Development of Sound Wave Experimentation Tools Which Influenced by Relative Humidity Using Audacity

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Abstract. The development of experimental tools is important for teachers to assist in the learning process of physics. The purpose research is to develop a sound wave experiment tool that is influenced by relative humidity. The experiment tool was made using a closed and open end PVC tube with a length of 142 cm. Relative humidity obtained is boiling water vapor. Water vapor is entered the PVC tube and the relative humidity level is measured in the tube using a hygrometer. The experiment tool is equipped with audacity software to detect and display sound waves which enter PVC tube. The experimental results are viewed through a graph of sound velocity against relative humidity levels in the tube. When the temperature is 29°C the relative humidity value is 86% with a sound speed of 412 ms⁻¹ and measurement error of 2.01%. The conclusion is the speed of sound increases linearly with increasing relative humidity.

1. Introduction
Physics is built to include the role of theory and experiment [1]. Experimental activities in learning physics obtain the findings from various investigative activities collected and arranged systematically into a collection of knowledge which is called a product. Experimental activities can help in understanding the concepts contained therein. Experimental activities are carried out through experiments about something, observing the process, and writing down the results of the experiments [2, 3]. The process of experimentation can be found in all spheres of life, such as sound wave experiments in physics laboratories [4].

Jaafar et al. [5, 6] Sound waves are abstract concepts in physics, direct activities such as experiments and demonstrations are often recommended to increase students’ understanding and strengthen their knowledge. However, most laboratories do not have gauges that are sophisticated enough to conduct sound wave experiments. The experimental instrument developed was a smartphone-based sound wave experiment tool to visualize the harmonic series in the second tube closed, one closed and the second open. Kadri et al. [7] developed a sound wave experiment tool using freeware visual analyzer (VA) and low-cost material to replace sophisticated and expensive instruments, so that several sound wave demonstrations could be used.

Muhafid [8] research on the development of experimental tools for sound wave fast propagation with an android smartphone based data acquisition system, obtained the value of the sound wave velocity in the air for the open organa pipe is $340.9 \pm 0.3 \text{ ms}^{-1}$ with an accuracy rate of 98.1% and a precision of 99.90%. And for fast sound wave propagation in the air on closed organa pipes is $341.8 \pm 0.1 \text{ ms}^{-1}$ with an accuracy rate of 98.4%, while for precision it is 99.97%.
In this paper, the sound wave experiment tool is developed by adding the factors that influence it. That is a sound wave experiment that is affected by relative humidity. The results of these experimental devices are expected to provide information about the speed of sound in the air affected by relative humidity.

2. Methodology
The initial process of developing experimental tools begins with sketching tools. Figure 1 shows a sketch of a sound wave experiment tool that is affected by relative humidity. Experimental tools are created and developed according to the sketch. The special purpose of the experimental tool is to determine the speed of sound in air affected by relative humidity. The experimental apparatus was made using a PVC tube with a length of 142 cm, a gas stove, an erlenmeyer tube for water containers and a rubber hose to connect tool components and materials.

The sound catcher that enters the PVC tube uses a pinch microphone mounted on the end of the open tube. Pinched microphone connected with computer. To detect and display the speed of sound in a PVC tube the audacity software installed on the computer is used. The measuring instrument used to see the relative humidity level in a PVC tube is the hygrometer.

Choose a place that is not noisy when conducting experiments. Noisy places will cause inaccurate data retrieval. for tools to work stably and without defects, it must be assembled correctly on a flat surface. When operating the device, perform data retrieval in 15 seconds, so that the results obtained are more accurate. then observe the sound speed affected by relative humidity through the audacity software installed on the computer.

3. Results and Discussion
The results of this study can be seen through the image of the sound wave experiment tool that is affected by relative humidity and is accompanied by a graph of increased humidity on the increase in sound velocity.
Figure 2 is the result of making a sound wave experiment tool that is affected by relative humidity. Relative humidity is produced through steam that is heated using a gas stove made. The water in the erlenmeyer tube is heated until it boils and produces steam. Steam in the erlenmeyer tube enters the PVC tube using a rubber hose. Before the steam enters the PVC tube, the hose in the erlenmeyer is connected to a small box as a dividing point between the water droplets and the water vapor flowing through the hose. From the box, the steam enters the PVC tube through a wedge hose and observe the humidity level that enters the PVC tube using a hygrometer. Place the pinch microphone on the open end of the tube and connect the microphone to the computer.

![Figure 3. Sound wave velocity displayed through the audacity software](image)

Dects and displays sound wave velocity on PVC tubes using audacity software, so that it can be observed and measured the speed of sound waves during propagating in the air affected by relative humidity. Display the sound wave speed at audacity can be seen in Figure 3.

![Figure 4. Graph of increase in relative humidity to sound waves speed](image)

Figure 4 shows the results of measurements of sound wave experiment tools that are affected by humidity. Based on this data, an increase in humidity can increase the speed of sound due to a decrease in the dominant air density. In the initial state, the humidity level was 78% with a sound speed of 343 ms$^{-1}$. At a humidity level of 97% the sound speed is 412 ms$^{-1}$, and there continues to be an increase in humidity of up to 99% with a sound speed of 686 ms$^{-1}$, and a measurement error rate of 2.01%. The speed of sound increases linearly with increasing relative humidity.
4. Conclusion
An increase in relative humidity will increase the speed of sound waves in the air, due to a decrease in its dominant density. Sound waves have a strong influence on relative humidity because they affect the amount of density of particles in the air. Thus, the speed of sound increases linearly with increasing relative humidity.

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