BRAKE PARTICLE EMISSIONS

BRAKE EMISSION TASK FORCE 2
FUTURE OUTLOOK

DEVELOPMENT OF A COMMONLY ACCEPTED METHOD FOR MEASURING BRAKE PARTICLE EMISSIONS

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DISCUSSION ON TESTING PARAMETERS
BACKGROUND CONCENTRATION – NOT SOLVED

2. Background/blank concentration check

Valid measurements only when quantity of emissions collected/measured during testing is at least five times the corresponding overall blank value. Each Lab shall report the applied method for the blank evaluation.

Open topics - to be discussed/agreed

- ✓ Do we need to correct the measured particle emissions over the test cycle by the particle background concentration? How reliable is background subtraction and up to what level?
- ✓ AVL-TUI reported background concentrations in the order of ~150#/cm^3 for 23 nm with emissions at the 60% of the cycle being close to background. Will we propose a maximum allowed background concentration (i.e. ~100#/cm^3 for 10 nm)?
- ✓ The particle background concentration measurement needs to be described in detail. The following methods are proposed:
  - *Measured at test duct flow with ventilation applied for 1h after the end of testing without any system modification (preffered)*
  - *By pushing the pads back away from disc to avoid contact and dust creation*
  - *Measured at test duct flow, cooling air at temperature and humidity conditions, and with no brake pad or rotor installed*

DISCUSSION ON TESTING PARAMETERS
BACKGROUND CONCENTRATION – NOT SOLVED

Open topics - to be discussed/agreed

- ✓ **Do we need to correct the measured particle emissions over the test cycle by the particle background concentration? How reliable is background subtraction and up to what level?**

HORIBA highly recommends subtracting the particle background for the PN measurement. The procedure/calculations for the background substraction is very well described in existing regulations and can also be applied for Brake Dust measurements.

There is no need to include the background correction into a mandatory measurement protocol because the emissions without the background correction will always be overestimated (therefore, all parties will implement the background correction anyway…). The PMP TF2 just needs to define a robust procedure for this correction.

TUI suggests that the subtraction of the particle background concentration is conceivable under the following conditions: a. constant / reproducible background concentration and b. minimum background concentration - only then is subtraction effective

DISCUSSION ON TESTING PARAMETERS

BACKGROUND CONCENTRATION – NOT SOLVED

Open topics - to be discussed/agreed

- ✓ **AVL-TUI reported background concentrations in the order of ~150#/cm³ for 23 nm with emissions at the 60% of the cycle being close to background. Will we propose a maximum allowed background concentration (i.e. ~100#/cm³ for 10 nm)?**

  TUI suggests that the definition of a fixed limit is essential! The background concentration must be monitored and the filter efficiency evaluated. This ensures that the background concentration is lower compared to brake-induced emissions, especially in urban areas. If these values are exceeded, this indicates leaks in the sampling system or reduced filter efficiency, which requires further action. The use of HEPA filters according to EN 1822 (>99.95%) should be an integral part of the system.

  [Horiba] A maximum limit of the background concentration could be specified. HORIBA would recommend not to set an upper limit for the background concentration by an absolute quantity, but a relative value to the correspondent average concentration of the emission limit. HORIBA also suggests discussing some general aspects before fixing a number on the allowed PN background concentration:

  - ✓ We need to define whether the particle background concentration is measured as solid or total PN? HORIBA highly recommends using "solid PN", as the term "total PN" would raise a lot of other questions such as the volatile background/ the utilization of charcoal filters in the cooling air duct in order to avoid condensation of volatile/ semi-volatile particles etc.
  - ✓ The definition of a maximum allowed particle number background concentration of ≤100#/cm³ for solid particles >10nm is highly dependent on the CPC counting efficiency requirement at 10nm, which we have not discussed yet! Do we follow a similar approach as described in the sub23nm addition of GTR15 with counting efficiency requirements of 65% ±15% at 10nm (and >90% at 15nm)?

DISCUSSION ON TESTING PARAMETERS

BACKGROUND CONCENTRATION – NOT SOLVED

Open topics - to be discussed/agreed

- ✓ **The particle background concentration measurement needs to be described in detail. The following methods are proposed. 1. Measured at test duct flow with ventilation applied for 1h after the end of testing without any system modification (preferred); ~~2. By pushing the pads back away from disc to avoid contact and dust creation; 3. Measured at test duct flow, cooling air at temperature and RH conditions, and with no brake pad or rotor installed~~**

  TUI suggests that 1. should be extended - it is essential to determine the particle background concentration before starting the main measurement. Therefore, it is recommended the determination of the particle background concentration over a period of 5- 10 minutes a. before, b. during and c. after the measurement; evaluation of the concentration profile with evaluation of reproducibility/trend (decreasing, increasing concentrations must be recorded in a protocol); this allows a comparison of the background concentrations to different sections and the identification of deviations.

  Determination of the particle background concentration by means of 10/23nm-CPC which is used for the main measurement; during the measurement, rotation of the brake disc is not permitted (e.g. to improve the cooling effect) and a constant volume flow is evacuated from the enclosure (parameters for temperature and humidity are identical to the main measurements)

  [Horiba] In general, HORIBA agrees with this proposal! We should add that the particle number background concentration should be measured under the same conditions as in case of the actual test (flow rate, temperature, humidity…).

  [AUDI] It is necessary to ensure a sufficient "cleaning duration" of the ventilation / duct, which takes more than 5-10 min. depending of the air flow rate. 1 h is fine if a sufficient air flow rate is used (by the way: we have already a very time consuming procedure, any additional time is discussed very critically in regards of costs

  [Link] Split the background (blank) measurement into two 30-min runs, once before (waiting 1 minute after reaching stable airflow speed, temperature, and humidity) and once after the test (ISO 9096:2017)