Investigation of brake wear particle emissions from heavy-duty vehicles

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Brake particle emissions are a big threat against humans and must therefore be reduced. Three brake pad materials from the brake system manufacturer Haldex were compared to gain better understanding and find the best alternative.

The new Euro 7 standard that will be introduced will include particle emissions from brakes, namely PM10, which is particles smaller than 10 μm. Most research today is being conducted on passenger cars with this thesis being one of the first about heavy-duty vehicle brake systems.

When the brakes are applied, the brake pads are pressed against a brake disc converting the kinetic energy of the vehicle in to heat via friction. During braking both the pad and disc are worn and some of the worn debris becomes airborne particles which can cause cases of inflammation, heart disease, lung cancer, asthma attacks, chronic bronchitis, cancer, dementia and pneumonia.

The focus in this thesis is on particle emissions form heavy-duty vehicles during city driving since brakes are applied more often during city driving and therefore cause more brake emissions. Tests were performed to compare three different brake pad materials. The tests were performed in controlled laboratory experiments where the median and maximum temperature of the bake discs of a city bus were simulated. A city bus was chosen since that is the heavy-duty vehicle which has the highest brake disc temperatures.

The tests found that under the same test conditions do the pad materials behave quite differently. The pads reached different temperatures and even the same material reached different temperatures during different tests of the same test conditions. The coefficient of friction was similar for the three materials. One pad was found to have the most PM10 at both median and maximum temperature while another had the least PM10 at both temperatures. The PM10 was found to increase with both temperature and wear. The pad that emitted the least PM10 increased the most in emissions between the two temperatures. The pad with the most PM10 increased the least between the two temperatures. The number of particles per cubic centimeter was also found to increase with temperature and wear. The pad that emitted the smallest number of particles at the median temperature was the pad that emitted the most particles at the maximum temperature. The pad that emitted the most particles at the median temperature emitted the least particles at the maximum temperature. Wear of the brake pads and brake discs were found to increase with temperature. One of the brake pad materials saw a drastic increase in pad and disc wear between the two temperatures while the other two saw a similar increase to each other.

One of the brake pads was declared as the best pad material with regards to PM10 at both temperatures. This pad had the least pad wear and number of particles per cubic centimeter at the median temperature. It however had the most disc wear at both temperatures. At the maximum temperature, the pad also had the most pad wear and emitted the most particles per cubic centimeter. The pad material also had the largest increase in pad and disc wear, PM10 and number of emitted particles between the two temperatures. Surprisingly did the pad material that was the worst with regards to PM10 at both temperatures have the least pad and disc wear as well as emitting the smallest number of particles per cubic centimeter at the maximum temperature. The increase in PM10 between the temperatures was the smallest for this pad to.