Appendix 3: Portable Emissions Sampler

Based on Applied Research Services Technical Bulletin 72 (2005)

The portable emissions sampler captures particulate emissions using a method based on Oregon Method 41 (OM41). This method is also known as the Condar Method.

Principle of operation

The sampling head includes a dilution system to dilute and cool the flue gas. This simulates the dilution and cooling that occurs when flue gases mix with ambient air, and results in condensation of oily compounds such as polyaromatic hydrocarbons, which can then be captured on the filter.

Flue gases are drawn into a manifold through the sample probe. Dilution air is also drawn into the manifold through small holes in its face. The diluted gases are then drawn through two filters, which collect the particulate emissions.

Details of the sampler

General

The sampler includes a sampling head (detailed below), which captures the sample of particulates. In addition, flue temperature is measured, flue gases are analysed continuously for oxygen and carbon dioxide content, and the carbon dioxide content of the diluted gas stream is analysed. The sampler also contains gauges to monitor and set gas flows through the sample head and flue gas analysers, canisters of drying agent to remove water vapour from the gas streams, a gas meter to quantify the sample flow, and a vacuum sensor to monitor filter loadings.

The sampler contains two analysis trains, which are programmed to start and stop at a flue temperature of 100°C. The calculation of the emissions rate is made using results from both analysis trains. The first sampling train draws diluted flue gases on to a filter and gives the weight of particulates per litre of flue gas (Wp/V). The other sampling train performs a gas analysis, which gives the volume of flue gas per kg (dry weight) of fuel burned (V/Wf). This is done directly from the analysis and does not rely on a knowledge of how much fuel was burned.

The chemistry of the process means a fixed amount of fuel requires a well-defined volume of air to burn it completely and generate a known volume of flue gas. If exactly this amount of air is supplied, then the volume of flue gas produced per kg of fuel burned is also known. Under these conditions the flue gases contain no oxygen (it would have all been used up). In reality additional air is supplied. This additional air will dilute the flue gases and result in a measurable amount of oxygen in the flue gases, which allows the degree of dilution to be calculated and hence the actual volume of flue gas per weight of fuel burned.

Dividing the first result by the second ([Wp/V]/[V/Wf]) gives the emissions rate (Wp/Wf). Filters on the samplers were changed daily, and where possible the sampler was run for seven days in each household. The sampler is interfaced to a laptop computer, which activates the sampling pump when the heater is operated and the flue temperature rises. The computer is also used to log data.

Sampling head

The sampling head consists of a stainless steel dilution manifold (length 100 mm, internal diameter 49 mm) fitted with two end caps. One end cap is fitted with a short probe with a glass insert. The probe is inserted into the flue so that the inlet is near the flue centre. Dilution air is admitted to the manifold via 12 x 1 mm diameter holes in the face of the end cap. The sample is collected on two 47 mm glass

fibre filters (Gelman Type A/E Cat No 61631) mounted on two filter holders fitted to the other end cap of the manifold.

Figure A1: Schematic of sampling head

See figure at its full size (including text description).

Apart from the probe and manifold assembly, the sampling assembly is the same as used in AS/NZS 4012/3. As with NZS4013, two glass fibre filters are used to collect the particulate materials. The flue gas composition is also measured, and is used to calculate the total volume of gas that has passed up the flue per kg of fuel burnt. The total emissions can then be calculated from the rate at which material is collected on the filter and the dilution ratio.

Comparison with results obtained with AS/NZS 4012/3

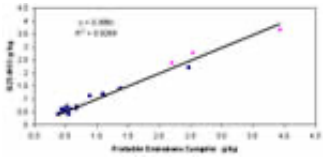
Laboratory tests of wood burners for compliance to particulate emissions standards in New Zealand are currently carried out according to methods set out in the joint Australian-New Zealand standard AS/NZS 4012/3. The test involves capturing the entire gas stream exiting the flue, which is then passed to a dilution tunnel where it is mixed with room air, which provides dilution and cooling. The particulate sample is drawn from the end of the dilution tunnel. Because the velocity of gas in the dilution tunnel is more easily measured than that in the flue, the amount of particulate generated is relatively easily calculated.

During the comparative tests the portable emissions sampler was set up in the test room and run at the same time as the laboratory test rig.

Results

Figure A2 shows the results of 19 runs carried out on a range of heaters. Of these, 17 (squares on the graph) were obtained during tests where fuelling was carried out in accordance with the requirements of AS/NZS 4012/3, and three (triangles) were carried out during five-hour runs under a 'real-life' fuelling regime, in accordance with Sustainable Management Fund Contract Application Number 2205. Results are particulate emissions in g/kg.

Figure A2: Comparison of results obtained with portable emissions sampler and AS/NZS 4012/3



See figure at its full size (including text description).

The results show that there is a good correlation between the results obtained with the two methods.