

## **EXECUTIVE SUMMARY**

It was observed in previous studies that sewage sludge conditioned with polyelectrolytes was hard and difficult to crush. If this should be the case with all polyelectrolyte treated sludges, this change in the properties of the sludge may reduce the soil conditioning abilities of sewage sludge that are applied to agricultural land.

Sewage sludge is reported to be hydrophobic while it is claimed that other organic sludges produced by industry are hydrophilic. It was observed in the laboratory that dried sewage sludge is not easily wettable. This observation may indicate that dried sewage sludge exhibits hydrophobic properties. It is hypothesized that sludge dewatering agents may contribute to higher hydrophobicity of sewage sludge. Thus, the mechanical and microbial breakdown of the sewage sludge when applied to soil may be adversely affected by the restricted ability to wet the sludge. Sewage sludge that is added to soil contributes to the organic matter in the soil and it is expected that it would mineralize similar to soil organic matter. However, due to higher ambient temperatures in South Africa than in the European countries, the mineralization of soil organic matter is faster in South Africa than in the Northern hemisphere countries.

Most cationic polyelectrolytes are amine-based material. It is known that quaternary amines are good algacides and therefore toxic. It is a requirement that polyelectrolytes used in potable water production should have a health certificate indicating the maximum concentrations allowable in potable applications. This is an indication that the material has toxic properties. If the sludge conditioner acts as an inhibitor of microbial activity in the treated soil, the mineralization of the sludge would be adversely affected. If the mineralization is adversely affected, the application rate of sludge to agricultural soil could be affected.

Alternatives to polyelectrolytes for sludge conditioning exist and the benefits and disadvantages of these alternatives should be quantified. Alternative sludge conditioners include: lime, aluminium compounds, ferri- and ferro compounds. The effect that metal salts would have on sludge quality could also be important and should be determined.

The objectives of this investigation were therefore:

- a. To determine the effect of various conditioning agents (organic and inorganic) used in sludge treatment at different concentrations on the properties (dewatering, wettability, chemical composition, hardness, biodegradability, mineralization, etc.) of sewage sludge.
- b. To develop an operating guideline for the use of dewatering agents for sewage sludge treatment.

The study was done by identifying the most common conditioning agents (organic and inorganic) that are normally used at sewage treatment plants for sludge conditioning. The effect of the different conditioning agents on the properties of the conditioned and unconditioned sludge were then determined. The specific resistance to filtration was used as a measure of sludge filterability. Sludge wettability was determined by determining the water uptake after sludge conditioning. The metal content of the inorganic conditioned sludge was measured with XRF analysis. The Shore hardness test was used to determine the hardness of the sludge. Sludge biodegradability was determined through BOD and COD analysis. Sludge mineralisation was studied by mixing the conditioned sludge with soil and determining the release of ammonia and nitrate nitrogen over time.

The following conclusions can be made as a result of the investigation:

- The polyelectrolyte sludge conditioners used for sludge conditioning prior to dewatering showed better sludge dewatering characteristics (filterability) than the inorganic sludge conditioners. Ferric chloride, however, showed good sludge dewatering characteristics. The disadvantage of the inorganic sludge conditioners is that they increase the heavy metal content of the soil.
- The water uptake of the conditioned and unconditioned polyelectrolyte treated sludges was about the same. Therefore, water uptake is not inhibited by the addition of polyelectrolytes to the sludge.
- The water uptake of the inorganic conditioned sludges was less than that of the unconditioned sludge. Therefore, the inorganic conditioned sludges appear to be more hydrophobic than the unconditioned sludge and could be more difficult to biodegrade in the soil.
- Little difference was observed in the hardness of the unconditioned and conditioned polyelectrolyte treated sludges. This may indicate that there is little difference in the hydrophobicity of the sludges if it is argued that a harder sludge is more hydrophobic than a softer sludge.
- The BOD/COD ratios of the conditioned and unconditioned polyelectrolyte treated sludge were about the same. Therefore, the sludge conditioners appear not to affect the biodegradability of the sludge adversely.
- The mineralization rate of the conditioned sludge was slightly higher than that of the unconditioned sludge. Therefore, sludge mineralization is not adversely affected by the addition of polyelectrolytes to the sludge.
- The conditioned and unconditioned sludge both add nutrients to the soil. The sludge should therefore be effective as a supplementary fertilizer for agricultural soil. However, the nutrients may also contribute towards groundwater pollution if the quantity applied to soil is not properly managed.
- The commonly used polyelectrolyte sludge conditioners should not cause any harm to the environment under conditions normally used for sludge conditioning prior to dewatering.
- The concentration of sludge conditioners (2 to 8 mg/g dry solids) used in this study appears not to have a negative effect on the soil conditioning properties of sewage sludge and could serve as a guideline for the concentration of sludge conditioners to soil.

The following recommendations can be made as a result of this study:

The polyelectrolyte sludge conditioners investigated are not adversely affecting the soil conditioning properties of sewage sludge. The inorganic sludge conditioners, on the other hand, have the potential to increase the heavy metal content of the sludge and consequently the soil on which the sludge is disposed. Therefore, the current practice of applying organic sludge conditioners to sewage sludge should be maintained. However, a watching brief should be kept on new sludge conditioning agents appearing in the market which could adversely affect the soil conditioning properties of sewage sludge.

