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How the wastes composition can influence flow sheet and management of a mechanical-biological treatment plant

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Topics

This work aims to show how the needs of a mechanical-biological treatment (MBT) plant could change over the years of operation, by considering the different composition of the wastes collected and treated.

It also exposed how it is possible to revert from these changing by adapting the plant setup to restore the biological stabilization efficiency.

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Introduction

The EU Landfill Directive (1999/31/EC) required member states to change their approach about bio-waste management, with the aim of reducing the amount of waste sent to landfill and to attenuate impacts connected with their disposal.

In order to be used as recovery material inside landfills and to contribute to the reduction of the quantities of organic matter allowed in landfills, aerobic bio-stabilised organic waste are required to comply with the limit (1000 $mgO_2/kgVS \cdot h$) established for the dynamic respirometric index .

In the next slide operating data about a MBT plant located in Rome are investigated, analyzing the input waste, the treatment of the organic fraction and the operated process to obtain the stabilized output

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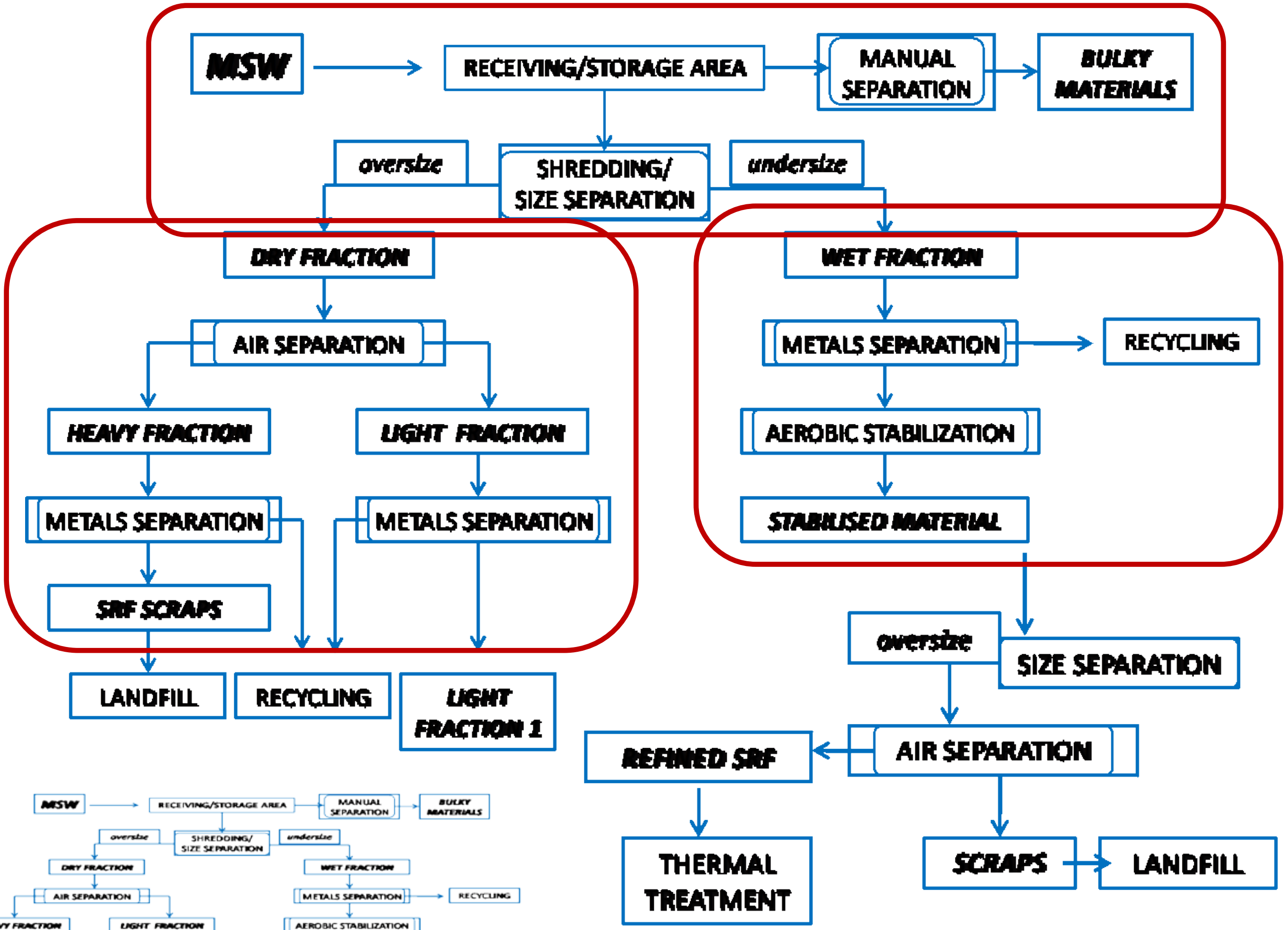
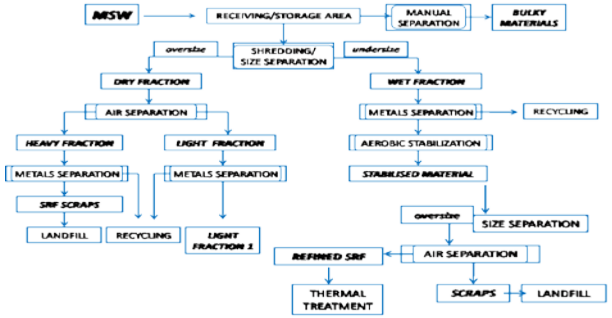
Materials and method – MBT plant





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Materials and method – Analytical Methods

The composition of the residual mixed waste fed in the plant, was evaluated on 3 samples, in accordance with the APAT method.

The biological stability degree was analyzed by determining the potential dynamic respiration index (DRI), which provides information about the absolute maximum rate of oxygen consumption due to microbial activity (according to the procedure reported in the Italian Standard UNI/TS 11184-Method A - 2016).

According to UNI/TS 11184, VS content was determined measuring the loss-on-ignition after 6 h at 550 °C.

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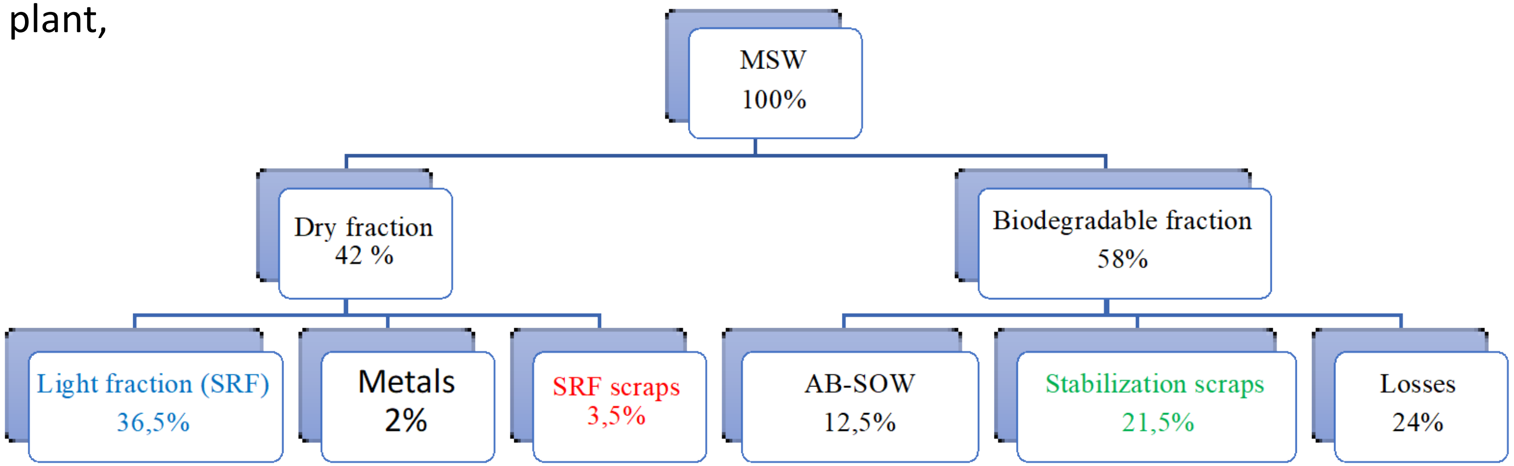
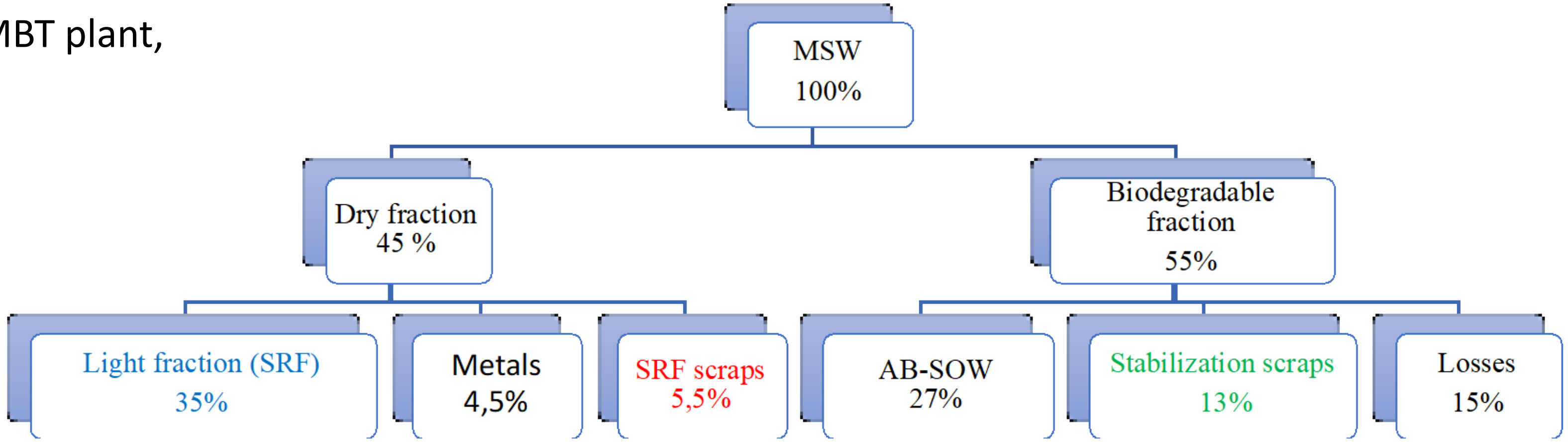
Results and Discussion

Mass balance of the MBT plant,
at the start up, in **2009**



Mass balance of the MBT plant,
in **2019**



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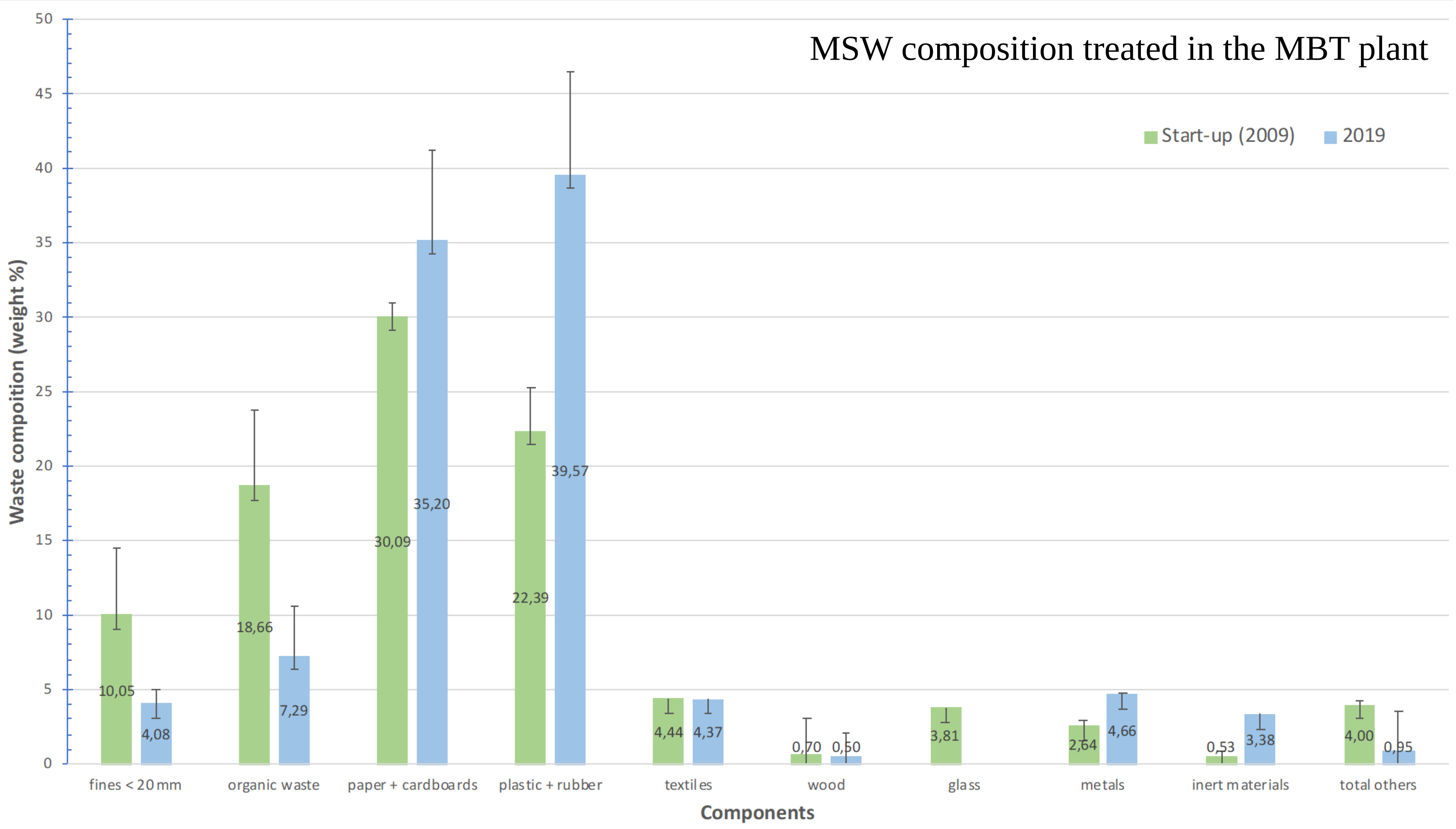
Results and Discussion



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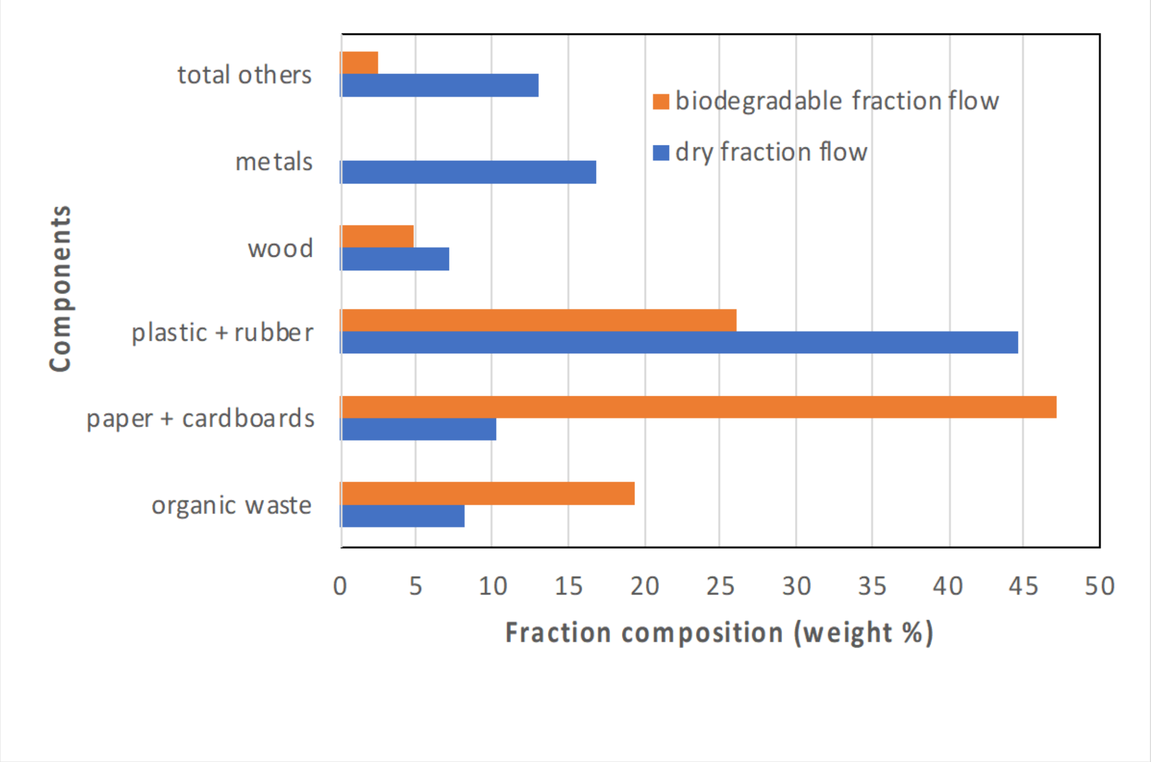
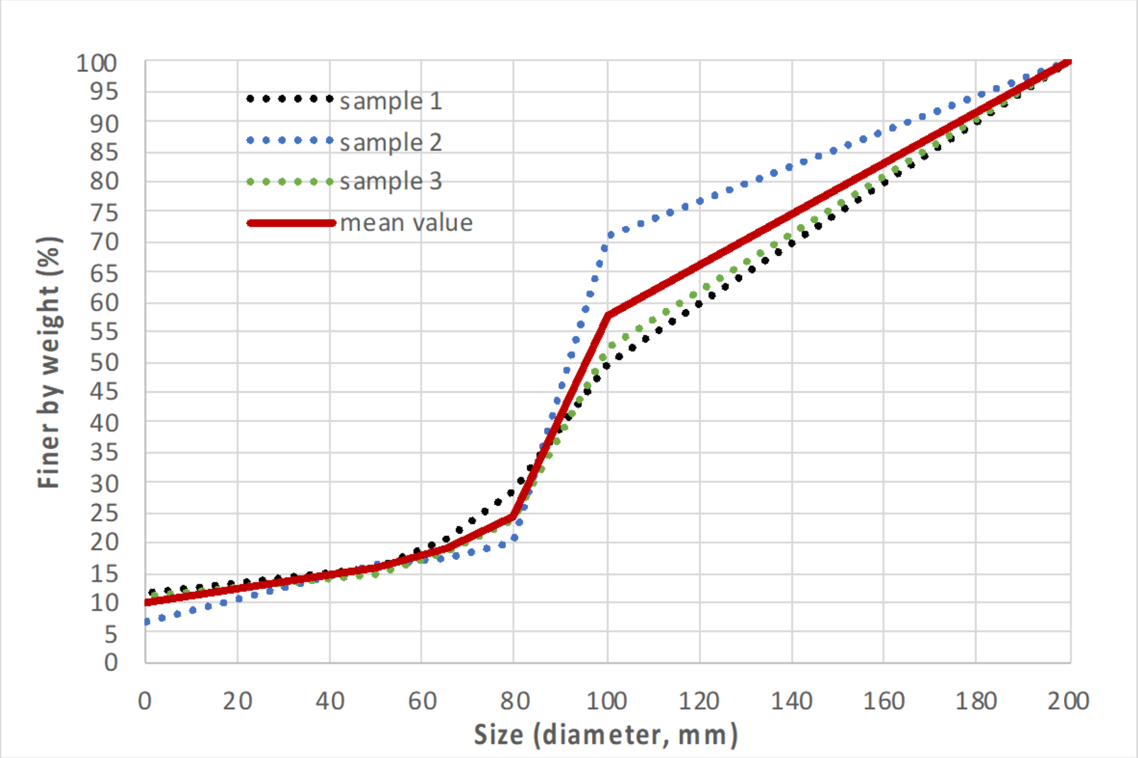
Results and Discussion

Composition of the overflow and under flow at 65



a

size distribution of the MSW treated at the MBT plant



b

year 2019

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Results and Discussion

Aerobic stabilization process in two reactors (unit 1 and unit 2) operating in parallel

INPUT

50% INPUT

50% INPUT

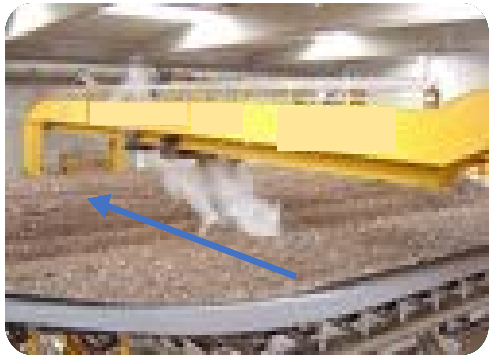
unit 1

unit 2

OUTPUT

OUTPUT

TOTAL OUTPUT



> 25 mm

SCREEN (25 mm)

Stabilization Scraps

< 25 mm

AB-SOW

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Results and Discussion

Unit 1

	Air flowrate (m^3/h) [mean] A B C D	Temperature biogas (°C) [mean] A B C D	Fan depression (mm H_2O) [mean] A B C D
1	3970	61	-172
2	4784	62	-168
3	4479	57	-175
4	4784	65	-167

	Stabilizing Temperature (°C) [max/mean/min] A B C D	Stabilizing Umidity (%) [max/mean/min] A B C D	DRI (mgO_2/kgVS h) [mean] A B C D
1	70/69/66	37,0/34,1/32,1	3.666
2	70/69/66	40,9/36,8/32,9	
3	61/59/57	36,6/34,1/30,6	
4	66/64/62	34,3/32,2/29,0	

Unit 2

	Air flowrate (m^3/h) [mean] A B C D	Temperature biogas (°C) [mean] A B C D	Fan depression (mm H_2O) [mean] A B C D
1	3257	67	-238
2	3868	67	-190
3	2545	56	-182
4	3563	62	-184

	Stabilizing Temperature (°C) [max/mean/min] A B C D	Stabilizing Umidity (%) [max/mean/min] A B C D	DRI (mgO_2/kgVS h) [mean] A B C D
1	64/62/62	34,6/33,3/32,1	4.184
2	63/60/60	34,4/32,4/29,6	
3	70/68/68	37,4/34,3/31,3	
4	68/67/67	37,2/34,2/32,5	

INPUT

1A 1B 1C 1D

2A 2B 2C 2D

3A 3B 3C 3D

4A 4B 4C 4D

detected control parameters in the two reactors found in 2019

OUTPUT

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Results and Discussion

Aerobic stabilization process in two reactors (unit 1 and unit 2) operating in series

INPUT

unit 1

> 25 mm

OUTPUT

SCREEN (25 mm)

Stabilization Scraps

INPUT

< 25 mm

unit 2

TOTAL OUTPUT

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Results and Discussion

Main operating parameters of the two reactors at different operating modality

		Reactors in parallel 2019	Reactors in parallel 2019	Reactors in series		
		Detected values	*Simulated and optimized values*	*Simulated and optimized values*		
		Mean value Unit 1 and 2	Mean value Unit 1 and 2	Total	Unit 1	Unit 2
Air flowrate						
stoichiometric amount (S)	Nm^3/d	523.016	523.016	612.178	282.506	329.672
total amount (T)	Nm^3/d	750.000	2.634.339	3.076.261	1.425.338	1.650.923
T/S	-	1,4	5	5,0	5,0	5,0
Biodegradable fraction	%	55,00	55,00	55,00	55,00	42,00
Mean Temperature in the reactors	°c	65,00	70,00	-	63,50	73,25
Mean water content in the reactors	%	34	39	-	38,25	39,25
AB-SOW						
% refered to MSW	%	27	17,0	15,0	27,0	15,0
Biostabilized scraps						
% refered to MSW	%	13	13,0	13,0	13,0	-
Losses						
% refered to MSW	%	15	25,0	27,0	15,0	27,0
Detention time	d	18	19	30	9	21

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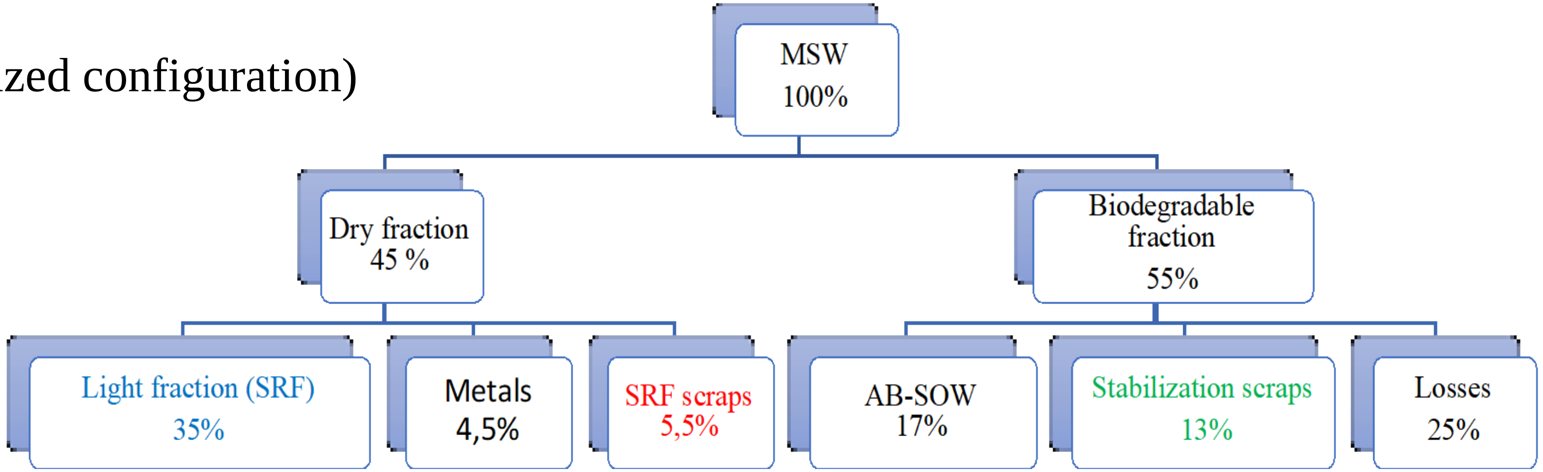
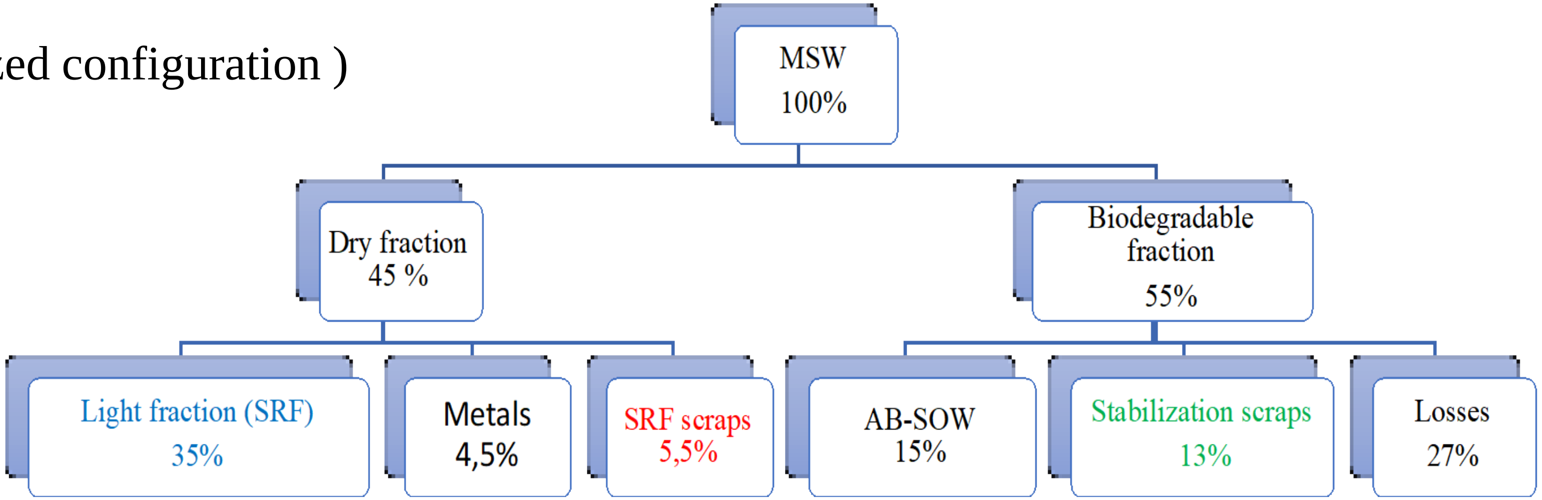
Results and Discussion

Mass balance:
reactors in parallel (optimized configuration)



Mass balance:
reactors in series (optimized configuration)



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Results and Discussion

Detected control parameters
in the reactors in series (2020)

		Reactors in series – Detected values		
		Total	Unit 1	Unit 2
Air flowrate				
stoichiometric amount (S)	Nm^3/d	612.178	282.506	329.672
total amount (T)	Nm^3/d	1.077.360	642.504	434.856
T/S	-	1,8	2,3	1,3
Biodegradable fraction	%	40	40,00	27,00
Mean Temperature in the reactors	°c	-	70,75	72,00
Mean water content in the reactors	%	-	37,10	37,70
AB-SOW				
% refered to MSW	%	16,0	-	16,0
Biostabilized scraps				
% refered to MSW	%	13,0	13,0	-
Losses				
% refered to MSW	%	11,0	-	11,0
Detention time	d	32	12	20

Unit 1

	Air flowrate (m^3/h) [mean] (A–D)	Temperature biogas (°C) [mean] (A–D)	Fan depression ($mm\ H_2O$) [mean] (A–D)
1	6820	61	-236
2	6413	64	-252
3	6616	59	-264
4	6922	57	-246

	Stabilizing Temperature (°C) [max/mean/min] (A–D)	Stabilizing Umidity (%) [max/mean/min] (A–D)	DRI (mgO_2/kgVS h) [mean] (A–D)
1	70/69/68	47,0/42,8/40,1	not detected
2	74/71/69	46,1/40,1/30,1	
3	80/71/63	42,4/34,1/28,0	
4	74/72/70	37,4/31,5/25,2	

Unit 2

	Air flowrate (m^3/h) [mean] (A–D)	Temperature biogas (°C) [mean] (A–D)	Fan depression ($mm\ H_2O$) [mean] (A–D)
1	4988	57	-190
2	4072	53	-189
3	4886	58	-207
4	4173	29	-215

	Stabilizing Temperature (°C) [max/mean/min] (A–D)	Stabilizing Umidity (%) [max/mean/min] (A–D)	DRI (mgO_2/kgVS h) [mean] (A–D)
1	76/75/72	38,2/37,8/37,5	901
2	79/74/70	44,1/41,3/39,0	
3	75/74/72	45,0/40,2/35,1	
4	68/65/64	32,6/31,4/30,3	

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Conclusion

By comparing the operating conditions in the years 2009 and 2019, it was observed:

- a reduction in the potentially biodegradable fractions (from 29% to 11%) composing the fed wastes
- an increasing in the paper and similar fractions (from 31% to 35%);
- an increasing in plastics fractions (from 22% to 40%).

Thus, different solutions were evaluated to better separate plastics and scraps from the flows that is aerobically treated in the basins.

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Conclusion

Main changes:

- screening of the wastes;
- basins configuration, operating with reactors in series and using a screening unit (25 mm) before transferring the stabilizing material from unit 1 to unit 2.

These changes simplified the management of both drying and stabilization steps, as evidenced by final DRI values.

The validity of these change was also confirmed once the changes were implemented and the consequent surveys carried out.

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