Fig. 1: ANOVIS system variants for flexible vibration and noise analysis in production.

Sounds Good

Noise, Vibration and Harshness (NVH) Analysis at MAN in Nuremberg

MAN Truck & Bus AG in Nuremberg produces a wide range of modern commercial vehicle engines. Each individual engine is subject to comprehensive tests before it leaves the factory, including tests for undesirable noise and vibrations (noise, vibration and harshness, NVH). This is where the ANOVIS system is used, supplied by MEDAV. These vibration and noise analyses are effective in helping to safeguard the high quality standards of the Nuremberg engine plant.

ANOVIS Detects Component and Assembly Faults

The NVH analysis carried out using MEDAV's ANOVIS system constitutes an important component of the so-called engine cold test in which engines are filled with oil and then driven by an electric motor. In comparison with other methods, this approach is economical, ecological and simultaneously provides in-depth testing. The ANOVIS test system (fig. 1) records noise and vibrations at various points on the engine and determines characteristic values for assessment of the individual engine components from the signals, with the following aims:

- Identification of engines with conspicuous vibration and noise behavior.
- Identification of component and assembly faults based on the supplied signals
- Identification of the fault for effective support of the rework.

MAN exclusively uses Polytec laser vibrometers as vibration sensors, alongside microphones for airborne noise measurement.

To evaluate the sensor signals, ANOVIS offers comprehensive signal processing and classification methods ranging from simple frequency analysis and rotation-angle synchronized methods (order analysis) to automatic limit value adaptation. The signal components that arise are related to engine kinematics and, based on their characteristics, are allocated to moving parts of the engine (example in fig. 2).

The ANOVIS test system can, through its modularity, be flexibly adjusted to match a wide variety of different engine variants. This also refers to the selection of the sensor type. The IVS-200 and IVS-400 laser vibrometers that are used also permit vibration measurements on difficult-to-access measurement points or locations that are in some way "non-cooperative". Thus, for example, it is in some cases necessary to measure the black-painted surfaces of a high-pressure pump. Process-reliable signal measurement with 20 kHz bandwidth is also no problem here using the IVS industrial vibrometer and intelligent speckle elimination integrated into ANOVIS, The few manual steps required as part of the maintenance, for example, to check the position and focus, are taught in a training course to enable reliable operation during production. In this way, ANOVIS makes it possible to detect a large number of potential types of defects, which are otherwise undetectable using other testing methods. For example:

- Damage and manufacturing deviation in the camshaft
- Noise in the valve-train assembly, e.g. caused by too much clearance
- High pressure pump and other auxiliary component faults
- Toothing faults, damage and geometrical faults on cogs, incorrect tooth-flank backlash

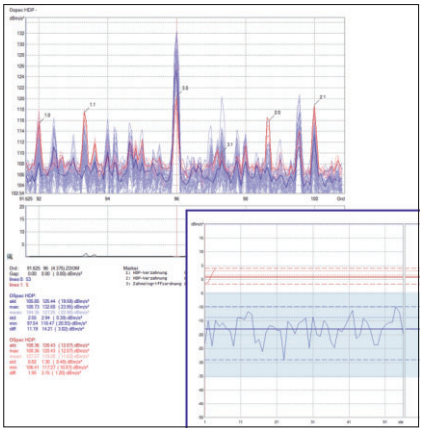

Fig. 2: Sideband energy measure based on order analysis for assessment of toothing vibrations.

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- Turbocharger faults, for example, damage and geometrical faults
- Missing connecting rod bearing shells and foreign bodies in the combustion chamber

Systematic errors are practically non-existent in modern engine production. The particular advantage of using ANOVIS for vibration and noise measurements is its ability to identify individually occurring, random errors. Additionally, the vast experience of the MEDAV division, Industrial & Automotive Solutions (IAS), in engine testing allows the identification of the cause of the faults. Also, practical tools are provided to quality engineers for analysis and statistical evaluations, with the help of which, production can be continuously further optimized.

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"Laser Vibrometers Measure Where no Other Instruments Can Reach"

Interview with Dipl.-Ing. Olaf Strama, director of Industrial & Automotive Solutions (IAS) at MEDAV

■ Mr. Strama, you lead the IAS division of MEDAV. What are your application areas?

The Industrial & Automotive Solutions Division specializes in vibration and noise analyses, including notably the so-called NVH test. It is used by our industrial customers for such tasks as the end-of-line testing of engines, gearboxes and steering components.

■ How long have you been using laser vibrometers and what first caused you to do so?

We have been using laser vibrometers for vibration measurement since the '90s. We started with a Polytec CLV and then we purchased a batch of IVS-200 industrial vibration sensors. In the meantime, we have used its successor, the IVS-400, especially for measurement points that are difficult to access or where a high measurement bandwidth is required for automatic production.

The breakthrough came about 10 years ago. Since then, our ANOVIS testing systems have been equipped with an intelligent speckle elimination feature. With its introduction, the number of false measurements in engine production lines producing more than 1000 engines per day could be reduced to 1 – 2 cases per month. Measuring with a bandwidth of 20 kHz on machined metal surfaces is reliable.

■ How do you view the use of laser vibrometers up until now and what do you consider to be the essential advantages of optical measurements when compared with the alternatives?

As already mentioned, accessibility to the optimal measurement points is one primary criterion, as is high flexibility for use with different types of test pieces. Also, the wide bandwidth of the laser vibrometer achievable in automated testing is another argument, as some error types are only identifiable at high frequencies. Laser vibrometers also score high because they lack mechanical parts that wear out and do not require frequent calibration.

■ How reliable is the laser vibrometer under harsh industrial conditions?

Many IVS-200 units have been used daily in engine testing for over 10 years. With many customers, maintenance is only implemented once it becomes necessary as indicated by the signal quality, which is statistically determined by ANOVIS.

■ What is the reaction of your customers and what proportion of orders have laser vibrometers as the vibration sensor?

From our point of view, users react positively if the sensor fulfills its task and no problems occur during daily use. The evaluations carried out by our customer support department regularly indicate that this is the case with laser vibrometers. The IVS industrial vibration sensors have contributed significantly to the attractiveness of the solution we offer in a considerable number of installations.

■ How do you see the potential of laser vibrometers for cold and hot testing applications in the automotive industry?

As a provider of vibration and noise measurement systems we offer our customers complete testing solutions for their production right from the start. These solutions consist of optimized sensor technology for the required application, matching data acquisition hardware and the needed analysis and evaluation of the defined task. The engines to be tested are becoming more complex and, consequently, the optimal measurement points are more difficult to access. Hence, and because of the frequency range required to carry out the tasks, the choice is increasingly likely to be a Polytec industrial vibration sensor.

Thank you very much for the interview, Mr. Strama!