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

Meeting #24 – Thursday 13 FEBRUARY 14:00 – 15:00

Minutes of Meeting – Final Version

1. Tour de Table: AUDI-(SG) Sebastian GRAMSTAT; AVL-(TM) Thanasis MAMAKOS; BMW-(KK) Katharina KOLBECK; BREMBO-(MF) Matteo FEDERICI; BREMBO-(GP) Guido PERRICONE; BREMBO-(FV) Fabrizio VENANZONI; CONTI-(AR) Achim REICH; DRIV-(MM) Marcus MORBACH; Ford-(JG) Jarek GROCHOWICZ; GM-(MR) Matt ROBERE; Horiba-(DL) Dmytro LUGOVYY; Horiba-(YO) Yoshinori OTSUKI; ITT-(SA) Simone ANSALONI; ITT-(AS) Agusti SIN; JARI-(HH) Hiro HAGINO; JRC-(TG) Theodoros GRIGORATOS; LINK-(CA) Carlos AGUDELO; LINK-(RV) Ravi VEDULA; OPEL-(OB) Olaf BAUSCH; TMD Friction-(AP) Andreas PAULUS; TSI-(RA) Bob ANDERSON; TSI-(JS) Jürgen SPIELVOGEL; TSI-(SP) Stephan PERCOT; TU ILMENAU-(DH) David HESSE.

2. Brake enclosure design: YO provided a more detailed presentation with Horiba's recommendation regarding the brake enclosure design. The full presentation as well as the views of Horiba on the topic are provided with the attached document. FV introduced the newly designed brake enclosure of Brembo. A discussion with questions and answers mainly regarding particle losses in the enclosure followed. Brembo recommendations on the topic are also attached to the email.

3. Recommendations for the enclosure: TG drafted the following recommendations regarding the enclosure design based on the input of the TF2.

Design requirements for the enclosure are defined with the aim of achieving maximum transport efficiency, maximum particle distribution/uniformity and minimum residence time. The definition of the geometric boundary conditions – as well as of the design of the enclosure – allows for adjustments and innovative further developments; however, provides some general guidance to ensure systems' comparability. The following recommendations are provided:

1. ***The brake enclosure shall incorporate good aerosol sampling practice that includes the avoidance of sharp bends and abrupt changes in cross-section and the use of smooth internal surfaces (i.e. curved edges) to*** **reduce flow recirculation zones*****. Gradual changes in the cross-section are permitted; however, it is recommended to apply smooth transition angles to overcome these cross-section changes and avoid application of 90 degrees – and larger – bends****;***

2. ***The brake enclosure shall come in dimensions which allow for measurements of all common sizes of LDV brake assemblies. However, it is strongly recommended to avoid oversized enclosures due to higher residence times and increased particle losses.*** *Maximum dimensions might be specified in the future when more data become available;*

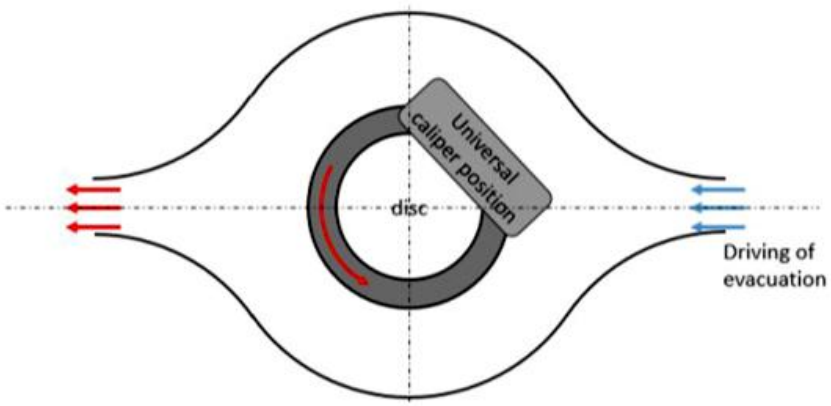
3. ***The use of electropolished surfaces (stainless steel) for the design of the inner walls of the enclosure is recommended****;*

4. ***The enclosure shall be designed in such a way that a maximum particle residence time of 3 sec is ensured. Every lab shall report the minimum and maximum residence times for their setup based on their specific designs and the applicable cooling air flow rates.*** *The calculation of the residence time shall be performed in house by means of commonly acceptable simulation tools. A common CFD simulation methodology could be discussed in the future.*

The position of the brake calliper differs significantly among different vehicles. Additionally, the air flow to the brake disc varies for each vehicle depending on parameters such as the design of the vehicle chassis, the geometry of the wheel housing, the presence of knuckle fixtures, etc. Therefore, it is not possible to accurately replicate real flow and cooling conditions for all different vehicles and configurations. Similarly, it seems not possible to simulate real particle movement/path. Thus, the realistic objective of the enclosure design should be to optimize particle transport (minimize losses) and provide comparable measurements between different setups. This can be achieved with the standardization of some parameters with the most prominent being the application of a common calliper position, the application of a common direction in the evacuation of the system, and the application of a common direction of the disc rotation relative to the evacuation of the system. The following adjustments are proposed:

5. ***The calliper shall be positioned at the upper part of the disc between 2 o'clock and 10 o'clock (2 o'clock or 1 o'clock or 12 o'clock or 11 o'clock or 10 o'clock).*** *Options might be restricted in the future when more data relative to the different options become available;*

6. ***The brake disc shall rotate in the direction of the evacuation (CCW) as illustrated in the figure*** *(the figure is indicative and does not imply a proposal for the adoption of the illustrated geometry)*



4. Next Meeting: The next meeting will take place on 27.02.2020 and the topic will be "background concentrations".