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Food waste disposers

Experimental and real studies for small and large communities

Summary

- Food wastes characteristics and impact in sewers
- Food waste fermentation in sewer
- Economic aspects connected with FWD
- The experience in a small community
- Conclusions

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Average specific contribution of FWD

Macropollutant	*Range*
TSS, g $PE^{-1}d^{-1}$	50 – 90
COD, g $PE^{-1}d^{-1}$	95 – 121
BOD, g $PE^{-1}d^{-1}$	31 – 59
(TKN), gN $PE^{-1}d^{-1}$	2.5 – 4.0
NH3/N, gN $PE^{-1}d^{-1}$	1 – 4
COD/TKN ratio	30 - 38
Ptot, gP $PE^{-1}d^{-1}$	0.25 – 3.00
Fats and Oil, g $PE^{-1}d^{-1}$	7.2 – 7.8
Water, l $PE^{-1}d^{-1}$	1 – 2
Energy, Wh $PE^{-1}d^{-1}$	4 - 7

Energy and water consumption of FWD-s are quite insignificant

OFMSW — Organic fraction of municipal solid waste

Separated collected → SC-OFMSW

SS-OFMSW ← Source sorted

Characteristics

	Average
Water , %	74.4
(TS), %	25.6
(TVS), % TS	96.5
(TCOD), gCOD/gTS	1.2
TKN, % TS	3.2
Ptot, % TS	0.2

FW and OFMSW are the same:

- High organic content
- High COD/Ntot ratio (38-60)

- SS-OFMSW 15 – 25% of waste
- FWD is very clean (No plastic, glass, paper, etc..)

Food waste: (Italian) fractions

- Fruits
- Pasta bread
- Vegetables
- Meat
- Fish

Fraction.	*Consumption*		*Food Waste*		
	Kg/P.E./y	*%*	*%*	*Kg/P.E./y*	*%*
Fruit	94	18	30	28	24
Pasta-Bread	180	35	20	36	31
Vegetables	152	29	30	46	40
Meat	79	15	5	4	3
Fish	11	2	20	2	2
TOTAL	516	100	-	116	100

317 g/PE/ d → 300 g/PE/ d OFMSW

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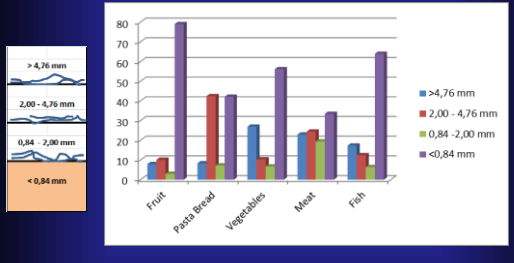
What happens in disposer

FWD effluent

Wet particle size distribution

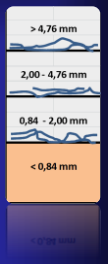


Considering small particles (< 4,76 mm) only vegetables and meat can produce screenings in WWTP if they are not transformed in sewer

Food wastes Characteristics and impact in sewer

Macropollutants ratio in FWD effluent

FRACTION	CODs/COD <0,84 mm %	RBCOD/CODs %
Fruit	86	15
Pasta-Bread	17	38
Vegetables	80	47
Meat	18	92
Fish	22	70
FWD effluent	73	28



RBCOD readily biodegradable COD
CODs soluble COD (<0,45 um)

Considering that urban waste water has 5-10% of RBCOD, the FWD produces an optimum influent for the WWTP

Food wastes Characteristics and impact in sewer

FWD impact on sewer

- Hydraulic overload
  - 300 g/PE/ d → 2 l/PE/ d ⟷ WW 200 l/PE/ d
- Macropollutants mass overload
  - Any overload does not modify the fluid dynamic characteristics of wastewaters in sewer
- TSS sedimentation must be studied

FWD impact in sewer

FWD effluent impact on sewer

Macropol.	Wastewater (WW)		FWD		FWD/WW
	g/PE/d	%	g/PE/d	%	%
TS	290		67		23
TSS	90	31	42	63	47
TDS	200	69	25	37	12

Macropol	Wastewater		FWD		FWD/WW
	g/PE/d	%	g/PE/d	%	%
TVS	148		64		43
TVSS	67	45	42	65	62
TVDS	81	55	22	35	28

FWD effluent:

- **Max Overload on sewer TS 23%**
- **Sensible overload on sewer for TVSS (62%)**

Food wastes Characteristics and impact in sewer

FW Settling and floating fraction

Floating material → It arrives to WWTP

2.00 – 4.76 mm

<0.84 mm

0.84 – 2.00 mm

Settled material → It can leave sediment in sewer

FWD impact in sewer

	Distribution (%)		Solid in WWTP(%)		Solid settled in sewer (%)
	< 0.84 mm	> 0.84 mm	< 0.84 mm	> 0.84 mm	
Fruit	79	21	79	19.5	1.5
Pasta- Bread	42.1	57.9	42.1	37.5	20.4
Vegetables	56.1	43.9	56.1	36.2	7.7
Meat	33.4	66.6	33.4	57.7	8.9
Fish	63.9	36.1	63.9	26.8	9.3
Food waste	50.1	49.9	50.1	33.1	16.8

FWD effluent cannot determine problems in sewer because only 17% of TS can settle

Sewer as transport way for FW

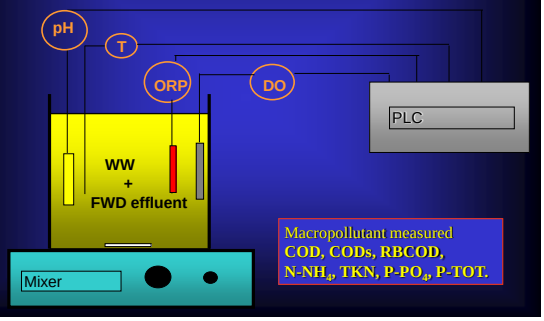
WW – FWD MASS OVERLOAD EVALUATION

WW	FW	Over load	
	22 – 25 TS%		
290 gTS/PE/d	66 – 76 gTS/PE/d	23%	
70 – 90 gTSS/PE/d	42 gTSS/PE/d	52%	
120 gCOD/PE/d	86 - 97 gCOD/PE/d	75%	
12 gN/PE/d	3 gN/PE/d	25%	
3.5 gP/PE/d	1,5 gP/PE/d	43%	EU
1.2 gP/PE/d	1,5 gP/PE/d		IT

The hypothesis to use sewer as a way to dispose food waste for all the PE connected to the sewer has the maximum impact to increase COD of 75%, TSS and P (in EU) of 50%, Nitrogen of 25%, while the flowrate in dry and wet weather conditions remains the same

Fermentation of food waste in sewer

Device to study FWD effluent transformation

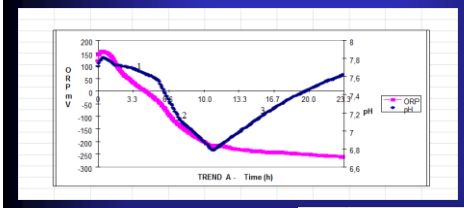


Macropollutant measured
COD, CODs, RBCOD,
N-NH$_4$, TKN, P-PO$_4$, P-TOT.

Fermentation of food waste in sewer

Three trends for pH and ORP can be observed (A, B,C) when 2 l FWD and 200 l WW are mixed

Trend A - Profile 1,2,3



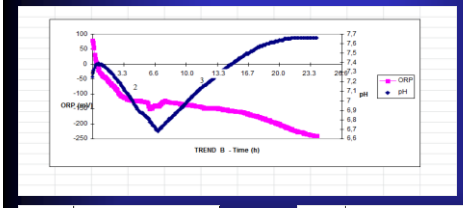
Trend	Substrate
A	fruit, pasta, bread
B	vegetables
C	meat, fish

Profile	Reaction
1	hydrolysis of particulate matter
2	fermentation with RBCOD, VFA production
3	decarbosilation VFA, methane production

Fermentation of food waste in sewer

Three trends for pH and ORP can be observed (A, B,C) when 2 l FWD and 200 l WW are mixed

Trend B – Profile 2,3



Trend	Substrate
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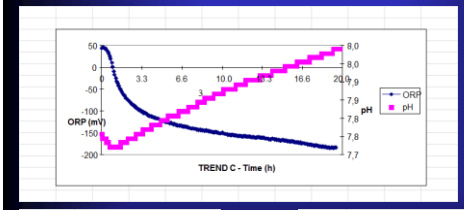
Fermentation of food waste in sewer

Three trends for pH and ORP can be observed (A, B,C) when 2 l FWD and 200 l WW are mixed

Trend C – Profile 3



Trend	Substrate
A	fruit, pasta, bread
B	vegetables
C	meat, fish

Profile	Reaction
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FWD / conventional OFMSW disposal

Comparison

- Disposer investment cost: 250 €
- Life time 10 – 15 years: 17-25 €/y
- Average family of 3 components: 0.056€/kg

OFMSW

Conventional disposal		WW+FWD	
Collect. & transport	0.055 €/kg	• investment cost	0.056 €/kg
Disposal	0.075 €/kg	• treatment cost	0.035 €/kg
	0.130 €/kg		0.091 €/kg

The experience in the small community of Gagliole (MC Province – Marche Region . ITALY)

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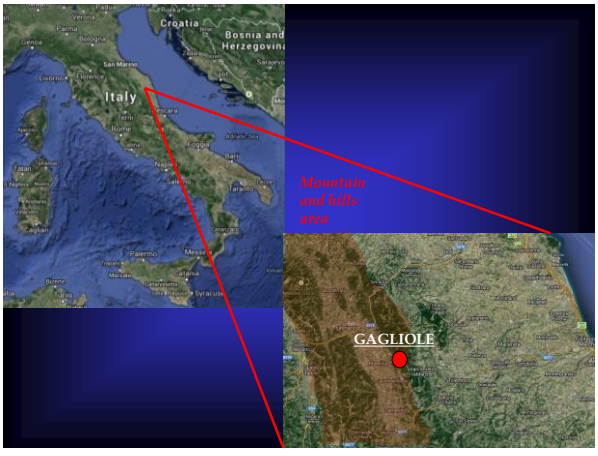


The small community of Gagliole

Public Utility		Consmari			
Province		Macerata			
surface	km2	2772			
inhabitants		300000			
density	PE/Km2	108	Italian density	PE/Km2	270
Small communities	%inhabitants	74			
Gagliole	PE	230			

To collect 1 ton of OFMSW truck covers 120 km from food waste composting center (Consmari)

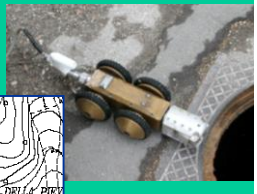
FWD

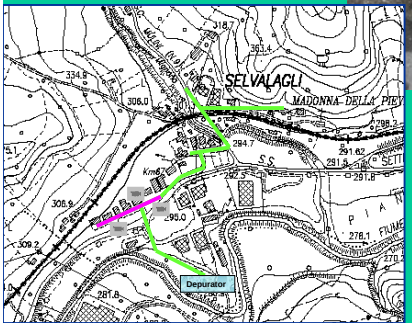
	Families	P.E.	%
District	83	230	100
FWD for family	35	95	41
FWD infant school	-	60	26

Experimental time : 5 Months

FWD impact on sewers

- 09/09/2005 Inspection– Start up
- 03/10/2005 – Inspection one month later



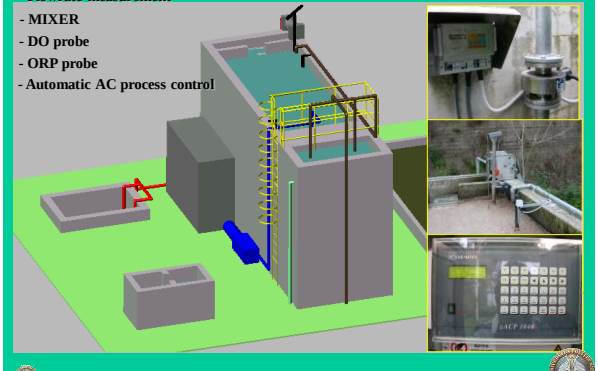


03/10/2005

NO SEDIMENTATION IN SEWER

WWTP upgrading for Alternate Cycle process

- Flowrate measurement
- MIXER
- DO probe
- ORP probe
- Automatic AC process control



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Impact of FWD on WWTP

FWD mass overload on WWTP influent			
COD	TSS	Ntot	Ptot
44%	30%	19%	--

COD and its degradability			
	COD/Ntot	RBCOD/COD	RBCOD/Ntot
No FWD	9.9	0.20	1.98
FWD	12.2	0.24	2.88

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WWTP performances

N balance						
Management	Ntot in KgNtot/d	Ntot out KgNtot/d	E%d %	E%n %	E%dd %	E%nn %
No FWD	3.2	2	48%	78%	61%	78%
No FWD management upgraded	1.7	1.2	31%	78%	39%	78%
FWD management upgraded	2.0	1.1	42%	89%	47%	90%
FWD AC process	5.2	0.9	83%	87%	93%	88%

WWTP energy consumption			
	Energy kWh/y	Energy cost €/anno	Energy saving %
No FWD	42,924	4,877	0%
No FWD modified management	33,945	3,857	21%
FWD modified management	33,945	3,857	21%
FWD and AC process	27,916	3,172	35%

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CONCLUSIONS

FWD is a feasible alternative to the collection, transportation and treatment of SS OFMSW because it:

- **produces an effluent free of waste as plastic, glass, paper, etc., but with organic matter (mainly suspended but very fine);**
- **has an irrelevant hydraulic impact on sewer;**
- **determines a relevant mass overloading of mainly carbon and solid, but not of nutrients (P and N), therefore it has a very high denitrifying potential;**
- **has no enough time to remove organic substances in sewer, but it has enough time to produce RBCOD: for this reason, FWD can enhance the nutrients removal in WWTPs, especially in small communities;**
- **FWD-sewer-WWTP line is economically sustainable in comparison to the collection, transportation and treatment of OFMSW, where Solid Waste and Water are managed by different authorities/companies: costs for sewer and WWTP management must be considered!**

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References

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