Measurements of petroleum-infiltration rates in frozen soils from Bethel, Alaska, for secondary containment design

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Industrial facilities in Arctic climates often have facilities for storage and distribution of petroleum fuels. Secondary containment at these facilities commonly includes berms, catchment basins, and ditches. Various fuel-spill scenarios influence design for secondary containment. Containment berms and basins often require lining with synthetic fabrics, grouts, or treated-soil liners. A fuel-storage facility in Bethel, Alaska is presently undergoing secondary containment design and construction. We conducted field tests at the Bethel facility to measure fuel-infiltration rates in frozen soil. Laboratory tests provided data on samples with controlled moisture contents, soil types, and freezing temperatures. Field and laboratory tests identified potential fuel-penetration depths with time.

We used ASTM Method D 5093-90, using a double-ring infiltrometer with a sealed-inner ring, for field tests. Infiltration rates were measured in frozen, ice-saturated, silty sand. The average infiltration rate was 4.3×10^{-8} cm s^{-1}. Three different types of soils were retrieved for laboratory testing. Organic-rich silty sand, silty-sand fill material, and sandy silt represent the three main soil types at the facility. We used a falling-head permeameter to measure hydraulic conductivities of laboratory samples. Samples were disturbed and compacted at densities typical of site conditions. Testing occurred at saturated and unsaturated soil-moisture contents in a cold room at -4°C (25°F). Our tests used a Diesel #2/Jet A-50 fuel mixture (heating fuel) consisting of predominantly Jet A-50. Laboratory results indicate hydraulic conductivities decrease as ice saturation increases. Environmental site conditions in Bethel result in active layer and permafrost sandy soils meeting Alaska standards for liners in petroleum facilities.