Abstract

Construction and testing of an air horn can provide educational insight into how certain design decisions can influence resulting acoustic properties. Using readily available materials such as PVC pipe and tin sheeting, one can construct an air horn capable of producing sound waves in the 100+ decibel range and frequencies between 150 and 400 Hz. Upon completion of a prototype, many experimental opportunities are available. The degradation of sound intensity over a distance can be tested by use of a sound level meter. Due to the unidirectional behavior of the sound waves from the horn, samples from different distances and angles from the source can provide more understanding of how sound propagates as a wave in an open environment, as opposed to it being a simple directional wave.

Theory of Operation

The sound produced by an air horn is caused by a rapid pressure change in the main chamber. Compressed air enters through the inlet, but is initially contained within the main chamber. The pressure is applied to all of the surfaces within the chamber (Figure 1), however the external walls of the main body are much thicker and can withstand much higher pressures than that of the diaphragm. This results in the diaphragm flexing away from the chamber and allowing the pressurized air to flow into the outlet pipe in its attempt to reach equilibrium (Figure 2). When this occurs, the pressure in the main chamber is reduced back to its original state and the diaphragm snaps back to its original position as well, resulting in a loud “slap” against the end of the outlet pipe. This process repeats itself hundreds of times per second, resulting in what seems like a pure tone from the horn.

Upon completion of the testing, changes to the initial construction design can be implemented to investigate the relationship between the new model’s performance and the prototype’s. The air horn provides many opportunities for experimentation and testing. For example, frequencies and sound intensity can be altered by making design adjustments such as: diaphragm size, diaphragm material, housing material, bell size, nozzle thickness of the diaphragm had an aim to alter sound quality. From there we will experiment with different widths and pressure to determine the optimum combination to produce a clear tone that can be easily analyzed.

Design and Manufacturing

To facilitate all of the variable tests we wanted to perform, we needed to completely redesign and rebuild the horn from the ground up. We used the Solid Edge ST4 cad program to facilitate the design process. This gave us the ability to dynamically change the specifications as either design problems arose or we decided to add/remove an adjustable variable. We decided on an aluminum main body for a solid build that could support both the air pressure and the stress of constant handling and transportation.

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Reference

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