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DEVELOPMENT OF A NEW SAMPLING METHOD TO MEASURE CONDENSABLE PM

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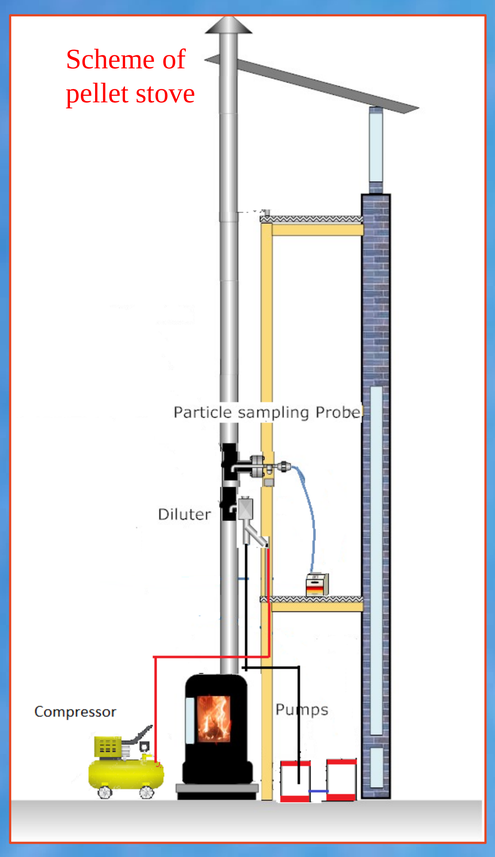
Scheme of pellet stove

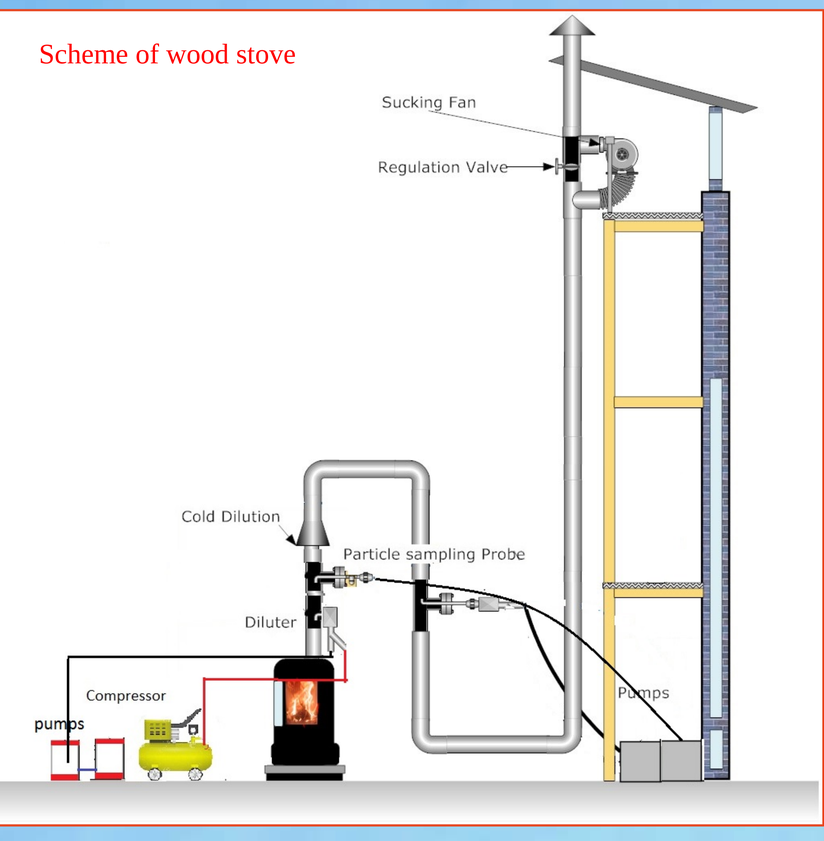


Schemes of the experimental plants in ISSI

- ✓ In order to test the new sampling train to measure condensable PM both pellet stove and wood stove have been used.
- ✓ The exhausted gases are extracted from the stack, through a nozzle which keeps a constant flow and send it to the new sampling train (Dil PM)
- ✓ As reference method a traditional hot particulate sampling was performed where the sampling filter was heated at 120°C and condensation was prevented (HF PM).
- ✓ For the wood stove even a dilution tunnel, according to the method UNI EN 16510-1 [1], where the flue gases directly produced by the appliance are mixed with cold air have been used to compare the new system (Tun PM)
- ✓ To control heat generators and emissions, O2, CO, CO2, NOx and volatile organic compounds (VOC) were monitored by continuous analyzers, connected to a data logging system.

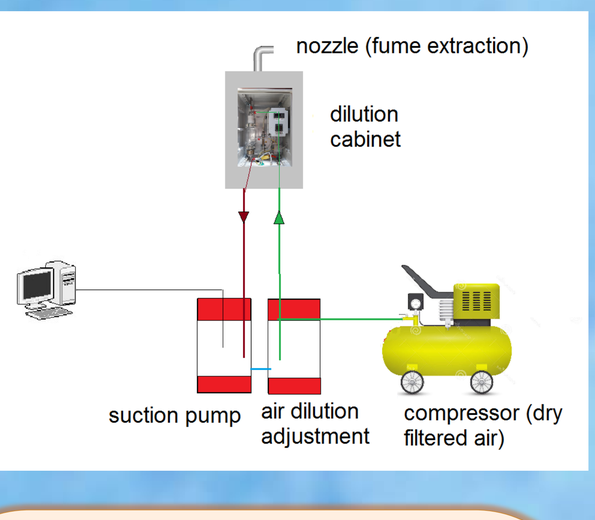
[1] UNI EN 16510-1:2019 *Residential solid fuel burning appliances – Part 1: General requirements and test methods*

Scheme of wood stove



The new designed sampling train

The exhaust gases, withdrawn from the chimney, go through the dilution chamber where are mixed with a controlled air dried and filtered at a temperature around 40°C coming from the compressor to allow nucleation and condensation processes.
Then the flue gases are conveyed to a filter to collect condensed particles.
The system is totally controlled by a software that allow to regulate the dilution ratio up to 10 and the suction flow rate between 1 to 10 Nl/min



The dilution chamber

The dilution chamber is the core part of the system, the exausted gases enter from the top of the chamber in a mixing cone, tangetially the preheated dilution air is injected. The gases pass then through the residence chamber where nucleation and condensation occur. The temperature in the residence chamber is adjustable and continuosly checked with a termocouple.
The particles formed are then collected on a filter

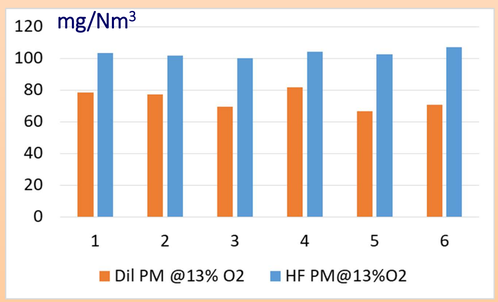
Dilution chamber first setup

- ❖ Nozzle not heated
- ❖ Residence time up to 0.6s
- ❖ Filter cartrige

disadvantages

- ✓ filter cartridge fragmentations
  - ➢ difficul weigh
  - ➢ Difficult handle
- ✓ Condensation in cold nozzle

Pellet stove



Dil PM appears lower than HF PM: loss of material

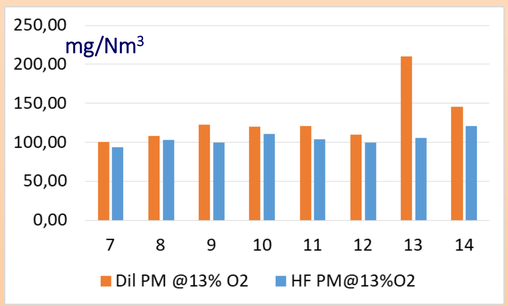
Dilution chamber second setup

- ❖ Heated nozzle
- ❖ Residence time up to 0.7s
- ❖ Handmade plane filter

disadvantages

- ✓ Not enough residence time

Pellet stove

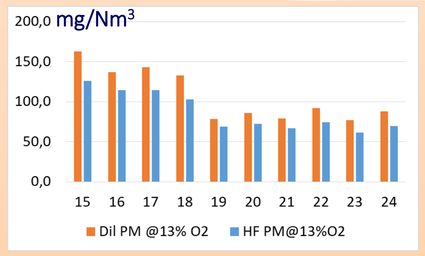


Dil PM is higher than HF PM: condensation occoured, but higher differences are expected

Dilution chamber third setup

- ❖ Heated nozzle
- ❖ Residence time up to 3 s
- ❖ Plane filter

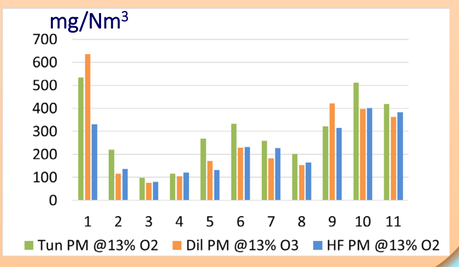
Pellet stove



differences between Dil PM and HF PM as expected due to higher residence time

Wood stove

Deposition of PM in the nozzle: some more adjustment are required



Next steps

- ✓ Change the nozzle for the wood stove because a huge amount of particle settles during sampling
- ✓ Testing the new method in different labs with different plants (ongoing activity)
- ✓ Analyze PM in order to quantify VOC collected with condensable PM

Acknowledgement

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