Calculation of the Helmholtz Resonator Using COMSOL® in an Acoustic Lecture

Y. Koike [1], M. Hashiguchi[2], D. Mi[2]

[1]Department of Electronic Engineering, College of Engineering, Shibaura Institute of Technology, Koto, Tokyo, Japan
[2]Engineer Division 1, Keisoku Engineering System Co., Ltd., Chiyoda-ku, Tokyo, Japan

Abstract

In the field of electronic, electro-acoustic apparatus is one of the important applications. There is an acoustic class in the department of electronic engineering, Shibaura Institute of Technology. The class is "Acoustic systems" which opens in 2nd semester of 3rd year. To foster the student's comprehension on frequency characteristics of a cavity and on an acoustic element, the students will learn numerical analysis of a Helmhortz resonator. Generally, a resonance frequency of Helmhortz resonator is calculated by acoustic element concept. In the class, a can bottle or a glass one is employed as the Helmhortz resonator. Before experiment, the students are able to calculate the resonance frequency by only measuring the dimensions of the can bottle or the glass bottle. The thinner cylindrical part in the bottle corresponds to the acoustic mass and the thicker part in the bottle is the acoustic compliance. Each acoustic element value is able to be determined by the dimension, air density and air sound speed. In the practical measurement, we prepare a simple FFT analyzer. Using the built-in microphone in a personal computer, they can measure emitted tone sound when they blow the mouth of the bottle. As a result, they can confirm the precision of their rough calculation result. Due to the slope part in the bottle, the difference between the rough calculation and the measurement is around 30%. After the rough calculation, they analyze the frequency response of the bottle they employed using the finite element application, "COMSOL". The difference between the measurement and the analysis result decreases within 10%. Because of practice on the Helmhortz resonator, we expect that they would understand the validity of FEM in order to improve the precision of the calculation result of the resonator.
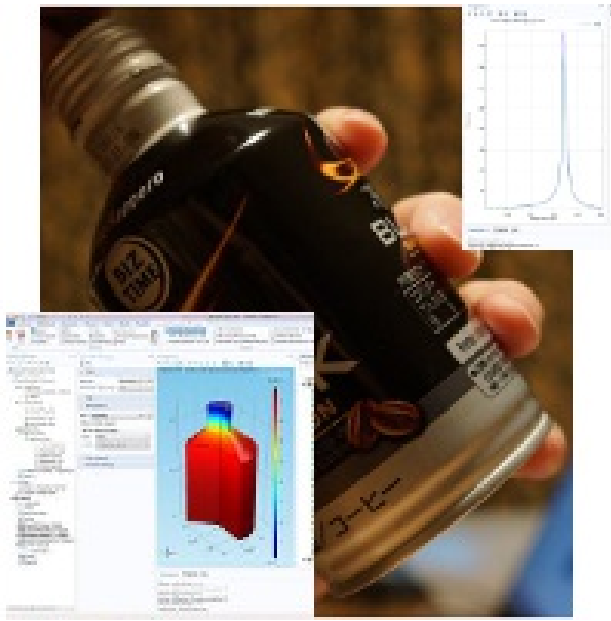
Figures used in the abstract

Figure 1: The brief introduction of the Helmhortz resonator practice using COMSOL and a can bottle.