

WASTEWATER TREATMENT

Uncertainties surrounding the nature and concentration of organic pollutants found in South African sewage sludge have meant that guidelines for safe utilisation in agriculture adopt a very conservative approach. New research has provided much-needed information on organic pollutants in sludge in different parts of the country, and lays the basis for safer disposal and more beneficial use.

Prevalence of Organic Pollutants in South African Sludge

The current dilemma

Large quantities of sludge are generated in sewage treatment plants. Disposal is done in accordance with legislated rules so as to avoid adverse impacts on the environment.

Possibilities for disposal include land application, landfill, incineration and disposal at sea. **Despite the existence of guidelines, the disposal process continues to be one of the most challenging problems for wastewater treatment plants.**

The current *Guidelines for the Utilisation and Disposal of Wastewater Sludge* promote the application of sewage sludge to land not only as a safe disposal option, but also as an option to use sewage sludge beneficially. Economically, this form of disposal benefits both sewerage works by providing a source of income, and farmers, by providing a source of cheap fertiliser. Sewage sludge contains many constituents of agricultural value, including organic matter, nitrogen, phosphorus and potassium, and to some extent, calcium, sulphur and magnesium.

Despite the benefits of sewage sludge as a soil conditioner and source of nutrients in agriculture, the long-term sustainability of applying sludge to land is not without question. Sludge also contains highly polluting substances, including pathogens (viruses, bacteria, protozoa, eggs of parasitic worms), toxic heavy metals and toxic organic substances. There is some existing knowledge (as incorporated into the present guidelines) about the extent to which the presence of metals and pathogens limit the utilisation potential of sewage sludge. However, the lack of information on the occurrence of organic pollutants in South African sewage sludge has remained a source of uncertainty with regard to providing guidance regarding the sludge's utilisation potential.

The national guidelines document for the disposal of sewage sludge, because of prevailing uncertainties, generally adopts a conservative approach in setting out norms for safe disposal. This, in itself, may unduly restrict the realisation of attainable benefits that could otherwise derive from the sustainable use of this potential resource.

Organic pollutants in sludge

As a consequence, establishing the prevalence of organic pollutants in South African sludge has recently been a priority research area. Acquired knowledge concerning organic pollutants, used in conjunction with knowledge of the potential risk to human from using organically polluted sludge, would allow guidance concerning permissible pollutant levels in sludge to be given to producers, users and regulators.

It was necessary to first assess the suitability of available methods of sampling, preservation, extraction and analysis required for the adequate determination of these organic pollutants before a survey of organic pollutants could be done.

The research approach followed was, thus, to:

- Carry out a literature study to establish **international experience** regarding risks to humans from utilisation of organically polluted sludge, and to determine the most suitable method(s) currently being used for extraction and analysis of potentially harmful organic compounds in sewage sludge;
- Establish **standardised methods** for sampling and preservation of sludge samples;
- **Test the selected methods** for extraction efficiency and reproducibility using standards and spiked samples;
- Carry out a **screening process** on sewage sludge samples for the purpose of determining the existence of the most persistent organic pollutants;

- **Quantify the targeted organic contaminants;** and
- **Compare values** so obtained with those contained in the previous sludge guidelines and recommend improvements in the listed maximum permissible concentrations of organic pollutants in sewage sludge.

The literature survey indicated that while not much is known about plant uptake of phthalates and nonylphenols, most organic pollutants in sludge applied to agricultural land are not taken up by plants. The risk of human exposure to pollutants therefore resides mainly in the eating of raw or semi-cooked crops following their contamination by the spreading of sludge directly on to land planted to these crops, or in the consumption of animal products where animals have ingested soil and sludge through grazing on sludge-treated land.

The international literature further provided information on the most common methods for extracting and analysing organic compounds and guided the selection of appropriate methods for use in the further investigation of South African sludge. In the absence of any universally accepted methods, the US EPA standardised methods 3510C (liquid-liquid extraction) and 3540C (Soxhlet extraction) for the aqueous and solid sewage sludge, respectively, and 3660B (sulphur clean-up process) for purification, were favoured because they are simple, inexpensive and effective.

Accordingly, samples were transported at below 4°C and stored at between 2.5°C and 3.5°C. To test extraction efficiency and reproducibility, a 'clean' sludge matrix was prepared and then spiked with a mixture of six chlorinated pesticides at half the regulatory limits. The Soxhlet method showed an extraction efficiency of ≥80% for all the pesticides investigated. A total of 109 samples from 78 sewerage works were extracted.

The status quo

A total of 712 organic compounds were identified in South African sewage sludge. These included phenols, pesticides, phthalates, furans, amines, aldehyde, esters, acids, chlorinated hydrocarbons, alcohols, and hydrocarbons among others. Detailed information for each of the wastewater treatment plants has been compiled and may be accessed in the final report on this research.

Recommendations

Based on the results of the research, the following recommendations are made:

- The methods selected for this study of organic pollutants are recommended for further use.
- The low level of occurrence of organochlorine pesticides (that are listed for regulation in the 1997 Guidelines) indicate that there is no need to continue regulating this group of organic pollutants.
- The three compounds or groups that require regular monitoring based on their occurrence are p-cresol, nonylphenols and polycyclic aromatic hydrocarbons (PAHs).
- Since liquid sludge contains high values for phenols when compared to solid sludge, it is recommended that the effluent from wastewater plants be analysed for nonylphenols.
- Polychlorinated biphenyls (PCBs) should be quantified and regularly checked, especially in Gauteng where they found to occur.
- Other listed compounds should be quantified in only a few areas to gauge their level of occurrence.
- There is a need to carry out a five-yearly screening process. This will update the regulator of any changes in the occurrence of organic compounds and will also bring to light new compounds that may need to be regulated.

Revision of Guidelines

This study has provided much-needed information on the quality of South African sewage sludge with respect to organic pollutants. Findings have been related to the limits set by the previous South African guidelines and also international limits. This information has started supporting decision making at national level and has also assisted in the preparation of the current edition of the national guidelines.

Further reading:

Methodology and Survey of Organic Pollutants in South African Sewage Sludges: Volume 1 (Report Nr: 1339/1/07). To order this report contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za