

AGEING OF SEWAGE SLUDGE

-some physical and chemical properties in relation to landscaping

Abstract

This thesis deals with the changing properties and leaching characteristics of ageing sewage sludge. The focus is on the behaviour of sludge applied as thick layers for different land applications such as landscaping or covers on landfill.

The aim was to investigate the development of structures and the changes in physical properties and to throw light on the behaviour of ageing sewage sludge. I also investigated the leaching character of metals over time, relationships of metals to the size of leached particles, together with possible correlations to external factors.

Lysimeters and large-scale applications of sewage sludge layers were used to examine structures which developed and other physical properties.

Sewage sludge is a material with high organic content, with up to 90 % porosity and a great ability to hold water. This makes the sludge a changing material due to the ongoing degradation of organic matter, decreasing volume, and the possible development of structures due to significant shrinking.

Homogenous water-saturated anoxic sludge was found to be practically impermeable, but exposure to oxidising and drying conditions caused significant shrinkage cracks and led to preferential flow regimes.

Monthly sampling of leachate from a lysimeter with anaerobically digested sewage sludge was conducted over a four year period. Leachate was filtered into size fractions and analysed for metals. The results showed an initial release from the "fresh" sludge of metals, at first partly associated with particulate and colloidal matter, but after two years almost all elements were in the < 10 kDa fraction. Even though most elements showed a decreasing trend with time, a majority also showed seasonal variability. This was probably due to temperature-related nitrification and the release of nitrate, which also caused a marked pH decrease to the level where Al-buffering probably started and the pH was stabilised at 4.1.

Mass balance calculations showed that large fractions of the original macronutrient contents were leached, together with a considerable fraction of Ni, Cd and Zn. Zinc caused initial toxicity to *Daphnia magna*. Some elements including P and Pb were almost immobilised in the sludge.

Leachate from sixteen year-old lime-stabilised sludge sampled during one year also showed large variations for some metals.

The leaching characteristics of sewage sludge should be taken into account when planning the application of thick layers of sludge, because a low pH might develop, leading to increased metal mobility. The mobility of Zn, Ni, Cd and Al are of special environmental concern.

Sewage sludge in covers used as barrier constructions should be kept water-saturated and at high pH, to minimise the development of oxidising conditions and its consequences.

Keywords: sewage sludge, physical properties, preferential flow, lysimeters, covers, landscaping, leaching, metals, nitrification, seasonal variations.