Status and perspectives of sludge management

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Abstract: It is well recognized that management of sewage sludge is a critical environmental issue, due to fast increase in sludge production as a result of sewerage extension, new installations and upgrading of existing facilities. Further, sludge is produced under different technical, economic and social contexts, thus requiring different approaches and involving different solutions. To provide useful information for all people interested in this field, and give a contribution to take appropriate decisions, the IWA Specialist Group on Sludge Management recently published a Report aimed at overviewing the sludge field in different parts of the world. Generally speaking, a sludge management policy should aim to reduce the amount of sludge production, produce a safe and hygienic material, and apply reuse options instead of disposal ones. In all cases, a regular and environmentally safe sludge management requires the development of realistic and enforceable regulations appropriate to local circumstances, and the definition of standardized methods for sludge analysis, and guidelines for good management practice. In this paper, current wastewater and sludge treatment provisions, current and anticipated legislation, current research horizons, anticipated evolution of management approaches, and prospects for application of innovative and/or simple technologies in different parts of the world are discussed.

Keywords: Management; energy recovery; material recovery; wastewater sludge

INTRODUCTION

It is well recognized everywhere that management of wastewater sludge is one of the most critical environmental issues, due to the very fast increase in sludge production as a result of sewerage extension, new installations and upgrading of existing facilities. Further, sludge is produced under different technical, economic and social contexts, thus requiring different approaches and involving different solutions to get optimal management procedures.

To provide useful information for the benefit of all people interested in the sludge management field and give a contribution to take the most appropriate decisions, IWA recently published a Report aimed at overviewing the sludge field in different parts of the world (Spinosa, 2007). The Report, the first in the new Water21 Market Briefing Series, has been produced in collaboration with IWA’s Specialist Group on Sludge Management. An extended Summary of the Report has been also published in Water21 Magazine (Mc Cann, 2006).

In eight subsequent chapters, individual authors with specialist regional knowledge in this field give an overview on the topic of wastewater sludge in their part of the world: Western Europe, Central and Eastern Europe, North America, Latin America and the Caribbean, East Asia, South Asia and China, Africa, Australasia.

Each chapter discusses (i) current wastewater and sludge treatment provisions, (ii) current and anticipated legislation, (iii) current research horizons, (iv) anticipated evolution of management approaches, and (v) prospects for application of innovative and/or simple technologies. In this paper above aspects are summarised.

WESTERN EUROPE

Main aspects to be evidenced in this area are the tight legislative controls imposed throughout the EU and the wide variation in the degree to which individual countries resort to particular and–use or end-disposal routes. For example, sludge use in agriculture currently varies between less than 10% in Sweden and nearly 70% in Spain.

The great attention now being given to the recycling of all biodegradable wastes within the context of a sustainable soil policy has involved the need for improving the legislation applicable to sludge and other biodegradable wastes, so the revision of the Directive 86/278/EEC for sludge utilisation in agriculture and the development of a Biowaste Directive have been undertaken. However, at the moment, this process has not yet been completed because subjected to the development of a basis legislation on soil protection, that will then become the reference regulation for the proposed new legislation on biodegradable waste.
The general perception is that environmental European politics are pushing towards recycling, but often unjustified restrictions are imposed thus rendering very difficult and costly the application of this possibility.

Land application seems to remain in this region a major option for many more years, but the declining public acceptance and more stringent limits are becoming a limiting factor.

Landfilling of sewage sludge will be reduced, mainly due to methane emissions heavily contributing to greenhouse effects, but in many countries sludge management systems are based on landfilling, so strong changes will be required to run other disposal routes. In particular, the Directive 99/31 introduced targets for the reduction of biodegradable municipal waste to be landfilled:

- by 2006 to 75% of total biodegradable municipal waste produced in 1995;
- by 2009 to 50%;
- by 2016 to 35%.

The extent to which different regions have undergone development will influence the future of sludge management. Some areas will change their disposal route from landfilling to land application, others will change from land application to incineration, and some others will leave out a step going directly from landfilling to incineration.

In all cases, a number of requirements, such as guide and/or limit values, are contained in sludge regulations, but methods for determining the respective parameters are often not described, so the definition of standardized procedures and methods become a necessary support to fulfill legal requirements.

In order to give the necessary support to the development of the EU Directives dealing, directly or indirectly, with sludge, the European Committee for Standardization (CEN) established the Technical Committee 308 (TC308) whose scope is the standardization of methods and procedures employed for sludge characterization, and the production of guidelines for good management practice. It is to note that CEN is formed by almost all European national standardization bodies, not only by EU countries.

EASTERN EUROPE

Also in this area sludge management is in a period of rapid change in line with the expansion of wastewater treatment plants construction, particularly in those countries that have recently become members of the EU, as they are obliged to harmonize their legislation and operational systems with the European one.

In sludge treatment there is more use of anaerobic digestion in the thermophilic range, and there are examples of full-scale use of mechanical disintegration and use of sludge lysate produced during the disintegration.

As far as disposal is concerned, methods are strongly influenced by local economy, and therefore cheaper methods prevail.

Due to legislation changes, the amount of landfilled sludge in Eastern Europe will decrease especially in smaller countries with a high population density, while a slow increase in the market share of more expensive technologies, such as incineration or other thermal treatment methods, can be expected. However, this increase will be probably much slower in comparison with Western European countries.

The agricultural use of sludge, with more strictly controlled quality, seems however to continue to be a sustainable solution in this region.

Specific situations are those found in the Russia Federation and Turkey.

With reference to Russia Federation, the impression given is that this country lags behind the advances being seen elsewhere in the region. New and developing legislation in the fields of waste disposal and environmental protection seems to be apparently formulated with laws in the EU and other countries taken into account, but it is not clear that this developing legislative framework has yet had practical effects on sludge management.
During the last years, due to the change in the economic situation, there has been a substantial shift towards the use of more efficient techniques for sludge treatment.

Turkey has been much more influenced by the EU legislative framework and has combined this with an extended programme of sewerage and treatment plant construction. A range of modern technologies is applied, being composting the most important of these.

The municipal sludge produced is commonly stored in municipal solid waste landfill areas, and spread on land for agricultural purposes. Some plants are using sludge composting with solid municipal wastes as a final utilisation option.

**NORTH AMERICA**

Throughout North America it appears that public and political perceptions will ultimately guide sludge/biosolids policy and practices. These perceptions must be founded on (i) scientific principles able to describe what we do know, and (ii) risk assessments that examine what we cannot know.

These priorities are being currently addressed by a variety of initiatives to engage the public and gain their confidence with regard to sludge management policies; they are:

- the 2002 National Research Council Report calling for further work on chemicals and pathogens in sludge and on methods to assess associated health risks;
- the 2003 Biosolids Research Summit organized by Water Environmental Research Foundation;
- the creation of the National Biosolids Partnerships that developed a voluntary environmental management system based on Manuals of Good Practice and Guides on their implementation.

Among other subjects, both countries, U.S.A. and Canada, have continuing extensive research programmes looking at (i) risks from dioxins and furans, (ii) accumulation of anti-microbial agents in sludge, (iii) pathogens reactivation and regrowth, (iv) odour sources and relevant mechanisms, etc.

**LATIN AMERICA & THE CARIBBEAN**

In Latin American countries efforts on sanitation have had a concentration on wastewater treatment, while little priority has been in practice given to sludge management, so the primary focus of investment in the area has been addressed to:

- water supply, considering that 15% of population has no access to safe drinking water;
- sewerage and wastewater treatment considering that 20% of population is without adequate sanitation.

The quite small attention given to sludge management is reflected in the local legislations that often simply adopt regulations of industrialised or more advanced countries without any attempt to adapt it to local situations.

Therefore, main needs in the region include the:

- development of appropriate low cost methods to make sludge safe and suitable for reuse in agriculture;
- the development of legislation adapted to the area with the improvement of institutional capacity to guarantee its enforcement.

Based on the importance of agriculture in Latin America, as well as the degree of soil erosion, land application for crop production and reclamation are considered the best management practices.
EAST ASIA (JAPAN & SOUTH KOREA)
In Eastern Asia region, Japan and South Korea show a particularly major contrast, the former country opting for the highest technological approaches to sludge management, with problems following higher energy costs, the latter one continuing to dump most of its sludge output into the ocean, to be however ceased in 2008.

In Japan the rate of agricultural reuse is limited and is now decreasing. Composting seems to be an alternative, so it has been planned to make composting a bigger part of reuse operations as the high energy costs of thermal processes become more problematic, but this option is subjected to strict regulation for heavy metals, and also the acceptance of farmers, who prefer animal manures, is still questionable.

Japan is particularly opting for the highest technological approaches to sludge management; the use of incinerated ash or dewatered cake as an ingredient of Portland cement is growing each year, and also other thermal solidification processes, being gravels, bricks, molten slag and lightweight aggregates examples of end products, find crescent interest, but problems due to energy costs increase are a real limiting factor.

South Korea planned to ban ocean dumping in 2008, but current national law on fertilizers prohibits use of sludge on agricultural land, so a law change is therefore essential for future security of outlets. It has also had successful trials with sludge as feedstock for earthworms, and sludge admixtures with coagulants and plant seed as a protective surface against erosion on sloping cut ground.

It clearly appears that in both cases changes in legislation are becoming essential.

SOUTH ASIA & CHINA
In Asian countries the situation is highly differentiated.

Apart from the specific case of China, the range of population for countries in Southern Asia area is wide, and consequently approaches to sludge management extend over a similar range of extremes: from Vietnam (78 millions in population) where only one sewage treatment plant is in operation, with 6 more planned, being the sludge lagooned, to Singapore (4.3 millions) where all sewage is collected and treated, being the sludge almost totally landfilled on an off-shore island site.

Malaysia plans are to cover 85% of population by 2022, and to replace the use of drying beds and lagoons with centralised mechanical dewatering and disposal to landfill or land reclamation in coming years.

Taiwan is following a policy of total reuse by 2010 from landfilling to a mix of composting for horticulture and co-incineration with municipal solid waste with ash reuse.

As regards China, at present it is very difficult to have statistics on the production and disposal of the produced sewage sludge, and also on regulations there existing. It seems, however, that there practically do not exist regulations particularly addressed to sludge treatment and disposal.

Any case, sewage treatment plants are being built at a considerable rate, and sludge production is estimated to reach 8 M-tds/y by 2020 with agriculture pinpointed as the favoured end outlet.

AFRICA
In African countries, with the exception of South Africa where sludge deriving from over 900 wastewater treatment plants is treated in a variety of traditional options and guidelines and regulations, currently in revision, are already available, there is a lack of easily accessible information on sludge management practices or on relevant legislation or guidelines in nearly all the countries in this continent.

Similarly to Latin American countries, efforts on sanitation have had a concentration on wastewater treatment, while little priority has been presently given to sludge management. The result is that often legislation of industrialised countries on sludge is simply adopted by these countries, but not adapted to local situation. This is not really surprising considering the general lack of sanitation coverage, almost none in rural areas and 180 million unserved in cities.
Sanitation systems mainly include on-site systems, such as septic tanks, bucket latrines, pit latrines. The management of sludge is typically limited to on-site storage, and in many cases the treatment plant consists of integrated pond systems that have never been de-sludged. Any case, a number of encouraging initiatives for improving the management of sludge from on-site sanitation systems have been reported. The treatment of faecal sludge includes pond based systems (Ghana, Benin and Mali), constructed wetlands (Mali), co-treatment in ponds (Burkina Faso), co-treatment with wastewater in ponds (Botswana and Tanzania) and co-treatment with wastewater in activated sludge plants (South Africa).

AUSTRALASIA

The regulatory framework in Australasia has traditionally focused on ensuring that the impacts of treated effluent on the receiving environment were acceptable. As a consequence, water businesses throughout the country historically tended to stockpile sludges as a means of reducing costs.

However, more recently there is strong unanimity of view amongst state regulators that more sustainable management of sludge is desirable; this means also recovery of the amount of residual energy, but this option can be difficult to be implemented because of community concerns and energy costs.

Within this framework, both Australia and New Zealand are making strong efforts to carry beneficial recycling to land forward as the main end sludge outlet for the medium term future.

Australia is already well advanced on that way, with almost total beneficial reuse applied to sludge from major cities, where over 50% of population is residing, while New Zealand has further to go, still relying heavily on landfilling, but with a lot of research activity on beneficial outlets around biggest cities.

It is also to be mentioned the National Biosolids Research Programme by CSIRO to assess the effects of metals, nutrients, pathogens and trace organics.

CONCLUSIONS

Above discussion illustrates once again that sludge management is a continually evolving area, subject to a complex of influences tied to specific national and local conditions, and exposes the fundamentally common interest in developing sustainable end outlets, preferably through beneficial reuse rather than disposal in a manner protective of the environment and public health.

From a global overview it clearly appears that the development of correct sludge management procedures requires:

- assessing management route capable of maximizing the recycle/recovery benefits;
- developing operational systems appropriate to local circumstances, including economy, geography, climate, etc.;
- developing realistic and enforceable regulations adapted to local situations and accompanied by standardized procedures and methods for sludge characterization and by guidelines for good management practices;
- assuring long-term services and sustainable operations.

Within this general framework, it is possible to evidence that:

- leading countries have established routes to beneficial recycling, primarily at this time to land, but with an eye to the longer term future, if adverse soil impacts should become apparent;
- some countries, like Japan, are already at that stage of evolution, great interest being addressed towards high temperature processes, but current conditions on energy costs and emission restrictions are militating against those processes;
- at the other extreme, for many millions of people in several regions the long term future holds only the prospects of the most basic on-site sanitation facilities primarily aiming at safe operational practices to protect public health.
Finally, to avoid any confusion or misunderstanding, it seems necessary to clearly define the boundaries of the terms “sludge” and “biosolids”. Apart from difficulties of translation of the term “biosolids” in languages other than English, it should be recommended to continue to use the word “sludge” when speaking of the solids streams within the wastewater treatment plant or not introduced in recycle/recovery cycles, and to use the word “biosolids” only after the solids, in whatever form, leave the treatment plant, destined for any form of beneficial use.

REFERENCES


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