

PMP – Particle Measurement Program Informal Working Group Task Force 2– Brake Dust Sampling and Measurement

Meeting #28 – Thursday 22 APRIL 2021 15:00 – 16:00 CEST

Minutes of Meeting – Final Version

1. Participants: As in the file “*28th TF2 Meeting Attendance*” uploaded in TEAMS.

2. Background: This is the second in a series of meetings discussing the mass measurement approach applied by different labs. TG introduced the meeting clarifying that not all technical requirements discussed in these meetings will apply to the upcoming interlaboratory study. However, it will be useful for participating labs to familiarize themselves with existing standards in the field of PM measurements.

3. Mass Discussion: AM presented AVL’s experience with brake PM measurement. AM briefly introduced the group to the fundamentals of PM measurement including the applied methodology, high-level definitions, and the approach followed by AVL. AVL discussed sampling efficiency focusing on three different areas of interest: **transport and extraction**, **classification**, and **weighing**. Regarding transport and extraction, it is noted that the volumetric flow of the extracted sample shall remain constant in a given setup. Potential sources of error during transport and extraction may include anisokinetic and/or anisoaxial sampling, inertial impaction, and gravitational deposition. Details on how to handle these parameters – as well as recommendations on how to minimize losses – are given in slides 10-16 of the attached presentation “*AVL presentation brake PM*”. Regarding classification, different solutions are available with the most common being cyclones and cascade impactors. Specifications for both types of instruments are well defined in ISO standards (Slide 18). In all cases, the efficiency curve depends on the volumetric flow which needs to be maintained constant. The effect of pre-classifier design is shown to be stronger in PM_{2.5} compared to PM₁₀ measurement. Details on inertia classifiers are given in slides 17-20 of the attached presentation. Filters weighing can also become a source of significant error if not performed appropriately. Two types of filters are specified in the regulation for exhaust PM measurement. PTFE membrane filters are more difficult to handle and add complexity in case of brake emissions measurement. Teflon coated glass fiber filters seem to be easier to handle. Loading shall not become an issue when measuring emissions higher than 1 mg/km, whereas pressure drops due to loading are expected to be negligible.

AVL’s overall recommendations for PM measurement are summarized below (full list available in slide 24 of the attached presentation):

- ✓ Avoid exchanging inertial classifiers when tunnel flows are adjusted. Additionally, sampling shall take place at a constant flow independently of the tunnel flow;
- ✓ Thin wall nozzles shall be used to ensure isokinetic sampling for PM₁₀ and PM_{2.5} and U₀/U ratios shall be maintained within 0.9 – 1.1;
- ✓ Aspiration angle shall be restricted to ±15° to avoid excessive losses due to anisoaxial sampling;
- ✓ Avoid the use of flow dividers for PM measurements as they can lead to inertial deposition and complex velocity profiles;

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- ✓ Report penetrations for the PM sampling train;
- ✓ Provide a description of the weighing procedure to ensure accuracy – this can become an issue at large tunnel flows and/or future low-emitting brake systems;
- ✓ Both TX40 and PTFE filters currently allowed in automotive exhaust regulation should be allowed. It seems that Teflon coated glass fiber filters are easier to handle.

The follow-up discussion touched upon several topics. One very crucial issue relates to the application of impactors and how to deal with bouncing phenomena. FR recommended providing specifications to eliminate bouncing (Si-grease?). Additional concerns regarding the impactors' loading over long cycles were raised. The need to prescribe specifications on how to clean cyclones was also highlighted. A question regarding what is considered to be a typical error in PM measurement was also discussed. The $PM_{10}/PM_{2.5}$ ratio could be used for validation purposes when modifications to the testing parameters occur. RV added that isokinetic and isoaxial specifications proposed by AVL are in line with ISO 9096, whereas EPA Method 1A prescribes specifications regarding the location of the pitot tube for velocity measurement. The latest relates to the need for specifying reference velocity.

4. Next Meetings: The next meeting will take place on 29.04.2021. Horiba will present its point of view on the topic of PM measurements.