular bioreactor. The demonstration was anticipated to last approximately 6 weeks, however, sampling at the anticipated mid-point of the test (23 days) showed that dinoseb was not detected in any of the samples. This was in spite of the fact that the average ambient temperature during this period maintained the bioreactor at an unseasonable 18°C. Thus, post-treatment sampling was initiated.

Demonstration Testing of the J.R. Simplot Ex-Situ Anaerobic Bioremediation System gave the following results:

- The process can reduce the levels of dinoseb in the feed soil to below detection limits. Based on an average pre-treatment concentration of 28 mg/kg and a final post-treatment concentration below the detection limit of the analytical instrumentation a, >99.8% reduction of dinoseb was achieved.
- No known polymerization products were found in the analysis of the post-treatment samples.
- Other pesticides (nitroanaline, malathion, and parathion) were reduced from parts per million levels in the feed soil to below the analytical detection limit in the treated slurry.
- The process can successfully operate with bioreactor temperatures as low as 18°C, much below optimum.
- Treatability studies and, to a limited extent, the Demonstration Test has shown that continuous mixing of the bioreactor is not required. A static system can achieve acceptable results providing the soil, water, and potato starch are well-mixed during loading of the bioreactor.

The presence of other herbicides and pesticides in the feed soil negated the meaningful purpose of performing toxicity tests on the pre- and post-treatment samples as part of the dinoseb Demonstration Test. However, toxicity tests will be performed as part of the demonstration for TNT degradation.

An Innovative Technology Evaluation Report describing the complete Demonstration and other pertinent information will be available in the Summer of 1994.

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