INFRASOUND NOISE RADIATED FROM VIBRATING SCREENS AT AN ORE REFINERY: PART 1 – PROBLEM ANALYSIS AND SMALL SCALE MODEL DESIGN

Louis-Alexis Boudreault, Michel Pearson and André L'Espérance
Soft dB inc., Quebec, QC, Canada, G1S 3G3, www.softdb.com

1. INTRODUCTION

An infrasound problem has been identified at an ore refining factory. Despite being inaudible, the infrasound levels are high enough to generate discomfort among workers and to generate vibration in the building structure.

Measurements were taken on site and led to identify the vibrating screens as the dominant source. The 10 m by 3 m screen area vibrating in a vertical motion produces an average pressure level of 115 dB at 14 Hz at 2 m from the source.

In order to evaluate potential solutions allowing to reduce the screens' acoustical emission, a 1:15 scale model was built to be tested in laboratory. This approach proved to be appropriate considering the acoustical complexity, the cost and difficulty related to the evaluation of solutions on site.

Noise mapping techniques were used to highlight the radiating patterns and measure the performance of tested solutions. (Part 2)

2. NOISE SOURCE DESCRIPTION

The vibrating screen consists of a concave shaped vibrating plate. The ore inflow comes at the top of the screen and the coarse particles go out at the bottom. The screened particles are collected using a pyramidal shaped hopper.

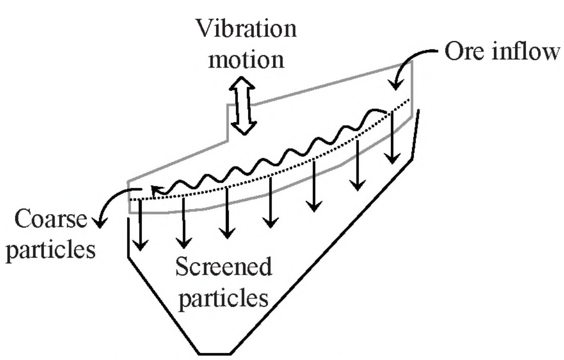

Figure 1. Vibrating screen schematic

The vibrating plate associated to the pyramidal hopper acts like a giant baffled loudspeaker:

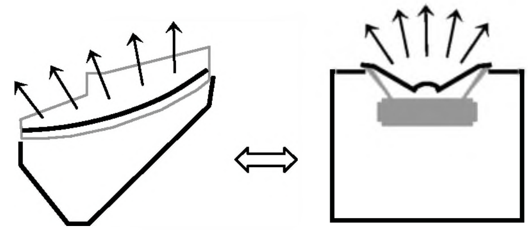

Figure 2. Loudspeaker analogy

3. MODEL DESCRIPTION

The 1:15 scale model is built from wood and has basically four parts: the screen plate, the hopper, the inertial base and the structure. Each of these elements is mechanically isolated from the others using neoprene pads.

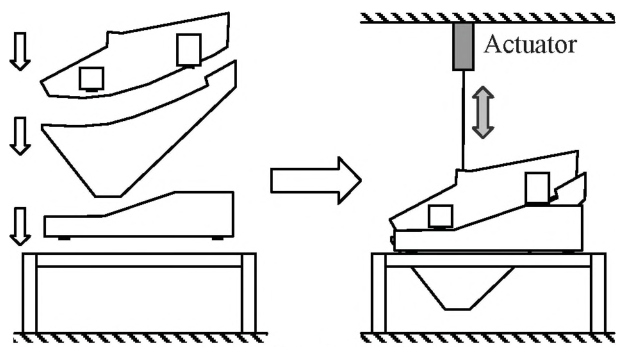

Figure 3. Small scale model elements

A vibration actuator is fixed to the ceiling and attached to the screen to generate the vibration motion.

4. ACOUSTICAL TREATMENTS

4.1. Acoustical short-circuits

Acoustical short-circuits, or holes in the screen plate were made in order to equilibrate the acoustical pressure on each side of the screen plate. The holes also reduce the radiating area of the screen plate reducing even more the generated sound pressure.

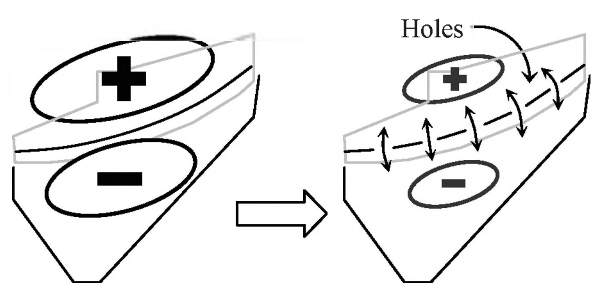

Figure 4. Acoustical short-circuits concept

The final solution took the shape of a slot in the center of the screen plate running from the top to the bottom. This solution allowed maximizing the holes' area without comprising the industrial process.

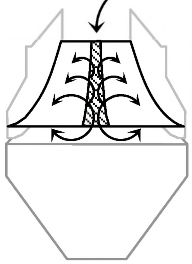

Figure 5. Acoustical short-circuits implementation

4.2. Enclosure volume

A closed-box acoustical system acts as a first order high-pass filter where its cut-off frequency is linked to the enclosure volume. The cut-off frequency increases as the enclosure volume is reduced. If the operating frequency is located on the rolloff, increasing the cut-off frequency will cause attenuation. To validate this concept, several hopper volumes where tested on the model.

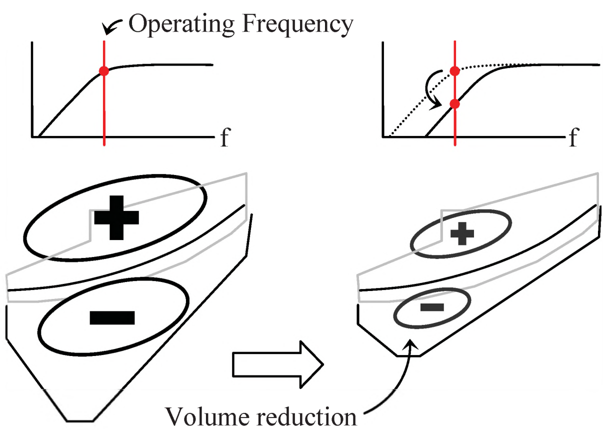

Figure 6. Enclosure volume reduction concept

Tests performed on the small scale model indicated that a smaller enclosure volume led to greater attenuation. A new hopper was designed with this phenomenon in mind:

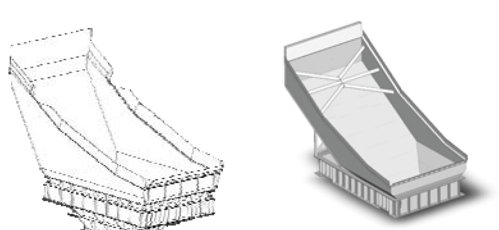

Figure 7. Hopper comparison

5. FINAL CONCEPT AND RESULTS

The final concept includes the two basic phenomena described above: acoustical short-circuits and enclosure volume reduction.

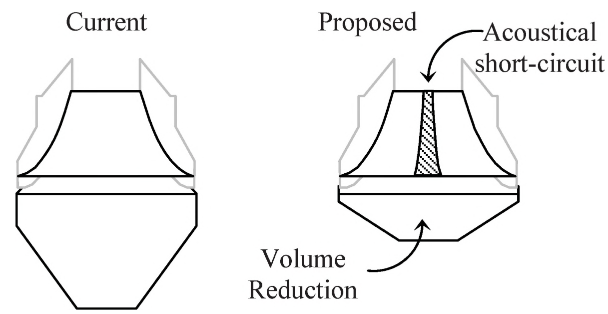

Figure 8. Final Concept

The first implementation stage is to implement the slot on the screen plate. The second stage is to implement the reduced volume hopper. The graph below presents the attenuation provided by each implementation stage on the small scale model.

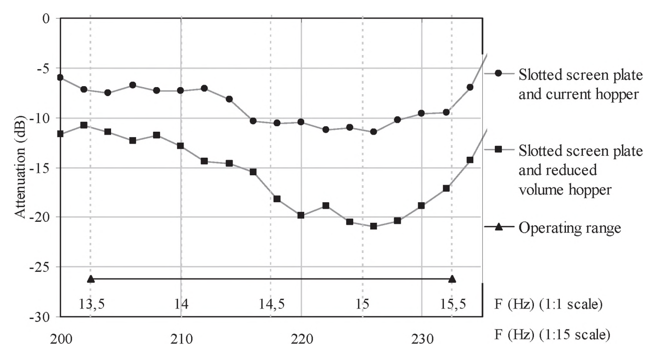

Figure 9. Attenuation results on small scale model

Tests performed on the small scale model led to 5 to 12 dB attenuation for the first stage of implementation. The second stage adds additional 5 to 10 dB attenuation for a total of 10 to 20 dB attenuation over the operating range. On-site implementation is currently ongoing.

6. CONCLUSION

In conclusion, it has been shown that the small scale model approach proved to be an appropriate way to analyze the problem and identify solutions for this particular case.

Part 2 of current article covers noise mapping techniques used on the small scale model to identify radiating patterns and measure the performance of tested solutions.