European Commission

Biodegradable Waste subject to biological treatment (compost/digestate)

Product quality criteria

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Organic pollutant monitoring requirements

Joint Research Centre

Introduction

- **Issue**: need for requirement for organic pollutant measurements questioned by TWG experts
- **Used arguments**:
  - It is not clear why the 4 parameters PAH, PCB, PCDD/F and PFC have been chosen
  - Analysis cost organic pollutants= very high
  - Organic pollutants allegedly do not appear in source separated materials and hence can be avoided by reducing input material list
  - It is not clear how the limit values have been set for (organic) pollutants

Why 4 parameters PAH, PCB, PCDD/F, PFC?

- Table 9 in 3rd WD shows that PAH, PCB and PCDD/F are most regulated organic pollutants
- Sewage sludge compost showed frequent exceeding of existing PFC limit values
- Other parameters less frequently encountered in existing legislation/literature or showed few limit exceedings

	AT (a)	BE (Fl) (b)	BE (Wal; digestate) (c)	DE (d)	DK (e)	FR (compost) (f)	LU (g)	SI (h)	CH (i)
PAH (mg/kg dm)	**6** (sum for 6 congeners **)	Individual limits for 10 congeners	**5** (PAH_{16})		**3** (sum for 11 congeners***)	Individual limits for 3 congeners	**10*** (PAH_{16})	**3**	**4*** (PAH_{16})
PCB (mg/kg dm)	**0.2** (PCB_6)	**0.8** (PCB_7)	**0.15** (PCB_7)		**0.08*** (PCB_7)	**0.8** (PCB_7; only for sewage sludge compost)	**0.1*** (PCB_6)	**0.4** (1st class) **1** (2nd class) (PCB_6)	
PCDD/F (ng I-TEQ /kg dm)	**20**		**100**				**20***		**20***
PFC (mg/kg dm)	**0.1**			**0.1**					
AOX (mg/kg dm)	**500**		**250**						
LAS (mg/kg dm)			**1500***		**1300**				
NPE (mg/kg dm)			**25***		**10**				
DEHP (mg/kg dm)			**50***		**50**				

- Hence original proposal focused on these 4 parameters

Analysis costs organic pollutants

- Recent data provided by stakeholders: estimated cost in Euro per analysis of compound set

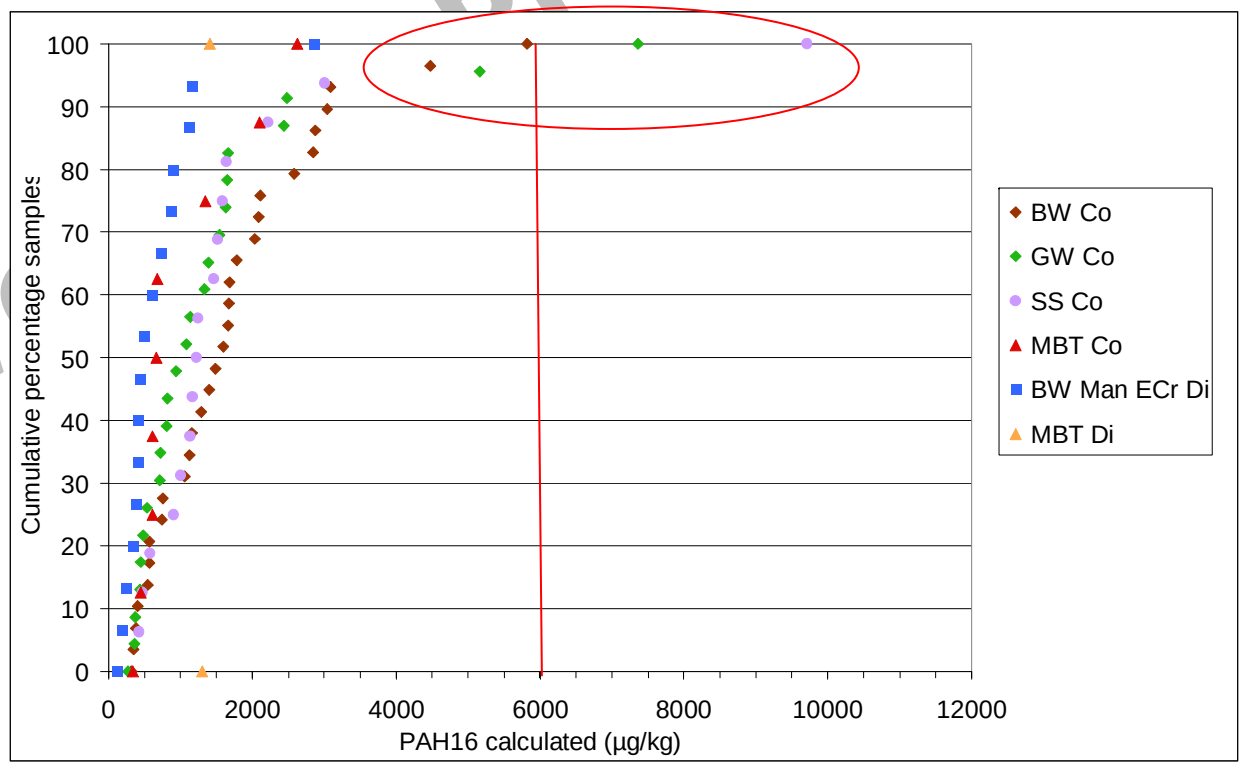
Source	Heavy Metals	PAH	PCB	PCDD/F	PFC
AFOR/REA	43	140	85	300	150
EBA		85	85	345	
EPA DK		245	480	425	
Participating lab FATE		100	100	1000	
NL	137	125	156	741	
Average	90	139	181	562	150

- Conclusion:
  - PAH and PFC analysis least expensive, followed by PCB, but PCDD/F analysis very expensive
  - PAH and PCB analysis slightly more expensive than e.g. heavy metals

Occurrence organic pollutants: PAH

- Occurrence PAH_{16} in compost and digestate **in JRC Sampling and Analysis Campaign** (PAH_{16} extrapolated from PAH_{12}, Ntot= 102):

- Biowaste and sewage sludge compost have highest overall PAH concentrations
- Green waste compost and MBT compost generally less loaded
- Digestate displays lowest loadings
- 2 BW Co, 2 GW Co and 1 SS Co sample show very high loading



Occurrence organic pollutants: PAH (2)

- Occurrence PAH_{16} in compost and digestate **from source separated input materials** (recent data from literature and stakeholders)

Source	Year	Sample number	N≥3 mg/kg (50% of proposed limit)	N≥6 mg/kg (proposed limit)
WRAP, UK	2011	10	4	1
Bayern, DE	2007	29	>2	1
Bad.-Württemb., DE	2007	29	9	0
BAFU, CH	2012	26	11	5
EPA, IE	2009	6	>1	1
Brändli et al., CH	2007	72	38	9
Sum		**172**	**>65**	**17**
			>38%	10%

➔ Literature confirms non-negligible occurrence of PAH_{16} in compost and digestate materials, **even when derived from source separated input** !

Occurrence organic pollutants: PAH (3)

- PAH in output materials appears to be linked to undesirable input materials (treated wood in IE EPA study, road side material in BAFU CH study) → measurement of PAH can help support market confidence in high quality product
- Biodegradation?
  - PAHs are known to biodegrade to a certain extent: half-lives depend on compound type and literature source and range from days to decades
  - BUT: biodegradation/transformation ≠ mineralisation →metabolites may be very persistent (e.g. Meyer and Steinhart, 2001) or PAHs can be transformed in other toxic compounds such as oxy-PAHs (Lundstedt et al., 2007)
  - Hence, precautionary approach may be appropriate

Occurrence organic pollutants: others

- Proposed limits in 3rd WD were 0.2 mg/kg for PCB, 0.1 mg/kg for PFC and 30 ng I-TEQ/kg for PCDD/F
- JRC Sampling and Analysis Campaign:
  - PFC (Ntot=108): limits exceeded by 3 out of 15 sewage sludge compost samples; no exceedings of limits or 50% of limit values by any other compost/digestate sample
  - PCB and PCDD/F (Ntot=20): no exceedings of limits or 50% of limit values by any compost/digestate sample
- Literature on compost/digestate **from source separation**: low loadings

Compound class	Total sample number	N>50% of proposed limit	N> proposed limit
PCDD/F	57	3	2 (WRAP, UK; Bayern, DE)
PCB	168	3	0
PFC	66	0	0

How have limit values been proposed ? (1)

- Taking into account 4 EoW conditions:
  - Can the material be **used** at this limit concentration?
  - Will the limit allow sufficient materials to enter the **market**, while ensuring market confidence by being strict enough?
  - Are limits in line with **existing legislation/standards**?
  - Is **environmental/human health protection** guaranteed ?

	AT (a)	BE (Fl) (b)	BE (Wal; digestate) (c)	DE (d)	DK (e)	FR (compost) (f)	LU (g)	SI (h)	CH (i)
PAH (mg/kg dm)	**6** (sum for 6 congeners **)	Individual limits for 10 congeners	**5** (PAH_{16})		**3** (sum for 11 congeners***)	Individual limits for 3 congeners	**10*** (PAH_{16})	**3**	**4*** (PAH_{16})
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- Hence any proposal should aim at a balance between all 4 EoW conditions.

How have limit values been proposed ? (2)

- Example of proposed limit of 6 mg/kg dry matter for PAH_{16}

4 EoW conditions should apply:

- Can the material be **use**d at this limit concentration?
- Will the limit allow sufficient materials to enter the **market**, while ensuring market confidence by being strict enough?
- Are limits in line with **existing legislation/standards**?
- Is **environmental/human health protection** guaranteed ?

Checks for compost/digestate:

- No known problems for use, no special precautions needed. Use possible within existing national legislative frameworks.
- Around 90% of compost/digestate materials seemed to meet proposed criterion in JRC campaign and literature.
- Same limit value as in proposal for revision of EU sludge and fertilizers legislation; situated around average of comparable MS legislation on fertilizers/products.
- Literature suggests that limit value will not lead to adverse environmental or human health effects

Summary and proposed modification

- **Summary**:
  - PAH_{16} : occurrence is non-negligible, fate is unclear, source seems linked to undesired input materials and the measurement cost is relatively low
  - PCB, PCDD/F and PFC display lower loadings and have a generally higher measurement cost
- **Proposed modification**:
  - Reduce mandatory organic pollutant measurements to PAH_{16} instead of 4 types (PCB, PCDD/F, PFC no longer mandatory)
  - Allow for substantial measurement frequency reduction following recognition year for well performing plants (1 sample per 50 000 tonne input material or).
    - Would well defined spot monitoring program be an alternative ?
  - On condition that input materials do not contain sewage sludge
  - Future revision to depend on more extensive data availability

Limit values for Cu&Zn, other PTEs and physical impurities

Introduction

- **Issue**: limit values for Cu&Zn, other PTEs and physical impurities are too strict/not strict enough
- **Used arguments**:
  - 3rd WD does not base limits on risk assessment and micronutrient need
  - Locally high background concentrations in certain regions (UK, IT), due to historical pollution or geological features, make it difficult to meet limits
  - Physical impurities only cause visual nuisance and are inert
  - A considerable number of materials currently on the market will not meet the requirements

Assessment

- 3rd WD does not base limits on risk assessment and micronutrient need
  - Criteria should take into account 4 WFD EoW conditions, hence limits should be in line with use/market/existing standards&legislation as well
  - Available risk assessments generally focus only on safe soil concentrations, but studies also link high background metal concentrations in ground- and surface water to fertilization (Bonten et al., Alterra Report 2024, 2010; EFSA, 2010)
  - In general, it seems that Cu and Zn levels could be slightly relaxed, given the micronutrient value, provided high values are clearly labelled to allow protection of extremely vulnerable areas
- Locally high Pb, Ni background concentrations in certain regions (UK, IT), due to historical pollution or geological features, make it difficult to meet limits
  - Pb, Ni, etc have no micronutrient value. Increasing the limits entails risk of targeted dilution of polluted input materials.

Assessment

- Physical impurities only cause visual nuisance and are inert
  - Visual nuisance entails risk of undermining market confidence (historical cases)
  - Physical impurities are not inert: leaching, dissolution and ingestion by microfauna can occur
- A number of materials on the market will not meet the requirements
  - Market confidence should not be undermined by opening up markets to materials with low (perceived) quality according to many stakeholders
  - Other recycling possibilities still exist for these materials

Summary and proposed modification

- **Summary**: Cu and Zn levels could be slightly relaxed, given the micronutrient value, provided high values are clearly labelled to allow protection of extremely vulnerable areas
- **Proposed modification**:
  - Allow materials with Cu levels of 100-200 mg/kg and Zn levels of 400-600 mg/kg, provided these are clearly labelled as "Compost/digestate materials with high Cu and/or Zn content"
  - If materials exceed 100 mg Cu/kg or 400 mg Zn/kg, the exact concentration should be indicated

Stability

Product quality criteria
Application of end-of-waste criteria

Introduction

- **Issue**: diverging opinions from TWG experts on need and feasibility of a stability parameter for compost/digestate
- **Used arguments**:
  - Needed to avoid "shred and spread" materials
  - Problems of materials during storage, transport and application
  - "Fresh" materials with high organic matter are needed by the market
  - Existing standards too divergent to allow introduction of a single parameter

Assessment

- Needed to avoid "shred and spread" materials
  - Stability parameter may help in protecting the market against material with incomplete treatment (e.g. masking of high pollutant concentrations by material with high amounts of non-degraded organic matter)
- Problems of materials during storage, transport and application
  - Uncontrolled emissions from materials with high biological activity should be avoided
  - Introduction of a stability parameter could allow for temporary storage outside waste framework
- "Fresh" materials with high organic matter are needed by the market
  - These materials may be better shipped and used under controlled conditions than as uncontrolled products

Assessment

- Existing standards vary too widely to allow introduction of a single parameter
  - Compost
    - Most compost stability standards based on respirometry or self-heating
    - Studies (e.g. WRAP 2009, UK) show that many compost stability standards are well correlated (e.g. Rottegrad IV ≈ 15 mmol O_2/ kg org. matter/h ≈ 16 mg CO_2/g org. matter/d)
    - No Horizontal standards are available, but EN standards exist for OUR and self-heating ("Rottegrad"): EN 16087-1,2
  - Digestate
    - For digestate, fewer standards available (organic acids, biomethane production, respirometry)
    - No knowledge about correlation between existing stability standards for digestate

Summary and proposed modification

- **Summary**: the introduction of a stability requirement could help ensure market confidence in a well treated product and tackle the issue of storage. Harmonization of standards is not yet complete and should be encouraged for possible future revision of EoW criteria.
- **Proposed modification**:
  - For compost: allowed limits are: 20°C temperature rise (Rottegrad IV&V), 15 mmol O_2/ kg org. matter/h and 16 mg CO_2/g org. matter/d; measured according to EN 16087-1,2. Other already existing methods in MS allowed at present.
  - For digestate: allowed limits are respirometric index result of 50 mmol O_2/kg org. matter/h, organic acids content of 1500 mg/l or residual biogas potential of 0.25 l/ g volatile solids.
  - For introduction of new limits and methods for digestate stability: requirements to be as strict as existing systems
  - Requirements to be met for both producing and receiving MS (unless system from producing MS recognized by receiving MS)

Adaptation of measurement frequency in case of input changes

Introduction

- **Issue**: the requirements for resetting the measurement frequency are questionable
- **Used arguments**:
  - 5% may be too strict, especially for materials with low risk such as those derived from source separation

Assessment

- 5% may be too strict, especially for materials with low risk such as those derived from source separation
  - Changes should be better defined and the 5% value may be increased

Summary and proposed modification

- **Summary**: reassessment needed of measurement frequency reset in case of input material change
- **Proposed modification**:
  - Reset needed in case a change of 10%, based on the annual input expressed in weight, of the input materials occurs
  - A change includes the change of supplier, the change of waste type or the geographical change of input materials (change in origin of more than 25 km).
  - A change does not include seasonal variations, nor normal daily fluctuations that also occurred in the recognition year (e.g. natural fluctuations of input from municipal biowaste and green waste collection points)
  - For plants with regular changes (more than one per year), the measurement frequency should remain the one of the recognition year
  - On condition of reduced input material list