Partitioning of nutrients and micropollutants along the sludge treatment line: a case study

A. Gianico · C. M. Braguglia · G. Mascolo · G. Mininni

Received: 15 November 2012 / Accepted: 26 March 2013 © Springer-Verlag Berlin Heidelberg 2013

Abstract A 2-year sampling campaign was conducted in three wastewater treatment plants of various sizes in the Rome area to assess the occurrence of nutrients and micropollutants among primary, secondary and digested sludge. The primary purpose was to evaluate the quality of different sludge types and their suitability for agricultural use. Primary sludge was consistently more polluted than secondary in terms of organic micropollutants, whereas heavy metals partitioned equally among the sludge types. In digested sludge, the heavy metal concentrations were always below limit values proposed for agricultural utilisation. In contrast, organic micropollutants concentrated during anaerobic digestion and affected the quality of the digested sludge. Secondary sludge resulted less polluted and richer in nitrogen and phosphorus (up to three times) than primary sludge and is hence more suitable for agricultural use. Separate processing of primary and secondary sludge might therefore be an innovative option for sludge management that could maximise the possibilities of agricultural use of secondary sludge and limit disposal problems only to primary sludge. In fact, primary sludge could be easily treated and disposed of by conventional processes including thickening, anaerobic digestion, centrifugation and incineration, whereas the difficult digestibility of secondary sludge could be improved by disintegration pre-treatment before stabilisation.

Keywords Sewage sludge · Nutrients · Agriculture · Heavy metals · Organic micropollutants · Sludge separation

Introduction

Proper management of sewage sludge is a growing challenge due to rapid urbanisation and the resultant increase in sludge production due to the implementation of Directive 1991/271. Sewage sludges arising from wastewater treatment plants (WWTPs) can be called biosolids when they are well stabilised by digestion or other treatment processes and meet criteria for application to agricultural land as conditioners or fertilisers.

In recent decades, sludge processing was generally accomplished through conventional systems, consisting of gravity thickening of mixed primary and waste activated sludge, biological aerobic or anaerobic stabilisation and final mechanical dewatering. However, the produced sludge might not be suitable for final disposal or utilisation according to legislative standards. Conventional wastewater treatment approaches are unable to remove inorganic compounds such as heavy metals (Cd, Cr, Cu, Pb, Ni and Zn) or recalcitrant organic micropollutants (as for example pharmaceutical products, synthetic organic pesticides and plasticisers) used in households, trade and industry and these substances can therefore be detected in sewage sludges and treated effluents. Consequently, current European legislation (Urban Waste Water Treatment Directive 91/271/EEC and Nitrates directive 91/676/EEC) defines a protection strategy based on source abatements and end of pipe treatments. This legislation will force wastewater treatment facility owners to face technical challenges and will also account for a large portion of the capital and operating costs of any wastewater treatment facility.

In the future, sludge is to be envisaged not as waste but as a valuable resource that needs to be recycled. This new strategy will change the typical disposal route by minimizing the amount of sludge disposed of in landfills, which will continue to serve as emergency backup systems.

The two components in sludge that are technically and economically feasible to recycle are nutrients (primarily nitrogen...