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Forschungsvereinigung Verbrennungskraftmaschinen e.V.
FVV | Research Association for Combustion Engines

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Zero-impact vehicles (ZIV): How engines must perform to prevent a negative impact on air quality

A research project initiated by the FVV shows: If vehicles driven by combustion engines comply with very strict exhaust emissions limits, they no longer have a negative impact on air quality. However, the maximum permissible emissions limit for individual vehicles depends on the respective driving and traffic situation.

Frankfurt/M., 23.05.2022 // The regulations for maximum permissible emissions limits for motor vehicle exhaust are to be further tightened in Europe. Against this background, a recently completed research project¹ of the FVV examined a question that is only simple at first glance: How far must the emissions of vehicles driven by internal combustion engines be reduced so that they no longer have a negative impact on air quality? To this end, a team of researchers led by Prof. Dr.-Ing. Stefan Hausberger of Graz University of Technology correlated vehicle emissions for two air pollutants - particulates and nitrogen oxides - with the immissions measured at various locations, i.e. the concentration of pollutants in the air. A relevance criterion common in environmental law was used as a target value: If the emission of a technical installation causes a contribution of less than three per cent to the locally permissible total pollution, no further environmental impact assessment has to be carried out. Hausberger explains: "With this approach, we can define the emissions limits that a zero-impact vehicle must mandatorily comply with."

To determine the contribution of vehicle emissions to air quality, the researchers first calibrated a simulation model using data from the "Neckartor" measuring station in Stuttgart. This shows: If the entire vehicle fleet were to be converted to the currently applicable Euro 6d final emissions limits, the pollutant content in the air would drop drastically - for nitrogen oxides, for example, by 93 percent compared to the measured values from 2016. However, the three-percent criterion would not be met.

To ensure that the three-percent criterion can be met for the immission at a specific location in the world, not only the emissions of all vehicles in the immediate vicinity of the measuring point are relevant. The respective traffic situation, the built-up area and even the weather must also be taken into account. Using air quality data from all over Europe, the researchers therefore modelled several extreme scenarios. These included a multi-lane urban access road used by 75,000 vehicles per day, as well as stop-and-go traffic on the motorway, a section of motorway with no speed limit and a mountain pass road with a gradient of more than ten percent. For the alpine scenario, different driving modes were

also taken into account.

The results of the simulations carried out for the different locations vary greatly. In dense urban traffic, a zero-impact car should emit an average of 6.7 milligrams of nitrogen oxides per kilometre. In stop-and-go traffic on the motorway, it would even be only 2.0 milligrams per kilometre. Due to the significantly lower number of vehicles, on the other hand, the three-percent criterion would be met when driving on the mountain pass road even if emissions rose to as much as 74 milligrams per kilometre. "European exhaust emissions legislation does not yet know driving situation-related limit values," says Hausberger. "However, our results show that it is not individual extreme situations that are decisive for air quality, but above all everyday traffic in urban conurbations. Extreme driving situations could therefore also be taken into account with higher emissions limits".

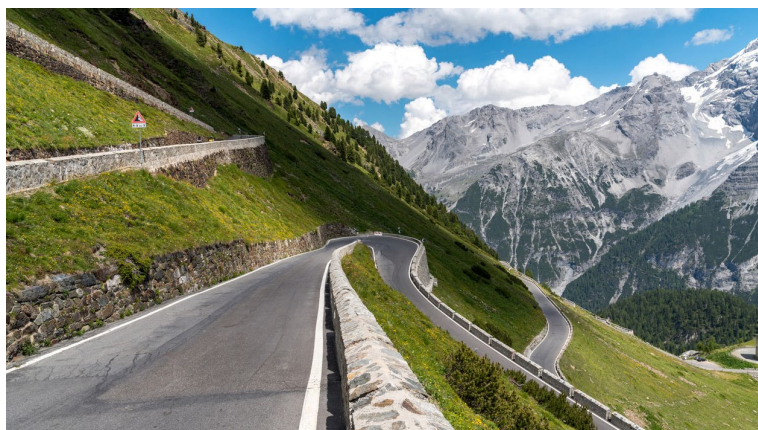
This statement is confirmed by further simulations carried out within the project for urban conurbations. This shows that with a fleet consisting of 100 percent zero-impact vehicles, nitrogen oxide emissions at the Neckartor in Stuttgart would only be at the level of the existing background pollution.

Notes on the research programme

1 | FVV Research Project No. 1407: Definition and requirements of "Zero-impact emissions" from an air quality perspective. Conducted at Graz University of Technology with the support of the consulting companies FVT, Graz, and Aviso, Aachen. Completed on 31 March 2022.

Images

1 | The FVV study simulated different driving modes for its extreme scenario ›alpine pass road‹



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About FVV

Our task is to keep the future open | The FVV creates knowledge-based insights into forward technologies promoting climate neutrality and zero emissions from sustainable energy conversion systems – collectively and always at a pre-competitive level. We have a clear fact-based compass and we are always open to the best solution from a technical, economic and environmental point of view. In doing so, we organise open-topic research along the value chains, bringing together companies with the same interests regardless of size and economic power. We network bright minds and benefit from their knowledge and experience. We think ahead and open up paths to the world of tomorrow for young talents. This is how inner drive and passion give rise to technological progress.

We are prime movers | In our innovation network, globally operating manufacturers of power systems, fuel cells, vehicle / aircraft / industrial engines and turbo machinery, as well as their suppliers and development service providers, conduct together with universities and other research institutions pre-competitive, collective research on future technologies. The goal is to operate energy converters – internal combustion engines, hybrids, turbines, compressors, turbochargers and fuel cells – with renewable energy sources in new (partially) electrified, integrated and digitalised energy conversion systems in a more efficient, cleaner and sustainable way - to the benefit of society, climate, environment and industry. The FVV has invested almost 1 billion euros in 1,500 research projects since it was founded in 1956.

Further information at www.fvv-net.de/en