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Biodegradation of propylene glycol by soil bacteria

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Propylene glycol (PG) is widely used as a component of deicing agents for aircrafts. Its intensive use in Northern airports is a source of pollution for soil and groundwater even in the presence of recovery systems. Generally PG-based deicing agents are sprayed on the aircrafts over a recovery platform where most of liquids (deicing and melted ice) are collected to a treatment plant. Some of PG is retained by the aircraft wings where it prevents the formation of new ice. During take-off some of PG can drain over the runway and the surrounding soil. In winter the PG is absorbed by the snow layer on the surrounding soil. Melting of snow in spring gives rise to PG percolation in porous soil layers and groundwater underneath. Since PG is toxic to human beings, groundwater pollution has to be prevented.

PG is biodegradable by soil bacteria in several environmental conditions. The rate and the extent of biodegradation can be severely limited by many factors, such as temperature, biomass concentration, availability of additional nutrients (nitrogen and phosphorus sources) and of electron acceptors (oxygen, nitrate, sulphate, iron and manganese oxides). Enhancing the rate and the extent of biodegradation in the porous unsaturated layer can prevent the pollution of groundwater.

In this paper we present experimental data on the biodegradation of PG in soil slurries under aerobic and anaerobic conditions. Soil samples from the Gardermoen Airport (Oslo, Norway) have been used as source of PG-degrading microorganisms. The effect of addition of nutrients and electron acceptors different from oxygen has been studied. The rate of degradation is very slow in the absence of added nutrients and follows a zero order kinetics in time both under aerobic and anaerobic conditions. It is probably due to maintenance metabolism without biomass growth. By addition of ammonium and phosphate the rate is notably increased and follows first-order kinetics in time. Tentatively an explanation in terms of exponential growth of PG-degrading biomass is postulated.

By supplementing oxygen or nitrate, the methanogenic degradation of PG can be prevented, ensuring complete mineralization to water and carbon dioxide.