



ESPP WORKSHOP

PHARMACEUTICALS AND ORGANIC CHEMICALS IN SEWAGE BIOSOLIDS

MALMÖ 27<sup>TH</sup> OCTOBER 2016

# FATE OF PHARMACEUTICALS AND PERSONAL CARE CHEMICALS IN COMPOSTING OF BIOSOLIDS

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**RAMBOLL**

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*SUMMARY: High technology wastewater treatment plants (WWTPs) are very effective in cleaning of wastewater concerning removal of BOD, nitrogen and phosphor, while removal of xenobiotic organic compounds (XOC's) often is based on a partitioning between water and biosolids. Thus many XOC's and their metabolites can still be found in biosolids removed from the process. Due to a relatively high concentration of minerals and organic matter in the biosolids it is generally considered to be a sustainable practice to recycle the nutrients back to the soil. Composting of biosolids together with shredded straw and garden park waste seems to be a promising means to degrade the present xenobiotic organic compounds before recycling the biosolids to the soil. Full-scale industrial experiments have shown that the composting process has the ability to degrade some pharmaceuticals and personal care products (PCPs) present in the biosolids.*

### 1. INTRODUCTION

Most of the population in EU is connected to waste water treatment plants (WWTPs) via municipal sewerage systems. The municipal wastewater derives from a variety of sources, including households, hospitals, industries, fish farming, and street run off. More than 50.000 WWTPs are operating in the European Union and more than 8 million tons of dry solids are produced per year (Eriksson et al., 2008). In Denmark each citizen on average produces 150 m<sup>3</sup> wastewater per year, which contains approximately 240 mg/L<sup>-1</sup> suspended solids. Most of the suspended solids consist of organic matter that together with minerals, heavy metals and hydrophobic organic compounds end up in the biosolids. High technology WWTP's conduct mechanical, chemical, and biological treatment. After treatment the effluent water is discharged to recipients and in most cases, the biosolids is dewatered, in a second process that turns it into a cake with 11-40 % dry solids.

# THE DANISH SLUDGE DIRECTIVE "SLAMBEKENDTGØRELSEN"

XOCs	mg/kg dry matter
LAS	1,300
DEHP	50
NPE	10
ΣPAH	3

LAS: Linerar alkylbenzen sulfonate  
 DEHP: di(2-ethylhexyl)phthalat  
 NPE: Nonylphenol ethoxylates  
 PAH: Polycyclic aromatic hydrocarbons

Heavy metals	mg/kg dry matter	mg/kg total phosphorus
Cadmium - Cd	0.8	100
Mercury - Hg	0.8	200
Lead – Pb	120	10,000
Nickel- Ni	30	2,500
Chrome - Cr	100	
Zinc – Zn	4,000	
Copper - Cu	1,000	

The use of biosolids on Danish farmland is regulated according to departmental order from the Danish Ministry of the Environment and the EU Directive (86/278/EEC).

Stabilized biosolids can be applied directly on farmland for non-consumption crops if the 4 xenobiotic organic compound group and the content of heavy metals are below the limit.

# COMPOSTING

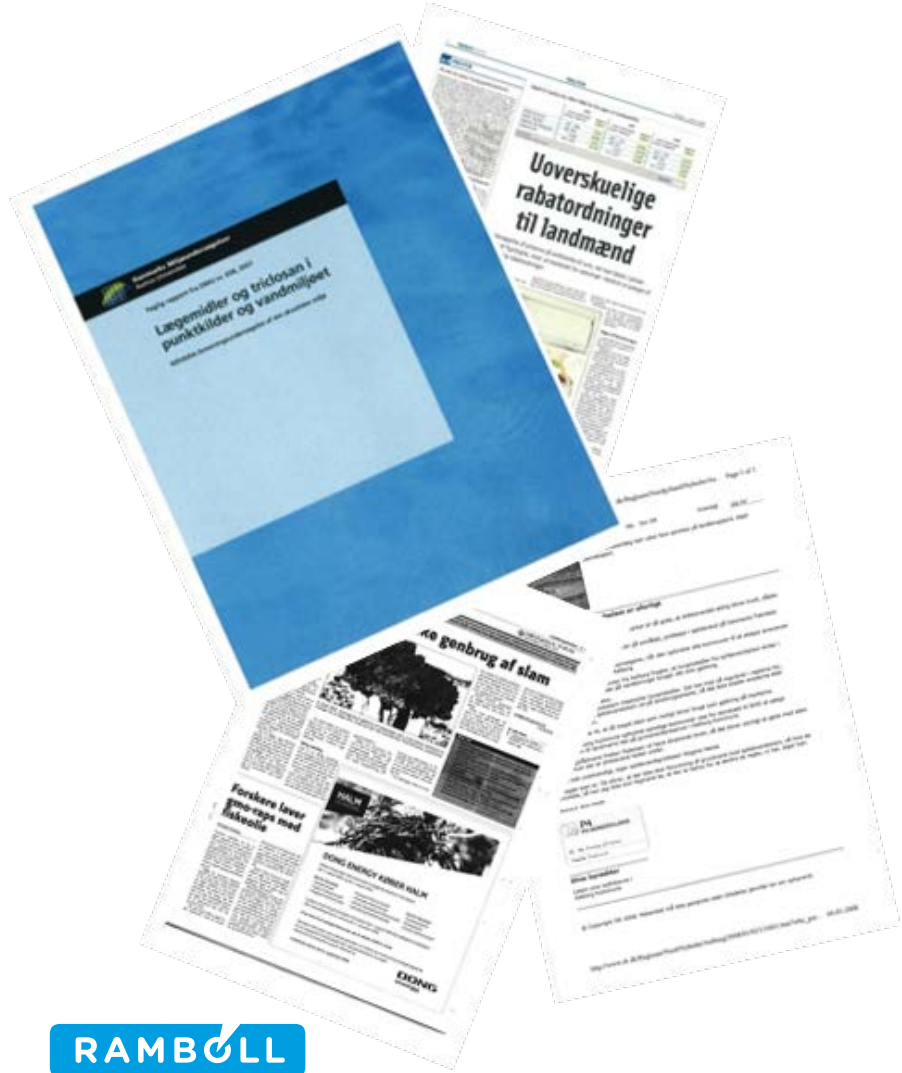
Composting is a treatment process in which organic material such as sewage biosolids is converted into compost through a biological decomposition under aerobic conditions.

Comparing to directly use on farmland, composting has been shown to be a quicker and more effective way to degrade some xenobiotic organic compounds e.g. LAS, DEHP, NPE and PAH.

The most common composting process in Denmark is pile composting.



# SCREENING PROJECT FROM 2008 AARHUS UNIVERSITY (DMU)



- Screening of pharmaceuticals and bioside (triclosan) for human as well as veterinary use
- Samples were collected of influent and effluent as well as biosolids at sewage treatment plants
- In biosolids 8 out of 25 pharmaceuticals were detected
- Triclosan was detected in all samples of sewage biosolids
- Television news, Papers, radio ect.
- Reactions from Politicians, Municipalities and Environmental Organisations

# LITERATURE STUDY

The literature study included the composting process ability to degradation of compounds such as biocides (triclosan), Personal Care Products (PCP), organic xenobiotics (PAH, LAS, DEHP and NPE) and pharmaceuticals.

## Conclusion

- The literature on the subject is scarce - especially in terms of degradation of triclosan, PCPs and pharmaceuticals.
- There is well known ability for the composting process to degrade different xenobiotics such as LAS, DEHP, NPE and PAH.

Previously full scale study	Reduction (%)			
	NPE	LAS	DEHP	PAH
Sewage biosolid composted 20 weeks at Odense Environmental Center	54-86	100	60-81	19-59

- More work was needed.

# PRELIMINARY FULL SCALE INVESTIGATION SAMPLES

## Investigation using random tests of:

- 3 samples of sewage biosolids from Odense NW WWTP, sewage from 200.000 PE.
- 3 samples of matured compost from Odense Environmental Center. The mature compost is composted sewage biosolids (from Odense NW WWTP), garden/park waste and straw. It's containt 14% sewage biosolids.
- Samples were kept in freezer and freeze dried before further cleaning-up procedures.
- Concentration of 20 substances were analysed.



# PRELIMINARY FULL SCALE INVESTIGATION RESULTS (PHARMACEUTICALS)

		Sewage biosolids µg/kg DM	Compost µg/kg DM	Reduction* %
Ibuprofen	Anti inflammatory substances	10,3	<1,5	34,5
Diclofenac		10,7	<1	52,4
Tetracycline	Antibiotics	441	<15	86,0
Estrone	Female sex hormones	8,5	30,3	-1.6
Progesterone		14,8	65,2	-2.2

\*Mass balance calculation based on mean values of 3 samples



# PRELIMINARY FULL SCALE INVESTIGATION RESULTS (PERSON CARE PRODUCT)

		Sewage biosolids µg/kg DM	Compost µg/kg DM	Reduction* %
Triclosan	Biocid e.g. in tooth paste	2.033	110	71,5
Triclosan-me (Metyl triclosan)	Metabolite of triclosan	93	0	43,6
HHCB (Galaxolide)	Musk compound in e.g. cosmetics and detergents	15.133	713	75,3
AHTN (Tonalide)		1.407	217	19,1
DEHP	PVC plasticizer	32.466	3.000	51,6

\*Mass balance calculation based on mean values of 3 samples

# COMPARATIVE STUDIES

Contact was established to Aalborg University to further assess the fate of pharmaceuticals and PCPs by composting.

- Aalborg University (Master thesis; Control of organic chemical's degradation during composting of sewage sludge) investigated degradation of 8 compounds of organic contaminants during composting at KomTek Miljø (municipal composting of sewage biosolids, garden/park waste, different organic residue and straw).
- Degradation was found to take place mainly in the first few days of composting.
- Results are indicative.

	Reduction (%)							
	Triclosan	Triclosan-me	HHCB	AHTN	DEHP	OTNE	TCPP	HHCB-lactone
Preliminary full scale investigation	72	44	75	19	52			
Aalborg University (Pena-Martinez, 2009)	96	95	99	99	99	99	24	94

# FINAL REMARK

- It seems that some pharmaceuticals, personal care products and organic xenobiotics can be reduced during the composting process.
- More work is needed to confirm the results and to establish the proportion of the reduction.



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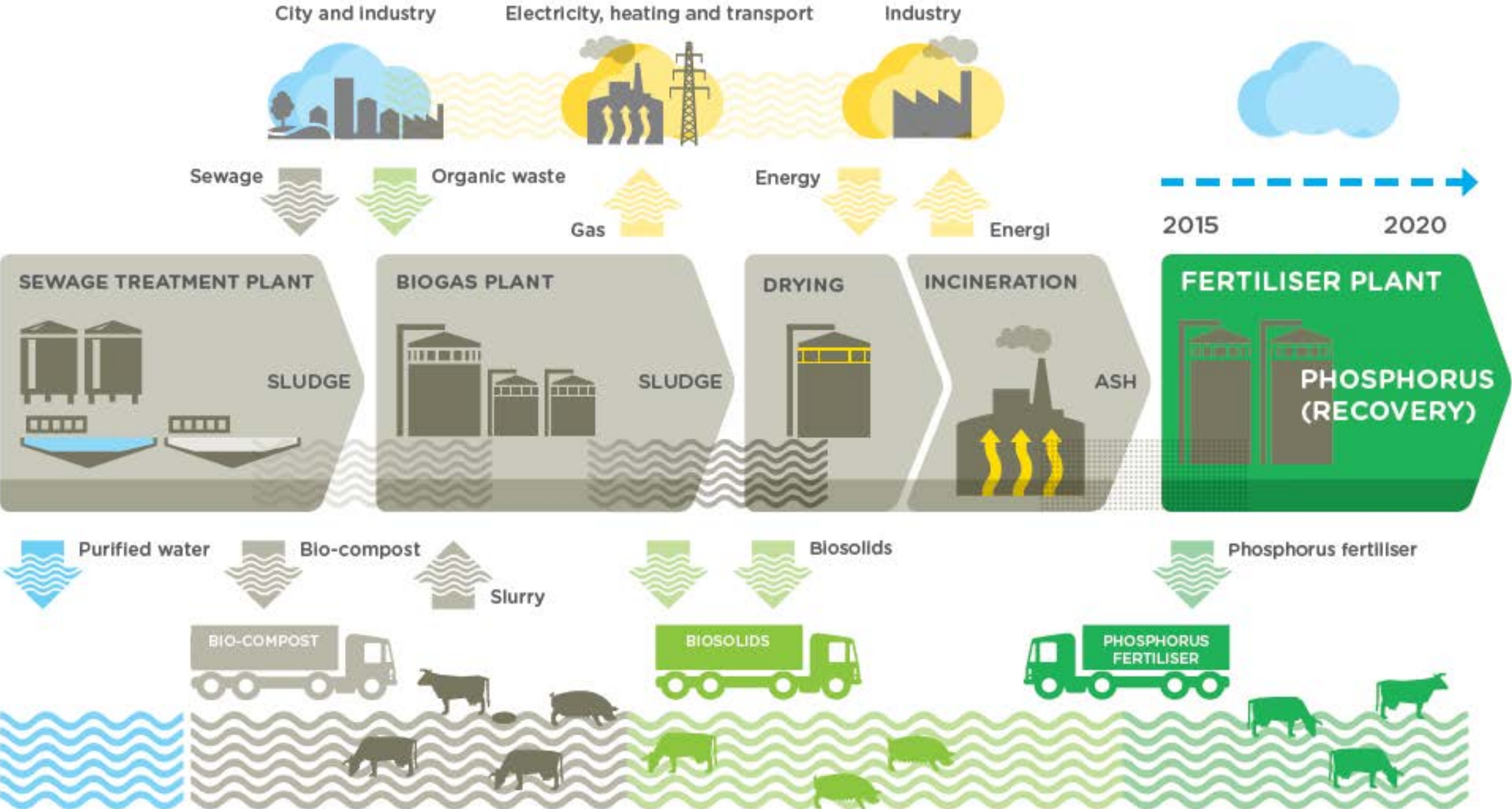
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Recycling of P from sludge ash

Removal of pharmaceuticals from wastewater

Struvite

# RAMBOLLS WORK WITH SEWAGE SLUDGE



THANK YOU !