

Determination of inorganic pollutants and assessment of the current South African guidelines on permissible utilisation of sewage sludges

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Abstract

A total of 71 sludge samples originating from 61 sewage treatment works in South Africa were used in this investigation. Moisture, pH and total mineral ion content were determined. Moisture values were found to vary between 2.7% and 88.5% with the pH of the majority of the samples falling between 5.1 and 6.5. Mineral ion determinations showed that P was the most abundant in most of the sludges whereas, of the heavy metals, Zn had the highest concentrations and Cd the lowest. The current results (for 10 elements) were compared with the current South African maximum limits as stipulated in the permissible utilisation and disposal of sewage sludge for unrestricted use. The amounts of Cu, Se, Pb and Zn were found to be above the limit in more than 90% of the samples. No sewage works met the required limits for all the elements of interest. The results were also compared with the USA and EU limits, according to which all the elements were within the acceptable range and over 50% of the sludge samples met the required limits. These results suggest that the current South African limit is too conservative.

Keywords: sewage sludge, mineral ions, heavy metals

Introduction

Large quantities of sludge are generated in sewage treatment plants. The material is composed largely of highly polluting substances and it undergoes various treatments at sewage works in order to render it suitable for disposal or reuse. Among the most harmful components of sludge are pathogens (viruses, bacteria, protozoa and eggs of parasitic worms), toxic organic substances and toxic heavy metals (Bruce et al., 1989; Tchobanoglous and Burton, 1991; Smith, 1996). The adverse effects relating to heavy metals in the environment are due to their accumulation in the soil and in crops resulting in phytotoxicity, zootoxicity and harm to human health (Bern-Liebefeld, 1991; Rudd, 1987; Schmidt, 1997). The presence of major nutrients (nitrogen and phosphorus) that control biomass growth also plays a significant role in eutrophication-related problems when untreated or partially treated wastewater is disposed of and finds its way into water-bodies (Nhapi and Tirivarombo, 2004; Alastair et al., 1996; Jandu, 2004; Roy, 1996). The ultimate disposal of sewage sludge includes soil application, landfill, lagooning, incineration and disposal to sea amongst other options. Owing to the high concentration of many harmful substances present in sludge, many countries have banned disposal to sea. The disposal process continues to be one of the most difficult and expensive problems in the field of wastewater engineering (Tchobanoglous and Burton, 1991).

A well-treated sludge can be used as a nutrient source for vegetation. In South Africa an estimated 28% of the sludge generated at the sewage plants is used beneficially (Du Preez et al., 1999) whereas in countries such as Japan, the United Kingdom (UK) and USA, 42, 50 and 35% respectively of their sludge is used (Environmental Protection Agency (EPA), 1993). It is,

therefore, clear that South Africa needs to improve its usage of sludge. This should include agricultural application for crop cultivation, soil reclamation in areas where mining activities take place and application in gardens. The beneficial usage of sewage sludge is a potential source of income to the sewage works and to farmers it could be a source of cheap fertiliser. Application of sewage sludge to land is restricted due to the presence of toxic organic substances and toxic heavy metals (Korentajer, 1991). The other limitation is the National Guidelines for the disposal of sewage sludge, which are sometimes very restrictive (WRC, 1997).

The aim of this investigation was to quantify the amounts of inorganic pollutants and phosphorus (as P) nutrients in sludge from 61 sewage works covering the 9 provinces of South Africa. The study provides much needed information on the quality of South African sewage sludge with regard to mineral ions. In terms of the bigger picture the paper assesses the current South African legislation (Guidelines) on permissible utilisation and handling of sewage sludges (WRC, 2002) by comparing the findings with the legislation and with the international limits, namely United States of America (USA) and European Union (EU). The information is expected to support decision making at national level.

Materials and methods

Collection and sampling of sludges

Sludge samples were collected from 61 wastewater treatment centres in the 9 provinces of South Africa, namely: Gauteng (GP), Mpumalanga (MP), Free State (FSP), Western Cape (WCP), KwaZulu-Natal (KZNP), Limpopo (LP), North West (NWP), Eastern Cape (ECP) and Northern Cape (NCP). The total number of samples collected was 71. At each sampling area a series of random samples was taken and mixed to produce a uniform composite sample. Glass containers with PTFE-lined closures were used for holding the samples. These were transported to the laboratory in an icebox at a temperature of approximately

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