Management of waste sludge from waste water treatment plants

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Sewage sludge or waste sludge is a residual product from the treatment of urban and industrial wastewater. Sludge, originating from the waste water treatment process, is residue either moist or mixed with a liquid component, generated during the primary, the secondary and the tertiary treatment.
Driving Forces


- The quantity of sludge from waste water treatment plants has been, for several years, increasing greatly in Europe.

- For most of the countries, where data are available, the quantity of sludge produced per capita has increased over the last 10 years.
Between 1995 and 2000, the amount of sewage sludge used in agriculture increased in the United Kingdom, France, Spain, Italy and Ireland, whereas it decreased in Germany, Denmark, Sweden, Finland, Austria, Portugal and Belgium. The amounts of sewage sludge used in agriculture are negligible in the Netherlands and Greece.
Routes for sludge disposal

Routes for sludge disposal:

- Landfilling
- Incineration
- Using of sludge in agriculture (landspreading)

At Community level the reuse of sludge accounts for about 40% (agricultural use, composting) of the overall sludge production, but landfilling as well as incineration in some Member States are the most widely used disposal outlets despite their environmental drawbacks.
Routes for sludge disposal

Factors that influence sludge management:

- Cost
- Ease of disposal
- Accessibility of sites
- Human and animal health concerns
- Environmental concerns
- Social concerns

The Sewage Sludge Directive 86/278/EEC seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on soil, vegetation, animals and humans.
The type of disposal varies between Member States and Accessing Countries. In the Member states, the agricultural use prevails (32%), followed by landfill (25%), composting (13%) and incineration (13%).
Landfilling


- Organic matter decomposes in a landfill and is not available for plant growth. In same time more organic matter in landfill means more landfill gas produced.

- Different VOCs have been reported

- Low cost

- Landfill gas if not captured and used, contribute considerably to the climate changes effect.

- Leachate can contains several compounds such as ions, heavy metals, organic compounds and micro-organisms. I

- Available landfill capacity.
Incineration

Different types of incineration may be considered as sludge disposal routes:

- Mono-incineration,
- Incineration with other wastes,
- Co-incineration when sludge is used as a fuel in plants whose purpose is the generation of energy or production of material products such as coal power plants or cement plants,

Expensive disposal option for sludge

Problem of residues, which are about 30% of the input mass. They may be regarded as hazardous waste – a cause of the contamination by heavy metals

When sludge is incinerated the organic matter is decomposed mainly to carbon dioxide.
The agricultural sector needs supply of nutrients and organic matter (humus) to compensate for losses through harvest, grazing...

Sewage sludge serves both purposes, primarily as a supplier of micro-nutrients and organic matter but also as a supplier of nutrients such as nitrogen, potassium and phosphorous.

Sewage sludge contains compounds of agricultural value but it can also contain pollutants. Compounds of agricultural value include organic matter, nitrogen, phosphorus and potassium, and to a lesser extent, calcium, sulphur and magnesium.

The three main categories of pollutants which affect the sludge quality are:

- Pathogens,
- Heavy metals and
- Poorly biodegradable organic pollutants.
Using of sludge in agriculture - pollutants

Pathogens

- Sewage sludge contains various micro-organisms, especially when biological treatments are carried out. Only some of them have health-related impacts.

- Sludge may also contain plant pathogens that may present a risk to human, animal or plant health. The types of pathogens usually considered are viruses, bacteria, protozoa, and helminths. Their load in sludge varies along time.

- Bacteria found in sludge include Salmonella spp., E.coli, Leptospira, Clostridium, Shigella, Pseudomonas, Listeria, Streptococcus…

<table>
<thead>
<tr>
<th>Number/liter</th>
<th>Liquid manure</th>
<th>Dairy sludge</th>
<th>No disinfected urban sludge</th>
<th>Disinfected urban sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic bacteria</td>
<td>$3.5 \times 10^6$</td>
<td>$6.2 \times 10^6$</td>
<td>$7.3 \times 10^7$</td>
<td>$3 \times 10^3$</td>
</tr>
<tr>
<td>Staphylococcus</td>
<td>$9 \times 10^4$</td>
<td>$8 \times 10^2$</td>
<td>$1 \times 10^3$</td>
<td>$&lt;6$</td>
</tr>
<tr>
<td>Coliforms</td>
<td>$2 \times 10^5$</td>
<td>$2.9 \times 10^3$</td>
<td>$6.1 \times 10^3$</td>
<td>$&lt;6$</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>-</td>
<td>$5.3 \times 10^3$</td>
<td>$3.6 \times 10^3$</td>
<td>$&lt;6$</td>
</tr>
<tr>
<td>Salmonella</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>
Using of sludge in agriculture - pollutants

Organic pollutants

A wide variety of organic chemicals may be found in sludge. They may affect soils, plant, animals and human health, and have impacts on the environment. The compounds to which it is most often referred (many others are present as traces) are:

- PAH : Polynuclear aromatic hydrocarbons
- PCB : Polychlorinated biphenyls
- PCDD/F : Polychlorodibenzo-p-dioxins/furans
- AOX : Sum of organohalogenous compounds
- LAS : Linear alkylbenzenesulphonates
- NPE : Nonylphenol and Nonylphenolethoxylates
- DEHP : Di(2-ethylhexyl)phthalate
Using of sludge in agriculture - pollutants

Heavy metals

- Numerous heavy metals can be present in sludge. Heavy metals may affect plant health and growth, soil properties and micro-organisms, livestock and human health, and accumulate in the environment.

- For each metal, the proportion of each origin may be very different, and the importance of heavy metals originating from the industry depends greatly from the industrial situation of each country.

<table>
<thead>
<tr>
<th>Heavy metal</th>
<th>Limit values for heavy metal concentrations in sludge for use in agriculture (mg/kg dm)</th>
<th>Average values for heavy metal concentrations in sludge in the Member States (mg/kg dm) [3]</th>
<th>Limit values for amounts of heavy metals which may be added annually to agricultural land, based on a 10 year average (kg/ha/y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>20-40</td>
<td>0.4-3.8</td>
<td>0.15</td>
</tr>
<tr>
<td>Chromium*</td>
<td>-</td>
<td>16-275</td>
<td>-</td>
</tr>
<tr>
<td>Copper</td>
<td>1000-1750</td>
<td>39-641</td>
<td>12</td>
</tr>
<tr>
<td>Mercury</td>
<td>16-25</td>
<td>0.3-3</td>
<td>0.1</td>
</tr>
<tr>
<td>Nickel</td>
<td>300-400</td>
<td>9-90</td>
<td>3</td>
</tr>
<tr>
<td>Lead</td>
<td>750-1200</td>
<td>13-221</td>
<td>15</td>
</tr>
<tr>
<td>Zinc</td>
<td>2500-4000</td>
<td>142-2000</td>
<td>30</td>
</tr>
</tbody>
</table>
Treatment of sludge

There are several types of sludge treatment for reducing water content in sludge: dewatering, thermal drying and thickening.

The conditioning is used for sludge structure modification.

Stabilisation and disinfection are used for reducing the odour generation and pathogen content in sludge. Process of stabilisation includes aerobic or anaerobic digestion, composting, lime treatment, pasteurization and others.
Treatment of sludge

- Pathogens, which originate from human and animal metabolism, can be eliminated when needed by sludge treatment.

- The removal in the treatment plant of the two other categories of pollutants does not seem technically or economically feasible.

- Instead of an “end of pipe” approach, preventive action should be taken at source.

- Discharge of heavy metals in the sewer must be reduced.
The quantity of sludge from waste water treatment plants will increase in future due to more rigorous legislation regarding waste water treatment.

The sewage sludge Directive 86/278/EEC seeks to encourage the use of sewage sludge in agriculture and to regulate its use in such a way as to prevent harmful effects on the environment.

Limit values for concentrations of heavy metals in sewage sludge intended for agricultural use and in sludge-treated soils are in Annexes IA, IB and IC of the Directive but there are no limit values for organic pollutants and pathogens.

The European Commission is currently assessing whether the current Directive 86/278/EEC should be reviewed – and if so, the extent of this review.

A more uniform and comprehensive approach is needed to regulate the use of sewage sludge in agriculture based on risk assessment. There are large differences between risk assessments for agricultural use in sewage sludge in European countries and in the USA.
In accession countries sludge production is expected to be 10 times less than in member states. This is due to small extend of waste water treatment plants.

Sludge quality is similar to sludge quality in member states.

In accession countries there are higher uncertainties (percentage of sludge not meeting requirements, pollution prevention costs, and sludge production forecast…).

There is lack of data about generated quantities of sludge and sludge disposal routes.

Legislation is covered only in small extend and there is lack of strategy dealing with sludge disposal.
Conclusion

- Safe and long term solutions for the destination of sludge produced by the urban waste water treatment is a vital element of a sustainable functioning of the waste water treatment plants.

- It is very important to determine strategy for sewage sludge management in accessing countries where the number of waste water treatment plant will increase in process of complying with European regulations.

- There is insufficient reporting about quantities of generated sludge and routes of disposal in some European Countries and in almost all Accessing Countries.
Proposed indicators

- Produced quantities of sludge
- Used sludge disposal options and quantities
- Data needs: total agricultural area, area of agricultural land treated with sewage sludge; subindicator: amount of sewage sludge applied, average heavy metal content
- Content of heavy metals
- Content of pathogens
- Content of organic pollutants
Proposed Management Strategy

- Strategy for sewage sludge disposal management should be integrated with waste water treatment management.

- The strategy of waste management should be considered before choosing the type of treatment of waste water.

- A more uniform and comprehensive approach in regulation is needed for disposal routes for sewage sludge. There is need for more data and indicators that will enable more precise overview.

- The recycling of sludge, in agriculture is considered by the Commission as the best solution, provided the way of its use are harmless for human health and environment.
Proposed Management Strategy

- Compliance with the existing legislation is a minimum condition for this safe use. Information and communication are also essential to ensure the development of the use of sludge in agriculture.

- In the same time, efforts must be made for the necessary improvement of the quality of sludge and the optimisation of its quantity. Actions must be taken at source, upstream the waste water collecting systems, in order to reduce or eliminate the discharges of pollutants into the sewer. This discharge must be subject to prior regulations and/or specific authorisations satisfying specific requirements, in order in particular to ensure that sludge can be disposed of safely in an environmentally acceptable manner.
Thank you for your attention!