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Physics for AET

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The Barrel Reverb Tank

With a giant steel oil barrel trusted upon us with great enthusiasm, we built our concept for our project based around former students use of the barrel. The previous project attempt was to achieve the longest possible reverb time. Our intent was to determine the absorption coefficients’ of different lining materials using the barrel as a test chamber. We used the tone burst method into the barrel to determine the reverb decay times with different material linings and used the absorption calculation derived from the Sabine equation to find our answers. Our results show that foam had the highest absorption coefficient over wood and the steel of the barrel.

The center of the project being the barrel was first put to use by former PHY 2010 students as a means of creating a prolonging reverb tank. Their method consisted of the Tone Burst procedure, which involves projecting a loud reference tone for a brief amount of time into the space you’re measuring. With a microphone recording the event, the decay time of the tone burst will be documented in your recording medium. Analyzing your data will reveal the decay time of the space. A particular method the previous group attempted was to fill the space with dense pieces of metal for the purpose of creating more modes in the barrel space. With more “room” modes resonating, the decay time would hypothetically increase.

For our experiment, we wanted to focus on determining the absorption coefficients based off the recorded decay time. We understood that since the barrel has such a finite amount space, we were not going to achieve outlandish results as far as decay time goes. With improved sound isolation and projection, we hoped to achieve absorption measurements that coincide with general consensus of which materials would absorb more effectively. The final lab in the coarse material was a helpful procedure to draw from with our experiment. The lab outlines the basic procedure of the tone burst method, and we used the calculations derived from our work to aid us in calculating the absorption coefficients of wood and acoustic foam.

Our design and execution of our experiment began with the materials needed to do so. The 50 gl. steel oil drum was lent us from the physics department. Materials invested by the group members were epoxy for gluing the rubber lid lining to the top of the barrel, bendable hardwood, aural foam 1’x1’ squares, Dynaudio BM5a MkII speaker, Audix TM1microphone, power saw, Protools DAW software and interface for recording, and SHAART software.

First we wanted to improve on the design of the former group by removing the speaker generating the burst tone out of the barrel to maximize space inside the barrel. The former group used adhesives to attach a speaker to the underside of the barrel’s lid. We used a power saw to cut a (sizes) rectangle into the top of the lid and lined the perimeter of that opening with acoustic foam. The open made a perfect nestling for the speaker to rest and project into the barrel.

We also wanted to isolate the microphone from the speaker for the obvious need to get accurate measurements of the decay time, and not the tone itself. To do this we cut a piece of hardwood to fit in the diameter of the barrel and a length of (size). The side adjacent to the microphone was lined with acoustic foam as well.

The experiment was conducted at Kenny’s studio (bedroom). We used a pink noise tone due to its equal loudness across all frequency octaves. First we generated a burst tone with no lining in the barrel to record the decay time of the “dry” space. Then inside of the barrel was lined with hardwood, and the procedure was repeated. Finally, the wood lining was swapped out with acoustical foam and the experiment was repeated, giving us the decay times for each phase of the experiment. Our Results as followed:

**Figure 1** shows the charted results from SHAART comparing the decay time of the barrel and foam, as well as the barrel compared to wood. As you can see, the shorter decay time of the acoustic foam is intuitively following the predictions of a higher absorbtion coefficient. These measurements focus on 125hz. **Figure 2** shows the same comparison, with focus on 500hz. One of the interesting results of this data is the wood lining having the smallest decay time. The dry decay time of the barrel was also longest in this frequency. We believe this due to a room mode existing around 500hz. **Figure 3** shows the data results with the tone burst test done at 2khz. As expected, the barrel had the longest decay time followed by wood, and then foam. **Figure 4** shows the results of testing the frequencies at 8khz.

Using Our decay times, we determined the full frequency spectrum decay time for the barrel itself was 0.5 seconds, 0.15 seconds for hardwood, and 0.12 seconds for acoustic foam. **Figure 5** is an image of our mathmetical calculations used to determine the absorbtion coefficients. At the of the figure, we first calculated the furface area of the cylinder using basic geometry. From there we the sabine equation re formulated to solve for the absorbtion coefficient *a*. We used our surface area of 3,359in^2, the barrel’s dry decay time as TR1, or the reference decay time, and we used the decay times of the full spectrum hardwood and foam as TR2. Our calculations show that hardwood has an absorption coefficient of 0.00083 seconds, and acoustic foam had an absorption coefficient of 0.00105.

As we had set out to prove, the absorbtion coefficient of foam was indeed greater than the coefficient of the hardwoord. We also found how, different frequiences will show different behavior of decay time which we believe was the most revealing aspect of this experiment. We followed our engineering instincts and ran some music through the barrel to hear the effect the barrel chamber had, and as determined in class, it sounded like music in a can. Some thoughts on improving the experiment would be to re-focus on the task of prolonging the reverb as much as possible. With our calculations, we’ve show there is peculiar behavior around 500 hz, and further analysis of the space’s modes can spur better means of creating more modes and perhaps absorbing particluar frequncies for a finer tuned reverb chamber.

**FIGURES**

**Fig 1**

**FIG 2.**

**Fig 3.**

**Fig 4.**

**Fig 5.**

Works Cited

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