Field comparison of three inhalable aerosol samplers for welding fumes (IOM, PGP-GSP 3.5 and BUTTON)

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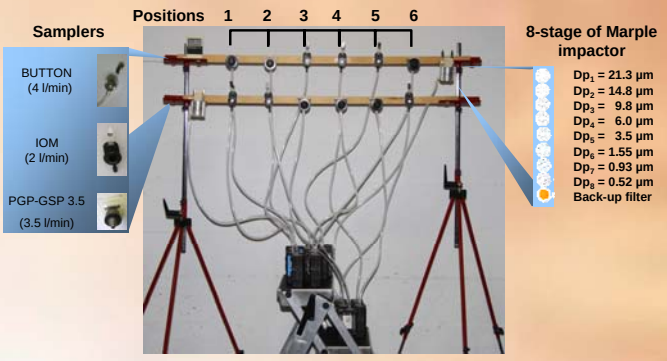
METHODOLOGY

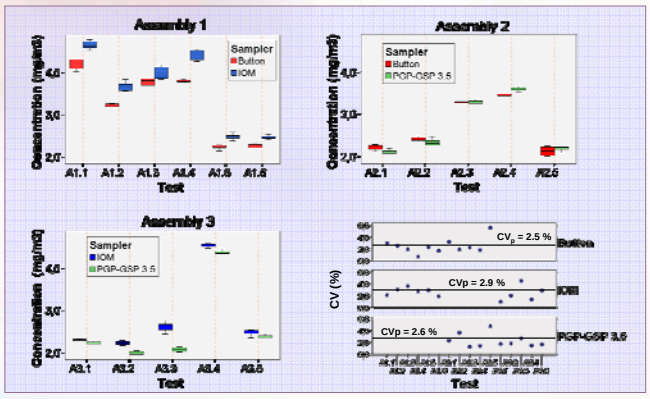
- Sampling was carried out in a welding training centre, where Manual Metal Arc (MMA) and Metal Active Gas (MAG) processes were used.
- Static samples were collected using the sampling assembly designed to place 12 samplers and 2 Marple cascade impactors at the same time.
- Three assemblies were used to compare the inhalable aerosol samplers:
  - Assembly 1 (A1): 6 Button samplers vs. 6 IOM samplers.
  - Assembly 2 (A2): 6 Button samplers vs. 6 PGP-GSP 3.5 samplers.
  - Assembly 3 (A3): 6 PGP-GSP 3.5 samplers vs. 6 IOM samplers.
- In each test, samplers positions in the bars were selected at random.
- Glass Fibre (GF) filters, with a pore size of 1 µm, were used as collection substrate and the mass of aerosol collected was determined by gravimetric analysis.
- The ratio of welding fumes mass concentrations was the chosen parameter to compare the behaviour of the samplers.



Sampling assembly used. No significant differences between the upper (1.65 m) and the lower (1.50 m) bars were found.

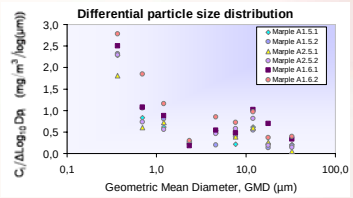
RESULTS

- The welding fumes concentrations were ranged between 2 mg/m^3 and 5 mg/m^3.
- For each type of sampler, the pooled coefficient of variation of the replicated samples were less than 3 %.



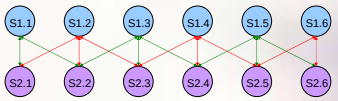
Box and whisker plots of welding fumes mass concentrations by different samplers. The coefficient of variation and the pooled CV for each sampler are also represented.

- About 70 % of the total mass collected by the 8-stage Marple cascade impactors was composed by particles with an aerodynamic diameter less than 3.5 µm.
- The differential particle size distribution of the welding fumes showed a bimodal distribution, characterized by two mass median aerodynamic diameters (MMAD) and two geometric standard deviations (σ_g).



Particles < 3.5 µm (70 % mass)		Particles > 3.5 µm (30 % mass)	
MMAD (µm)	σ_g (µm)	MMAD (µm)	σ_g (µm)
0.6	2.0	7.9	2.7

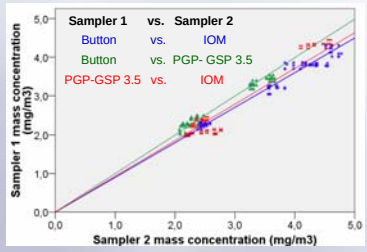
- The sampler performance was studied comparing the mass concentration of one sampler with the concentration of the closest paired-samplers. 232 pairs of valid results were considered.

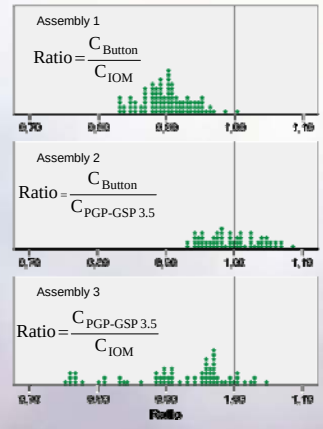


Scheme of samplers comparison

SAMPLER COMPARISON

- To compare the samplers performance, the relations Button/IOM, Button/PGP-GSP 3.5 and PGP-GSP 3.5/IOM were used.





Ratio	Number of pairs	Mean	CV
Button/IOM	**96**	**0.90**	**4.1**
Button/PGP-GSP 3.5	**64**	**1.00**	**4.0**
PGP-GSP 3.5/ IOM	**72**	**0.92**	**7.8**

Relationships between mass concentrations determined by the samplers and dot plots of the ratios of samplers concentrations.

CONCLUSIONS

- ✓ The aerosol homogeneity in the sampling area allows to compare the behaviour of the samplers (pooled CV < 3 %).
- ✓ The welding fumes collected by the impactors show a bimodal size distribution, characterized by the following mass median aerodynamic diameters and geometric standard deviations: 0.6 µm (σ_g = 2.0 µm) and 7.9 µm (σ_g = 2.7 µm).

For MMA and MAG processes and the described particle size distribution of the welding fumes:

- ➢ **The IOM sampler collects significantly more amount of the aerosol (P < 0.001) than the Button sampler.**
- ➢ **The IOM sampler collects significantly more amount of the aerosol (P < 0.001) than the PGP-GSP 3.5 sampler.**
- ➢ **The Button sampler and the PGP-GSP 3.5 sampler show similar performance (P = 0.598).**