COMPARATIVE EVALUATION OF DIFFERENT COMPOSTING TECHNOLOGIES FOR MUNICIPAL SOLID WASTES IN ISTANBUL

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Current Situation in Turkey

- Population ~ 70 million.
- MSW has over 50 % organics.
- ~ 50 sanitary landfills serving 60% of the population. 2012 target is 80%.
- 8 landfill gas to energy facilities (14 MW and 5 MW for 2 sites in Istanbul).
- 3 MSW (2 mixed, 1 source seperated) composting facilities.
- 2 yard waste composting facilities.
- 6-7 poultry manure composting facilities, 3-4 livestock manure composting facilities.
- 1 mixed MSW AD facility, 1 under construction.
- 6-7 industrial residual (potatoes, sugar, etc.) and manure AD facilities (incuding under construction).
- Sludge, wastewater, etc. digestion facilities (number ?).
- Over 300 MRF’s (28 in 2003).

Legislation

EU

- The EU Landfill Directive sets 25%, 50% and 65% reduction targets for disposal of biodegradable municipal waste (BMW) at landfills by 2006, 2009 and 2016, respectively compared to the total generation of such waste in 1995.
- The EU Packaging Directive targets:

Item	Target (%)
Glass	60
Paper and cardboard	60
Metals	50
Plastics	22.5
Wood	15
Overall recycling[1]	55-80
Overall recovery[2]	>60

- Turkey as a candidate country to the EU has to meet these targets.

Legislation

Turkey

- The National Landfill Directive (issued March 2010) sets 25%, 50% and 65% reduction targets for disposal of biodegradable municipal waste (BMW) at landfills by 2015, 2018 and 2025, respectively compared to the total generation of such waste in 2005.
- The National Packaging Directive targets:

Years	Glass	Plastic	Metal	Paper-cardboard
2009	36	36	36	36
2010	37	37	37	37
2011	38	38	38	38
2012	40	40	40	40
2013	42	42	42	42
2014	44	44	44	44
2015	48	48	48	48
2016	52	52	52	52
2017	54	54	54	54
2018	56	56	56	56
2019	58	58	58	58
2020	60	60	60	60

- The Renewable Energy Law (issued December 2010):

  Subsidy for renewable energy

National Solid Waste Master Plan of Turkey for 2005-2025 (Ministry of Environment and Forestry)

Region		Landfill, EU	Incinerator	Biogasification	C&D recycling	Compost, windrow	Compost, in-vessel	MRF, mixed waste	MRF, separated recyclables
1a	Istanbul, Izmir	5	12	0	10	7	3	3	10
1b	Other metropolitan municipalities	4	3	0	4	4	1	1	4
1c	Other municipalities	23	0	23	23	23	23	23	23
2a	Ankara	2	4	0	3	3	1	1	3
2b	Antalya/İçel	5	3	0	8	8	2	2	8
2c	Other metropolitan municipalities	11	8	0	11	11	3	3	11
2d	Other municipalities, Black Sea	24	4	20	24	24	20	20	24
2e	Other municipalities, Mediterranean/ Central Anatolian region	18	0	18	18	18	18	18	18
3a	Gaziantep	2	1	0	3	3	1	1	3
3b	Other metropolitan municipalities	4	0	4	4	4	4	4	4
3c	Other municipalities	21	0	21	21	21	6	6	21
Total		119	35	86	129	126	82	82	129

National Solid Waste Master Plan of Turkey for 2005-2025 (Ministry of Environment and Forestry)

Facility type	Total investment during the planning period (million EUR in fixed 2003 prices)
Biogasification	366
C&D recycling	214
Compost, in-vessel	467
Compost, windrow	67
Incinerator	2,826
Landfill, controlled	48
Landfill, EU	586
MRF, mixed waste	0
MRF, separated recycl.	0
Total	**4,575**

National Solid Waste Master Plan of Turkey for 2005-2025 (Ministry of Environment and Forestry)

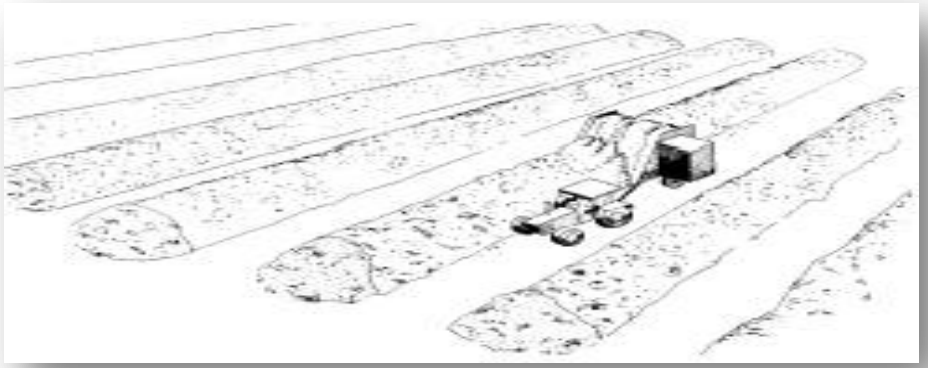
Net Cost (Investment and Operational, million EUR)

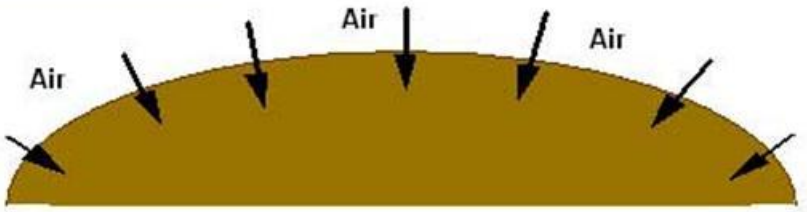
Sub-region	Total	1a	1b	1c	2a	2b	2c	2d	2e	3a	3b	3c
O&M expenditure	2,486	434	115	409	152	100	165	289	438	49	70	265
Re-investment expenditure	899	232	40	137	63	38	44	92	133	19	21	79
Investment expenditure	4,424	1,222	327	333	426	215	571	508	332	124	66	300
Total	7,809	1,888	482	879	642	353	780	889	903	192	157	645
Closure of dump sites	1,150											
Total (inc. closure)	8,959											

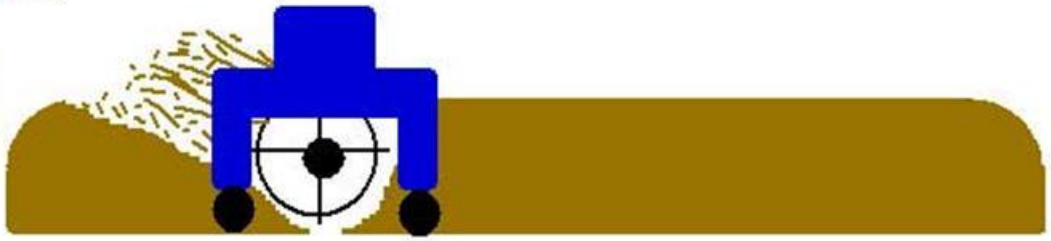
Objective

- investigate three different methods of in-vessel, turned windrow and aerated static pile systems for composting of municipal solid wastes in Istanbul.
- Process parameters and final product quality were evaluated in order to compare the technologies.

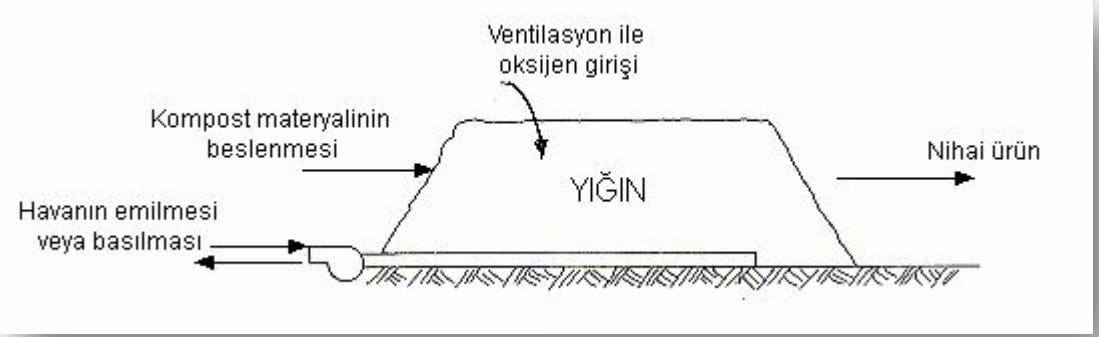
Windrow

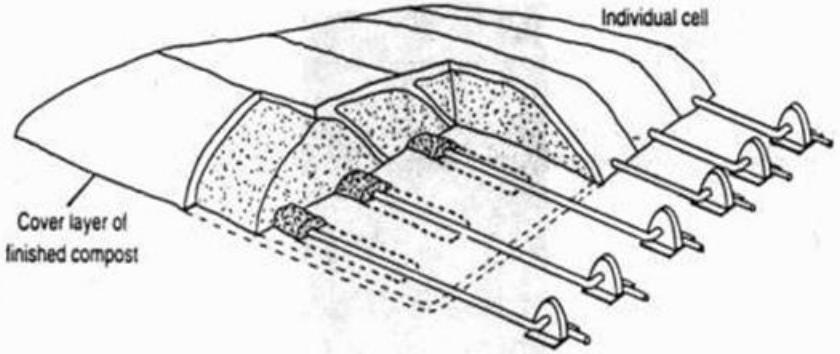


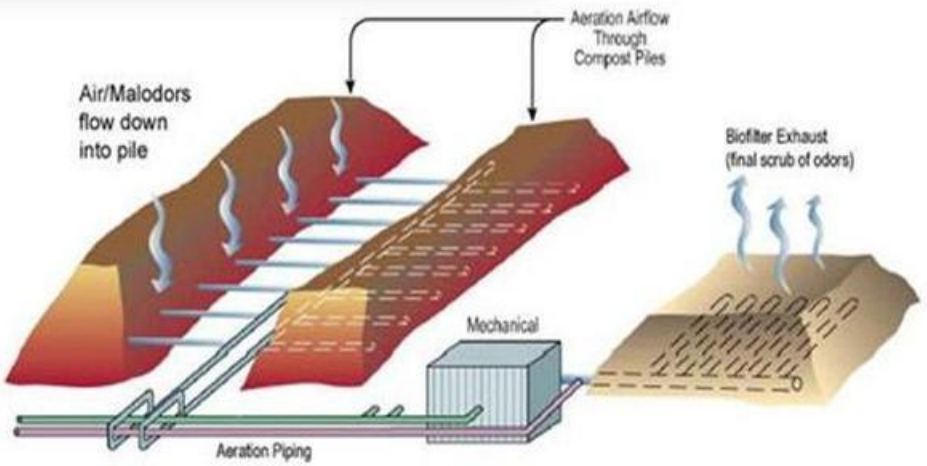


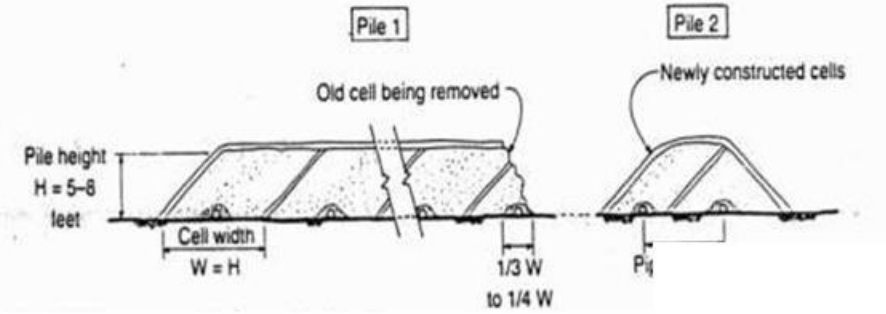


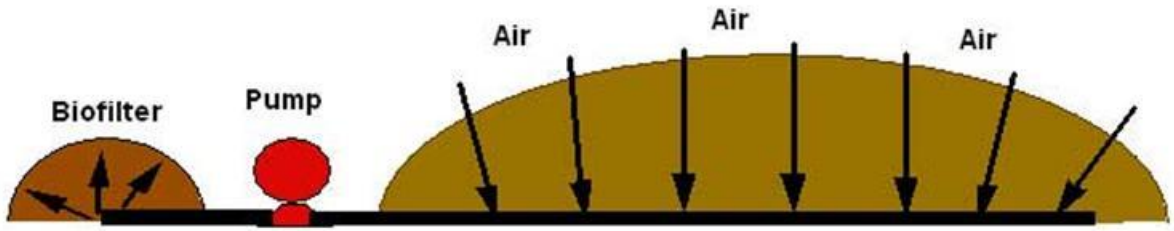
Aerated Static Pile



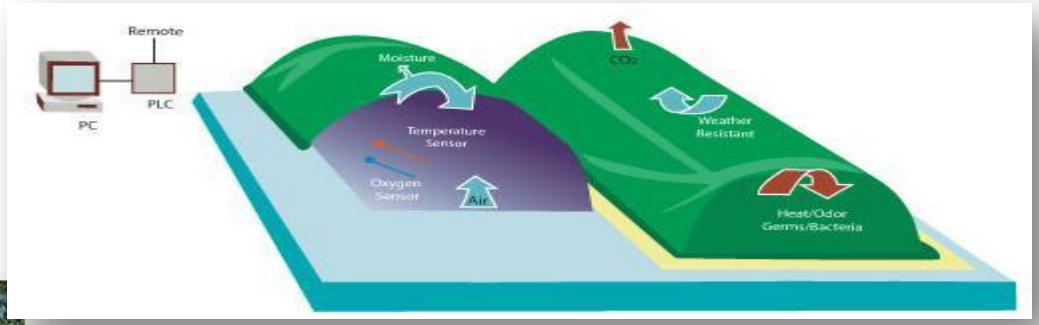


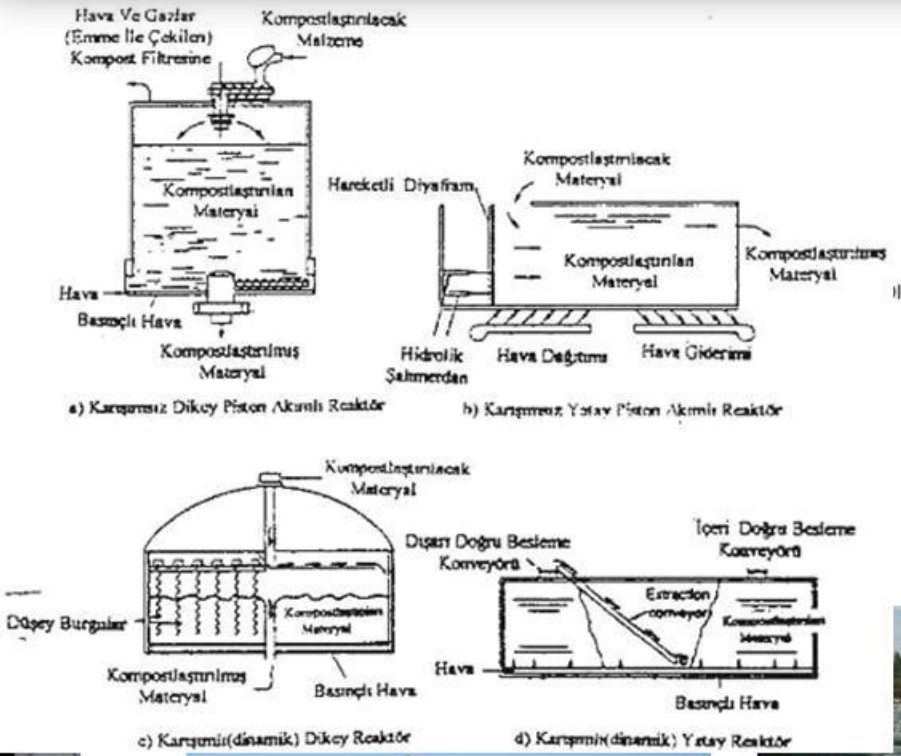


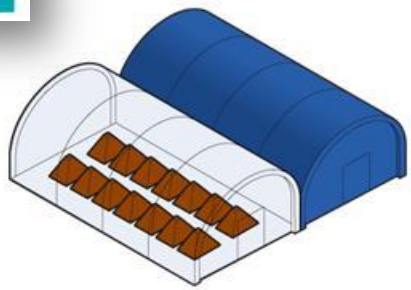


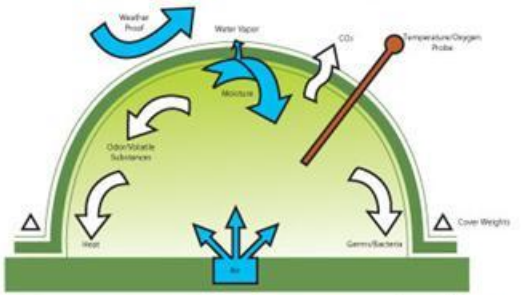


In-vessel


Remote
PC
PLC
Moisture
CO2
Temperature Sensor
Oxygen Sensor
Air
Weather Resistant
Heat/Odor
Germs/Bacteria


Hava Ve Gazlar
(Emme İle Çekilen)
Kompost Filtresine
Kompostlaştırılacak
Malzeme
Kompostlaştırılan
Materyal
Hava
Basınçlı Hava
Kompostlaştırılmış
Materyal
a) Karışımsız Dikey Piston Akımlı Reaktör
Hareketli Diyafram
Kompostlaştırılacak
Materyal
Kompostlaştırılan
Materyal
Kompostlaştırılmış
Materyal
Hidrolik
Şahmerdan
Hava Dağıtımı
Hava Giderimi
b) Karışımsız Yatay Piston Akımlı Reaktör
Kompostlaştırılacak
Materyal
Düşey Burgular
Kompostlaştırılmış
Materyal
Basınçlı Hava
c) Karışımlı(dinamik) Dikey Reaktör
Dışarı Doğru Besleme
Konveyörü
İçeri Doğru Besleme
Konveyörü
Extraction
conveyor
Hava
Basınçlı Hava
d) Karışımlı(dinamik) Yatay Reaktör




IAGRAM OF ODOUR STOP™ COMPOST COVER SYSTEM
Weather Proof
Water Vapor
CO2
Temperature/Oxygen Probe
Moisture
Odor/Volatile Substances
Heat
Air
Germs/Bacteria
Cover Weights

Experimental Design

- Windrow and aerated static piles were prepared at Istanbul Compost and Recovery Facility as an alternative for the current in-vessel (tunnel type) system. The municipal solid waste with the similar characteristics was used for all systems.

- The composting process started at the same time and lasted in eight weeks for all methods.

- Wood shavings were used as bedding material for piles.

Experimental Design

- For windrow and aerated static pile systems, triangular shape approx. 7.5 m length, 3.0 m width, 1.5 m height and a volume of 15 m^3 piles were constructed.
- While aeration was ensured by a blower for aerated static pile, front end loader used to turn and aerate windrow. For comparison, full scale Istanbul Metropolitan Municipality Composting Facility was used as in vessel system.
- Three composite samples were taken weekly from four different locations during the eight weeks for all systems.

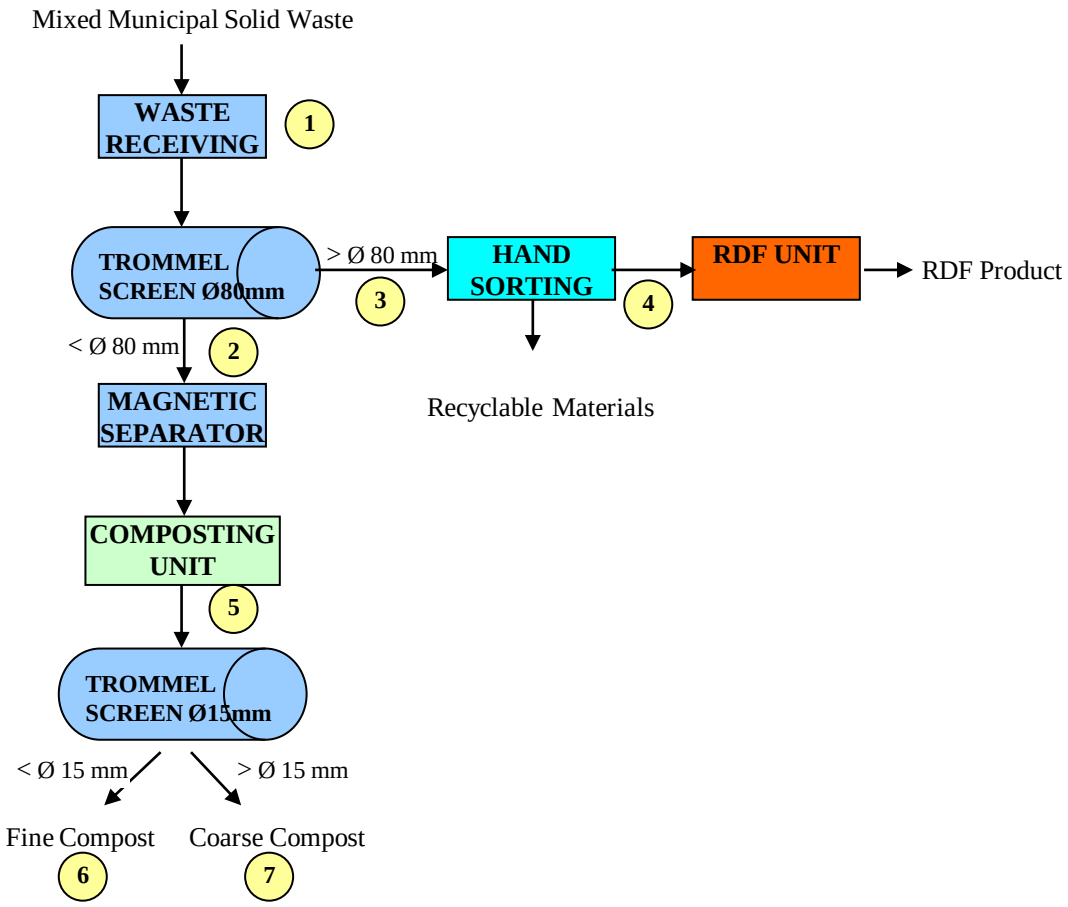
Istanbul Metropolitan Municipality Composting& Recycling Facility

- 32.000 m^2 closed area
- 1000 ton/day mucipal solid waste capacity
- 250 ton/day compost production
- Total MSW is 14000 tons/day in Istanbul

View of the Facility

Composting& Recycling Facility Units

- Waste Receiving
- Φ80 mm Trommel Screen
- Hand Sorting
- Composting Unit
- Φ15 mm Trommel Screen

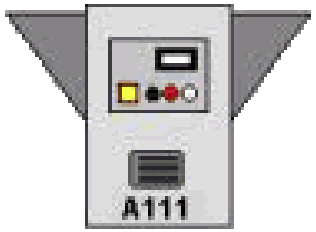


The flow chart of the Composting and Recycling Facility


Φ15 mm Trommel Screen
Composting Unit
Hand Sorting
Φ80 mm Trommel Screen
Waste Receiving


İSTANBUL BÜYÜKŞEHİR BELEDİYESİ
KATI ATIK İŞLEME
GERİ KAZANMA VE KOMPOST TESİSİ
GÜVENLİK
DANIŞMA
CEYNAK
MAN


AK-230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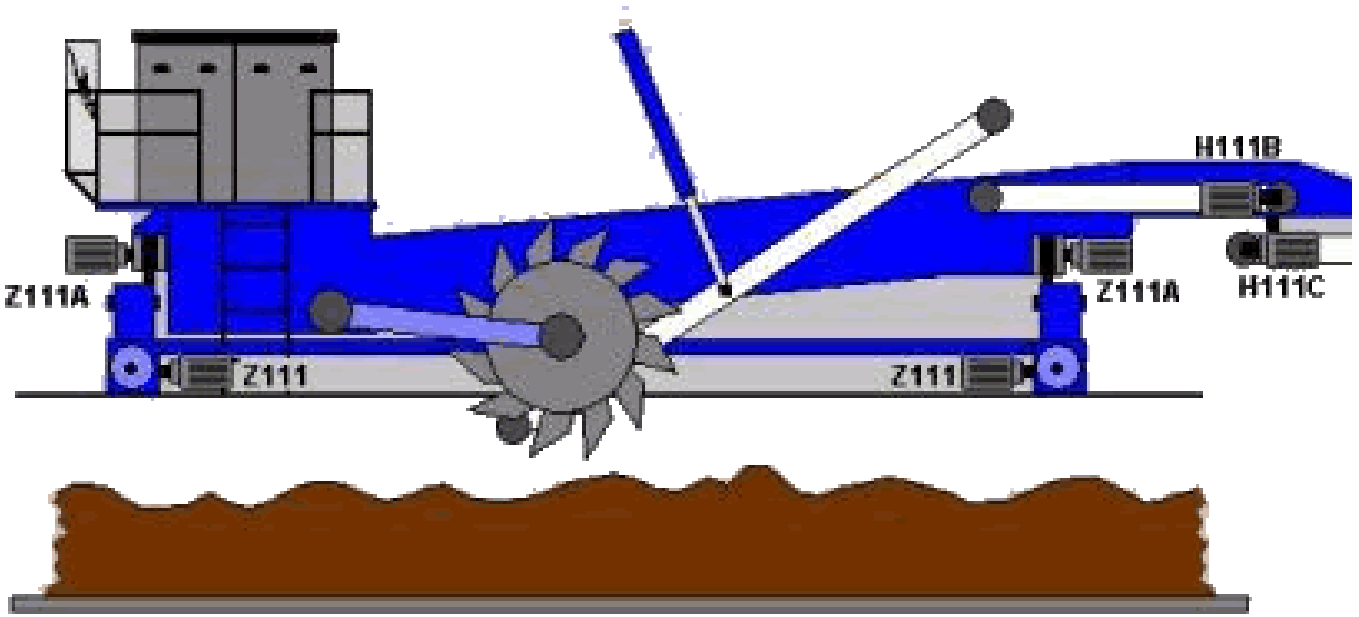

H111B
Z111A
Z111A
H111C
Z111
Z111

Windrow Construction

ASP Construction

Windrow Construction

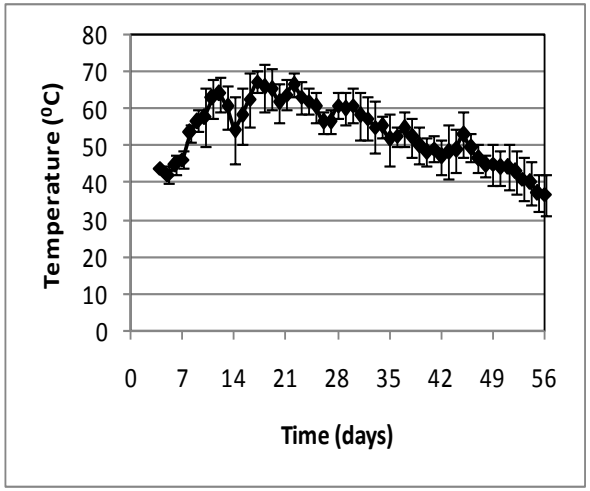
ASP Construction

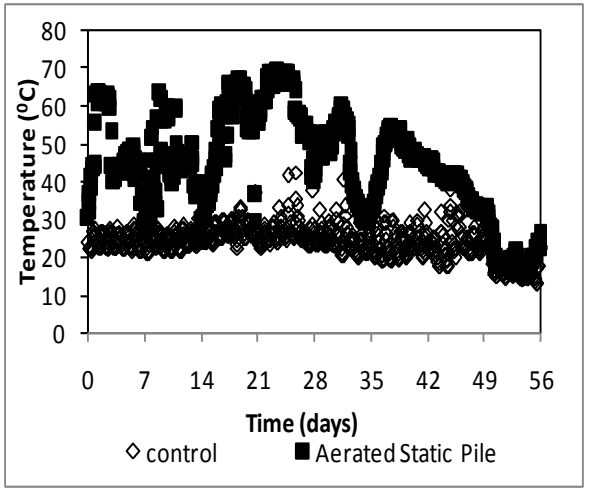
Analytical Methods

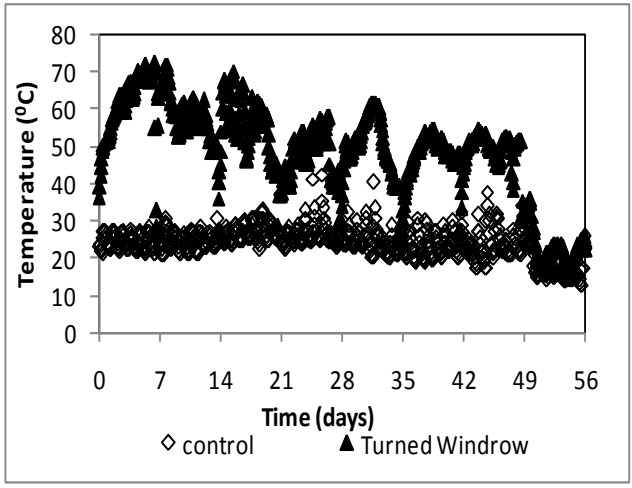
- The all physical, chemical and microbiological parameters were analyzed according to “Test Methods for the Examination of Composting and Compost (TMECC, 2001)”.

- Temperatures were monitored using two dataloggers (WatchDog 100 data logger, Spectrum Technologies, Plainfield, IL, USA) which were inserted in each pile at the depth of 50 cm to measure temperature every 2 hours during composting.

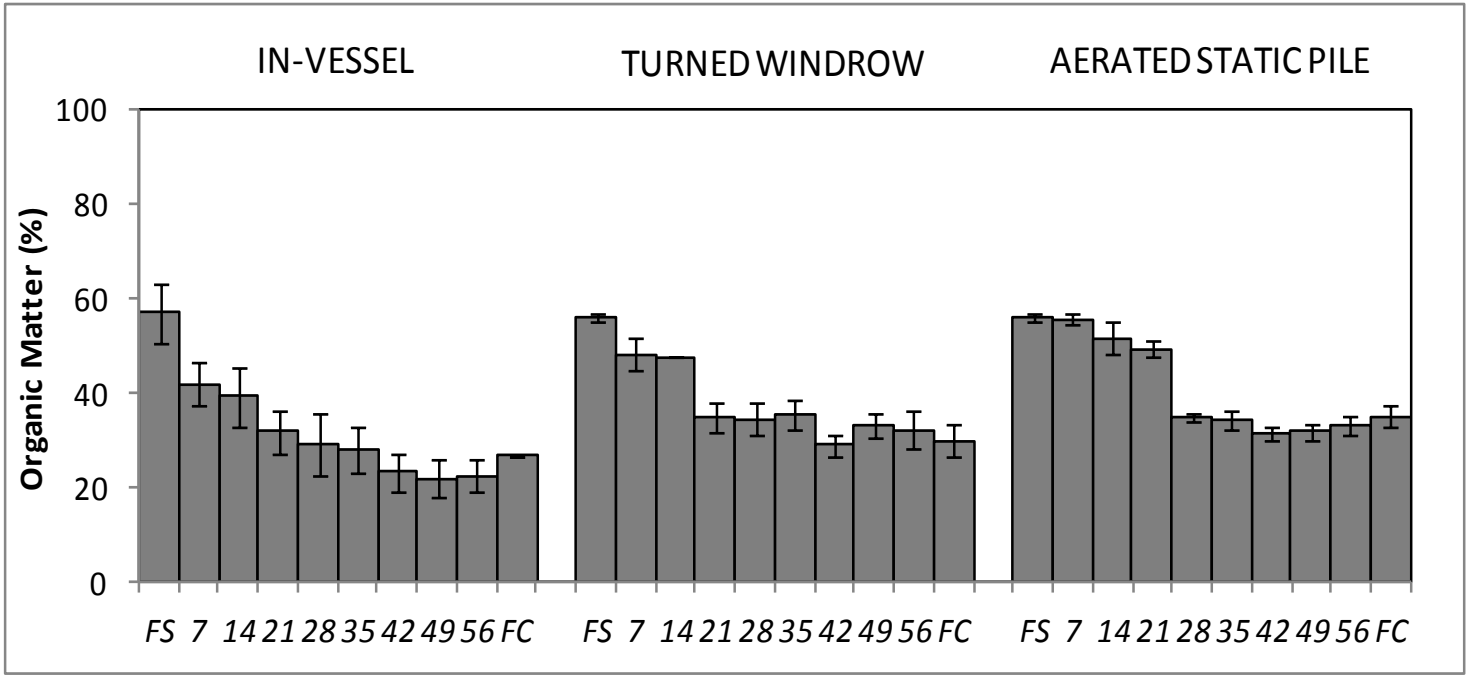
Results



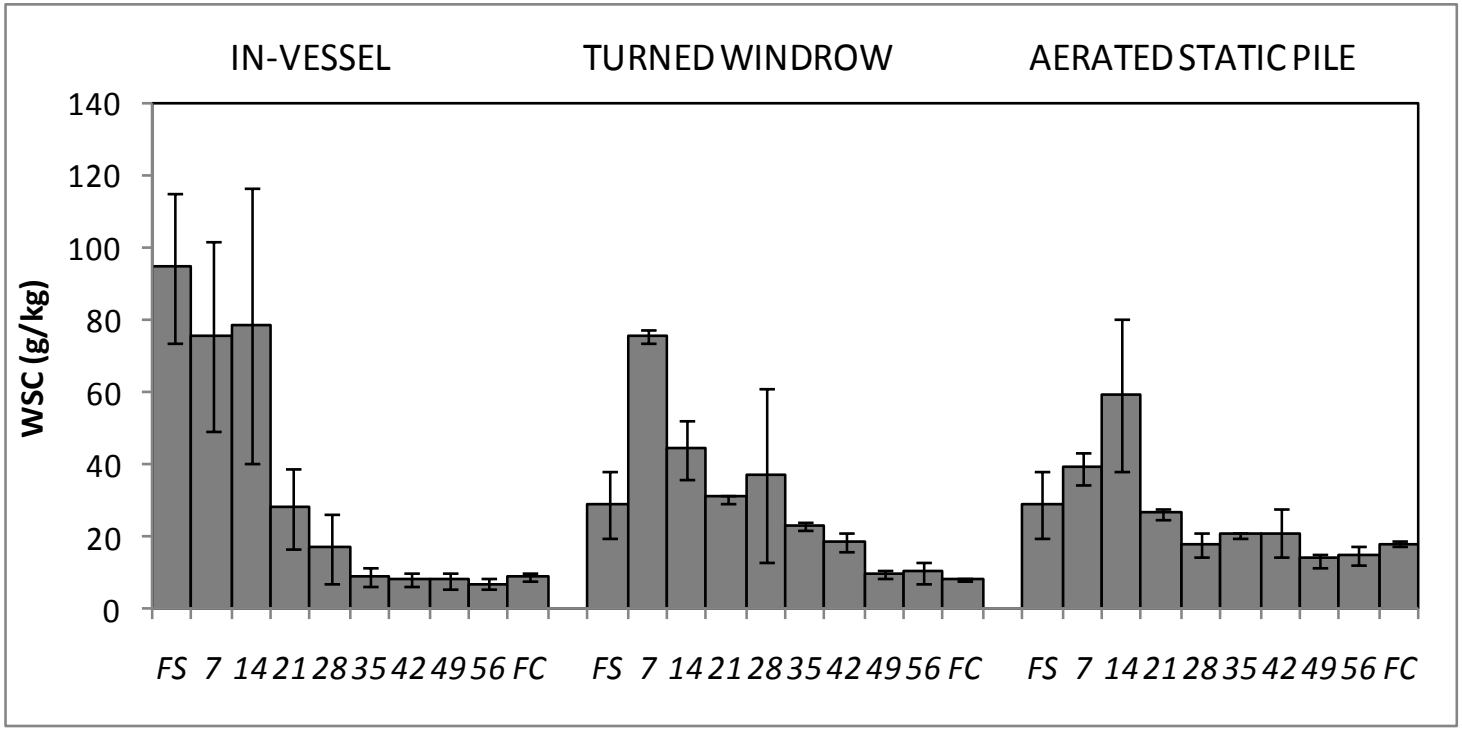




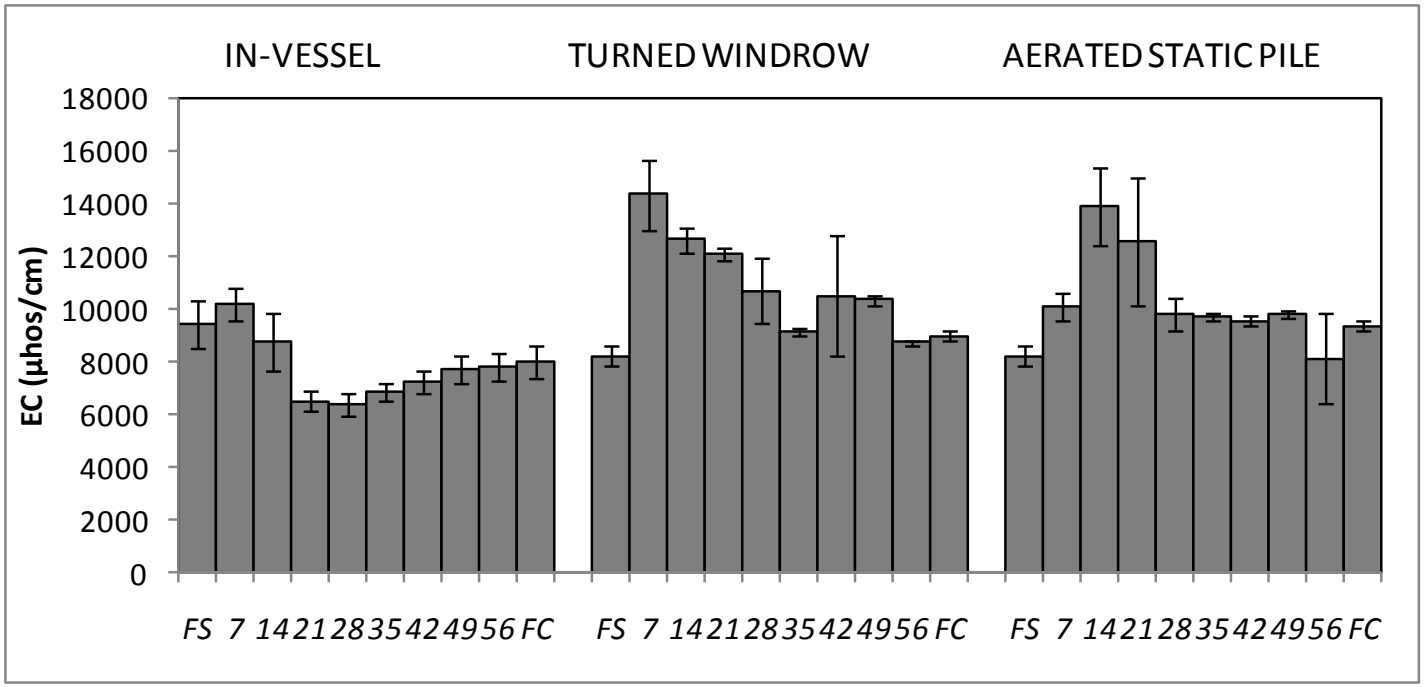
The average temperature profiles of in the in-vessel system, aerated static pile and turned windrow during composting



The average organic matter profiles of in the in-vessel system, aerated static pile and turned windrow during composting



The average Water Soluble Carbon (WSC) concentrations organic matter in the in-vessel system, aerated static pile and turned windrow during composting



The average EC concentrations organic matter in the in-vessel system, aerated static pile and turned windrow during composting

Heavy metal content of feedstock and final compost (FS: feedstock, FC: Final compost)

Parameter	Unit	In-vessel		Aerated Static Pile		Turned Windrow	
		FS	FC	FS	FC	FS	FC
Cu	mg / kg	130	561	147	1022	147	309
Pb	mg / kg	60	92	130	275	130	168
Zn	mg / kg	251	727	488	617	488	478
Cd	mg / kg	0.7	1.2	3.4	1.2	3.4	2.3
Cr	mg / kg	423	467	95	140	95	133
Ni	mg / kg	162	175	129	64	129	53
Hg	mg / kg	<1	<1	<1	<1	<1	<1
P	mg / kg	2031	2232	2031	3405	2031	2812

Characterization of MSW and compost products

Parameter	Unit	MSW	Fine Compost		
			In-vessel	Aerated Static Pile	Turned Windrow
pH	-	7.15±0.07	7.16±0.24	7.33±0.06	7.68±0.1
EC	µmhos/cm	8235±375	7606±1058	9380±156	8985±191
Moisture Content	%	58±1.20	34±0.9	42±2.8	44±2.3
Organic Matter	%dm	56±1	27±0.7	35±2	30±1.8
TKN	g/kg	10.56±0.01	15.5±2.5	15.65±0.59	15.58±0.27
NH_4^+-N	g/kg	0.05±0.03	0.08	0.155±0.02	0.136±0.02
WSC	g/kg	29±9	8.78±1.08	18.08±0.86	8.3±0.02
C/N	-	20.7±0.47	11.96	13.18	11.31
C	%	30.9±0.85	21.3±2.2	26.1±1.3	23.3±0.7
N	%	1.5±0.01	1.78±0.11	1.98±0.02	2.06±0.03
Pore Space	%v/v	89.7	73.2±3.2	73.3	76.2
Free Airspace	%v/v	64.2	18.9±3.7	35.0	42.2
Water-Holding Capacity	%v/v	25.0	45.7±3.2	38.03	34.0

Conclusion

- The composting process provided an acceptable degree of treatment for municipal solid wastes by using all methods.
- The results of the investigations prove the usefulness of pile composting methods similar to the current in-vessel system for municipal solid wastes. For all systems sufficient temperatures were reached to kill the pathogenic microorganisms and obtain sanitation.
- The products of all composting systems have suitable organic matter values specified by standards. Evaluation of WSC values showed that active fermentation period was completed in three weeks for all systems. Results of respirometry test were parallel with the change of WSC.

Conclusion

- In all systems, process parameters had suitable values throughout the process, and compost product had acceptable values for these parameters which were determined by standards.
- Windrow system had similar results with in-vessel system by means of the variation of general composting parameters. On the other hand, windrow system overcomes in vessel system due to the simplicity of operational conditions and lower capital costs.
- In this study, it was shown that municipal solid wastes contain high amount of easily biodegradable organic matter can easily be composted by windrow method as an alternative low cost technology instead of in-vessel composting systems.

THANK YOU FOR YOUR ATTENTION