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Agricultural use of sewage sludge and its regulation

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Abstract

Sewage sludge is waste for which the most positive outlet must be sought whilst, at the same time, making use of its qualities. In view of its organic matter and other nutrients content, it may be thought that the best system is to use it for agricultural purposes, although the load of heavy metals it may bear with it proves to be the main obstacle involved. Since it is a heterogeneous material whose composition depends on various factors, the content of such metals in sewage sludge will be highly variable. Thus it becomes necessary to always analyze sewage sludge before directing it towards agricultural use and also to know the heavy metal content of the soil where it is applied already so as to adjust this agronomical practice to the limits as set by current legislation in force. The provisions of law must also be complied with when certain substances deemed toxic or dangerous are present in sewage sludge. The purpose of all this is to prevent possible soil pollution and other kinds of risk involved in accumulation in the food chain.

Introduction

Water pollution has been increasing at the same rate as man's activity has developed on a domestic, industrial and agricultural level with increasing water consumption. This is why the need arose for regeneration to remove all its polluting load such as solid waste, microorganisms and a wide variety of soluble substances.

Thus, pollution is removed from water but a by-product is generated known as sewage sludge, which joins the long list of waste our society is producing. This is why an outlet for it was sought since otherwise it would involve an enormous loss of energy and general ecological imbalance. At the present time, this sewage sludge is disposed of in various ways but the end intended for it has to be perfectly controlled in order not to cause further pollution; an outlet has to be sought involving the least risks possible for the environment and where the best use can be made of its qualities.

In a country like Spain where, in general, soils are scant in organic matter and organic remains of an animal origin are becoming more and more scarce, it is natural to think that the best system for using this sewage sludge would be for agricultural purposes, with applications as a fertilizing material. Apart from providing organic matter (sewage sludge contains around 50% d.m.), it may also enrich soils with other nutrients like nitrogen (1–7% d.m.), phosphorus (1–5% P_2O_5 d.m.), potassium (0.1–3% K_2O d.m.) and other elements (most originating from sewage sludge stabilization treatments).

However, not all sewage sludge characteristics are positive in this sense since potentially toxic elements may be found within its composition. By definition, it is a heterogeneous material since it depends on wastewater, on the technology used and on the time of the year and thus industrial effluent will provide more polluted sewage sludge than that from treating wastewater of another type, mainly urban in nature.

Amongst negative aspects of applying sewage sludge as fertilizer its pathogen microorganism, heavy metal and certain organic compound content mainly stand out; whilst the former can be removed by treatment (composting) to obtain a well conditioned product, the latter have to be watched over both with respect

to their content and to their possible transfer to the soil and living beings.

Sewage sludge displays a large amount and variety of microorganisms depending on its effluent of origin and how long they remain will depend on the conditions of the environment where they live and the treatments the sewage sludge has undergone. Those which have been stabilized by anaerobic digestion may have the number of their pathogens reduced by as much as 90%. These, then, are the best for agricultural use.

What are called heavy metals is a group of metal elements, metalloids and non-metals like As, B, Cd, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Se and Zn, etc. which, though found in sewage sludge in relatively small amounts compared with its other components, may be excessive in many cases and represent a risk both in their toxicity in small concentrations and in their endurance and accumulative effect. The cycle such heavy metals undergo in the environment passes through any medium and may affect any of the beings populating it. Long term effects occur in the different links in the food chain. In addition, the antagonic and synergetic effects they have on other elements, which in most cases are essential to life, must not be forgotten.

Other substances which can be named as possible pollutants within sewer sewage sludge cover a wide group of organic compounds where most are characterized by being found in very low concentrations but they are very dangerous for their accumulative and enduring effects. Amongst such substances are PCBs (Polychlorobiphenyls), phytosanitary products, dioxins, organochlorated compounds and a long list of organic substances, all originating in industrial wastewater.

Legal regulations

The conclusion may be drawn, from all the foregoing, that the agricultural application of sewage sludge has to be made in a rational fashion, subject to prior experiments and always subjected to regulations which control this type of practice at any time and in all countries. This is why a series of regulations has been in force for some time now both at Community level and in each of the Member States dealing with regulating the agricultural use of this sewage sludge as best possible.

Sewage sludge used in agricultural operations was not included in Council Directive 75/422/EEC of 15 July, 1975 relating to waste. However, it was affected by the measures provided for in Council Directive 78/319/EEC of 20 March, 1978 relating to toxic and hazardous waste, since they are also applicable to sewage sludge inasmuch as it may contain or be polluted by matter or substances mentioned in Appendix A to said Directive, which represent a risk to human health or to the environment. For the same reason, in Spanish legislation, it is included in Basic Act 20/1986 of 14 May on toxic and hazardous waste. According to this Act's provisions, the management of sewage sludge or activities leading to its recovery must ensure that the final destination involves no danger at all whilst at the same time requiring such waste and its destination to be registered in order to facilitate information collection and monitoring by the authorities.

According to Directives 75/440/EEC and 80/68/EEC, sewage sludge must be used under such conditions that soil and surface and ground water protection is guaranteed.

This was why it was necessary to provide regulations ensuring they would be protected against the harmful effects of uncontrolled sewage sludge use. Whilst the latter displays useful agronomical properties, applying it must not harm soil quality and plant production, since certain heavy metals may be poisonous to plants and people. This has led to establishing limits with respect to their content in soil and in sewage sludge used.

Since it is necessary to control the quality of sewage sludge and the soil to which it will be applied, it is advisable to have a certain amount of related information which is to be periodically sent to the Commission. Taking this into account, the latter will make proposals if necessary to guarantee greater protection for the environment and soils.

With the purpose of standardizing all these circumstances, Council Directive 86/278/EEC of 12 June, 1986, was brought out. Its purpose was to regulate the use of sewage sludge in agriculture in order to prevent noxious effects in plants, soils, animals and human beings as well as promoting its correct use. According to this Directive, sewage sludge must be treated before agricultural use although under certain conditions, Member States may authorize the burial or injection of other types of sewage sludge into soil, provided no risk at all is involved. Its Appendices lay down certain limit values for heavy metals which it may contain:

a) Limit values for heavy metal concentration in soils: treated sewage sludge may not be applied to

soils displaying a heavy metal concentration higher than that laid down.

b) Limit values for heavy metal concentration in sewage sludge earmarked for agricultural use : treated sewage sludge for application to soil shall not exceed the limit values as laid down in its heavy metal content.

c) Limit values for annual amounts of heavy metal which may be introduced into soils, based on a ten year average: the maximum amounts of sewage sludge which may be applied per $ha^{-1}year^{-1}$ will be those which do not exceed the limit values set in accordance with the heavy metal content of the soil and sewage sludge to be used.

In addition, sewage sludge and soil sampling and analysis reference methods are included and the frequency of such analysis and of the specific parameters to be determined in them is mentioned in each case.

Likewise, member States shall forbid the use of waste sewage sludge on grazing land or animal feed crops, on horticultural and fruit crops (except fruit trees) and on horticultural or fruit crops in contact with the soil which are eaten raw, within terms which shall be set as per the circumstances of application and the crop itself.

Likewise mention is made of the possibility of the pH of soil to which sewage sludge is applied being less than 6 and thus the mobility of the heavy metals increasing and the possibility of transfer to the crop being much greater, with which limit values as set could be reduced.

Article 16 of this Directive 86/278/EEC lays down that member States shall bring the legal, statutory and administrative provisions necessary to conform to the said Directive into force in a term of three years as from its notification and they shall inform the Commission of the text of the provisions of internal Law they may adopt on them.

Royal Decree 1310/1990 of 29 October (published in the B.O.E. of 1 November, 1990) whereby the use of sewage sludge in the agricultural sector is regulated, arose from the need to transpose the aforesaid Directive 86/278/EEC to internal Spanish Law with the purpose of harmonizing our legislation and applying the same within the terms provided for, whilst laying down a regulation framework enabling sewage sludge production and its agricultural use to be reconciled.

This Regulation proves to be a perfect transfer of the Community Directive as it almost literally reproduces the conditions as set thereby. In addition, it could not be expected that Spain, with conditions better than other countries for treating and using sewage sludge, was to be more demanding in its regulation. Spanish soils are generally scarcer in organic matter and have a serious desertification problem. Combined with high pH in most of them, using sewage sludge becomes a highly recommendable agricultural practice.

This Royal Decree's pertinent Appendices also lay down the limit values of heavy metals (Table 1) where soils with a pH above or below seven are differentiated. The latter are where the highest values included in Directive 86/278/EEC are authorized since under these conditions, the mobility of these metals noticeably diminishes. Only in the case of copper, nickel and zinc are the limit values of concentration in soils somewhat higher than the Community's and this is an optional responsibility of Member States contemplated in the Directive for soils with a pH constantly higher than seven.

This Royal Decree 1310/1990 empowers the Ministry of Agriculture, Fish and Food to decree the regulations necessary for developing and complying with the same. It establishes a series of controls which the Spanish Regional Governments must undertake to monitor the use of sewage sludge in agricultural operations and so the National Sewage Sludge Register was created, under the said Ministry.

Thus it became necessary to standardize information and lay down the channels for its final compilation in fulfilment of the Commission's mandate (Directive 86/278/EEC, article 17) for drawing up a synthesis report on the use of sewage sludge in agriculture, specifying amounts used, criteria used and difficulties found.

By article 5 of the Ministerial Order of 26 October, 1993 on the use of sewage sludge in the agricultural sector (B.O.E. of 5 November, 1993), also dealt with in article 8 of Royal Decree 1310/1990, the National Sewage Sludge Register is assigned to the Directorate General of Agricultural Production and Markets (Subdirectorate General of Agricultural Production Media). Likewise, it lays down that this register shall contain information relating to the national Census of treatment plants (annual amount of sewage sludge produced, its treatment and destination) and the Entities engaged in the agricultural use of sewage sludge (composition, treatment and application areas). The information which may be requested for drawing up this Register is detailed in Appendices I and II.

Favourable climate conditions in Spain enable waste treatment and final destination solutions to be easily found; another possibility is agricultural and

Table 1. Limit values of heavy metals

Limit values of heavy metal concentration in soils (mg kg^{-1} d.m.)		
Parameters	Limit values	
	Soils with pH less than 7	Soils with pH over 7
Cadmium	1	3.0
Copper	50	210.0
Nickel	30	112.0
Lead	50	300.0
Zinc	150	450.0
Mercury	1	1.5
Chrome	100	150.0
Limit values of heavy metal concentration in sewage sludge (mg kg^{-1} d.m.)		
Parameters	Limit values	
	Soils with pH less than 7	Soils with pH over 7
Cadmium	20	40
Copper	1000	1750
Nickel	300	400
Lead	750	1200
Zinc	2500	4000
Mercury	16	25
Chrome	1000	1500
Limit values for annual amounts of heavy metals which can be introduced into soils based on a ten year average (kg ha^{-1} $year^{-1}$)		
Parameters	Limit values	
Cadmium	0.15	
Copper	12.00	
Nickel	3.00	
Lead	15.00	
Zinc	30.00	
Mercury	0.10	
Chrome	3.00	

forestry use as an organic amendment of the compost produced from sewage sludge. Thus, if these are products marketed as such amendments, their use in agriculture is subject to Spanish legislation on fertilizers and the like appearing in Royal Decree 72/1988 of 5 February, 1988, subsequently modified by Royal Decree 877/1991 of 31 May, 1991, Ministerial Order of 14 June, 1991 (B.O.E. of 19 June, 1991), Resolution of the Secretariat General for Agricultural Productions and Markets of 31 July, 1991 (B.O.E. of 9 August, 1991) whereby the application for registration in the Fertilizers and Like Product Register is processed.

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