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Abstract of the report 'Analysis of particle emissions created in small-scale burning'

Methods used

The particle emissions and polycyclic aromatic hydrocarbon (PAH compound) formation of fireplaces manufactured for domestic use by Nunnanlahden Uuni Oy were analysed according to the following test procedure. The measurements were conducted using the same burning process in standard conditions in both a fireplace with an older-generation traditional fire grate and a fireplace with a so-called Grate of the Golden Fire. Dry birch was used as firewood. During the burning, combustion gas was sucked into an adsorption tube (Type B/G, Dräger Safety AG & Co., Germany) and onto a particle filter for the purpose of analysing the PAH compounds. The samples collected were analysed using gas chromatography via a mass spectrometer (HP6890/HP5973 from Hewlett-Packard, USA), and the content of the various compounds detected was determined. Fine-particle measurements were conducted in real time during the burning tests using an ELPI electric vacuum impactor (Dekati Oy, Finland).

Summary of the results

During testing, fine particles and PAH compounds were detected in the combustion gas from small-scale burning. In comparing the traditional fire grate and the Grate of the Golden Fire, it was noticed that the Grate of the Golden Fire was cleaner in regard to emission production than the traditional fire grate was. In burning with the traditional fire grate, 14 different PAH compounds were detected, of which four were carcinogenic. By contrast, from burning with the Grate of the Golden Fire, three different PAH compounds were detected, of which one was carcinogenic. In addition, the concentration of the PAH compounds found in both grate types was ten times greater with the traditional fire grate than the Grate of the Golden Fire in a head-to-head comparison (see tables 1 and 2). Also, the masses of particles collected during burning were almost ten times greater than the respective particle masses in tests with the Grate of the Golden Fire.

The size distribution of fine particles after addition of firewood with the traditional fire grate reveals that most such particles were in the nanometre category, and their concentration (by amount) was as large again as that with the Grate of the Golden Fire (Figure 1). During steady burning, the number of fine particles formed with the Grate of the Golden Fire was slightly larger, and the mean value of the size distribution slightly smaller than with the traditional fire grate (Figure 2).

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Table 1. The PAH compounds (determined using GC-MS) and their concentration in micrograms per cubic metre of combustion gas sample studied. The samples were extracted from the particle filter.

Compound	**Traditional fire grate** µg	**Grate of the Golden Fire** µg
acepyrene	438	nd
anthracene	427	nd
benz(a)anthracene*	476	nd
benz(ghi)fluoranthene	475	nd
benz(k)fluoranthene*	506	nd
benz(a)pyrene*	481	nd
benz(e)pyrene	446	nd
chrycene	616	nd
fluoranthene*	482	31
phenanthrene	470	31
2-phenylnaphthalene	461	nd
pyrene	488	30
* = carcinogen nd = below identification threshold		

Table 2. The PAH compounds (determined using GC-MS) and their concentration in micrograms per cubic metre of combustion gas sample studied. The samples were extracted from the adsorption tube.

Compound	**Traditional fire grate** µg	**Grate of the Golden Fire** µg
indene	499	nd
naphthalene	470	nd
* = carcinogen nd = below identification threshold		

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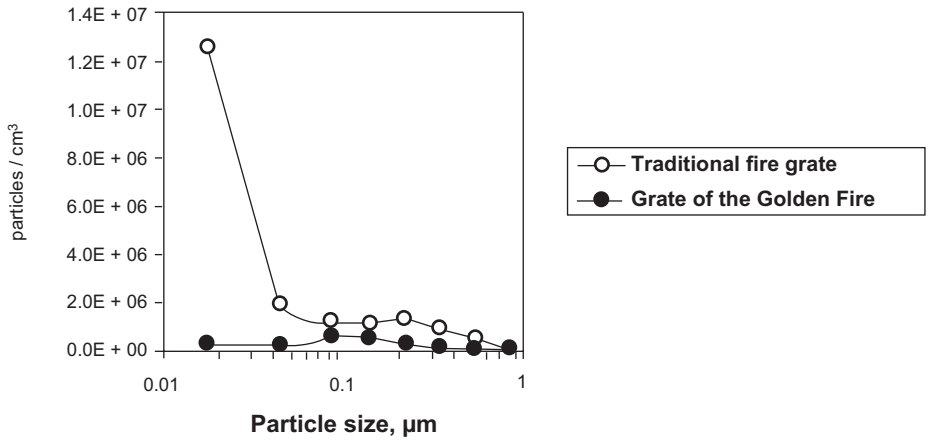

Figure 1. Particle-size distribution measured using ELPI equipment after the addition of firewood.

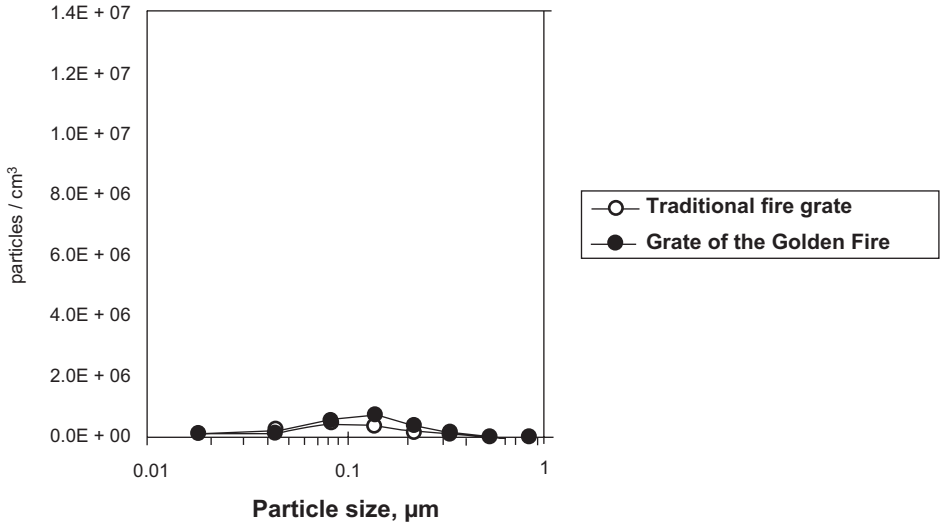

Figure 2. Particle-size distribution measured using ELPI equipment during steady burning.

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