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Microbial monitoring and most-probable number of microbes in soils capable of degrading aircraft deicing fluids

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Intensive use of propylene glycol (PG) and potassium formate-(PF) based aircraft de-icing fluids (ADF) are sources of pollution in Northern airports for soil and groundwater. When the contaminated snow melts in the spring, the de-icing chemicals can infiltrate the sandy soil rapidly. The pollutants are known to be degradable by soil microbes, biodegradation however might vary temporally and spatially. Non-invasive monitoring tools are mainly used to outline areas affected by contaminants and to monitor the flow and transport processes. Field sampling and laboratory measurements are required to examine microbial differences in soils, and the activity of PG degraders.

The objective of our work was to map this variability using techniques, such as the countable, colony-forming (CFU) aerobic and anaerobic microbial components (bacteria and fungi) in soils and their catabolic enzymatic activity, measured by fluorescein-diacetate (FDA) analysis. Ratio of potential PG degraders was studied by the most probable number (MPN) method. Soil samples from the Gardermoen Airport (Oslo, Norway) were collected during spring 2010, vertically at 0-110 cm below ground level, and horizontally at about 0-154 cm distance from the runway in 5 steps each. A 10-fold soil solution was done in basal medium at 10.000 ppm ADF, added to 96-wells microplates. Growth was tested after incubation at 22 °C for 2 and 4 weeks by iodonitrotetrazolium violet (INT). Cochran table was applied to calculate the MPN values of PG degraders.

There were an increasing abundance and activity of aerobic and anaerobic bacteria and fungi found further away from the highly contaminated runway, indicating toxic effects in this area. Also, below the 40cm soil layer a reduced microbial activity could be seen. The most probable number of microbes capable to degrade ADF correlates well with the CFU numbers and the measured FDA enzymatic activity of the soils. Near the most contaminated runway, 3% of the total heterotrophic bacteria could use PG as sole carbon source. This ratio was found to be increasing at less contaminated sites by reaching the value of about 13%. Three of the tolerant isolates were identified as Pseudomonas sp. The monitoring of microbial activity by the used methods proved to be appropriate for describing the potential PG degradation capacity of soils.