Italian National Agency for New Technologies, Energy and Sustainable Economic Development

INNOVHUB STAZIONI SPERIMENTALI PER L'INDUSTRIA

STAZIONE SPERIMENTALE PER I COMBUSTIBILI

innovazione e ricerca

27th European Biomass Conference Lysbon , 27-30 May 2019

Set-up of a new sampling method to measure condensable PM from residential solid biomass heating generators

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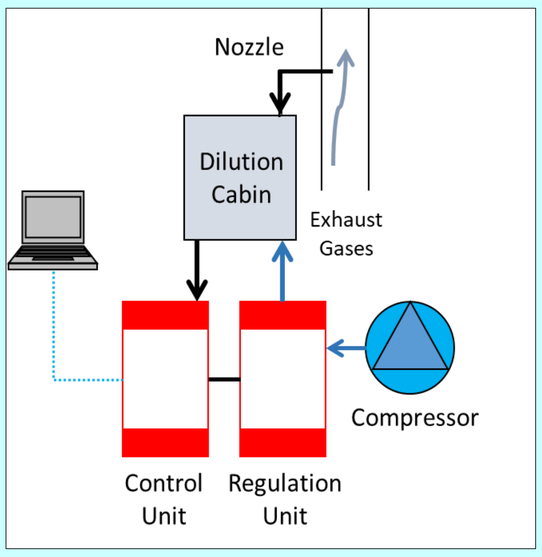
INTRODUCTION

Biomass combustion, mainly when associated to small scale domestic appliances, is recognized to be responsible for huge outdoor pollution. In addition to a high level of particulate matter (PM), this kind of combustion produces Total Organic Compounds (TOC), divided in very volatile organic compounds (VVOC), volatile (VOC) and semi volatile organic compounds (SVOC). These molecules leads to the formation of the so-called condensable PM, which is measurable collecting PM after the dilution of exhaust gases. No European harmonized sampling methods exists so far. Innovhub and ENEA are working to a new dilution system to measure condensable PM in the framework of IMPRESS II project.

MATERIALS & METHODS

New dilution sampling system scheme



Sampling system

The 5 components of the dilution system:

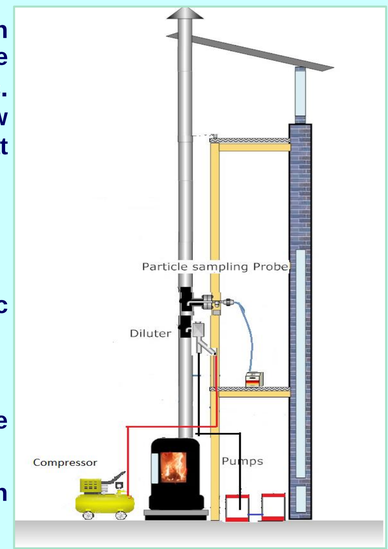
- ✓ **The compressor of ambient air**
- ✓ **The control unit, containing the pump and connecting the other devices**
- ✓ **The regulation unit, to maintain constant the dilution ratio in dilution chamber**
- ✓ **The dilution cabin, at a controlled temperature around 35-40°C, containing the dilution chamber, the thermocouple measuring the diluted gases temperature, the dilution air heater**
- ✓ **The lap-top with the software to make the sampling system automated**

Dilution system: exhaust gases are conveyed to a dilution chamber where they are mixed with dried air at 40°C. Then the gas is conveyed to a filter to collect condensed particles. Customer can set the Dilution Ratio (1:10) and the sampling flow rate (L/min). The system is totally controlled by a software that guarantee an automatic regulation of the flow rates.

Experimental tests:

- ✓ **with 8kW pellet stove fed with class A2 pellet**
- ✓ **other measured emissions: O2, CO, CO2 and volatile organic compounds (VOC)**
- ✓ **PM emissions:**
  - **Gravimetric sampling system with constant flow rate based on EN 13284-1 (HF PM). Filter holder @ 120°C.**
  - **Gravimetric sampling by means of the new dilution sampling system (Dil PM), PM @ 40°C.**

Test rig

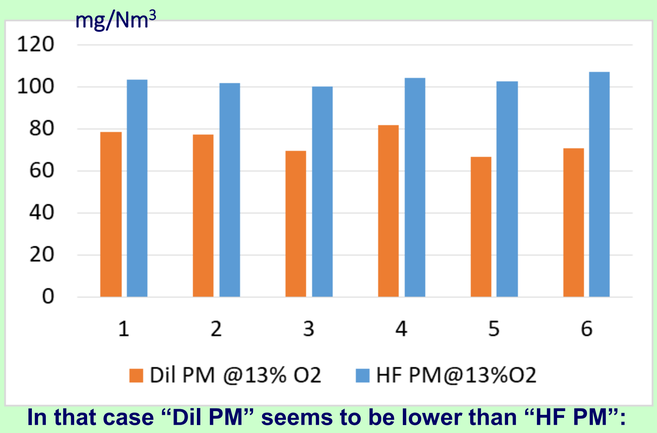


Dilution chamber first setup

- ✓ **Nozzle not heated**
- ✓ **Residence time in dilution chamber up to 0,6sec**
- ✓ **Filter cartridge, integrated in the dilution chamber, to collect condensed PM**

Opportunities:

- ✓ **Weight losses due to filter cartridge flaking**
- ✓ **Difficulties in filter weighting**
- ✓ **Difficulties in filter handling**
- ✓ **Condensation in cold nozzle**



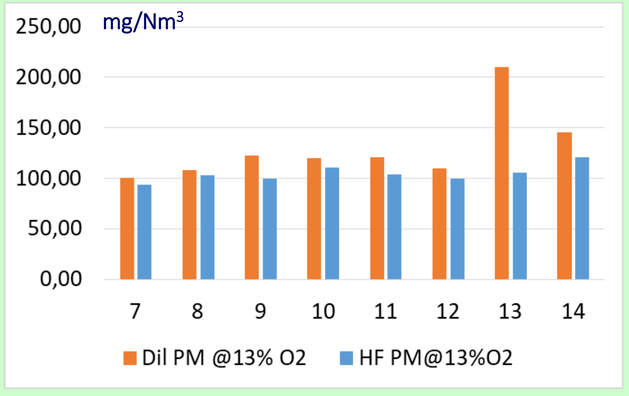
In that case "Dil PM" seems to be lower than "HF PM": fake news!

Dilution chamber second setup

- ✓ **Heated nozzle**
- ✓ **Residence time up to 0,6 sec**
- ✓ **Addition of plane filter holder**

Opportunities:

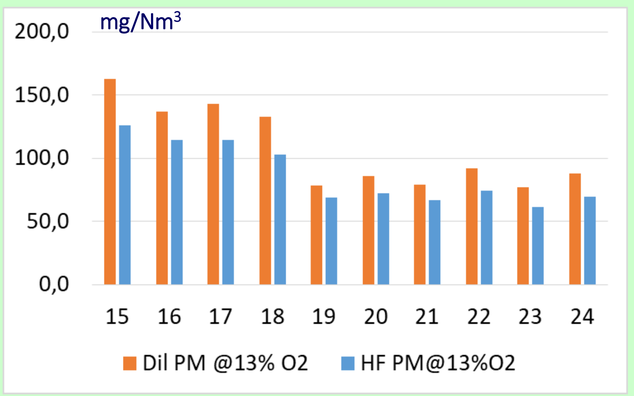
- ✓ **Difficulties in filter handling (homemade component additioning)**
- ✓ **Too low residence time?**



In that case "Dil PM" is higher than "HF PM": good news but higher differences are expected

Dilution chamber third setup

- ✓ **Heated nozzle**
- ✓ **Residence time up to 3sec**
- ✓ **Plane filter integrated to the dilution chamber**



In that case the differences between "Dil PM" and "HF PM" are higher than the second set-up due to higher residence time

NEXT STEPS

1) **Testing the new method with a wood stove, comparing the results with HF PM and with dilution tunnel sampling system**
2) **Testing the new method in different labs with different plants and different technicians managing comparing different sampling methods (ongoing activity)**
3) **Verify that with new method SVOC's are collected with condensable PM as well**

AKNOWLEDGEMENT

The described experimental tests and results are part of Work Package 2 of the project 16ENV08 IMPRESS 2: Metrology for air pollutant emissions, coordinated by NPL Management Limited, a UK metrology institute, and funded by EURAMET (European Associations of National Metrology Institutes), http://empir.npl.co.uk/impress/.

"This project has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme"

EMPIR EURAMET

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States