Green Foundry LIFE
LIFE17 ENV/FI/173

Composting method in cleaning the surplus foundry sand

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Composting method in cleaning and reusing the surplus foundry sand

The objective of the composting method is to

- **degrade the harmful organic substances of surplus foundry sand**
- **produce clean soil material**
- **reuse soil material in new applications**
    - landscaping
    - green construction
    - noise embankments
- **reduce the total amount of surplus foundry sand to be landfilled.**

MEEHANITE TECHNOLOGY

Cleaning foundry surplus sand by composting method

- Composting method has been tested by Meehanite Technology since 2015 with different binder system sand and dust specimens:
    - phenolic Alphaset sand and dust
    - furan sand and dust
    - bentonite sand
    - inorganic binder sand

- Composting method: Surplus foundry sand + animal manure, wood chops, waste sludge mixed → harmful organic substances are degraded by microbes.

- Results: **BTEX** (Benzene, Toluene, Ethylbenzene and Xylene)**, DOC** (Dissolved Organic Carbon)**, phenols, fluoride and PAHs** (Polycyclic Aromatic Hydrocarbon) have been **degraded by 70..80%.**

- National regulation of the Decree for Fertiliser Product (24/11)
  → soil material is clean, hygienized and mature

- Composting process is patented by Meehanite Technology Ltd.

Field construction work

Aeration system and wastewater collection systems

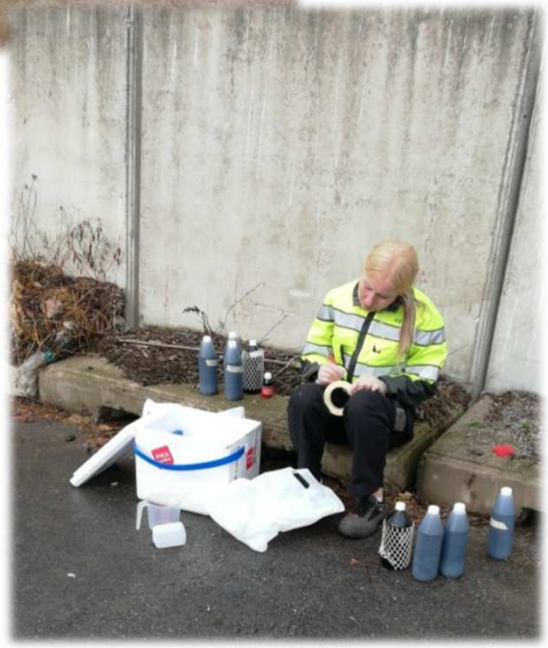
Industrial scale composting tests

Existing field by a waste management center

Composting process

- Turning/mixing the piles
  - → To aerate the compost material
  - → To speed up the process
- Degradation of harmful substances in 5-6 months
- Post-composting / maturation of 5-6 months
  - → mature and hygienized (no Salmonella, E-coli)
  - → no toxic compounds present and plants can grow
- Clean soil material can be reused for landscaping, green construction, noise embankments, etc.
  - → sieved before reuse

Monitoring the composting progress



ANALYSES

- Compost material
- Wastewater samples to access environmental impacts
- Temperature and pH measurements

Compost material regulations

Compost material regulations are set in the Decree of the Ministry of Agriculture and Forestry on ***Fertiliser Products (24/2011): Substrate – Mixture soil (5A2).***

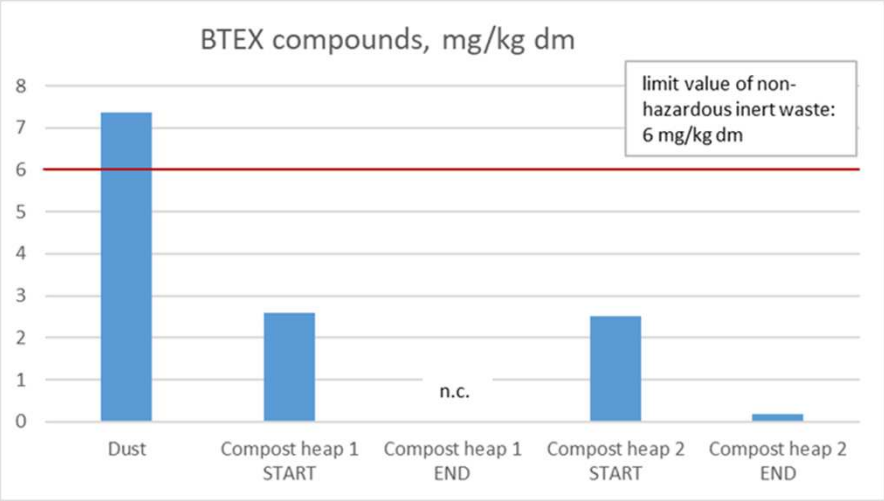
- Limit values and demands for ***heavy metals*** of the end-product, ***pathogens*** **(*Salmonella* and *E. coli*)** and ***impurities*** (weeds, garbage).
- In case surplus foundry sand is used for compost material it must meet the limit values in the ***Government Decree of landfills (331/2013) for non-hazardous inert waste*** for ***harmful metals*** and harmful organic substances.

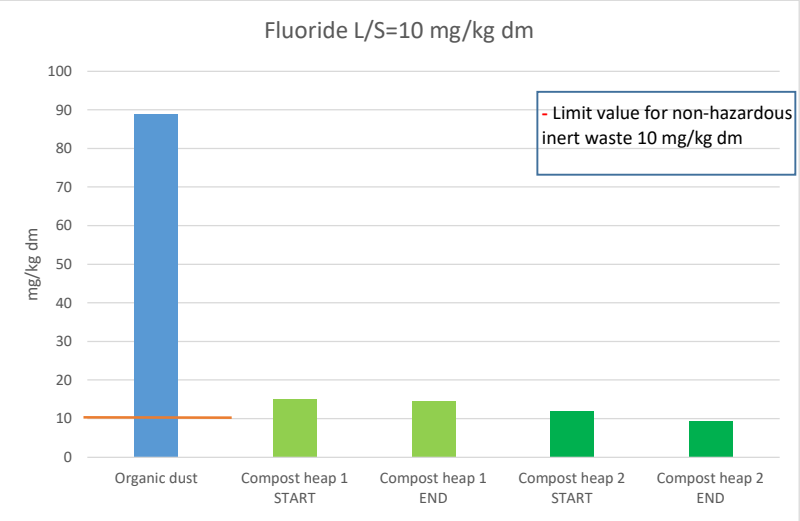
Results of composting tests with organic binder system surplus sands

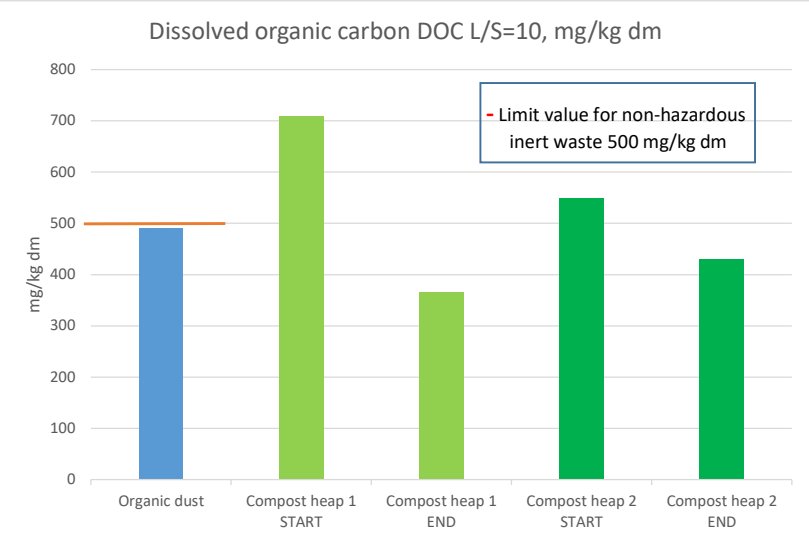
	Dust	Silo sand	Limit value for non-hazardous inert waste	Compost heap 1 (dust) START	Compost heap 2 (sand) START	Compost heap 1 (dust) END	Compost heap 2 (sand) END	**Compost heap 1 (dust) Degradation efficiency**	**Compost heap 2 (silo sand) Degradation efficiency**
DOC, mg/kg dm	4500	1600	500	7800	4700	2100	1700	**73 %**	**64 %**
Phenol index, mg/kg dm	1,20	2,10	1	5,5	1,4	<0,10	<0,10	**98 %**	**93 %**
Fluoride, mg/kg dm	180	23	10	39	6	21	<5,0	**46 %**	**17 %**

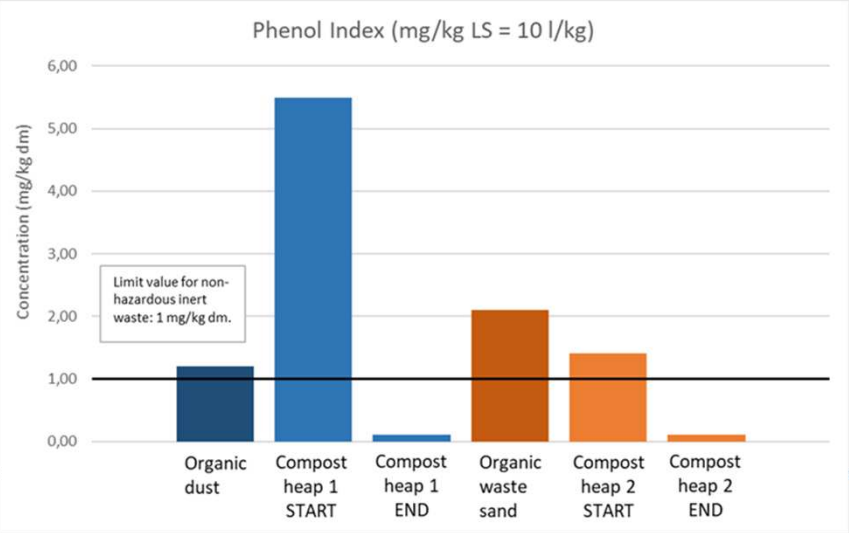
	Dust	Limit value for non-hazardous inert waste	Compost heap 1 (25%) START	Compost heap 2 (30%) START	Compost heap 1 (25%) END	Compost heap 2 (30%) END	**Compost heap 1 (25%) Degradation efficiency**	**Compost heap 2 (30%) Degradation efficiency**
TOC, % dm	12	3	23	25	20	20	**13 %**	**20 %**
DOC, mg/kg dm	2700	500	10000	9800	970	930	**90 %**	**91 %**
BTEX, mg/kg dm	7,38	6	2,60	2,50	0,30	0,29	**88 %**	**88 %**
Fluoride, mg/kg dm	36	10	17	12	8,9	8,9	**48 %**	**26 %**
Sulphate, mg/kg dm	3200	1000	3700	3500	2000	2000	**46 %**	**43 %**

Degradation of harmful substances in composting process









Analyse results of inorganic and organic surplus foundry sands before composting tests

		INORGANIC SANDS						ORGANIC SANDS			
		Sample A1	Sample A2	Sample A3	Sample B1	Sample B2	Sample C	Sample D	Sample E	Limit value for non-hazardous inert waste, 331/2013	Limit value for earth consctruction purposes, 843/2017 (covered bank)
Dissolved organic carbon (DOC)	mg/kg dm	90	37	230	**640**	**680**	**610**	**1600**	**4500**	**500**	**500**
Phenol index	mg/kg dm	<0,1	<0,1	0,11	<0,10	<0,10	<0,10	**2,10**	**1,20**	**1**	**10**
Fluoride	mg/kg dm	<5	5,5	<5,0	<5,0	**41**	**32**	**23**	**180**	**10**	**30**
Molybdenum (Mo) (mg/kg LS = 10 l/kg)	mg/kg dm	0,04	0,02	0,03	0,03	<0,01	<0,01	0,02	**1,08**	**0,5**	**1**

Wastewater results from composting tests

		Summer test 2019		Summer test 2020			
Analysis	Unit	Start 14.8.2019	Middle 13.11.2019	End / Start 1.7.2020	Middle 17.9.2020	End 19.11.2020	Limit value
Aluminium (Al)	mg/l	0,27	0,20	5,3	2,2	7,1	-
Arsenic (As)	mg/l	-	-	0,0080	<0,005	0,0082	0,1
Mercury (Hg)	mg/l	<0,0001	<0,0001	0,00018	<0,0001	0,00011	0,01
Cadmium (Cd)	mg/l	0,0015	0,00022	0,0011	0,00091	0,0015	0,01
Chromium (Cr)	mg/l	<0,003	0,0047	0,023	0,011	0,034	1
Copper (Cu)	mg/l	0,091	0,024	0,11	0,092	0,15	2
Lead (Pb)	mg/l	0,015	0,0018	0,032	0,019	0,056	0,5
Nickel (Ni)	mg/l	0,012	0,0051	0,025	0,014	0,026	0,5
Iron (Fe)	mg/l	1,4	0,36	10	4,7	13	-
Zinc (Zn)	mg/l	0,19	0,037	0,27	0,22	0,41	3
Total Nitrogen TNb	mg/l	28	6,8	16	9,3	28	-
Ammonium	mg/l	5,6	<2,0	3,7	0,14	5,3	-
Total phosphorus	mg/l	15	4,9	10	4,5	10	-
Chloride (Cl^-)	mg/l	-	12	36	14	49	-
Sulphate (SO_4^{2-})	mg/l	12	2,1	7,9	4	7,3	400
Fluoride (F^-)	mg/l	0,31	<0,1	0,16	0,18	0,26	-
pH	mg/l	7,1	7,5	7,0	7,9	7,1	6,0-11,0
BOD7	mg/l	30	2,6	37	9,5	57	-
CODcr	mg/l	940	230	580	480	1000	-
Solid Matter	mg/l	-	9,8	390	120	620	500
Fecal coliforms (bacteria)	cfu/100 ml	-	-	>1000000	3800	150	-
Electrical Conductivity	µS/cm	780	180	350	200	490	-
Phenol Index	mg/l	17	2,2	3,1	<0,008	<0,050	10
Polycyclic Aromatic Hydrocarbons (PAH)	mg/l	0,0001	0,0001	0,00016	0,00009	0,00014	0,05
BTEX	mg/l	0,0002	n.c.	n.c.	n.c.	n.c.	3
Hydrocarbons C10-C40	mg/l	-	<0,02	0,10	0,17	0,11	100

- = no limit value for the parameter n.c. = incalculable, because all the concentrations were below detection limits.

The limit values are from the Ekokem Instruction 1/09 (Ekokemin ohje 1/09) "Älä päästä haitallista ainetta viemäriin" and the waste water limit value list of Tampere Water (2016).

Concentrations exceeding the limit values

Conclusions of composting tests

- In this project we cleaned totally 500 tons of composting material in Finland/Spain (sand/dust portion 20-30%).
- The clean soil materials fulfilled the limit values for Fertiliser Products.
- Overall, good results with *Alphaset, furan* and *bentonite waste sands* since 2015.
- Inorganic waste sand are suitable for composting but they contain only small amount of harmful substances.

- Recommended to clean and recycle foundry sand back to foundry process.
- Composting method is an **cost-efficient method for cleaning the surplus waste sands/ dusts** which contain high amounts of harmful organic substances and produce clean soil material.
- By composting method harmful **organic substances (DOC, TOC, BTEX) and fluoride can be degraded by 70..90%**

- Business idea:
  - **Currently**, composting companies add natural sand in compost material (40%) after the composting process → **In future**, surplus foundry sand could be mixed in compost heaps in the beginning of the process → cleaned in 5-6 months.
  - Composting companies do not have to buy natural sand (save natural resources) → foundries transport surplus sands to composting companies (no deposit fees).
  - Aim is to reduce the amount of foundry sand to be landfilled.
  - Composting process can be operated by composting entities, waste treatment centers or group of foundries in same location.

Thank you!

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