Research in Progress

Forest Products Laboratory

Remediation of Buildings Chemically Contaminated as a Result of Floods

Post flood damage to a wood-frame house.

Chemical contamination of building materials may originate from stored chemicals following catastrophic events. This problem emerged after a catastrophic flood in Grand Forks, North Dakota, in April 1997. During the flood, a number of fuel oil tanks in residential basements ruptured. The spilled hydrocarbons mixed with water and were absorbed in concrete walls and wood-based building materials. After this event, slow evaporation occurred, and residents were exposed to hydrocarbon vapors for years. Common remediation techniques, such as heating and pump-and-treat technologies, proved to be inefficient. The key challenge is that chemicals can be entrapped along with water inside the pore spaces of solids, thus making them inaccessible to any common treatment.

Background

Bioremediation—the application of bacteria on contaminated wood—is suggested for nondestructive decontamination of hydrocarbons from wood-based building materials. The feasibility study of biological decontamination of concrete was successfully completed. The goal of this research is to extend the approaches and protocols already developed and apply them to wood. Wood is significantly different from concrete in its pore structure: Wood tracheids are well-defined and anisotropic, stretching in the longitudinal direction, whereas concrete pores exhibit no directionality. Penetration of chemicals into and out of wood has been extensively studied for bulk amounts of chemicals. However, the subset of this problem for low amounts of chemicals, which is important for wood contamination, has not been investigated.

Objectives

- Develop a computer-based simulation model of penetration of pollutants into building materials (wood and concrete).
- Conduct a feasibility study on the biological removal of chemicals from wood.

Approach

Preliminary research has demonstrated that the removal of heavy hydrocarbons from concrete and wood pores, regardless of treatment technology, is a mass-transfer-limited phenomenon under essentially static conditions. A diffusion model will be developed, based on existing pore diffusion models, to simulate the transport of heavy hydrocarbons from wood and concrete pores. Mass transfer is also influenced by the relative solubility of hydrocarbons in water and the

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water content of the solid pore structure. Diffusivities will be generated experimentally for three prototypical hydrocarbons. For wood, these experiments must also account for directional differences in wood pore structure.

For bioremediation, southern yellow pine specimens of various sizes will be contaminated with controlled amounts of pollutants and treated by bacteria under various controlled conditions. Three pollutants have been selected for Phase 1: *n*-hexadecane, naphthalene, and 2,4-dinitrotoluene. Selection is based on the variation of two key parameters affecting pollutant diffusion in wood: solubility in water and volatility. Wood-absorbed pollutants will be quantitated using scintillation counting and gas chromatography. Pollutant removal efficiency will then be determined and analyzed.

Expected Outcomes

A bench-scale protocol of wood decontamination will be developed. Information obtained in this study will be used to expand the approach to other pollutants. This information will be used in the future for obtaining knowledge on the interaction of chemicals (adhesives, preservatives, solvents) with wood. A preliminary computer-based model will be developed, and preliminary tests will be conducted (with a limited set of variables).

Timeline

Phase 1 of this project—the proof-of-concept study described above—is scheduled for one academic year, to be completed in May 2004. Work will then continue as a scale-up study with real-size wood and concrete specimens.

Cooperators

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