Evolution of electrical resistivity measurements during process of waste biodegradation at lab scale

S. Moreau, M. Bergeron, R. Clément

Second workshop on geophysical measurements in waste management
Malmö, 16-17 February, 2012

Pour mieux affirmer ses missions, le Cemagref devient Irstea

Cemagref becomes Irstea

National Research Institute of Science and Technology for Environment and Agriculture

www.irstea.fr

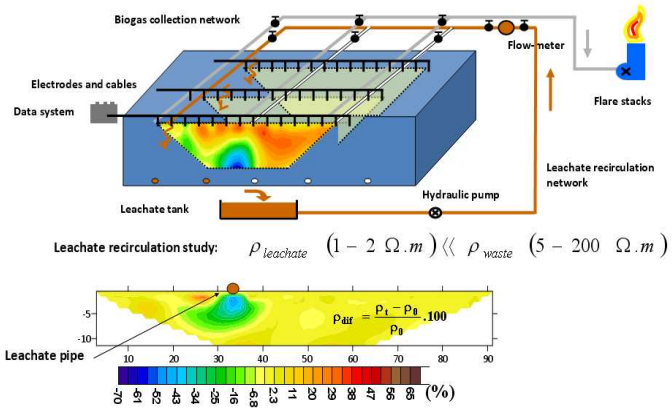
Introduction

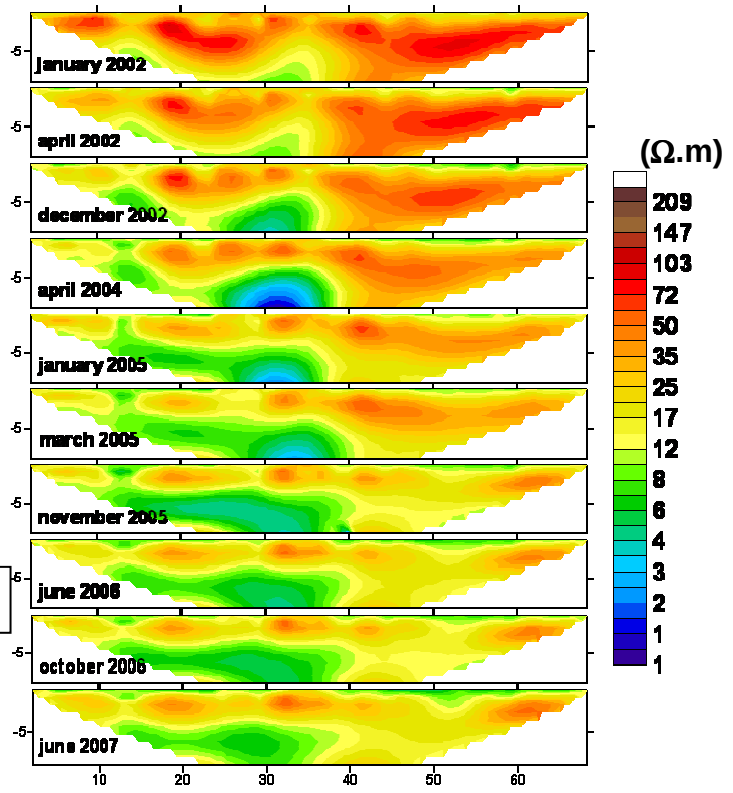
Many resistivity surveys have been conducted these last years

the main aims were :

- variation of water content during leachate flows
- gas detection in landfills
- temperature investigation to detect fire in waste mass
- ……

but the long term evolutions of resistivity are difficult to explain and waste composition seems to be influent on measurements

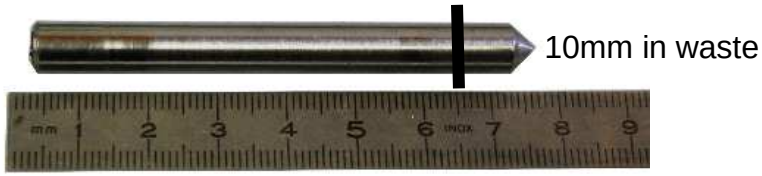




Laboratory tests were imagined to study this question

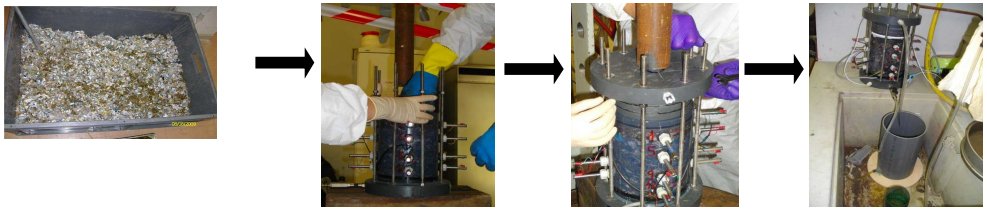
Materials and methods

cylindrical cell in PVC:	- internal diameter: 0.150m - volume: 3 liters
temperature	- 1 sensor in the middle of the cell
resistivity device	- 16 electrodes - 124 quadrupoles - Syscal Pro (Iris instruments)
biodegradation analyse	- bag for biogas sampling (volume) - biogas analyse with chromatograph - pH and conductivity of leachate injected/collected



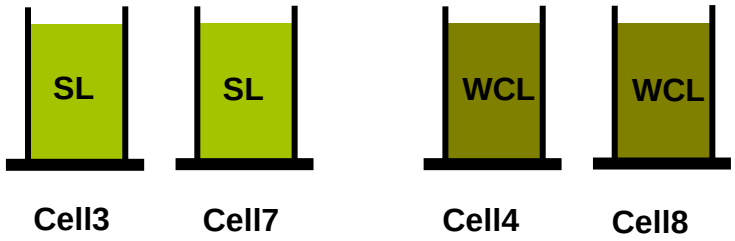
Materials and methods

Waste: - Modecom model (France, 2007)
- granulometry: 10 mm
- moistened with digested treatment plant sludge
- saturation and drainage with synthetic leachate (SL) or green waste composting plateform leachate (WCL)



Organic Waste	28.6%	Unclassified combustibles	3.3%
Paper	16.1%	Glass	13.1%
Cardboard	9.3%	Metals	4.1%
Composites	1.4%	Unclassified incombustibles	6.8%
Textiles	2.6%	Hazardous waste	0.5%
Sanitary textiles	3.1%	Fines < 20 mm	0.0%
Plastics	11.1%		

Experimental conditions
- low density 0.36 kg/kg (dry mass)
- field capacity to start the test after saturation and drainage phase
- controlled temperature 35℃
- 4 test cells:



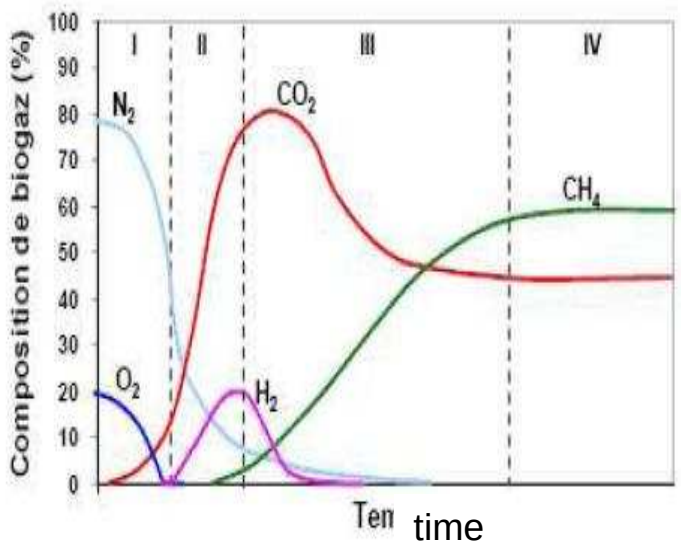
Materials and methods

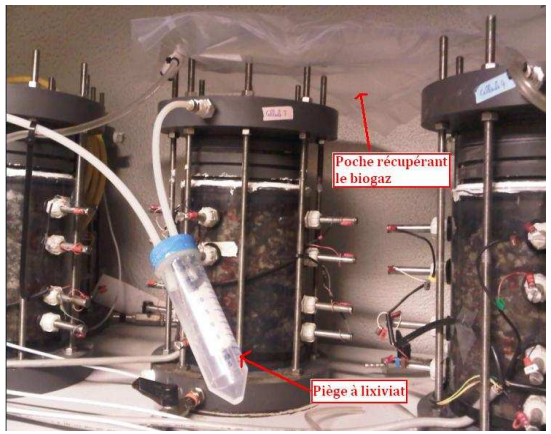
MSW anaerobic biodegradation: 4 steps process

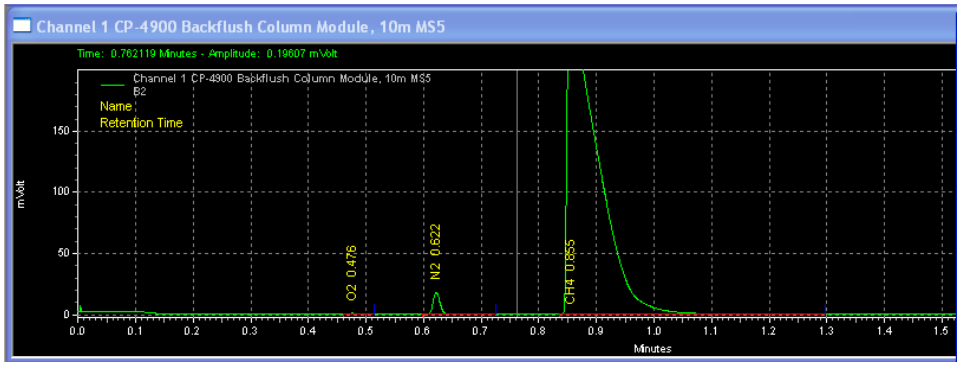
- Hydrolysis
- Acidogenesis
- Acetogenesis
- Methanogenesis: CH_4, CO_2

Key parameters:

- pH, temperature
- Volatile fatty acids concentration
- oxygen content
- moisture content





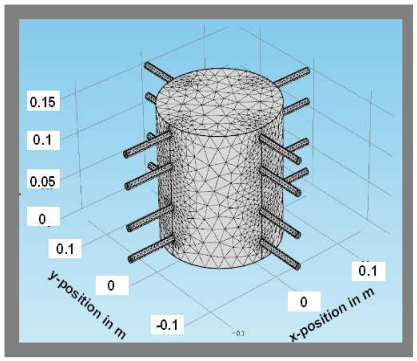


Materials and methods

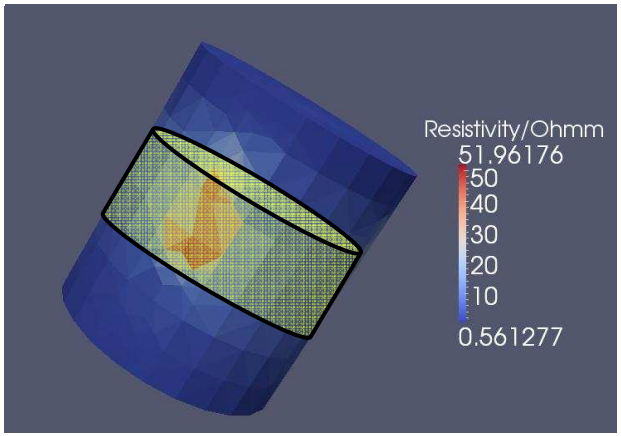
Electrical resistivity measurements:

- geometric factors evaluated with measurements and simulation (F3D-Lab),
- interpreted resistivity calculated with BERT (Gunther et al; 2007)

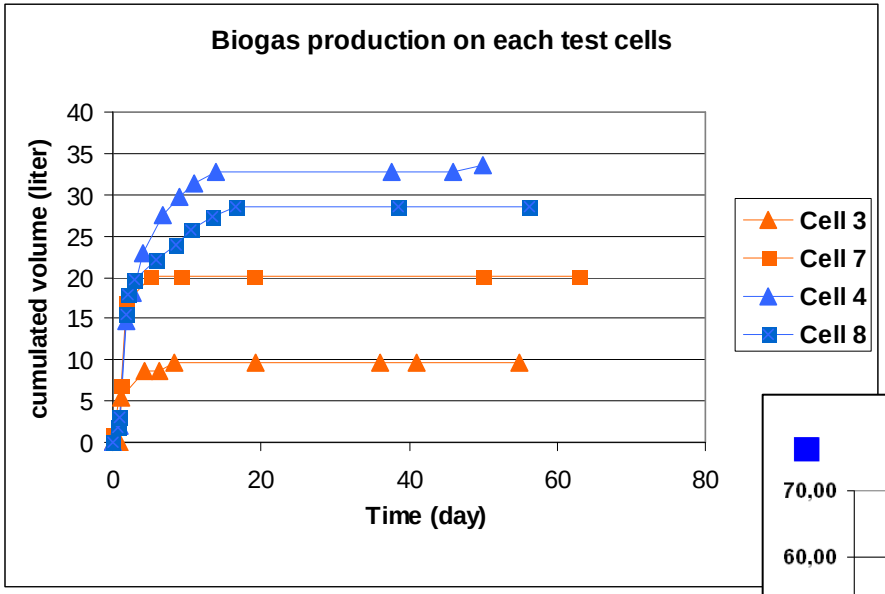
- Average resistivity is calculated using only 1/3 of interpreted resistivity at the middle of the test cell to avoid side effects from the top and the bottom



16 electrodes - 124 quadrupoles

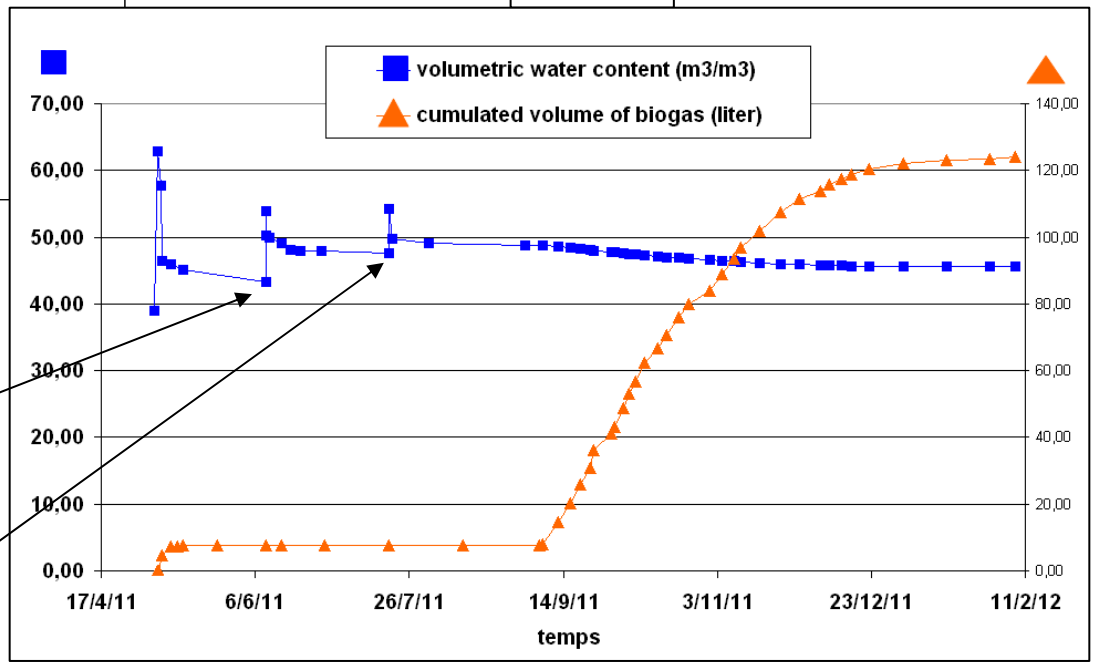


Results and discussions



Biogas production was stopped after 20 days of test for all the test cells

Cell 3



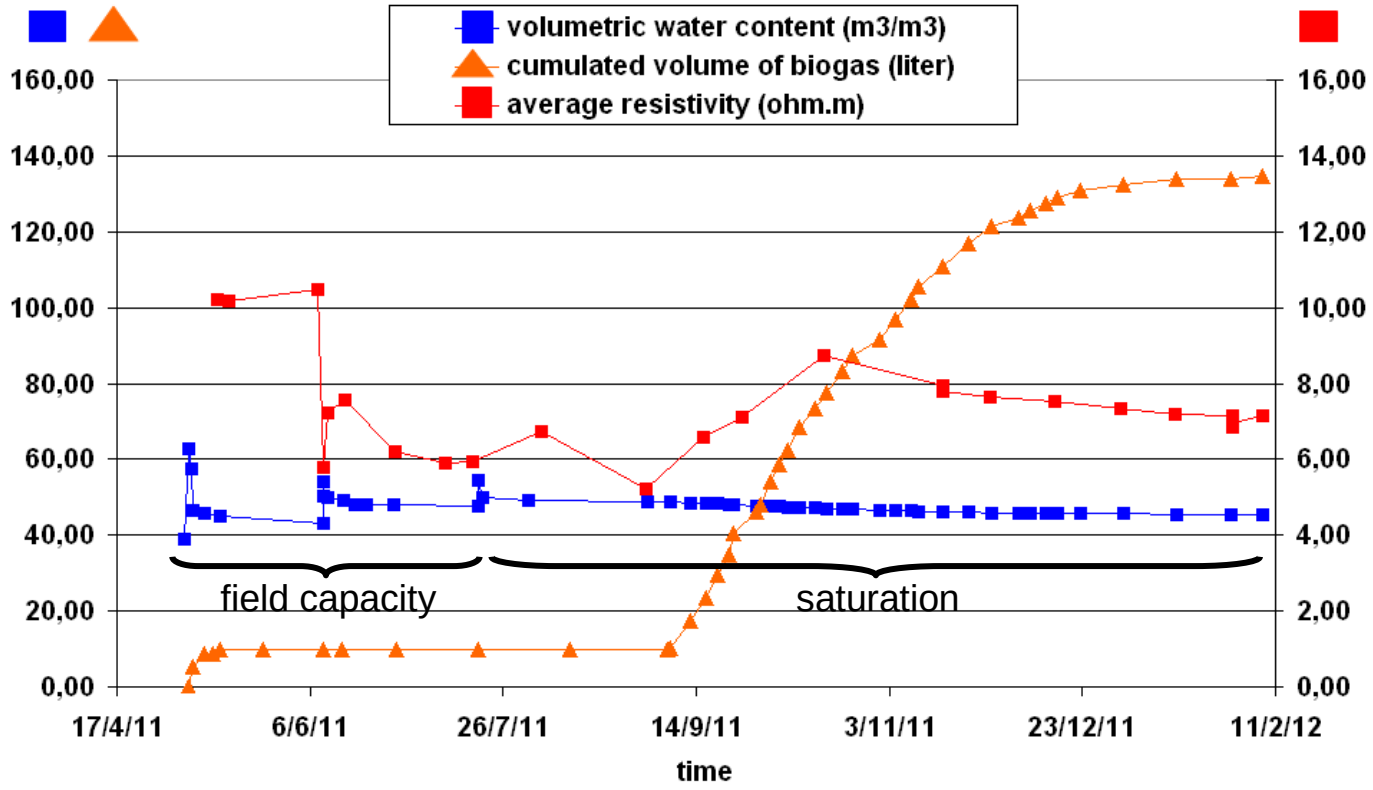
A second saturation-drainage phase was conducted (day) with no more effect on biogas production

Saturation condition was finally choosen to continue the test

Results and discussions

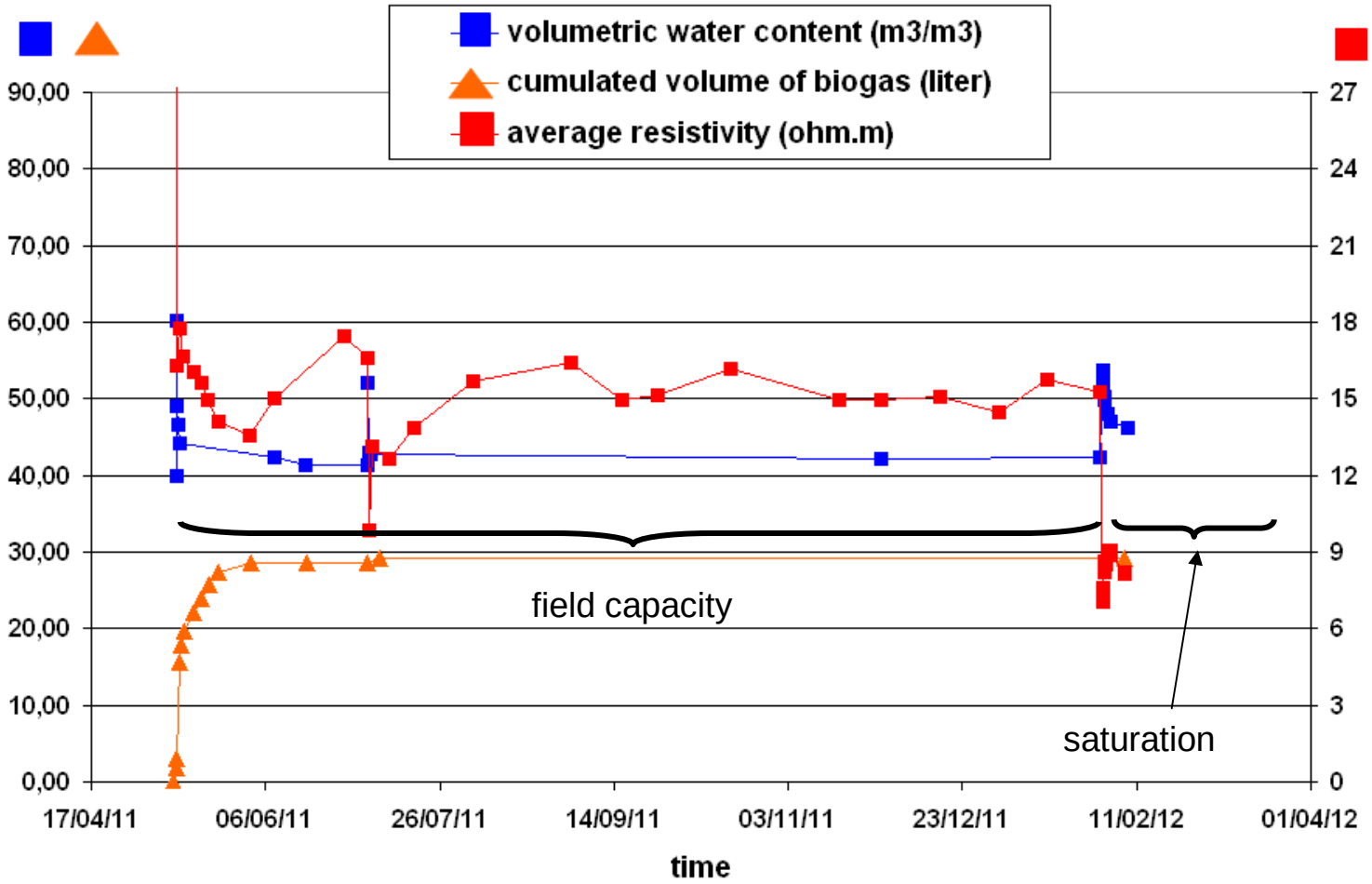
Cell 3: Modecom waste + synthetic leachate

biogas analyse:
- 55% CH_4 → Methanogenesis phase
- 45% CO_2



Results and discussions

Cell 8: Modecom waste + green waste composting plateform leachate



Conclusions

- The four test cells are still in hand
- Field capacity does not seem to be the best hydraulic condition to boost waste biodegradation
- resistivity variations are observed without significant evolution of water content
- resistivity variations (increasing) appear during biogas production
- Analyses of leachate composition (pH, VFA, ….) are managed to understand its chemical composition

→ According to the observed experimental problems, a new test is imagined

1) Hydrolysis

2) Acidogenesis

3) Acetogenesis

4) Methanogenesis