IN VITRO SIMULATION OF GASES PRODUCTION BY LIVESTOCK EFFLUENT USING MICRO GC FUSION®

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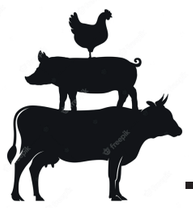
CONTEXT

Agriculture is responsible for 94% of ammonia emissions (NH3) in France, according to the SECTEN report in 2018. This gas, which is harmful to humans as well as animals, contributes to global climate deregulation and the creation of fine particles in the atmosphere. In addition, 68% of the methane (CH4) produced in France comes from livestock farming. Hydrogen disulfide (H2S) and nitrous oxide (N2O) are molecules that also result from agricultural activity. Livestock effluents and their management are two of the main sources of these different gases. At the laboratory level, the detection and quantification of these molecules isolated or mixed is very important to understand production mechanisms and monitor the effects of external factors or additives.

PRINCIPLE OF OPERATIONS



Sampling of agricultural effluents (manure, slurry, dropping, straw, sillage...)

Mixture formulation with known biochemical and physical properties

Aerobic condition

O_2

Anaerobic condition

O_2

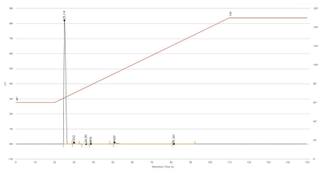
Atmospheric gases : N_2, O_2, H_2O

Green house gases : CO_2, NH_3, N_2O

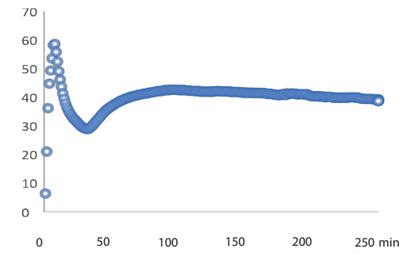
Biogases : CO_2, CH_4, H_2S

Inficon Micro GC Fusion®
Configuration :
Module A. RT Molsieve 5A, 0,25 mm (10m) [RT-Q-BOND (3m)]
Module B. RT-Q-BOND, 0,25mm (12m)
Carrier gas : Helium
TCD detector : 70°C
VICI Valco selector valve 16 streams

Data processing using Chembox by Chemlys



Chromatogram of CO2, NH3 and H2O on Micro GC Fusion



Chembox follow-up example of Micro GC Fusion analysis

APPLICATIONS

Anaerobic digestion

Organic matter

Livestock effluent

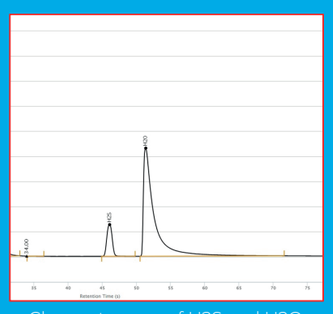
Industrial effluent

BIOGAS
CH_4 , CO_2 , H_2S

Anaerobic digestion of organic matter produces methane (CH4) from various effluent sources. Degradation of carbonaceous matter also produces carbon dioxide (CO2) and hydrogen sulphide (H2S)

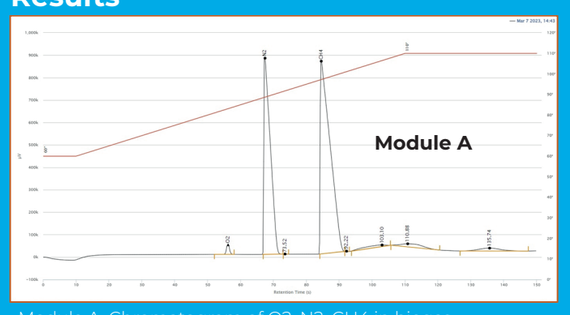
In the laboratory, anaerobic digestion ration simulations are formulated, and the production of these different gases is monitored in real time using the µGC, allowing to obtain precise kinetics over very long periods (10 days).

H2S is a harmful and odorous compound which is also responsible for concrete corrosion in the digesters

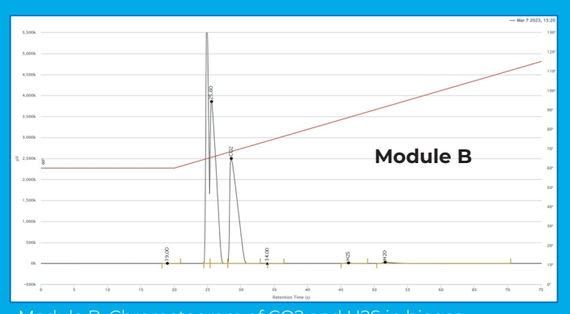


Chromatogram of H2S and H2O

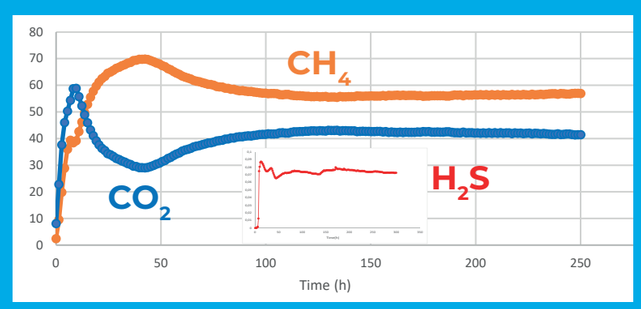
Results



Module A. Chromatogram of O2, N2, CH4 in biogas



Module B. Chromatogram of CO2 and H2S in biogas



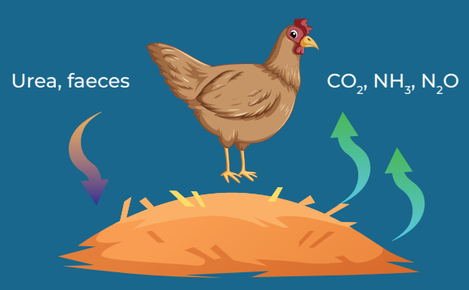
Follow up of CH4, CO2 and H2S of anaerobic digestion assay during 250 min

The biogas composition obtained is consistent with the literature (about 60% CH4, 40% CO2, 0.08% H2S; O2<1%). This type of analysis makes it possible to test additives allowing for example to accelerate the appearance of CH4 or to reduce the production of H2S.

Module A is used to separate and quantify CH4 and traces of O2 and N2. Module B is used to separate and quantify H2S and CO2.

The use of the stream selector allows for the parallel analysis of 16 minitanks of anaerobic digestion and to follow the long-term kinetics of gas production.

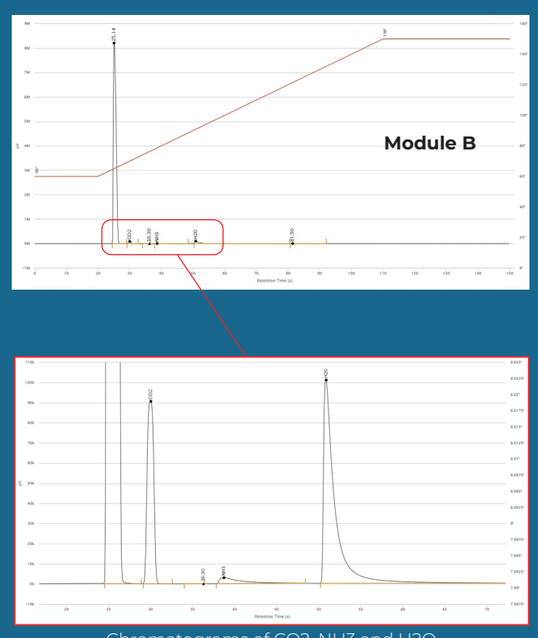
Aerobic degradation



The litter in breeding is a mixture of dry organic matter (straw, wood chips etc...), urine and faeces. This mixture decomposes in the presence of oxygen (composting process). Nitrogen compounds such as uric acid and urea produce ammonia (NH3) and nitrous oxide (N2O).

Ammonia is a dangerous gas that can induce severe lung infections for the animal or breeder. In addition, the loss of nitrogen as a gas decreases the fertilizer value of the effluent for the farmer's crops.

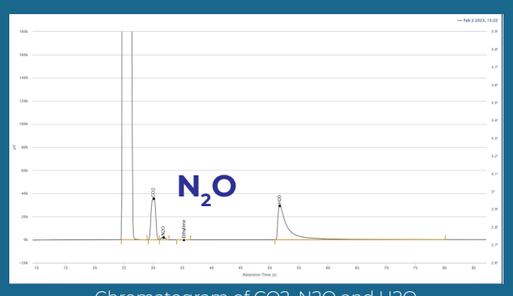
Results



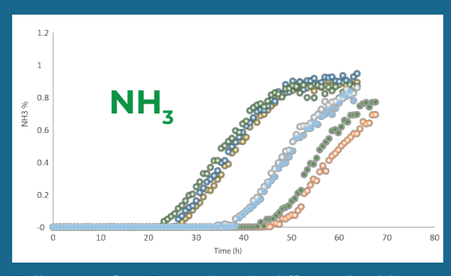
Chromatograms of CO2, NH3 and H2O

NH3 is difficult to separate from water when using isocratic chromatographic separation techniques. MIcro GC Fusion allows the separation and the determination of NH3 and N2O molecules produced by bedding reconstituted in laboratory (excreta + urea + straw).
Thanks to the Micro GC temperature ramping function, separation and resolution are better.
The simulated bedding allows to control biochemical parameters (carbon content, nitrogen content, moisture content...) and physical parameters, to have a good repeatability of gas production.

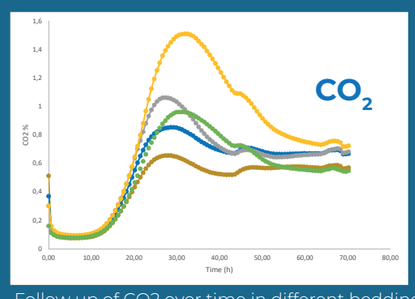
These bedding treatment test protocols will play a role in slowing down ammonia production.



Chromatogram of CO2, N2O and H2O



Follow up of NH3 over time in different bedding treatment tests



Follow up of CO2 over time in different bedding treatment tests

CONCLUSION

The microGC Fusion allows real-time and simultaneous analysis of the main gases from agricultural activities (CO2, CH4, NH3, N2O, H2S). Coupled with laboratory protocols, this equipment allows the establishment of kinetics of gas production, following different modalities. It allows us to study different models of animal litter, composting effluent or agricultural biogas production. These in vitro studies also allow rapid and accurate screening of different modalities and situations that would be impossible to quickly reconstruct on a field scale. The multi-channel technology, combined with the µGC, allows automation over the long period of gas production kinetics. These kinetics will be more or less rapid depending on the biochemical reactions considered. Simultaneous analysis of the gases allows complex monitoring of the atmospheres. For example, creation of an anaerobic atmosphere and thus following the production of CH4 and H2S resulting from it, during biogas production. The µGC is also capable of analyzing sample in a gas bag, a syringe or any other container thanks to its internal pump. This fonction is useful on field application.

Chemlys, official distributor of the analyzer in France, assists its customers with application support. This includes evolutions of the analytical solution for new processes (method setting, automation, sampling, etc.)

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