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Troubleshooting and reducing noise in home appliances

Test-based approaches can help lower sound power values systematically and efficiently

Executive summary

Noise levels and sound quality are important characteristics in all kinds of home appliances and white goods. Manufacturers realize that they can use pleasant sounds as brand identity and as a competitive advantage. By optimizing noise levels and the quality of the sound produced in each of their products, appliance manufacturers can bring acoustically better goods to the market.

How can manufacturers decrease the sound power value of next-generation dishwashers or washing machines? Trial-and-error or randomly adding acoustical material to prototypes are far from optimal approaches. Fortunately, test-based approaches can help lower sound power values in a systematic and time-efficient way.

Background

The current trends of living in increasingly dense cities, buying smaller living areas, and having open kitchens means that people are constantly surrounded by noise. Busy environments make a quieter home something to strive for. Customers have become more sensitive to noise generated by their household appliances. They do not want their conversations to be disturbed by a dishwasher's cacophony.

Brand perception is extremely important in the consumer and white goods sectors. As sound design can make or break a brand, large investments are made to perfect product acoustics. To troubleshoot and reduce noise in appliances, manufacturers must follow certain regulations and standards set by the International Organization for Standardization (ISO). For example, the ISO-based sound power procedure allows the comparison of noise values between different equipment in an absolute way, independent from the distance to the object and from the acoustical environment where it was measured. Moreover, the value obtained from the ISO sound power test appears on the European Energy Label for white goods. It allows manufacturers to compare their equipment with previous generations or with competitor brands. It also assures end-users that they are choosing the quietest brand when purchasing an appliance at the store or online.

Measuring the sound power value is one thing. But what if a key competitor releases a new model that is only 1 or 2 decibels (dB) lower than yours? Such developments in the market may cause manufactures to lose market share and revenue.

Figure 1: European energy label.

Smart strategies to improve noise in products

Manufacturers have several strategies for improving noise, including blocking the noise, determining its source, and with some further details, understanding the underlying phenomena.

Blocking the noise

Appliance noise can be blocked quite easily by adding acoustic material to dampen or absorb the noise before it enters the room. Extra acoustic material can be used inside the equipment to help lower the emitted noise. Typically, a bitumen layer is applied to the side panels of, for example, washing machines and dishwashers.

But what if manufacturers want to try new materials or a combination of multiple layers? It is not necessary to apply all the different acoustic materials every time they want to test them. Quantifying the acoustical absorption and transmission loss characteristics of such materials can be accomplished on a small sample using impedance tube standards, such as ISO 10534 or ASTM E1050 test methods, using the Simcenter™ Testlab™ software sound absorption or sound transmission loss solutions. As an alternative, room-based testing setups (ISO 354 and ISO 140) provide the same absorption and transmission loss curves.

Once the optimal material is selected, knowing where to apply it is next. Placing the acoustical material on all panels is not efficient. A better approach is to find the locations where such a material is most effective. If you produce thousands of dishwashers a day, saving one cent per unit on acoustical material could mean huge savings in cost. Knowing where the main noise leaks are located will tell you where you need to modify the design. The fastest way to find noise leaks is by using an array-based sound source localization technique, such as the one offered by the Simcenter™ Sound Camera™ system.

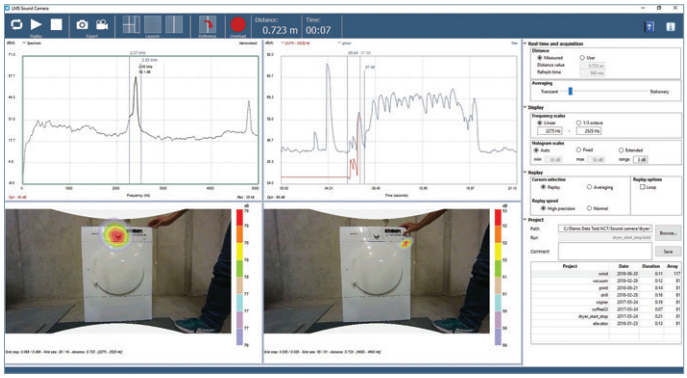

Figure 2: Simcenter Sound Camera system.

Real-time holograms show the acoustical hotspots, as well as the critical frequencies. Very similar to an infrared camera (where designated colors indicate the zones with higher temperatures), the sound camera identifies the origins of the highest noise levels.

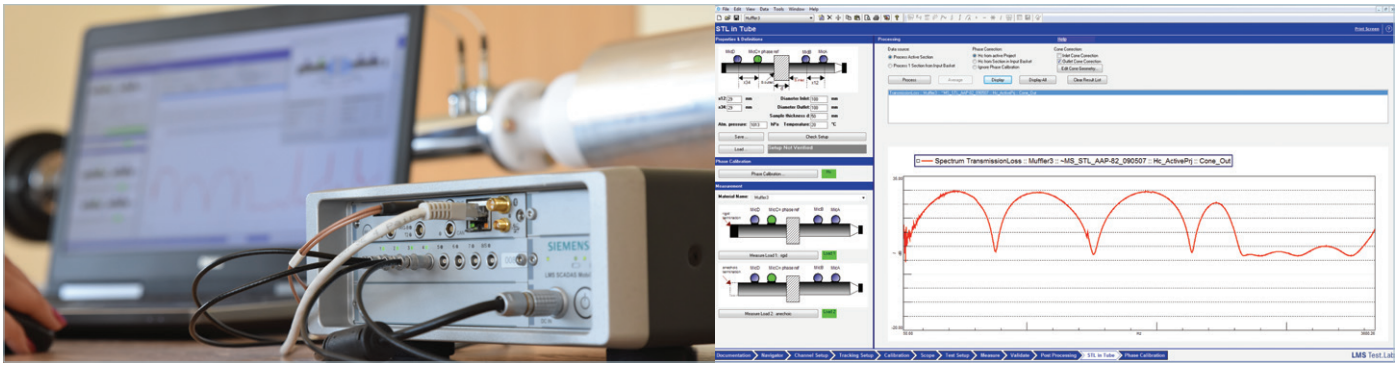

Figure 3: Transmission loss measurement.

Understanding the noise path

Instead of determining where the noise leaks out, another strategy can be to tackle the problem from inside. A washing machine has many moving parts: rotating motors and belts, springs that hold the tumble and others. They either generate vibrations and induce noise (the sources) or amplify certain frequencies (the transfer paths), such that an unexpected noise problem might occur (the receiver end). The Siemens Simcenter source-transfer-receiver approach will aid understanding of the underlying dynamic phenomena.

All components are identified and characterized as a function of their dynamic behavior. Understanding their interaction and knowing the critical frequencies and paths will help determine the "guilty component" you should be working on. This systematic approach can be started in a very simple manner by using impact testing and looking at transfer functions. Much more detailed insights on the complete dynamic behavior of products can be obtained with Simcenter Testlab transfer path analysis (TPA).

Shaping the noise

Some manufacturers of home appliances go even one step further: once they have the noise levels well under control, they start to examine how their equipment sounds and whether this sound is appreciated by the end-user. The beeping sound when pushing the start button, the opening and closing of the door, and the splashing sound when the washing machine does the laundry is all orchestrated into one pleasing hearing experience. Shaping the generated sound so the human ear likes it is the domain of sound quality engineering;

Figure 4: Simcenter SCADAS XS.

Figure 5: Simcenter Testlab Neo.

a domain rather new to the home appliances industry, but a well-established one in the automotive industry for decades.

The process of sound quality engineering involves the recording of different sounds, which is done using a binaural recording device, such as Simcenter™ SCADAS XS hardware and the binaural headset. These recordings can either be used to calculate sound quality metrics using Simcenter™ Testlab™ Sound Quality software or to run some listening sessions with a sample group of customers (called "jury testing") using Simcenter Testlab jury testing.

Figure 6: Jury testing using binaural headsets.

Sound quality metrics are objective calculations that intend to express how well certain sounds are appreciated by humans. Jury testing does the same in a subjective way by replaying the recorded sounds to a group of people who then electronically report their assessment of the sounds. However, as jury testing sessions are very time-consuming, the goal is to find a "golden formula" that combines sound metrics that correlate with the results obtained from jury testing campaigns.

All in all, combining different testing techniques will guarantee that the noise levels and sound quality of your home appliances stay under control. For all aspects concerning sound quality testing – binaural recording, sound metrics and jury testing – the Simcenter Testlab software and the Simcenter SCADAS platform offer dedicated tools and specific user interfaces that help complete these tasks efficiently.

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