A Study on Low Frequency Noise of Dehumidifier using Acoustic Characteristics

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***Abstract*—The purpose of this research is to analyze sound characteristics of low frequency noise of dehumidifier and moreover, utilize it as a method to remove and reduce low frequency noise. Common noises made from dehumidifiers can be seen into two perspective; fan noise and low frequency noise. Especially, low frequency noise of dehumidifier tends to be louder than home electronic devices which have similar characteristics. Also, depending on the height of the machine, characteristics of noise may vary due to its structural feature. Therefore, this research studies those causes and research on fundamental parameters for identifying what makes low frequency noise and how to reduce it.**

Keyword - Waveform coding, non-uniform Sampling, Peak and Valley, Adaptive filter, Zero-crossing

I. INTRODUCTION

In modern society, as quality of life increases, people are being more interested in well-being. Also, the reason for them preferring to make clean environment, fresh air and water, and maintaining body health can be seen as the same context. Under this circumstance, one of the hot issues among home electronics is the dehumidifier. Dehumidifier is a device that reduces humidity of the room by cooling indoor air and is drawing lot of attention like air conditioner. Application of dehumidifiers include, first of all, removing humidity. This function helps decrease discomfort index which appears during rainy season with high temperature and humidity. Also, its another usage is to dry clothes. It helps removing malodor in shoes. Furthermore, it prevents mold and mite that are formed between furniture. Like this, dehumidifier has many advantages but at the same time, it has disadvantages as well. That is the low frequency noise made when operating the machine. The biggest characteristics of low frequency noise is that it affects human body instead of ear. Another feature is that it is movable, usually placed near people so that people are exposed to low frequency noise lot more than other electronic devices. Thus, characteristics of low frequency noise from dehumidifier has to be identified to be reduced or removed. As this is the case, this research looks into sound characteristics of low frequency noise made from dehumidifier. In Chapter 2, it studies general characteristics of low frequency noise and in Chapter 3, it examines analysis on characteristics of suggested low frequency noise of dehumidifier. Following by this, it reviews experiment and its result in Chapter 4 and provides a conclusion in Chapter 5.

II. CHARACTERISTICS OF LOWER FREQUENCIES TO INDOOR

Frequency range of low frequency noise has not been globally standardized. That is, it is set in accordance to country standards. However, if under 100Hz, as this is the common range, it would be appropriate to consider 100Hz as the maximum range. It is difficult to set the lowest frequency. In terms of analysis and evaluation, even ones under 1Hz are possible to be evaluated. However, for research that looks into influence of main frequencies causing actual noise on human body, most of the cases, it is almost impossible to do it with sound sources under 8Hz. Therefore, the most applicable range can be said to be 10~100Hz. Especially frequency less than 20Hz is called as infra-sound which was before, referred to as unheard scope. Recently, sound power has become big enough to be heard well and its concept is change to not-easy-to hear frequency. Infra sound is indicated in dBG. As infra sound noise has low frequency it can only be decreased it sound energy travels a long distance. That is, if frequency is high, the size of decrease becomes larger and thus, if a person stays a little far away from the noise sources, it gives less effect on human body. However, lower the frequency, its effect may relatively become larger.

In general, among the types of low frequency noises, one that could be underestimated include noise floor noise. It is felt physically more than acoustically. Especially, if one is exposed to low frequency noise, it causes physiological responses. In Korea, like developed countries, Ministry of Environment is preparing guidelines for measuring and evaluating low frequency noise by researching its current status and influence on human body. For other countries, methods for measuring noise vary depending on the country but in most cases, basic standard to estimate indoor noise and space shall be sealed. Time adjustment of noise measurer is set on slow and estimation is made without changing DB.

A common characteristics of dehumidifier is that it is easy to move around and among home electronics, it is operated in a quite close distance to people. Therefore, this research analyzes characteristics of low frequency noise in two methods. The first method is done by selecting similar electronic device which also has high mobility and used in close distance to a person. Then, spectrum of its low frequency was analyzed along with that of dehumidifier. For the second method, the locus of noise was divided into two spots. First part is the fan noise which is located in upper part of dehumidifier and the second post is compressor noise. As this research focuses on low frequency noise of dehumidifier, it studies around compressor noise.

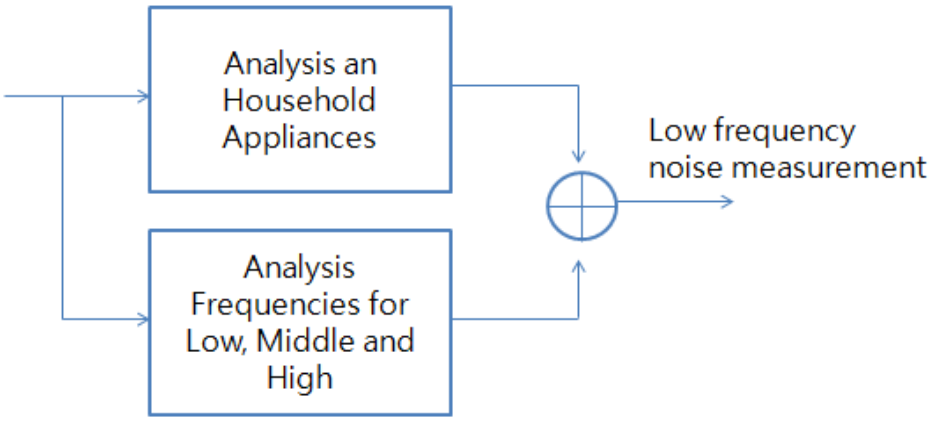

Figure 1. An analysis of general Appliances

Below Figure 1 is a simple block diagram describing above methods. For the first suggested measuring method, dryer, strong wind machine, refrigerator, humidifier, and dehumidifier were used. The measuring distance was all the same, 1m distance, and each low frequency noise was compared. As you can see in Figure 1, under 110Hz, dryer and humidifier had the lowest low frequency spectrum energy and in contrast, dehumidifier had the highest energy. For dryer, it had higher spectrum energy as it moved to high frequency than low frequency. This is because although dryer, similar to dehumidifier or strong fan it utilizes fan but due to its structural characteristics, its body vibration is more similar to high frequency than low frequency. That is why it has higher energy as it moves to high frequency scope than low frequency. In contrast, strong wind fan and humidifier which are the top first and second devices with low frequency energy, their vibration is generated more in low frequency scope which is opposite to that of hair dryer. Also, humidifier has cooler which is a type of compressor and that is why it has the highest low frequency energy spectrum. Considering that it is located close to human like humidifier and cooler, it could also be known from the conclusion that people are more exposed to negative reactions compared to other electronic appliances. As suggested in the second method, it studied compressor noise.

The Figure 2 shows comparison of spectrum energy of low frequency noise depending on height of dehumidifier. Each height is 0cm, 30cm, and 60cm, measuring distance was at every 1m interval from the position of dehumidifier. Also, spectrum envelope was drawn into a graph based on fan starting time. As you can see in Figure 2, low frequency scope had the highest energy at 0cm, followed by 30cm and 60cm. It was also found out that resonant frequency was noticeable at 480Hz scope where vibration took place. The cause of resonance is vibration in fan body located in upper part of dehumidifier, suction part of cooler, compressor located in lower part, and water tank. What is more, the reason for showing high energy in low frequency part as height decreases is because low frequency is made by vibration made from operation of compressor. Considering these points, it is obvious that a person sitting next to dehumidifier is easily exposed to low frequency noise.

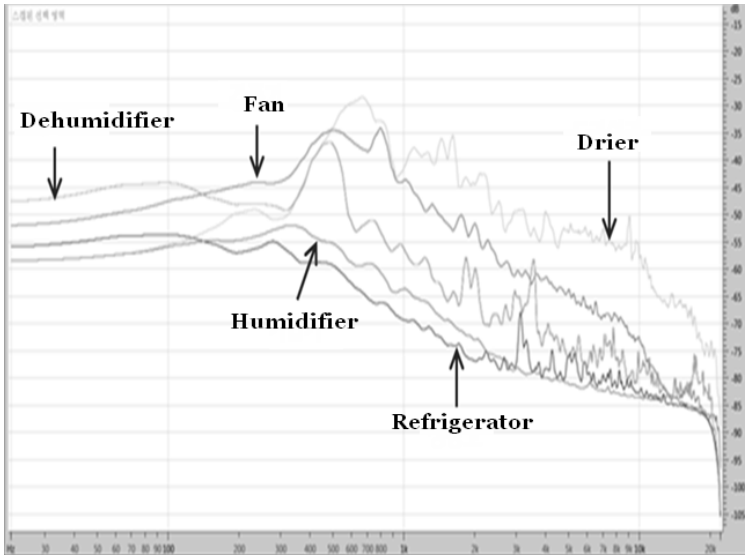

Figure 2. Compare of general Appliances

III. CONCLUSION

This research studies low frequency noise made upon operation of dehumidifier through analysis on its characteristics using sound signal. Measuring methods are done in two ways, first is to compare it with other home appliances that have similar characteristics. The second method is to measure low frequency noise from compressor depending on the height of dehumidifier at a constant distance. As a result, compared to other electronic devices, dehumidifier had relatively higher spectrum energy in low frequency under 110Hz. Also, based on result of comparative analysis on noise spectrum depending on height of dehumidifier, lower the height higher the energy was shown in low frequency scope. As this is the case, it is true that the person is easily exposed to noise if he/she stays close to dehumidifier. To prevent harm dehumidifier noise causes on human body further research will focus on reducing or removing dehumidifier noise.

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