Question 14

Murata Software

Q: What is the characteristic of analyzing ultrasonic waves?

A: Due to the high frequency of ultrasonic waves, their wavelength becomes shorter. Attempting mesh with four to six meshes per wavelength results in many meshes.

Refer to the next slides for the analysis.

Additional Information

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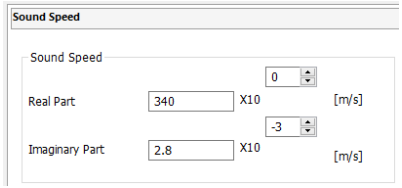
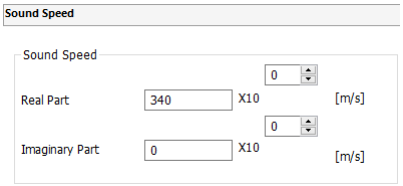
Analysis Setting

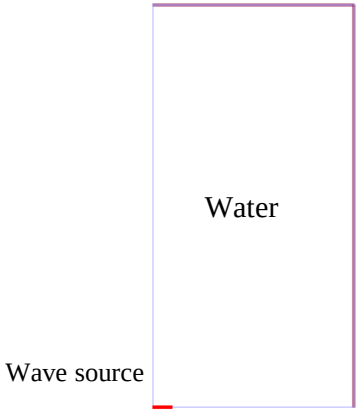
- Axisymmetric model
- Driving frequency: 1 MHz
- To take into account water loss, specify 2.8e-3 to the imaginary part of sound speed.

Harmonic Analysis



Transient Analysis

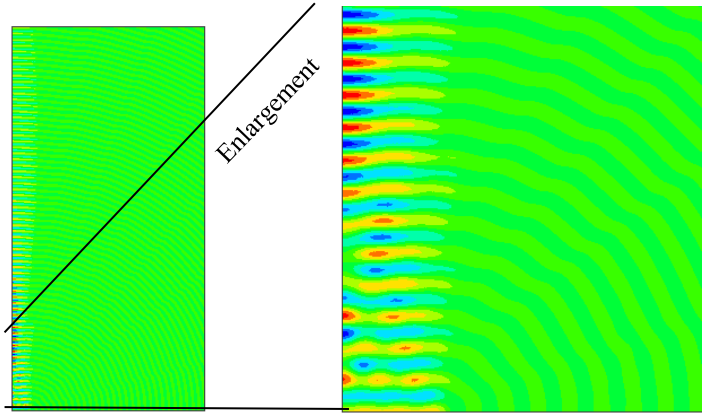




Setting Item	Notes
Real Part	Sets the sound speed. The sound speed in the 1-atm air is given by 331.5 + 0.6*t (t in Celsius)
Imaginary Part/Damping Coefficient	Sets the imaginary part and damping coefficient of the sound speed. The imaginary part indicates the attenuation, which sometimes cannot be ignored in the case of ultrasonics. Kirchhoff's equation is given below. The sound speed increases as the frequency increases. See here for more details. $c\_image = \frac{\omega}{2c}\left(\frac{4}{3}\frac{\mu}{\rho} + \frac{\gamma-1}{\gamma}\frac{\kappa}{\rho C_v}\right)$ ω: angular frequency, c: sound speed, μ: coefficient of viscosity, ρ: density γ: heat capacity ratio, κ: thermal conductivity, Cv: specific heat at constant volume It is $2.7\times10^{-7}f$ in the air, and $2.8\times10^{-9}f$ in the water, where f is the frequency. The damping coefficient used for the transient analysis is β in the equation (4') in Technical Notes. See How to Calculate from the attenuation constant [dB/m].

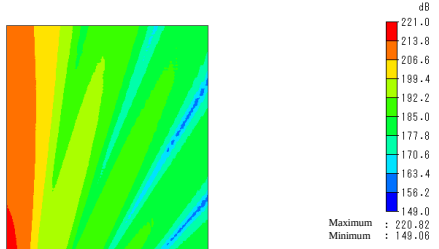
Additional Information

Contour of Sound Pressure [Pa]



Wave source

Contour of Sound Pressure Level [dB]



The diagram above indicates ultrasonic waves will travel in a highly straight line.