

The importance of the “*eliminate overestimation*” activated function during a BMP test performed with AMPTS II

A factor that impacts the biomethane quantification during a Biochemical Methane Potential (BMP) test is the *flush gas characteristics* especially if the gas production is low or the head space is large.

When a reactor is flushed (deaerated) with an inert gas (e.g., nitrogen (N_2)) having a chemical composition different from the biogas produced in the bioreactor, an overestimation of the gas production can occur. As the biogas is produced, it will mix with the flush gas and push away the mixture of the two gases. When the gas mixture reaches the carbon dioxide (CO_2) fixing unit, only the fraction of carbon dioxide will be absorbed by the alkaline solution, whereas the inert part of the flush gas will continue to the measurement unit and be registered. Thus, the presence of less carbon dioxide in the flush gas as compared to the produced biogas may lead to an overestimation (see Figure 1).

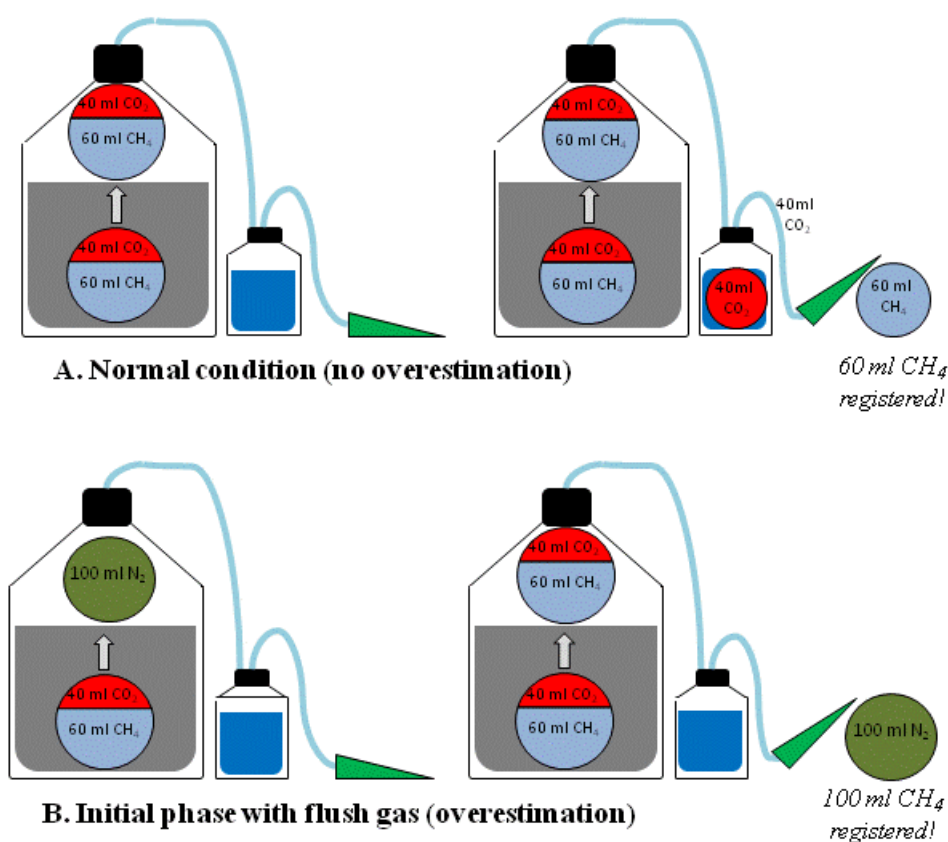


Figure 1. Schematic presentation of AMPTS working principle. The reactor can be flushed with (A) a standard gas having a chemical composition similar with the biogas or (B) an inert gas.

The overestimated volume at every measurement point, in this case corresponding to every cell opening, is assumed to be the amount of inert part of the flush gas (usually N₂ or CH₄ which do not react with alkaline solution) replaced by carbon dioxide in the system. The mathematical equations for calculating the overestimated volume at a specific measurement point are presented in Appendix C (Gas normalization calculations in AMPTS II) from the Operation and Maintenance Manual of AMPTS II.

The relative error (i.e., inaccuracy) introduced when the total accumulated volume of biomethane is measured by AMPTS II (if the function “eliminate overestimation” is not activated) is dependent on the headspace reactor volume and the volume of gas produced in the reactor. As seen in Table 1 and Figure 2, the error can be very high ($\geq 25\%$) if the working volume of the reactor is very low for a 500 mL reactor.

Table 1. Overestimated volume of methane at different measurement points during a BMP test. The values were calculated for the situation when the volume of flow cell is 10 mL, the concentration of flush gas is 100% N₂ and the headspace volume is increasing from 100 to 400 mL in a 500 mL reactor.

Head space (mL)	Registered CH₄ vol. (mL)	True CH₄ vol. (mL)	Over estimated (mL)	Rel. error (%)
100	100	74	26	26
	1000	960	40	4
	1500	1460	40	2.6
200	100	68	32	32
	1000	920	80	8
	1500	1420	80	5.3
250	100	66	34	34
	1000	902	98	9.8
	1500	1400	100	6.6
300	100	65	35	35
	1000	884	116	11.6
	1500	1380	120	8
400	100	36	64	64
	1000	853	147	14.7
	1500	1344	156	10.4

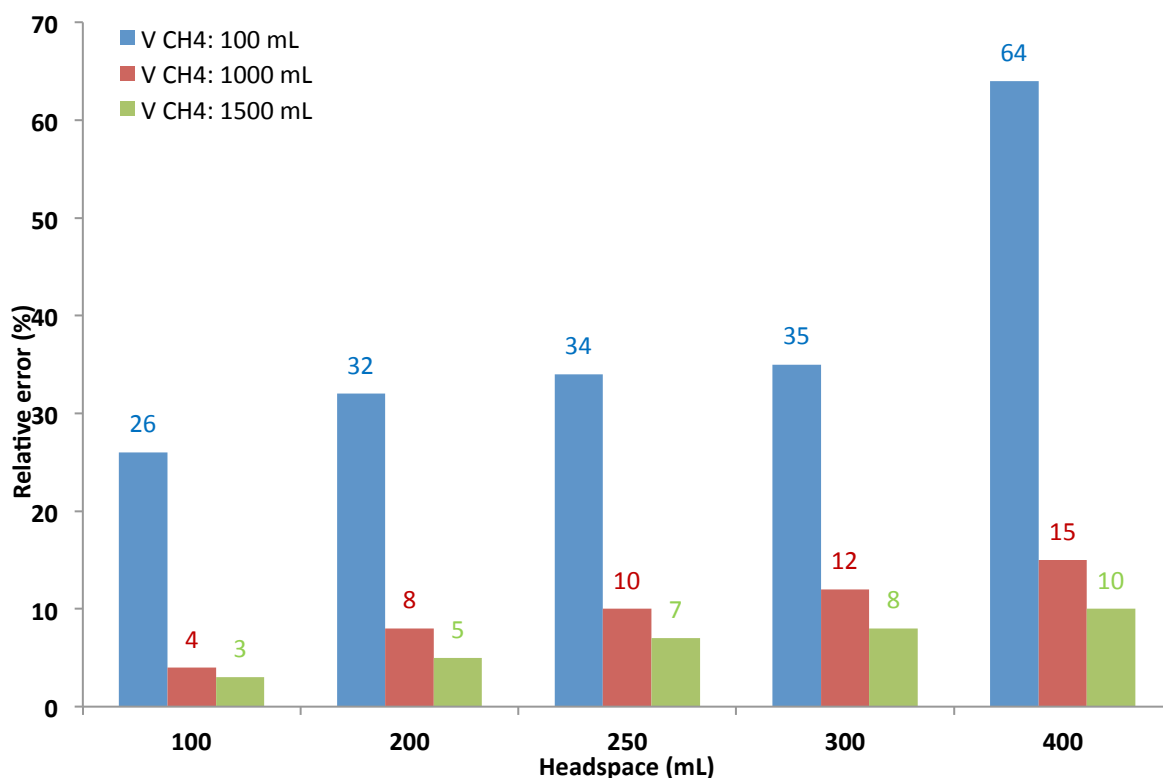


Figure 2. Effect of the head space reactor volume and the total registered gas volume on the accuracy of the AMPTS measurements if the function “eliminate overestimation” is not activated.

The “assumed methane content” is another parameter which has a low impact on the total volume of biomethane measured by AMPTS II. Table II presents the overestimated volume of methane and the relative error which can be introduced into the measurements when nitrogen is used as flushing gas and the function “eliminate overestimation” is not activated when a report is generated from AMPTS II.

Table 2. Overestimated volume of methane at different measurement points during a BMP test as a function of the assumed CH₄ content (50, 60 or 70%) in the produced biogas at the beginning of the AD process. The values were calculated for the situation when the volume of flow cell is 10 mL, the concentration of flush gas is 100% N₂ and the headspace volume is 100 mL.

Opening cycle	Registered CH ₄ vol. (mL)	True CH ₄ vol. (mL)			Over estimated (mL)			Rel. error (%)		
		50%	60%	70%	50%	60%	70%	50%	60%	70%
1	10	5.0	6.0	7.0	5.0	4.0	3.0	50	40	30
2	20	10.5	12.4	14.3	9.5	7.6	5.7	47	38	28
3	30	16.5	19.2	21.9	13.5	10.8	8.1	45	36	27
4	40	22.8	26.2	29.7	17.2	13.8	10.3	43	34	25
5	50	29.5	33.6	37.7	20.5	16.4	12.3	41	33	24
6	60	36.6	41.3	45.9	23.4	18.7	14.1	39	31	23
7	70	43.9	49.1	54.4	26.1	20.9	15.6	37	30	22

8	80	51.5	57.2	62.9	28.5	22.8	17.1	35	28	21
9	90	59.4	65.5	71.6	30.6	24.5	18.4	34	27	20
10	100	67.4	73.9	80.5	32.6	26.1	19.5	33	26	19
...										
25	250	203.6	212.8	222.2	46.4	37.2	27.8	19	15	11
...										
101	1010	960	960	970	50	40	30	5	5	4
102	1020	970	980	990	50	40	30	5	4	3
...										
149	1490	1440	1450	1460	50	40	30	3	3	2
150	1500	1450	1460	1470	50	40	30	3	3	2

To eliminate or to minimize the effect of methane overestimation during a BMP test when CO₂ is removed prior the measurements, the following actions could be taken:

- a) Activate the function “Eliminate overestimation” from the Experiment page before generating a report by AMPTS.

or

- b) Prior measurements flush the bioreactors with a standard gas having similar CO₂ concentration as the produced biogas (e.g., 60% N₂ and 40% CO₂; 60% CH₄ and 40% CO₂, etc)
- c) Decrease the reactor headspace as much as possible
- d) Keep the ISR (inoculum to substrate ratio) low enough by adding more sample biomass to ensure sufficient gas production.