Strong, But Not Loud

Tracking noise and vibration sources with state-of-the-art measuring systems for quieter commercial vehicles

The legislator makes increasingly strict demands of commercial vehicles in terms of acoustic and vibration behavior. New EU limit values for passing-by noise levels exacerbate the situation in just a few years – reason enough for IAV to set up a new test facility for acoustic investigations on vehicle components according to current quality requirements, extending right through to the scope of a commercial vehicle transmission.

Today already, the noise generated by 13 commercial vehicles together is not allowed to exceed that made by one single vehicle in 1980. And this is not the end: in 2014 the EU parliament decided on even stricter limit values for standard R51.03. As from 2016, passing-by noise levels of just 72 to 82 dB(A) are permitted depending on the weight and output of the truck. The limit values will continue to fall to 71 to 81 dB(A) by 2020 and 69 to 79 dB(A) by 2024. Complying with these limit values needs state-of-the-art measuring systems: this is the only way to reliably track down all the noise sources in the vehicle.

Furthermore, the whole subject of NVH (noise, vibration, harshness) must be treated as a key issue and tackled at an increasingly early point in the development process. "At the moment, NVH is an increasingly important topic", says Florian Brandau, IAV team manager for application engineering & NVH in commercial vehicles. "Hitherto the focus has been on emissions. But many commercial vehicles are still too loud to comply with future limit values, so that something urgently needs to be done here." Alternative powertrains also bring new requirements. For example, compressor and axle noises can quickly become unpleasant in electric buses, which is a huge challenge for suppliers of such components and auxiliary units. But the electric motors and their power electronics are not completely quiet either, although the noises they produce are in a different frequency range to combustion engines. We also look at the minimum noise level produced by electric vehicles, as a “warning” for pedestrians for example.

New NVH test facility

IAV has made extensive additions to its testing equipment in this field and is capable of precisely recording and evaluating noise levels, vibrations and torsional oscillations. "The equipment aims mainly to permit microphone, acceleration and torsional oscillation measurements and to evaluate pressure pulsations using highly dynamic pressure sensors", says Brandau. "This is an area where we have accumulated a wealth of know-how and experience over many years: NVH is a topic that needs a great deal of expertise."

State-of-the-art measuring equipment helps the IAV experts with their NVH tests, including devices from Müller-BBM. These cover all physical quantities necessary for system optimization, producing ultra-high-resolution results. Components are examined in a low-reflection, hemi-anechoic chamber as per DIN EN ISO 3744. There is also a test environment for measurements during accelerated passing-by as per ECE-R51.02/ISO 362, with IAV's proprietary measuring equipment registering both vehicle and meteorological data, as well as the noise levels.

Many possible noise sources

The measured values permit a wide range of evaluations that can be used to identify the problems, including analysis of frequency, time range, mode, and operation vibrations. There are also tools for simulation and transfer path analysis to support the search for noise sources already in an early phase of the development process, permitting the identification of individual problematic components.

"Unwanted noises are not necessarily generated just by the engine", says Brandau. "They are often produced by the A/C compressor, the transmission, the oil pump or other peripheral equipment of the engine."

The measurement results provide the basis for subsequent remedial action. In many cases, the problematic part can be adapted to reduce the disturbing noise. In oil pumps, for example, improving the inflow and outflow angle of the medium may be sufficient, or varying the number of vanes. If such modifications fail to have the desired effect, all that remains is secondary action: the noise source is attenuated by foaming or encapsulation. "No matter which method is chosen to reduce the noise level, IAV knows the measures and implements them reliably", says Brandau.

Measurements on a historical swing bridge

Up to now, the commercial vehicle experts in Gifhorn have mainly concentrated on testing components such as transmissions, oil pumps and A/C compressors from trucks and mobile work machines. Drive belts and drive shafts have also been tested on the test bench or in the vehicle to measure their torsional oscillations. Recently, the team took its measuring equipment to Wilhelmshaven for a special project. Wilhelmshaven's landmark is the Kaiser Wilhelm Bridge built by MAN in Augsburg in 1908. After undergoing refurbishment work, the swivel bridge started to make loud noises. The cause could not be found for many years. But IAV's modern measuring equipment finally identified the problems and contributed to the solution.

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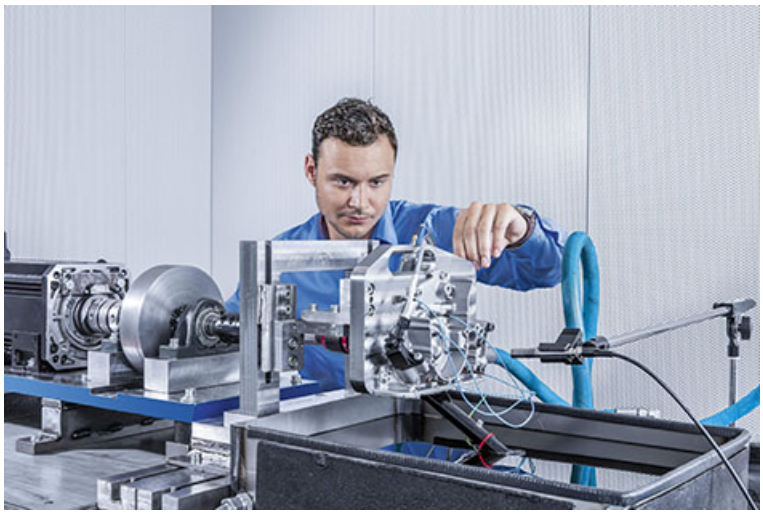

Measuring everything that's loud: state-of-the-art measuring equipment for precise recording and evaluation of noise levels, vibrations and torsional oscillations

Picture: IAV GMBH