Acoustic Modelling and Low Frequency Control of Furnace Noise

M.G. Faulkner*, K.R. Fyfe*, L. Cremers* and E.H. Bolstad†
*Department of Mechanical Engineering,
University of Alberta
†Eugene H. Bolstad Engineering
Edmonton, Alberta

INTRODUCTION

The high temperature hot water heating system at the University of Calgary uses three similar Dominion Bridge furnaces. The acoustic radiation from their stacks shows several distinct frequency components from 4 to 80 Hz. In order to explore techniques to reduce the levels in the 30-60 Hz range, finite element modelling of these furnaces was developed. Once the model confirmed that these frequencies were a result of resonant behaviour, it was further used to design a stack silencer which would meet architectural as well as acoustic criteria.

Evaluation of the silencer indicated that the reduction in overall level was close to that predicted by the finite element model.

MODELLING DETAILS

Initially a two-dimensional acoustic finite element model was formed as shown in Figure 1. The mesh was prepared with the ANSYS package while the analysis was done using the SYSNOISE software. The furnace was divided into four regions to account for

(1) the burner noise source - modelled as a moving wall
(2) the acoustic dissipation of the fire brick
(3) the open stack - modelled using a zero pressure condition with end correction
(4) the large temperature variation with the furnace - modelled using four areas

The acoustic pressure was calculated in the center of the physical end of the stack as shown in Figure 2 while those measured at the edge of the stack are shown in Figure 3. As the results were reasonably consistent a three-dimensional mesh was constructed. The results were only marginally different than the two-dimensional ones with essentially the same trends.

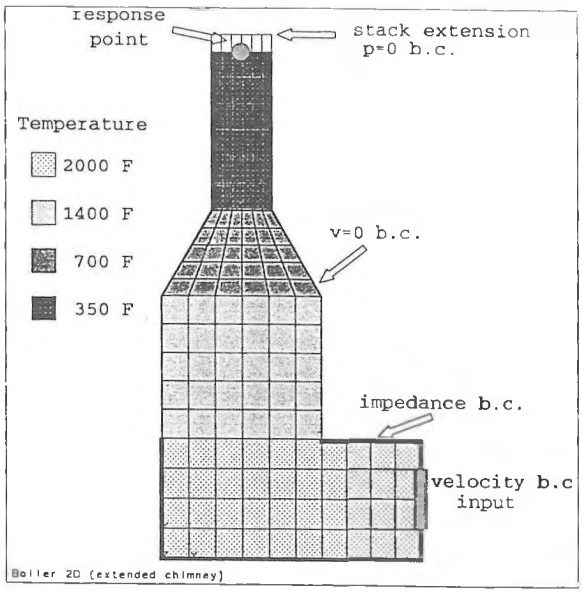
SILENCER DESIGN

As it was the 30-50 Hz frequencies which appeared to be the most bothersome, a silencer was added to the output stack as shown in the mesh of Figure 4. The silencer was simply a thick layer of insulation around a porous stack. The height of the stack was limited to maintain the architectural integrity of the building and to limit structural modification costs.

Figure 5 shows the frequency response plots for silencer lengths of 10, 12.5 and 15 feet. The model predicts a 7 to 8 dB reduction in the 30 Hz region with larger attenuations at higher frequencies.

CONCLUSIONS AND SUMMARY

A prototype silencer has been installed on one furnace and measurements of the stack noise radiation done. These results indicate that the levels have dropped 6-7 dB and that the resonances at approximately 30 and 45 Hz are not predominant.



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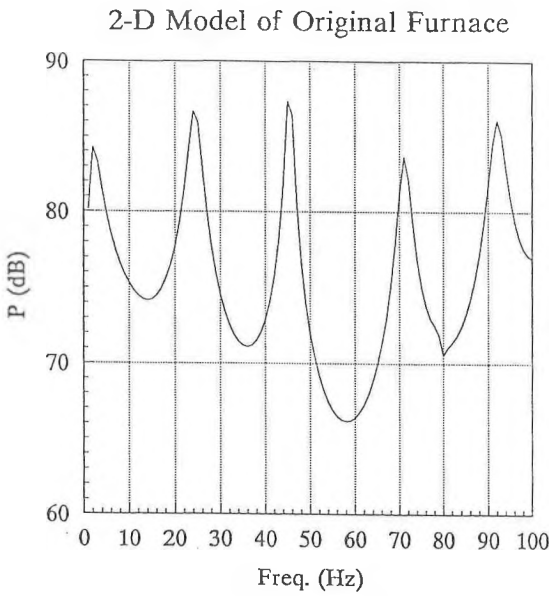

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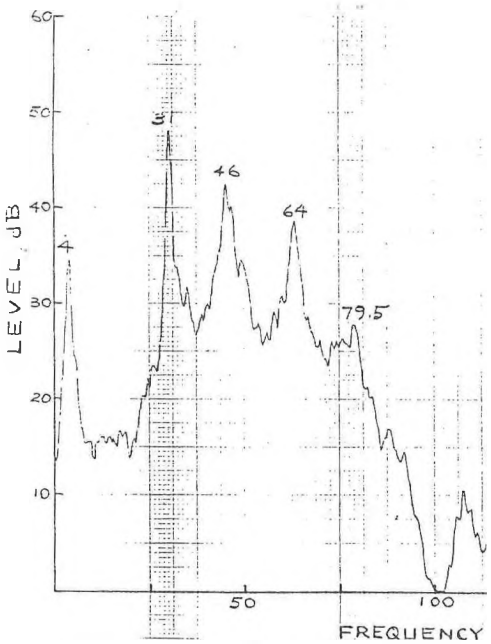

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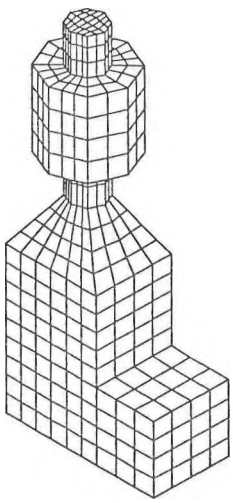

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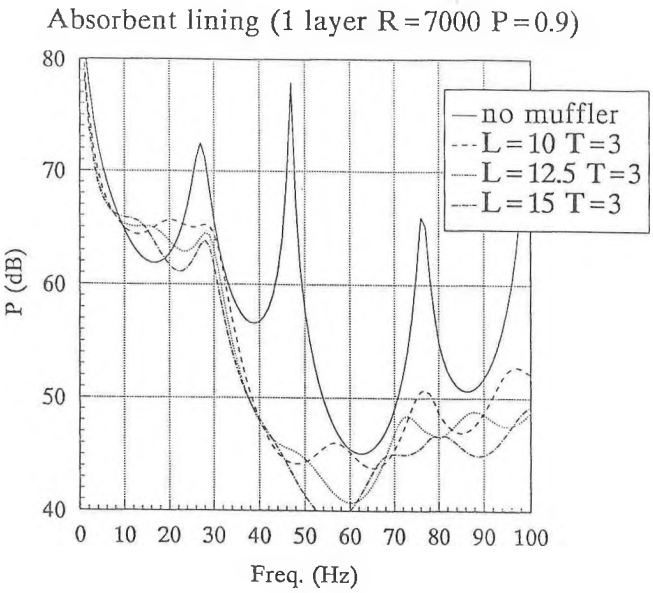

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