

A background image showing a wind farm in a grassy field. In the foreground, there is a large, blue, bear-shaped sculpture. Two people are standing near the bear, and a small dog is sitting on the grass. The scene is set during a bright, hazy day.

H2FC-SOSVECTOR
PROJECT SET-UP AND FINDINGS
GAS.BE – LABO



Measurement of the impact of the introduction of Hydrogen into natural gas on the efficiency of two gas fuel cells units



Unit 1 : BlueGEN BG-15 (Solid Power)

Input gas : 3 kW

Output Elec : 1,5 kW

Output Heat : 0,7 kW



Unit 2 : Remeha eLecta Ace 300 (BDR Remeha Group)

Input gas full cell only : 2 kW

Output Elec : 0,7 kW

Output Heat : 1 kW



Parameters to be measured and equipment required

| <u>Parameters</u> | <u>Equipement</u> | <u>Range of measurement</u> |
|-----------------------------|------------------------------|--|
| Gas input | Gas meter | 0 – 2,5 m ³ /H |
| Electricity production | Electric meter | Standard range |
| Heat production | balance | 0 – 60 kg |
| | Temperature probes | 0 – 100 °C |
| Surface temperature | Temperature probes | 0 – 100 °C |
| Gas Mixing composition | Micro-Chromotograph analyser | CH ₄ , Propane, N ₂ , H ₂ |
| Composition of exhaust fume | Fume analyser | CO ₂ , CO, NO _x , H ₂ |
| Temperature of exhaust fume | Temperature probe | 0 – 200 °C |

Challenges for a laboratory equipped to measure the operation of gas-fired central heating boilers: the relatively low level of heat transmitted to the water.

Solution : To ensure sufficient measurement accuracy, it is necessary to make measurements under stabilized conditions over a long period of time in order to reduce uncertainties related to the start-stop effect.



Measurement procedure

First measurement done with the standard reference gas used during the CE marking certification process :
G20 (100 % methane)

Then change of mixing :

- Time needed to have the correct mixing inside the unit
- Time needed to be sure of the stabilization of the functioning of the unit
- Time needed to take the measurements
- Time needed to take a second round of measurements (to increase the precision and to confirm the stabilization of the unit)

Then change to the next mixing

A measurements package includes : inlet water temperature, outlet water temperature, weight of water, electricity, gas consumption, gas composition, exhaust fume composition, exhaust fume temperature.



H2FC-SOSVECTOR PROJECT SET-UP AND FINDINGS

Mixing program done on unit 1 : solid power

| n° | Suggested composition | Real composition | | | | |
|---|---|------------------|-------------------------------|----------------|-----------------|----------------|
| | | CH ₄ | C ₃ H ₈ | H ₂ | CO ₂ | N ₂ |
| With modification of the settings of the appliance | | | | | | |
| G20-1 | 100%CH ₄ | 100,0 | | 0,0 | | |
| M1-1 | 90%CH ₄ +10%H ₂ | 89,3 | | 10,7 | | |
| M2-1 | 80%CH ₄ +20%H ₂ | 78,4 | | 21,7 | | |
| M3-1 | 70%CH ₄ +30%H ₂ | 68,7 | | 31,3 | | |
| M4-1 | 87%CH ₄ +13%C ₃ H ₈ | 86,7 | 13,3 | | | |
| M5-1 | 57%CH ₄ +30%H ₂ +13%C ₃ H ₈ | 59,8 | 10,2* | 30,0 | | |
| M6-1 | 96%CH ₄ +4%CO ₂ | 95,9 | | | 4,1 | |
| M7-1 | 66%CH ₄ +30%H ₂ +4%CO ₂ | 66,5 | | 29,6 | 3,9 | |
| M8-1 | 92,5%CH ₄ +7,5%N ₂ | 92,4 | | | | 7,6 |
| M9 | 62,5%CH ₄ +30%H ₂ +7,5%N ₂ | 62,8 | | 29,7 | | 7,6 |
| Without modification on the settings of the appliance | | | | | | |
| G20-2 | 100%CH ₄ | 100,0 | | 0,0 | | |
| M1-2 | 90%CH ₄ +10%H ₂ | 89,3 | | 10,7 | | |
| M2-2 | 80%CH ₄ +20%H ₂ | 78,4 | | 21,7 | | |
| M3-2 | 70%CH ₄ +30%H ₂ | 68,7 | | 31,3 | | |



H2FC-SOSVECTOR PROJECT SET-UP AND FINDINGS

Mixing program done on unit 2 : Remeha

| n° | Suggested composition | Real composition | | | | |
|----------|--|------------------|-------------------------------|----------------|-----------------|----------------|
| | | CH ₄ | C ₃ H ₈ | H ₂ | CO ₂ | N ₂ |
| G20 | 100%CH ₄ | 100,0 | | | | |
| M1 | 90%CH ₄ +10%H ₂ | 89,9 | | 10,1 | | |
| M2 | 80%CH ₄ +20%H ₂ | 80,3 | | 19,7 | | |
| M3 | 70%CH ₄ +30%H ₂ | 75,1 | | 24,9 | | |
| M4 | 90%CH ₄ +10%C ₃ H ₈ | 90,2 | 9,8 | | | |
| M5 | 63%CH ₄ +30%H ₂ +7%C ₃ H ₈ | 63,2 | 7,0 | 29,9 | | |
| M6 | 96%CH ₄ +4%CO ₂ | 95,6 | | | 4,4 | |
| M7 | 67,2%CH ₄ +30%H ₂ +2,8%CO ₂ | Not performed | | | | |
| M8 | 92,5%CH ₄ +7,5%N ₂ | 92,4 | | | | 7,6 |
| M8 extra | 92,5%CH ₄ +7,5%N ₂ | 92,9 | | | | 7,1 |
| M9 | 64,75%CH ₄ +30%H ₂ +5,25%N ₂ | Not performed | | | | |



Constataion during tests on unit 1 : solid power

- First raw of tests : The manufacturer first informed us that the device had to be configured remotely (internet) by their technical department for each different mix. For each change of mixture, we had to coordinate the change with a change of settings with each time an important stabilization time (+- 2 hours for each change).

After discussion with their R&D department, they confirmed that we could run the unit with the same basic setting.

- Second raw of tests : only perform with H2 mixing with methane.

Point of attention : the start procedure from scratch of the appliance take about 2 days to be in state to produce electricity.



H2FC-SOSVECTOR PROJECT SET-UP AND FINDINGS

Constation during tests on unit 2 : Remeha

- All measurements were done with the basic setting of the appliance.

Point of attention : the start procedure from scratch of the appliance take about 40 minutes to 6 hours to be in state to produce electricity. No explanation available from the manufacturer about the differences.



General constataions from boths tests

The tests were done in labo environnement with an exclusive operation of the full-cell without any other complementary éqipements (no extra buffer nor extra boiler)

The water flow and the temperature regime are very critical

Remeha : water temperature regime 20 / 65 °C with a flow of 19 l / hour

Solid Power : water temperature regime 30 / 37 °C with a flow of 85 l / hour

In normal circumstances, the unit are installed with their equipment including water buffer and all probes. The units manage everything by themself and the user or the installer have very little influence on the internal operations.

Those units need as much as possible a long running time without break to take the maximum advantage of their operation time.