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


*ENEa, National Agency for New Technologies, Energy and Sustainable Development **Innovhub Stazioni Sperimentali per l’Industria, Fuels Area

**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 lead 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**

### 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 cabinet, at a controlled temperature around 35-40°C, containing the dilution chamber, the thermocouple measuring the diluted gases temperature, the dilution air heater
- The laptop 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 kW 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 (DI PM), PM @ 40°C.

### New dilution sampling system scheme

- 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 nozzles

### Test rig

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

**Gravimetric sampling**

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<thead>
<tr>
<th>mg/Nm³</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
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<th>90</th>
<th>100</th>
<th>110</th>
<th>120</th>
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</thead>
<tbody>
<tr>
<td>Dil PM @13% O₂</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
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<td>12</td>
<td>13</td>
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<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>HF PM@13% O₂</td>
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In that case “DI PM” is higher than “HF PM”: good news but higher differences are expected

**Gravimetric sampling**

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<tr>
<th>mg/Nm³</th>
<th>0</th>
<th>10</th>
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<tbody>
<tr>
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<td>250</td>
<td>200</td>
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<tr>
<td>HF PM@13% O₂</td>
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In that case the differences between “DI 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**

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