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

Meeting #20 – Thursday 21 March, 2019, 14:00 – 15:00

Minutes of Meeting – Final Version

1. Tour de table: Participants: AUDI-(SG) Sebastian GRAMSTAT; AVL-(TM) Thanasis MAMAKOS; BMW-(RL) Rasmus LEICHT; BREMBO-(FR) Francesco RICCOBONO; BREMBO-(MA) Mattia ALEMANI; DEKATI-(MM) Mikko MOISIO; Ford-(JG) Jarek GROCHOWICZ; Ford-(MM) Marcel MATHISSEN; Federal Mogul-(CK) Christof KOLSCH; GM-(MR) Matt ROBERE; HORIBA-(DL) Dmytro LUGOVYY; ITT-(SA) Simone ANSALONI; JARI-(HH) Hiro HAGINO; JRC-(TG) Theodoros GRIGORATOS; Link-(CA) Carlos AGUDELO; Link-(RV) Radi VEDULA; OPEL-(OB) Olaf BAUSCH; TMD Friction-(AP) Andreas PAULUS; TSI-(RA) Bob ANDERSON; TU ILMENAU-(DH) David HESSE.

2. Soak time of novel cycle: Resume of the discussion of Meeting #19 on soak time. TG briefly presented the topic (see picture below).

TF2 MEETING #19

Topic: Soak time - Brake temperature at the beginning of the individual trips of the novel cycle

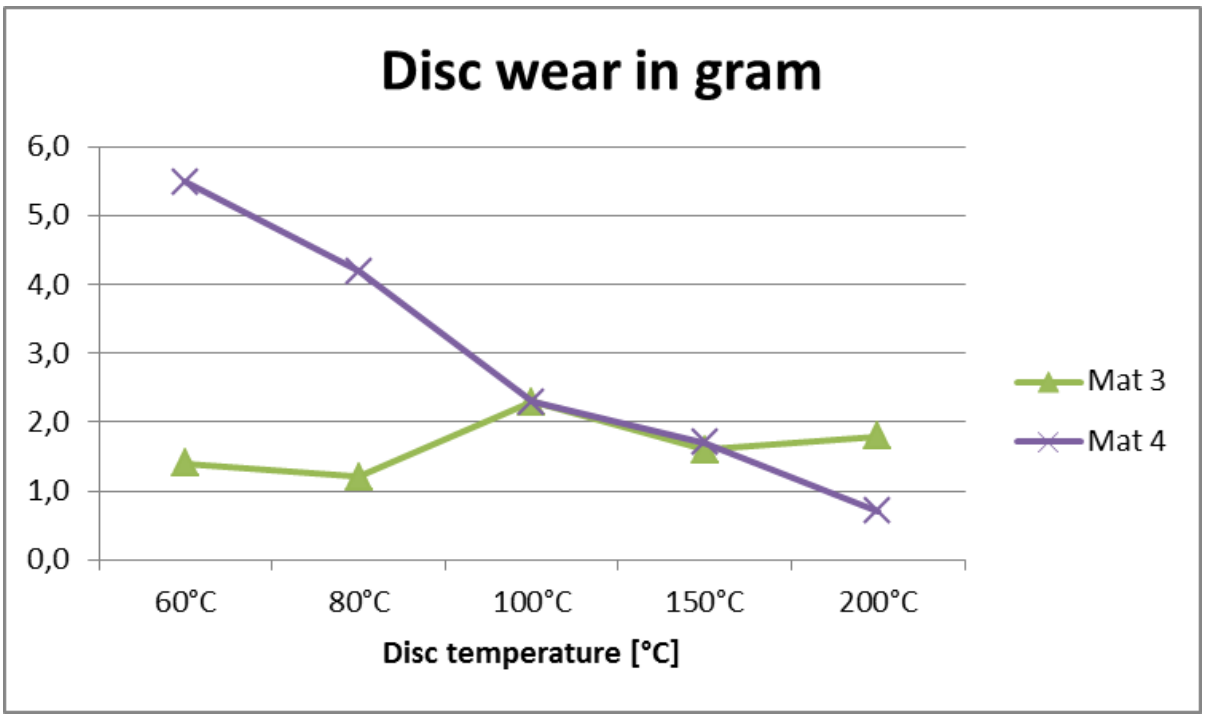
Problem description: Long soak times required for the brake to reach the starting temperature of each trip result in a prolongation of the cycle. This creates logistic and practical problems. Additionally, long soak times might introduce artefacts particularly in the measurement of PM emissions as air flow is applied in order to cool down the brakes faster.

Question: Would it be possible to reduce soak times to the expense of accuracy in the initial temperature? What would be the influence of higher initial brake temperature to the overall temperature profile and thus to the emissions?

Useful Data: Run the cycle with full soak times against running it by setting a maximum soak time for trips that do not reach the temperature immediately (i.e. 5 min) and compare average and maximum cycle temperatures. Additionally, if possible record PM and PN emissions of the two different options by using the same brake materials and operating conditions.

Desirable solution: Agree on a common way to run the cycle for the emission measurement campaigns with regards to the application of soak time.

During the previous meeting TM presented results from a measurement campaign of AVL at TU Ilmenau. TM gave some clarifications regarding the testing campaign. Soak time in TU Ilmenau campaign exceeded 5h. Conditioning of the pads was done with 30 WLTC repetitions. A flowrate of 270 m^3/h – similar to the Ford's paper – was applied (~40 kph). The main outcome of the comparison (novel cycle with full soak time vs. novel cycle without soak time at all) is that no significant differences in the average and maximum temperatures were observed. Furthermore, no significant difference in the PN emissions between 10 and 23 nm was observed. Finally, no significant difference between total PN emissions and only solid PN emissions was observed. These results indicate that when PN concentrations are considered over the cycle it doesn't make a significant difference whether full or no soak times are applied. JG mentioned that no application of soak times will result in higher brake temperatures with the risk of increasing PM emissions. JG demonstrated that different materials behave completely different in terms of wear also at lower temperatures (i.e. 60°C) (see figure below). A concern was raised also regarding post brake emissions if soak times are completely eliminated.

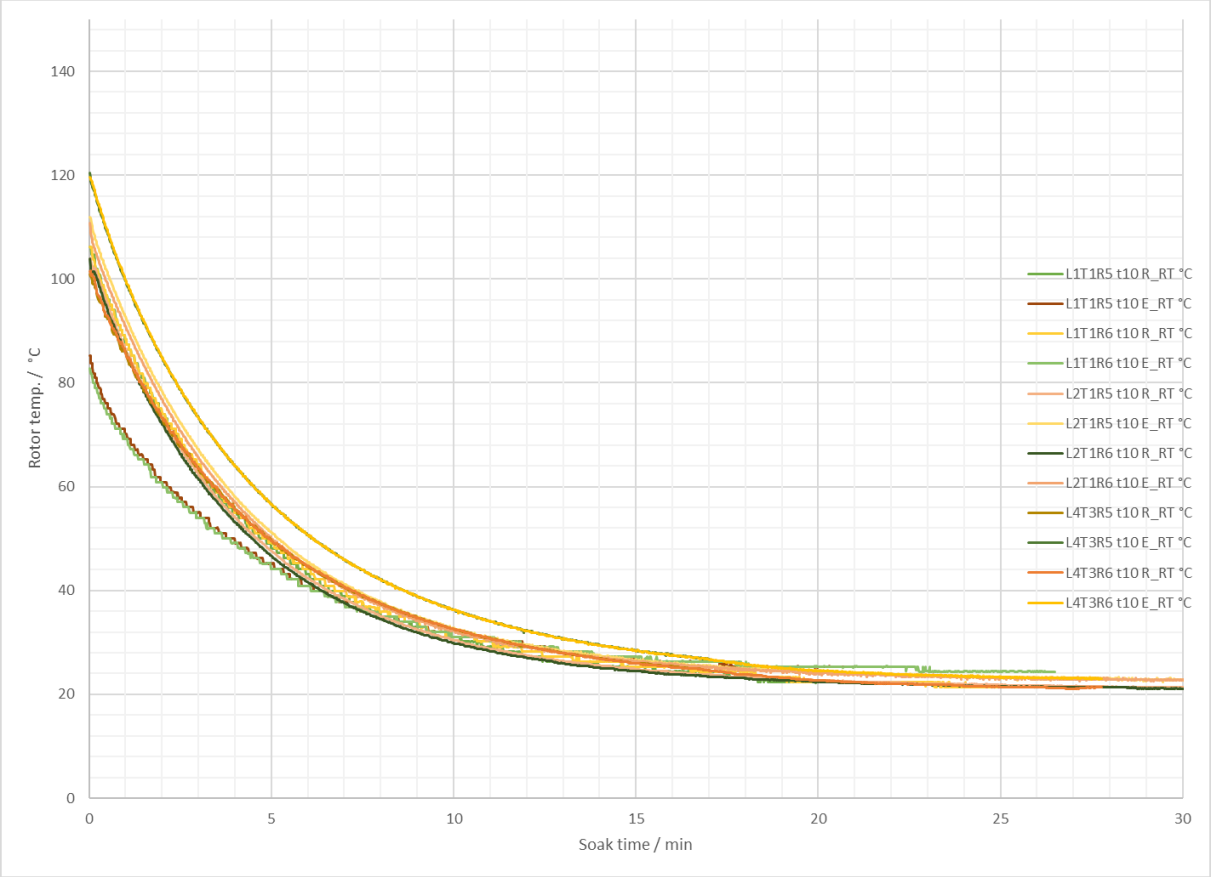


SG presented a similar dataset obtained at AUDI's dyno during an on-going campaign with Horiba. Both embedded and sliding TCs were employed for the measurement of the brake temperature. Total soak time was calculated to be approximately 30 min for the whole cycle due to the very high cooling air flowrate (corresponding to 45 kph). The basic message of the campaign is summarized to the table below. It seems that the lack of application of soak time does not significantly affect brake temperature also in this case (sound exception for trip 7). MM raised a concern regarding the metric (temperatures at the end of the tip might not be the correct metric). In any case if individual trips are studied one by one no significant temperature difference is noted. Full presentation is attached.

	T with soak times [°C]	T without soak times [°C]
Trip 1	30	38
Trip 2	30	43
Trip 3	30	38
Trip 4	30	43
Trip 5	30	50
Trip 6	below 30	below 30
Trip 7	30	90
Trip 8	30	45
Trip 9	below 30	below 30

CA presented a mini survey on the soak times recorded during the TF1 RR activity. For most labs one third of the cycle time is occupied by soak time. Some examples of the different trips were presented

and it was demonstrated that in most cases a soak time of 5-7 minutes is adequate for reaching a brake temperature of 40°C, whereas it can take up to 30 min to reach the desired 30°C (see figure below). A further confirmation of this observation will follow. Based on this data CA proposed to change the initial temperature of each trip from 30°C to 40°C and apply soak times accordingly. Full presentation is attached.



Possible Solutions – The following options exist in order to avoid long soak times: Run the cycle without soak times, run the cycle with a fixed duration for all soak times (i.e. 5 min), increase the target starting temperature of the brake system (i.e. 40°C). It seems that the last solution is the most appropriate but implications to PM emissions should be investigated.

3. Next Meeting: Next TF2 meeting will take place after the PMP Meeting. Date will be communicated by TG.