CIWM _PAS paper

Working Title "Where is PAS110 going?"

Authors: Andrew Godley[1], Paul Bardos[2], and Stephen Wise[1]

[1]Ricardo-Energy and Environment, Gemini Building, Fermi Avenue, Harwell, Didcot, OX11 0QR.

[2]r3 Environmental Technology Ltd, H9, TOB1, University of Reading, Earley Gate, Reading, RG6 6AT.

Introduction

The publically available specification (PAS100) for composts has been in existence since 2002 and has been periodically revised with PAS100:2011 being the current version. This specification, alongside the Quality Protocol for composts, confers end of waste status for many biowaste derived composts. More recently in 2010 the analogous PAS110 specification and quality protocol for digestates were published. The most recent version of PAS110, published in 2014, departs significantly from the previous version and from its sibling PAS100 compost specification when setting limits for potentially toxic elements (PTEs).

Achieving end of waste (EoW) status for any product generated from the processing of waste is an important step for the recycling of materials in the UK as it means the product is no longer regulated as a waste. In the UK EoW status is achieved by compliance with quality protocols (QP) and/or publically available specifications (PAS). In principle EoW status implies that there are very low and acceptable risks from any hazards that might be associated with product. Several QPs and PAS have now been developed for different waste derived products. Implicit within any PAS is that it consists of a description of the required product quality including maximum permitted levels of contaminants.

Both PAS100 and PAS110 exclude sewage sludge and "compost like output" (CLO) from mechanical biological treatment (MBT) of mixed waste as feedstocks to make a PAS compliant product. The rationale for this is based on an opinion that segregation of materials at source fundamentally reduces quantities of and hence risks from contaminants. However because of the nature of biowaste digestates it may be arguable whether there really is any less risk from PTEs from digestates complying with PAS110 compared with sewage sludge derived digestates. Yet the PAS110 compliant digestates are allowed EoW status. This article examines how this position has arisen and raises the criticism that the PAS110 is subjective rather than based on sound and objective risk assessment of hazards associated with the product.

Maximum permissible PTE contents in the PAS100 compost specification are based on units of mg/kg dry matter of compost. It is worth noting that the origin of the PAS100 was in a standard developed by a trade association in response to marketing needs. This standard was subsequently reviewed and extended during the PAS process. However, the PTE limits were not determined on the basis of formal risk assessment, but on a review of numbers in previously existing standards, modified for some PTEs on the basis of being "as low as reasonably achievable". The limits also do not cover all potential PTEs of concern (as we shall see below). Attempts have been made to justify these limit values by reference to limit values derived for contaminated land assessment. However, this is to misunderstand the critical importance of clear conceptual models of source –pathway-receptor linkages and the use of appropriate exposure modelling. I.e. the comparisons are not appropriate. It is not even clear from the PAS which receptors the limit values are intended to be protective of.

The PAS 100 PTE limit values were then adopted into the emergent PAS-110 limits for digestates (without formal risk assessment). The PAS100 limit values for PTEs are presented on the basis of concentrations on a dry matter (dry solids) basis. As composts generally have a high dry solids content (typically >40%) these units present little problem in everyday understanding. Digestates, on the other hand, are more diverse and the word "digestates" may be used to describe the whole output from an AD process (typically very low solids), the separated solids (fibre) or the separated liquor. The dry matter content may therefore vary depending on the product type from very little <3% in a separated liquor to >90% in a heat dried pelleted digestate. Some operating plants have found compliance with directly transcribed PAS100 limit values based on dry matter contents problematic, in particular for very low solids digestates.

Composts tend to have a wider range of potential uses than digestates. Whilst composts may be used in a wide variety of outlets such as agriculture, land restoration/landscaping, and horticultural growing media and soil improversIn practice virtually its only significant outlet in application to land in agriculture, with some use in land restoration (WRAP 2014). This limitation on outlets and the variable dry matter content of digestate has had an impact on the PAS110 development.

In the first digestate specification (PAS110:2010), PTE limits were based on the same absolute values as mg/kg dry matter (dm) as in the compost specification PAS100.However, there was the provision that if the digestate was applied to agricultural land these limits may be exceeded if the PTE application rates and PTE soil limits that are applied to sewage sludge applications to agriculture are applied (Table 2).

Table 2: PTE limits for application of sewage sludge to agricultural land (from CoP SS 2006)

	Maximum soil PTE concentration (mg/kg dry solids)				Maximum average annual PTE addition over a 10 year period (kg/ha)
pH	5-<5.5	5.5-<6	6-7	>7	
Zn	200	200	200	300	15
Cu	80	100	135	200	7.5
Ni	50	60	75	110	3
	For pH of 5 and above				
Cd	3				0.15
Pb	300				15
Hg	1				0.1
Cr	400				15
Mo	4				0.2
Se	3				0.15
As	50				0.7
F	500				20

Hence in the first version of PAS 110 and its associated QP EoW status could be attained for digestates applied to agricultural land (almost exclusively the only outlet available) without any product quality specification for PTEs. It therefore applied the same rules as for treated sewage sludge application to land which is applied under The Sludge use In Agriculture Regulations (1989) as a waste. This then leads to an inconsistency in regulation where the same rules apply to a waste (treated sewage sludge) and an end of waste product (PAS110 compliant digestate). This

inconsistency could be argued as diluting the validity of EoW status if it provides no greater risk mitigation than that given to sewage sludge which is, of course, regulated as a waste.

The new and current PAS110:2014 specification has a revised approach for dealing with the PTE issue where PTE limits are present as ranges based on the level of N in the digestate (Table 3). Therefore the PTE limits have become linked to the fertiliser value of the digestate.

Table 3: PTE limits in the PAS110:2014 limked to N content of the digestate (mg/kg fresh weight)

	Total nitrogen ranges in digestates (kg/t fresh weight)									
	<1	1-1.9	2-2.9	3-3.9	4-4.9	5-5.9	6-6.9	7-7.9	8-8.9	9+
Cd	0.12	0.24	0.36	0.48	0.6	0.72	0.84	0.96	1.08	1.2
Cr	8	16	24	32	40	48	56	64	72	80
Cu	16	32	48	64	80	96	112	128	144	160
Hg	0.08	0.16	0.24	0.32	0.4	0.48	0.56	0.64	0.72	0.8
Ni	4	8	12	16	20	24	28	32	36	40
Pb	16	32	48	64	80	96	112	128	144	160
Zn	32	64	96	128	160	192	224	256	288	320

As a first impression the rational for this revised approach to PTEs seems logical in the sense that virtually all digestate is used in agriculture or field horticulture (WRAP 2014) where its main benefit would be as a fertiliser, and because most of the N content in digestates is present in readily plant available ammonium form. This approach would appear to get round the issue of using limits with units based on mg/kg dry matter for digestates with very low dry matter contents such as whole digestates and separated liquors.

However, closer scrutiny reveals that some flaws and inconsistencies in this approach remain which arguably raises several other issues. These revised limits are based on N contents in ranges and when these are considered at the lower end (values more likely to be found in digestate liquors) there are significant inconsistences arising. For example a digestate having 0.99 kg N/t might have a Zn content of 32 mg/kg fresh weight (fw) and meet the criteria whilst another digestate having 1 kg N/t (just 1% more N) can meet the criteria with 100% more Zn (64 mg/kg fw).

Additionally if a digestate having 1 kg N/t and 64 mg/kg fw was applied to give a given N fertiliser application it would add twice as much Zn to the soil compared with a digestate that had 10 kg N/t and met the criteria of 320 mg Zn/ kg fw. This illustrates some flexibility within the PAS110:2014 limits with potential implications of permitted levels of pollutants added to soils during use.

Coming back to the position of sewage sludge if the average UK sewage sludge composition was recalculated for the same 1 kg/t N range then sewage sludge would fall well within the PAS110:2014 PTE limits. Again raising the query of whether PAS110 really provides any greater risk mitigation than a waste management activity and so why it can achieve EoW status. (Table 4).

Table 4: Estimated PTE content of average UK treated sewage sludge compared with PAS110:2014

	Average sewage sludge composition mg/kg DS	Composition sewage sludge if at 1 kg N/t fresh weight (mg/kg)	PAS110:2014 compliant digestate limit at same 1 kg N/t content (mg/kg)
N	38,162	1,000	1,000
Cd	1.38	0.036	0.24
Cr	78.2	2.05	16
Cu	329	8.6	32
Hg	0.903	0.024	0.16
Ni	31.7	0.83	8
Pb	121.6	3.19	32
Zn	682	17.9	64

Furthermore, the revised PAS110:2014 does not contain the previous requirement that PTE applications to agricultural land should not exceed the sewage sludge application and soil limits. However reference is made to the code of practise "Protecting our Water, Soil and Air. A Code of Good Agricultural Practice for farmers, growers and land managers" (CoP WSA 2009).

How close then might different PAS110:2014 compliant digestates come to exceeding the PTE application rates applying to sewage sludge? As example if the maximum wheat N fertiliser requirements of 280 kg N/ha (from the Fertiliser Manual RB209) were supplied by digestate it looks like the annual soil limit for Zn from the sewage sludge regulations might potentially be exceeded by a PAS110 compliant digestate with 1 kg N/t and the limits for the other PTEs nearly exceeded (Table 5). This suggests that there is little margin of safety between the PAS110 metal limits and soil protection which does not sit comfortably with end of waste status.

Table 5: Potential PTE loadings to soil from PAS compliant digestates compared with sewage sludge regulation limits.

	Maximum permitted metal content (mg/kg) of PAS110 compliant digestate of 1 kg N/t	Maximum permitted metal content (mg/kg) of PAS110 compliant digestate of 10 kg N/t	Sewage sludge application limit (annual average over any 10 year period, kg.ha)	PAS110 compliant digestate 1 t N/kg soil loading	PAS110 compliant digestate 10 t N/kg soil loading
Cd	0.24	1.2	0.15	0.067	0.034
Cr	16	80	15	4.48	2.24
Cu	32	160	7.5	8.96	4.48
Hg	0.16	0.8	0.1	0.045	0.022
Ni	8	40	3	2.24	1.12
Pb	32	160	15	8.96	4.48
Zn	64	320	15	19.92	8.96

Add to this that there are concerns about arsenic in food. Arsenic is regulated by the sewage sludge regulations, but is not limited in PAS 110 compliant digestates. These re additional grounds to query where is the justification for the end of waste status for PAS110 compliant digestates or the alternative view where is the justification for sewage sludge not having end of waste status.

However we recognise that in practice digestate application to agricultural soils is not likely to be aimed at providing all the N requirement and hence actual digestate loadings might likely be lower.

So what overall points are we raising in this article? Well there seems to be a problem with defining limits for PTEs in digestates because of the liquid state of many digestate products. In order for digestates to retain EoW status within the PAS110 specification, quite lenient PTE criteria have been devised, which could lead to significant quality differences in dilute liquid digestates. PTE controls required for digestates are no better than that applied to sewage sludge, indeed may be poorer especially for arsenic, and yet digestates can achieve EoW status. We ask the question of whether there are underlying stakeholder interests driving the PAS110 rather than sound science and whether it would be more prudent to have a level playing field based on good science. We believe that this a debate which should be had in the open, and we hope that this short article will provoke some responses and discussion.

References

CoP WSA (2009). Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers and land managers. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf

CoP SS (2006). Code of Practice for Agricultural Use of Sewage Sludge. http://adlib.everysite.co.uk/adlib/defra/content.aspx?doc=4196&id=4197

Fertiliser Manual RB209. Fertiliser manual (RB209) Version 8 including the 2011 errata. http://www.ahdb.org.uk/projects/CropNutrition.aspx

WRAP (2014). A survey of the UK Anaerobic Digestion industry in 2013. http://www.wrap.org.uk/sites/files/wrap/A_survey_of_the_UK_Anaerobic_Digestion_industry_in_2013.pdf