Air-Borne Noise Control for a Quieter Dishwasher

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Abstract

Quiet Consumer Appliances are becoming more important every day. Here noise from a Fisher & Paykel "Dishdrawer" Dishwasher is measured using sound intensity to determine the dominant noise generating areas, and develop a quieter product by applying air-borne noise control techniques.

The lower area (kick space) of the dishwasher has some holes and is close to the lower motor, and is shown to be one of the major noise sources. Double sealing in this area—sealing the motor and sealing holes in the kick space—provides a 3.4dBA reduction in the total sound power level of the unit.

Introduction

The three major performance indicators of dishwashers are energy consumption, cleaning performance, and drying performance. Most appliance manufacturers have achieved "A" grade in these three areas. Although noise is not the main issue for dishwashers, and there is no label requirement for noise, recent customer reports have talked about noise as very important to purchase choice along with styling and functionality.

There area number of noise producing mechanisms in appliances. However, they can be broadly classified as either air-borne noise, or structure-borne noise. Air-borne noise transfers noise to receiver from noise to noise, whereas structure-borne noise is a result of vibration.

In this paper we will concentrate on reducing air-borne noise.

Generally we measure noise with a single microphone. It is simple and cheap and sometimes it is quite effective. However, this method does not provide reliable information on the contribution of each part of a machine to the overall level of noise.

In contrast, sound intensity enables us to measure sound intensity area by area over a larger surface, to obtain information relative to this area. With this information we can map different surfaces of the product to obtain a noise map of the appliance.

Evaluation

Measuring Methodology

Sound intensity measurement equipment consists of a two-microphone intensity probe and an analyser. The dishwasher is mounted on a thin metal stand to keep it clear of the floor (see Fig. 1).

The first step of measuring sound intensity is to decide measuring methodology, such as measuring distance from the surface to probe, and the number of points to measure, etc.

For the purposes of these tests, we have chosen the following parameters;

- Distance from dishwasher

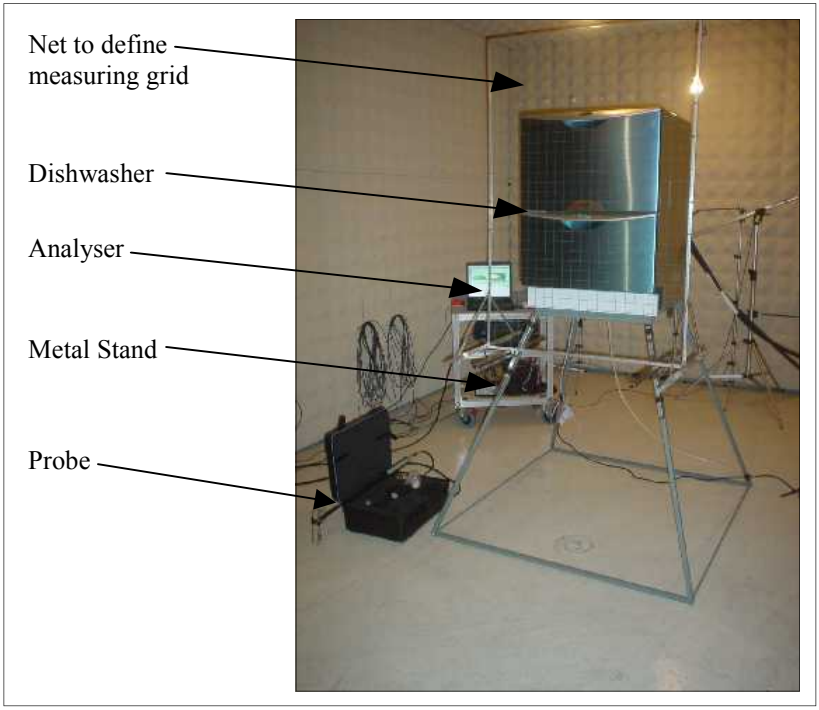

Figure1: Sound Intensity Test Setup

surface to probe: 100mm

- Measuring Grid: 120mm square grid. This grid was accurately defined using a fine "net" as shown in figure 1, and is a balance between needing sufficiently detailed results without obtaining too much information.
- Data Averaging: 10 times. At each point on the grid, the analyser takes 10 samples of the noise and averages the results.

Sound Intensity Results

Figure 2 shows a noise map of the front of the dishwasher. Although the sound intensity is generally symmetric left to right, there are two noticeable noisy areas—the horizontal centreline and the bottom of the machine.

The Dishdrawer is somewhat unique amongst dishwashers in that there are two independent washing cavities mounted on top of each other. As a result, there is a motor located at the position of the horizontal centreline of the machine, hence the measured "hot" spot at this location.

There are also some drying holes near this area which could be contributing.

The noticeable feature of figure 2 is that it is the lowest part of the dishwasher which generates the most noise. This is the area which

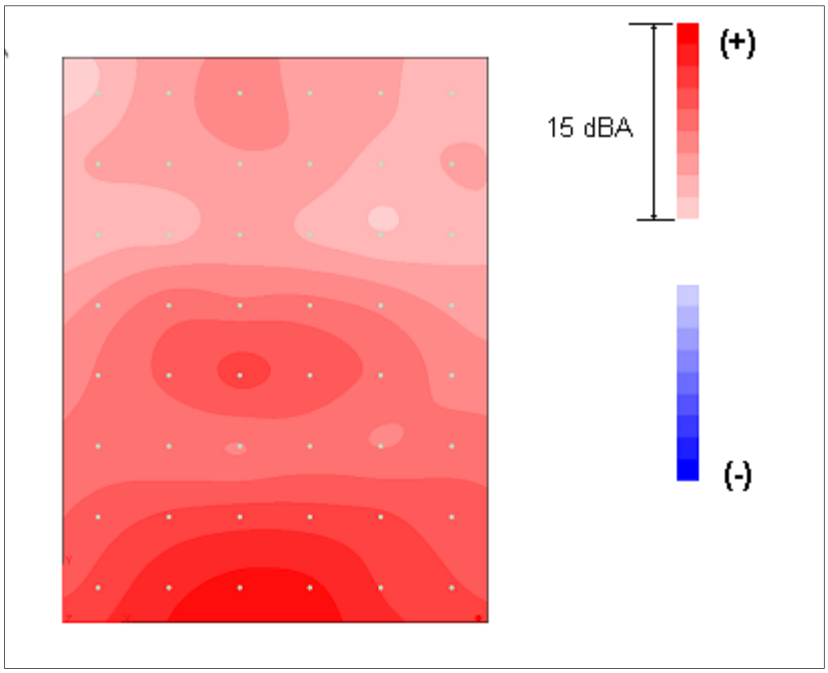

Figure 2: Sound Intensity Test Results of Front Surface (All

we have investigated in detail for this paper.

Development

Investigating noise sources

There are two obvious contributors to noise emitting from the lower part of the machine. The first is the holes and gaps in this area. The second is that there is a major noise-generating source in this area—namely the lower motor.

Treatment to reduce motor noise could detrimentally affect the washing performance, so we have not seriously looked at this option as yet.

Treatment

We have concentrated on reducing noise from the kick-space area. Our treatment includes covering of the motor and applying sealing between that area and the outside.

A steel cover over the motor noise area attaches directly to the washing cavity from the outside, with some vibration isolation applied to avoid structure-borne noise radiation from the steel cover itself. All holes in the front plate have been sealed off.

Sound Power Level

A figure for the dishwasher noise reduction given in sound power for the whole washing cycle has been measured. Because a dishwasher's washing cycle is not steady state (there are lot of different steps, such as water fill, washing, drain, dry, etc.), measuring a short duration would not be indicative of the machines sound level. It is therefore common practice to measure the sound power level according to ISO3744 over the entire cycle.

We have measured before and after treatment to assess the effectiveness of the applied noise control techniques.

Results

Noise during the washing part of the cycle has reduced by 4.4 dBA (Figures 4a and 4b). Over the entire operating cycle including quieter phases (drying, draining and filling) there is 3.4dBA reduction in Sound Power Level.

Another noticeable feature of the treated machine is that several of the dominant "spikes" in the

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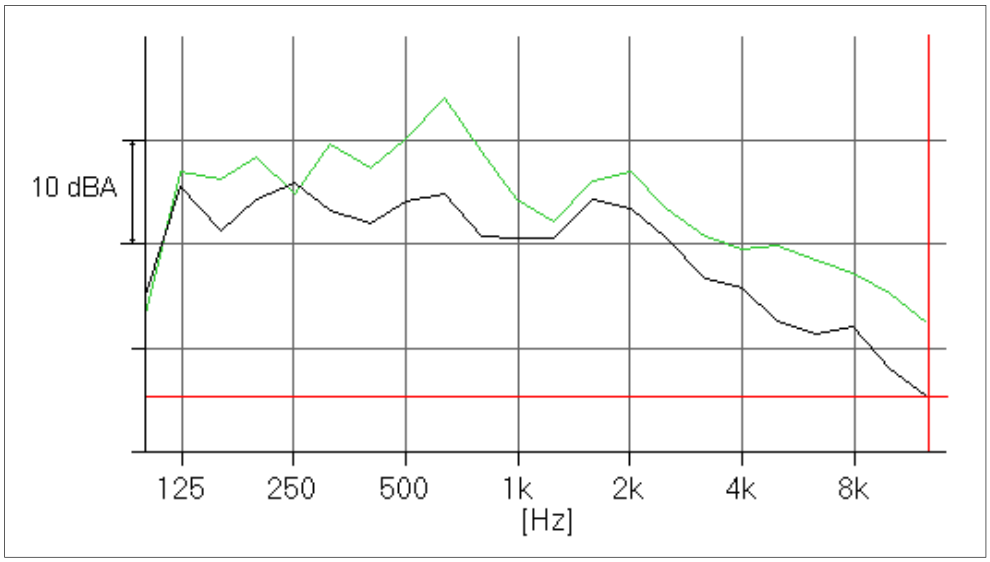
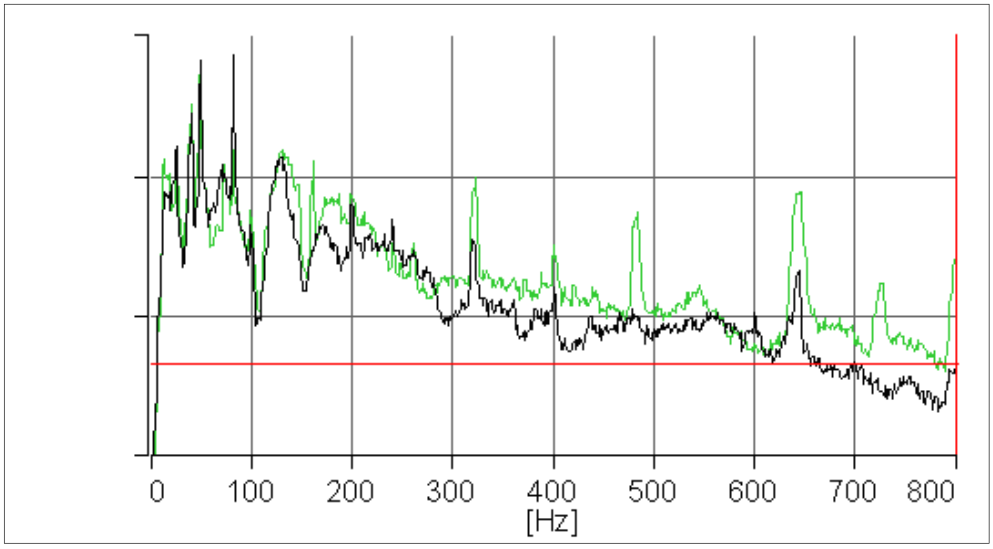


4a: 1/3 Octave Bands



4b: Narrow Band

Figure 4: 500mm from front of dishwasher during wash cycle

Light: Original, Dark: Treated

In the News—G6 Consultation Document

As reported in the last issue of New Zealand Acoustics, the Building Industry Authority (BIA) has prepared a consultation document outlining proposed changes to the acoustic provisions of the building code (section G6).

The proposed changes are wide ranging. In particular;

- The new requirements for inter-tenancy situations are around 5 dB more stringent than previously.
- There are now controls on noise from areas such as common spaces.
- Environmental noise provisions are included for areas subjected to high levels of traffic or aircraft noise.
- Building services noise is now controlled.
- All criteria are now specified as site-measured level differences, rather than transmission loss values as was previously the case.
- On-site compliance testing will become compulsory under the draft proposals.
- The extent of acceptable solutions has been broadened.

The discussion document is now available for public comment.

The BIA is keen to get feedback from as many people as possible. If you would like to make comments, phone 0800 242 243 to obtain a copy, or download an electronic version from www.bia.govt.nz.

Submissions have been extended to close on Monday 16th August 2004 ❑

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narrowband spectrum of the washing cycle have been eliminated (Figure 4b).

To put the measured improvements into context, it is interesting to note that almost all domestic dishwashers available in New Zealand have Sound Power Levels within a 10 dBA range. As such, even an apparently small reduction of 3 dBA is extremely useful.

Conclusions

A useful noise reduction of over 3 dBA has been achieved with minimal impact to a proven dishwasher design. Sound intensity measurement techniques have proved their value in identifying noise propagation areas. As a result, cost-effective paths to reducing sound have been indenfied and pursued.

To achieve additional noise reductions, individual noise sources will need to be identified and reduced at source.

This approach is likely to have more impact on the operating performance of the current product and therefore be difficult to implement and costly.

Attention to structure-borne noise issues is also likely to be required.

These issues will be addressed in future papers.

References

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