

## BACKGROUND

Agua de Murcia is a joint venture service company belonging to the AGBAR Group that manages the water cycle in the municipality of Murcia. Murcia Este WWTP is the biggest of the 17 WWTP (100,000 m<sup>3</sup>/d; 960,000 P.E.).

Murcia Este WWTP is a treatment plant of urban waste water by biological process of activated sludge, A2O type, which allows a significant removal of nutrients (N and P) in the treated water. The excess sludge generated is stabilized by an anaerobic digestion process (AD).

AD enables sanitization of the sludge, reducing its volume, with a minimum odor generation. Organic matter digested and stabilized can be used as a fertilizer rich in P and N and, moreover, there is a high-energy gas mixture, composed mainly of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>), the biogas. This biogas is a renewable energy source that can be exploited in their own WWTP for heat and power generation.



Murcia Este WWTP Digesters and biogas storage



Biogas valorization: CHP

On September 2012 the Murcia Este cogeneration system (CHP) started up. It is a biogas valorization with capacity to produce up to 1,000 kWh and covers the thermal needs of the sludge AD.

COGENERATION CHARACTERISTICS		
<b>BIOGAS</b>		
Biogas produced	2.7	NHm <sup>3</sup> /year
Biogas calorific power	5,000	Kcal/Nm <sup>3</sup>
Biogas available energy	15.5	GWh/year
<b>ELECTRIC POWER</b>		
Cogeneration electrical efficiency	40	%
Electric power produced	6.2	Gwhe/year
<b>THERMAL ENERGY</b>		
Cogeneration thermal efficiency	42	%
Thermal power produced	6.5	GWh/year

## OBJECTIVE

The main objective of this project is the identification and selection of the mixture/s of organic residues available in the Region of Murcia whose use in anaerobic digesters at Murcia Este WWTP supposes the contribution of benefits in both economic and environmental sense, with the increase of the biogas production.

## RESULTS

### TASK 1 Pre-release documentation phase

**OBJECTIVE:** The waste selection was based, not only on its characteristics as a substrate, but also on the availability along the year (possible seasonality), and its cost, considering its proximity to the WWTP.

The residues selected are:

- By-products from the food industry (RI),
- Landfill leachates (LV) and
- Agricultural residues from the secondary sector (TV).



### TASK 2 Laboratory trials

**OBJECTIVE BMP test:** evaluation of the potential CH<sub>4</sub> production of



Equipment: Automatic Methane Potential Test System (AMPTS) of Bioprocess Control.

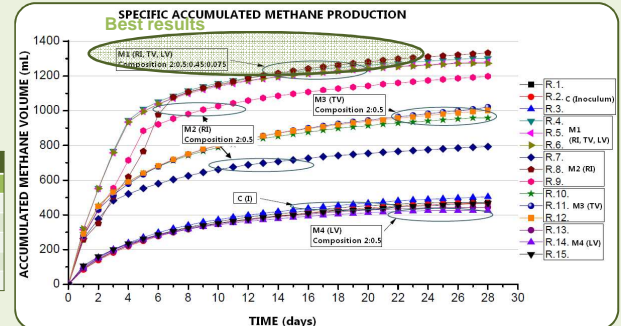
residue or residue mixture.

**Methodology** described in the German standard VDI 4630.

SUBSTRATES CHARACTERIZATION				
SUBSTRATES	pH	Conductivity (mS/cm <sup>2</sup> )	TS% (m/m <sup>2</sup> )	VS% (m/m <sup>2</sup> )
I (Inoculum)	7.25	8.82	4.49	2.45
RI	5.22	0.94	4.26	4.16
TV	4.08	0.94	27.54	25.59
LV	8.4	23.4	1.28	0.35

<sup>1</sup>mf: fresh mass

SAMPLES COMPOSITION	
SAMPLES	COMPOSITION (based on VS%)
Control (C)	Inoculum (I)
M1	(I/RI/TV/LV; 2:0.5:0.45:0.075)
M2	(I/RI; 2:0.5)
M3	(I/TV; 2:0.5)
M4	(I/LV; 2:0.05)



**OBJECTIVE Anaerobic co-digestion lab-scale test:** using the mixture with higher BMP<sup>2</sup> Simulate the real process of continuous anaerobic co-digestion and study possible improvements involved in the addition of RI.

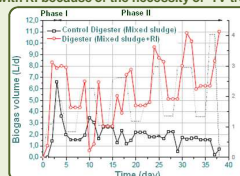
<sup>2</sup>Although the best BMP results are produced by the mixture RI/TV/LV, the trials are done only with RI because of the necessity of TV treatment before its addition.



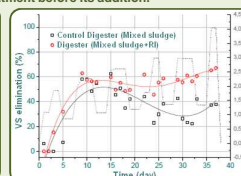
**Methodology** described in the German standard VDI 4630.

DIGESTION TESTING BENCH	
Digester 1	Control (C)
Digester 2	Co-digestion (Mixed sludge+RI)

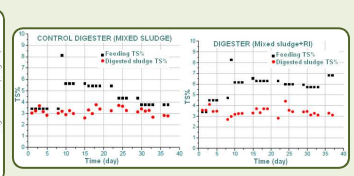
SUBSTRATES DESCRIPTION	
Inoculum (I)	Sludge from digesters
Activated sludge	Digester inlet sludge (Mixed sludge)
RI	By-products from the food industry



**Biogas daily production:** Higher biogas production at Co-digestion than in Control digester.



**VS elimination:** Higher VS% elimination at Co-digestion than in Control digester.



**TS production:** Similar TS% production in both digesters, although the feeding TS% at Co-digestion is higher than in Control digester.

The digestion testing bench consists of:

- 2 Anaerobic digesters
- Biogas flow meter
- 2 bags for biogas collection
- Equipment for biogas composition measurement

COMPOSITION COMPARISON								
DIGESTER	VFA (mg AcH/L)	Alkalinity (>2.5 CaCO <sub>3</sub> /L)	VFA/ALK <sub>T</sub> (0-0.1)	NH <sub>4</sub> <sup>+</sup> (<2.5 gr/L)	TN (gr/L)	pH (6-8)	Conductivity (mS/cm <sup>2</sup> )	CH <sub>4</sub> %
Control (C)	300	2.64-4.30	0.075	1.2	3.39	6.5-7.5	8.5-16	56.3
Co-digestion (RI)	270	2.55-4.24	0.067	1.3	3.45			51.0

**Inhibition:** There are no inhibitions problems. All the digestion control parameters (VFA, ALK<sub>T</sub>, NH<sub>4</sub><sup>+</sup>, TN, pH and Conductivity) are values inside the normality.

**CH<sub>4</sub>%:** The control digester has a CH<sub>4</sub> concentration a little bit higher than the Co-digestion digester.

## CONCLUSIONS

- **BMP test:** the highest CH<sub>4</sub> production is obtained with the mixture (RI, TV and LV). These are the residues used in Co-digestion trials. TV is rejected because of the pre-treatment necessity.
- **Co-digestion trials:** (1) there is a significant increase in the biogas production when RI is added, compared with Control, (2) the CH<sub>4</sub> composition is similar in both digesters, (3) there is a higher reduction in the VS elimination in Co-digestion, than in Control, (4) there is not inhibitions symptoms because all the parameters measured (total alkalinity, VFA, pH, conductivity, total nitrogen, ammonium) are normal in both digesters and (5) the final TS% of Control digested are not much higher values compared to Control because of TS of the RI is mainly VS.

## REFERENCES

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