NOISE SOURCE IDENTIFICATION

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Noise source identification (NSI) techniques are used to optimise the noise emission from a wide range of products including vehicles, household goods and wind turbines. The goal of NSI is to identify the most important sub-sources on an object in terms of position, frequency content and sound power radiation. Ranking of the sub-sources can then be used to identify where design changes will most effectively improve the overall noise radiation. With a considerable number of techniques available, NVH engineers might have need of an overview to help select the most appropriate solution. This paper gives some guidelines to help the selection together with some practical applications of NSI techniques. Emphasis is placed on the useful frequency range and the resolution of the various methods.

Sound mapping

The most straightforward method to detect a noise source is to map the Sound Pressure Level (SPL) at various locations around the noisy product. The SPL is measured with a single channel FFT or 1/3 octave analyser at each point of a defined grid. The measured data is then used to produce a contour map that gives a rough idea of the location and characteristics of the source.

The method is rarely used nowadays as it has mainly been superseded by sound intensity mapping. The main benefit of sound pressure mapping is the low cost involved. The limitations are that the method is time consuming, is particularly susceptible to the influence of background noise and can only be applied to stationary noise sources.

Since 1980's, the sound intensity technique based on a phase-matched pair of microphones, has been used to measure the acoustic energy flow. This yields not only the amplitude but also the direction of the sound energy. The method has been incorporated into a number of international standards to determine sound power. Sound intensity mapping involves the measurement of sound intensity spectra at a number of discrete points on a grid close to the object under test.

A contour plot is then produced and superimposed on a photograph to enable identification and documentation of the noise sources. To speed up the process a robot is often used to move the sound intensity probe from position to position. The main benefit of sound intensity compared to sound pressure is that it is a vector quantity.

The acoustic field can thus be represented with a magnitude and a direction. Thus it is possible to determine sound power of a source even in the presence of background noise. The technique is now mature so that complete sound intensity mapping systems are available as a 2 channel sound level meter. The spatial resolution of a sound intensity map is limited by the wavelength of sound and the distance between the measurement points in the mapping grid.

Selective intensity calculates that part of the full measured sound intensity that is coherent with a specific reference signal. If, for example, the vibration of a specific component is suspected to be the main cause of the radiated noise, then an accelerometer mounted on that component can be used to provide a reference signal for the selective intensity calculation. If the suspicion is correct then the selective intensity will be close to the full sound intensity observed.

The reference signal may be of any nature: acoustic, vibration, force, electrical etc. whichever provides the cleanest and least noisy representation of the suspected cause. The benefit of selective intensity compared to traditional sound intensity measurement is that it permits a more precise localization of the sound source.