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DETERMINATION OF SOUND SOURCES IN A DISHWASHER

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ABSTRACT
The noise emitted by a dishwasher is one of the main factors that have an influence the purchase decision of the customer. The best approach to reduce the noise is to act on the noise sources during the design phase. In this paper, tough, for an appliance already in mass production, the sound intensity method, according to ISO 9614, has been used to determine the sound sources, that are: the splash of the water on the tub and the electrical pump noise. The first noise has been damped installing absorbing material on different places of the tub, however the low frequency noise or the pump is difficult to insulate. As a result, the effect of damping the tub, reduce the acoustic power of the dishwasher by 12 dBA

1 - INTRODUCTION

Normally, a dishwasher works during periods expected or considered quiet by the users, such as after lunch or dinner.
So, the purchase decision of the user depends on the noise level of the dishwasher that must be calculated according to the corresponding standard [1], and indicated by means of an acoustic power label in each unit.
There are two possible ways of achieving this purpose. The best approach to reduce the noise is to act on the sound sources during the design phase, but if the product is in mass production it is expensive and difficult to modify any of its parts. In this case, it is better to act on the sound transmission paths, pasting absorbing materials onto the cabinet to damp its vibration and to absorb sound energy or placing this material in the free spaces between the sound sources and the dishwasher external cover. The last option is easier and requires less investment, but its main drawback is the cost increase of each unit, so a balance must be found between the value of the added material and the reduction of the noise emitted.

2 - INTERNATIONAL STANDARDS

The use of a methodology and equipment according to the international standards ensures the reliability of the measured data. These international standards divide the measurement methods in control, precision and engineering, being the last one the most severe.
The most relevant parameter to describe the noise emission of a household appliance is the acoustic power that can be calculated from pressure [2] or intensity measurements.
In this case the ISO 9614, has been followed. Part 1 of this standard is based on intensity measurements carried out in discrete points of a surface defined around the machine to test.
The main advantages of this technique are that the use of a suitable room is not required, and it is possible to find the position of the sound sources and to determine the transmission paths through the intensity maps produced from the data measured.

3 - MEASUREMENT METHODOLOGY

The measurement equipment consists of an intensity probe with two faced free field prepolarized microphones that let obtain the pressure gradient of the measurement field and a sound intensity two-channel analyzer, [3], that calculates the intensity as the time average of the sound pressure.

Figure 1: Measurement surface.

The first step is the choice of the measurement surface, in this case a parallelepiped because of the dishwasher shape, (see Figure 1). Every face, except the bottom, has been divided in 6x6 squares of 331'2 cm^2 and the measurement in the center of each square will let elaborate the intensity maps.
The target of the tests has been to analyze the following insulation:

- Dishwasher tub not insulated (see Figure 1)
- Dishwasher tub and door insulated with 4 mm thick bituminous plates (see Figure 2)
- The same as the previous case plus a 20 mm thick blanket on the door.

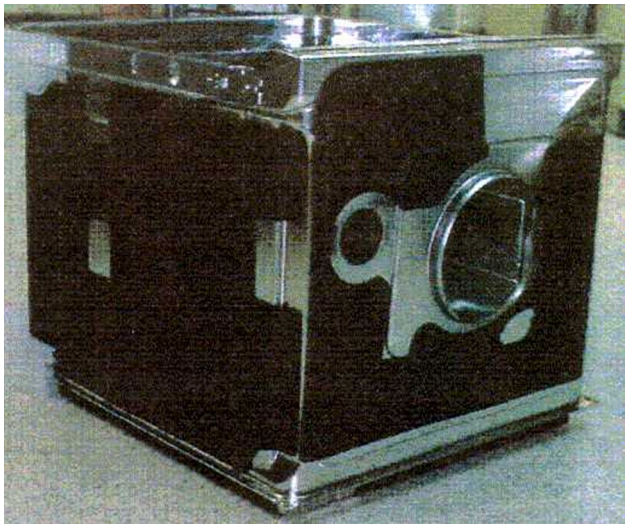

Figure 2: Tub insulated with bitumen.

The measurements have been carried out under the conditions indicated by UNE-EN 60704, and during a whole washing stage because is the longest and the most representative period.

4 - INTENSITY MAPS

4.1 - Dishwasher tub not insulated

The noise is produced by the splash of the water on the tub and on the crockery, and by the electrical pump, although the last one is masked by the splash of the water. From the analysis of all intensity maps, it is observed that the maximum noise level appears at the lower part of the front face where the

pump is located (see Figure 3). This noise escapes from the discontinuity between the tub and the door of the front face.

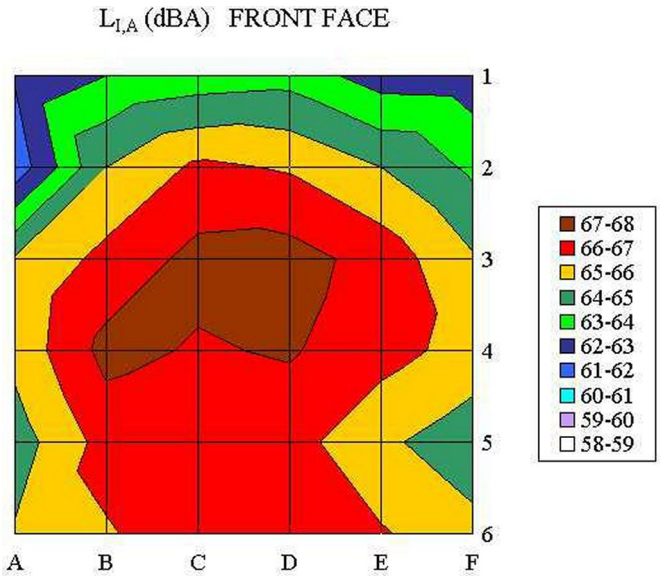

Figure 3: Tub not insulated; front intensity map.

4.2 - Dishwasher tub and door insulated with bituminous plates

The splash of the water is damped stiffening the tub with bituminous plates that insulate it acoustically. Now, the front face is again the nosiest but the distribution of intensity has changed (see Figure 4), and the maximum value is found at the lower zone corresponding with the pump.

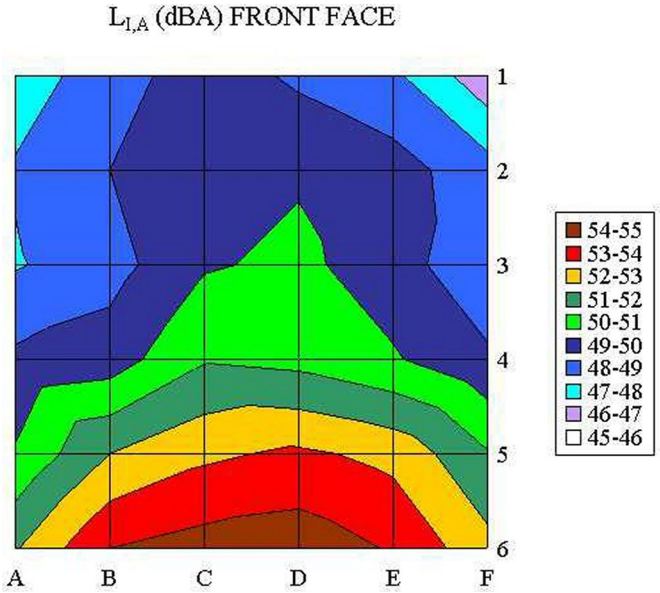

Figure 4: Tub and door insulated with bitumen; front intensity map.

4.3 - Dishwasher tub and door insulated with bituminous plates and blanket

The door has been covered with a blanket to avoid the emission by this zone. The dishwasher is less noisy but the noise of the pump is more noticeable than the rest. The noise level of the lower part of the front face is similar to the one obtained in the previous case (see Figure 5).

5 - CONCLUSIONS

The comparison of the acoustic power levels obtained in the three tests are shown in Figure 6, being the more relevant aspects:

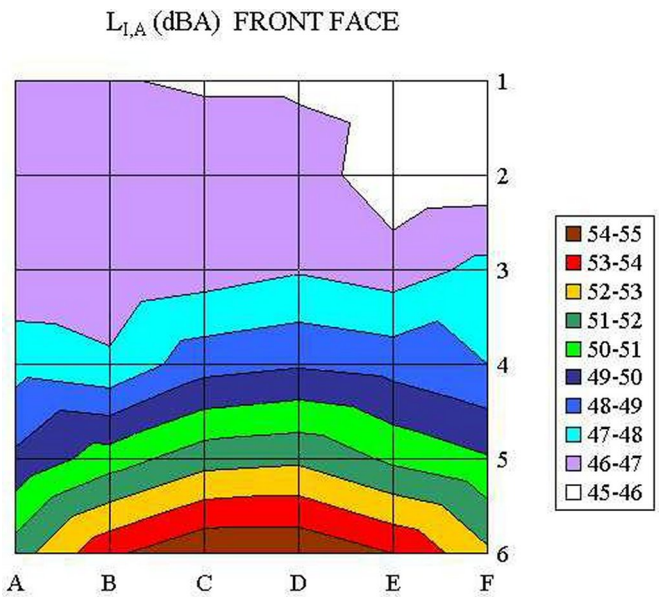

Figure 5: Tub and door insulated with bitumen and blanket; front intensity map.

- The main sources of the noise emitted by the dishwasher are the splash of the water on the tub and the electrical pump noise, being the front face the noisiest.
- The maximum intensity sound levels correspond with the lower zone of the dishwasher where the pump is located. In addition the effect of this source is reinforced by the reflectant floor.
- The low frequency noise of the pump is expensive and difficult to insulate
- The noise produced by the splash of the water can be damped installing absorbing material on different places of the tub.
- As a result, damping the tub, reduces the acoustic power of the dishwasher 12 dBA.

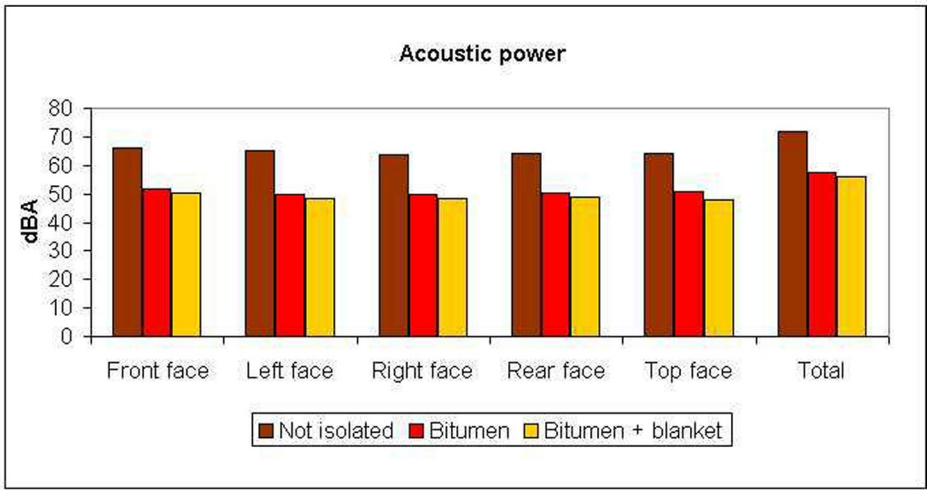

Figure 6: Intensity maps.

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