The correlation of EDT and T30 result of YMEC measurement compared with RT sabine theory and eyring in semi-anechoic room in physics department Institut Teknologi Sepuluh Nopember

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Abstract. In the science of acoustics required two special rooms namely Reverberation Chamber and Anechoic Room. In Anechoic room is a free field from the reflection of sound so this room used to examine signals in audiosonics. one of which can be used to evaluate the noise of a machine and the analysis of acoustic materials. The calculation approach of Reverberation time is based on the semi-empirical formulation of Sabine and Eyring's theory. Measurement software used YMEC, can determine the time of buzzing EDT and T30. This research was conducted in semi-an echoic room department of physics ITS. From the measurement results obtained, cut-off frequency value of 23 Hz and critical frequency 200 Hz. The correlation of EDT and T30 results of Measurement of YMEC compared with the Reverberation time of Sabine and Eyring’s Theory. Based on the measurement results obtained the corresponding reverberation time is EDT using Eyring theory approach method. Measurement T30 has almost the same value, but at 4000 Hz frequency experienced a significant increase. Reverberation time using the Sabine or Eyring theory has the same curve but for the value obtained Eyring theory is closer to the value of EDT.

1. Introduction
In the field of acoustics, designing or redesigning the space for acoustic quality in accordance with its function is often the subject matter. One of the important basic values that impact on the acoustic performance of space, whether the room to listen to music or listen to speech or seminar is the amount of reverberation time. This quantity can be calculated, but can also be measured. The problem is, the results of calculations and measurement results are often unclear.
The T-time measurement technology has undergone many developments. Initially, protractors were used in reading the recording of sound decay in a space. More advanced technology is developed by incorporating in-room sound decay recording technology with its automatic decay reading technology. One of the measurement software and readings of the sound decay in order to assign T space is the YMEC (Yoshimasa Electronic) software utility. This YMEC software tool, which can determine the timing of EDT (Early Decay Time) and T30.
Various approaches of calculating the humming time can be found, among which there is a calculation of the humming time of T based on the semi-empirical formulation of Sabine and there is also a calculation of T based on Eyring theory, which results can be different. Various software calculations T also appear, such as CATT, EASE, ODEON and many more.
Carolina Reich (2010) has conducted a” Statistical comparison of reverberation times measured by the integrated impulse response and interrupted noise method, computationally simulated with ODEON
software, and calculated by Sabine, Eyring and Arau-Puchades' formulas. "In this study, the measurements were performed using respond impulse method and computer simulation using ODEON version 9.0. Results showed the value of team reverberation Sabine ice is accurate, but in calculating T by using Eyring method there are still some problems.

In this research we will find "correlation between the calculation of Sabine and Eyring with measurement of T in Semi-Anechoic Room special room of ITS Department of Physics". Used the room because the material from the room has been known the value of absorption coefficient. The value of material absorption coefficient is needed to calculate the magnitude of T using both the Sabine and Eyring equations. Furthermore, the software used to measure is YMEC.

1.1 The object of the study

Acoustically known there are two types of room, namely the living room and the dead room. The life or death of sound in a room depends on the amount of sound absorbing material in the room. A room with lots of absorbent material will be a dead space, while if there is only a little absorbent material in the room, then the room will become a living space. Anechoic Room is a room with the entire surface mounted sound absorbing material, so it barely occurs reflection, meaning that all the sound waves that arrive at its surface are absorbed. Meanwhile, a reverberation chamber actually continuously reflects the waves that arrive at it almost without absorption. The size of life or death of indoor sound is further expressed by the amount of Reverberation Times. Reverberation Times is the time it takes for a sound to decay as much as 60 dB since the sound is turned off. Sabine (1900) issued the Time-T Reverberation equation by experimenting on the sound of the room and counting the Reverberation Time in the room. He observes that T depends on the volume of room and absorption occurring indoors. The drifting time equation defined by Sabine is as follows:

\[ T = \frac{0.16 V}{A + mV} \]  

With \( T = \) Reverberation Times (second) 
\( V = \) Room Volume \( m^3 \)  
\( A = \) Total room absorption (Sabine)  
\( m = \) air absorption coefficient (Sabine/\( m^3 \))

The formula given by Eyring begins with the assumption that the room is completely diffuse, meaning that at every point in space has the same level of sound intensity and energy is propagated in all directions in the same way. Eyring also assumes that the absorption of sound in space is quite uniform, the reverberation time defined by Eyring is as follows:

\[ T = -\frac{0.07 V}{S \log(1-\bar{\alpha})} \quad \text{or} \quad T = -\frac{0.16 V}{S \ln(1-\bar{\alpha})} \]  

The equation it is seen that for \(-\alpha^- (<0.2)\) the Eyring formula returns to the Sabine formula. In Reverberation Time measurements, generally the sound produced from the source is very difficult to decay as much as 60 dB and stay above the level of background noise in the room. For this reason we use several methods to approach reverberation time, by taking decay data for several dB, then extrapolating the result to 60 dB, and using the extrapolation time as reverberation time.

Semi Anechoic Room comes from the word an-echo which means room without echoes (without reflection). This room is designed to absorb sound waves, so that used a lot of absorbent material sounds on every surface of the room. This room should also be isolated from the noise source. The anechoic chamber in the ITS Department of Physics has the following qualifications: Dimensions = 7.8 meters long, 6.3 meters wide and 5 meters high. Doors, walls, floors and ceilings are covered by rock wool with a thickness of 5 cm and a density of 0.85 kg / m3. This adjusts to a standard that is reflection free and has a reverberation time value approaching zero seconds. Wall made of double brick and there is sound lock room. This is intended for sound insulation from the outside (roar must have a background noise level close to 10 dBA. To see the Anechoic room detail in the ITS Department of Physics see Figure 1 below.
To avoid vibration and reflection from the floor other than the floor given the material absorber rockwoll also made the stage 30. In addition to the room there Soundlock for sound from outside the room can not enter the room.

2. Experimental Methods
The calculation phase T uses the theories of Sabine and T Eyring. The required data is the dimensions of the room, the area of each surface and the material absorption coefficient of the room material both on reverberation chamber and anechoic room.

Seen in Figure 3.4 a room has an irregular shape so it takes a very detailed dimensional measurement along with its constituent material. Meanwhile, for Fig. 3.4 b, it appears that the room has a simpler dimension accompanied by an entire surface material composed of rock wool.

The measurement method using YMEC software uses a response impulse method (source impulse response) in the form of an explosive sound or generator signal generator which is then turned off automatically by YMEC software. The time required to decay as much as 60 dB by definition is used to determine reverberation time. However, in practice, 60 dB decay is very difficult, because the background noise level is quite high.. Specifically in this study will only be considered reverberation time EDT and T30. Both of these quantities still measure the reverberation time, ie the time it takes to decay as much as 60 dB since the source of the sound is turned off. EDT is a Reverberation time reading based on decay from 0 dB to 10 dB on the decay curve which is then extrapolated, while T30 bases on decay extrapolation results from -5 dB to -35 dB.

3. Results and Discussion
Results Measurement of reverberation time using YMEC can be seen in Figure 2 below. Comparison of the results obtained in Figure 2, found that the corresponding reverberation time is the measurement of EDT, whereas for T30 it still has problems at 4000 Hz. The properties possessed by semi-Anechoic that is free of reflection, so as to make the sound not to be reflected and the measurement is enough to use Early Decay Time (EDT).

The semi-Anechoic chamber in the physics department has a simple shape as shown in Figure 1. The space is only a square with its constituent material made of rockwool and carpet. The known form and material of the constituent can be used to calculate the time value of the hum. The calculation of the reverberation time using the sabine and eyring theory approach of the data in Figure 2 has the same curve anomaly but the approximate value is the Eyring theory.
Figure 2 Results of A-G reverberation time measuring and calculations with Sabine and Eyring theory

a. Reverberation Time (EDT) of Frequency
b. Reverberation Time (T30) of Frequency

One of the acoustic parameters used to evaluate the anechoic chamber is the distribution of SPL. This study also measured the magnitude of SPL by using 6 point as shown in Figure 1. The results obtained can be seen in Figure 3 SPL distribution.
It is apparent in Figure that the difference of SPL (sound pressure level) at point A-G has a difference of $>10\text{dB}$. This indicates that the semi-Anechoic space has an uneven distribution of SPL. The big difference is also because the space is a reflection free space and the magnitude is inversely proportional to the square of the distance.

4. Conclusion
The conclusion obtained in this study is to measure the reverberation time in space semi-Anechoic department of ITS Physics more appropriate with using EDT and theory used is Eyring. While the cutoff frequency obtained is 23 Hz with a critical frequency of 200 Hz.

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