High-Intensity Piezo-Ceramic Ultrasonic Transducer with Mechanical Amplifier and Radiation Plate

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Introduction: A COMSOL model was made to design a mechanical amplifier and radiation plate for the emission of high intensity ultrasound to air by means of a Langevin type transducer. In this work, ultrasonic irradiation is aimed at acting on flue gas containing fine particulate matter to realize a shift to higher particle sizes as a result of induced particle agglomeration.

Figure 1. Left: two ultrasonic horns, one with flexure mode Radiation plate. Right: off the shelf transducer (40Khz)

Computational Methods: The physical dimensions of the commercially available transducer were put into a COMSOL model to obtain the mode shapes and resonance frequencies. This model was validated and expanded with the amplifier and radiation plate for which the parameters were fine tuned to obtain a highest possible gain in sound pressure. The computation was done in the 2D axisymmetric frequency domain.

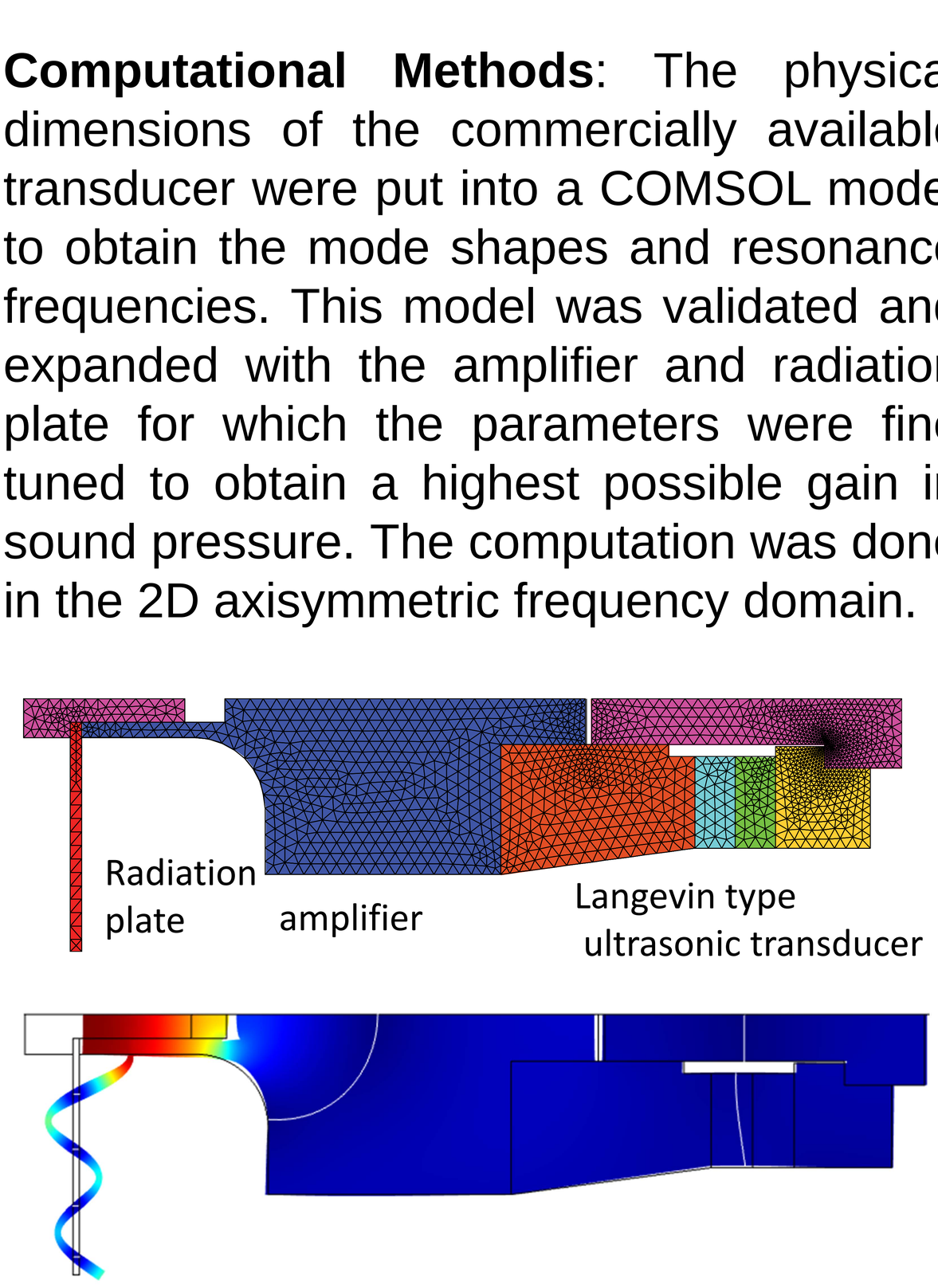

Figure 2. Transducer assembly and mode shape, the white lines indicate velocity nodes

Results: To use the COMSOL model for designing the amplifier and radiation plate, the transducer model needed to be validated, which was done by Laser Doppler Velocimetry (LDV) and impedance measurement.

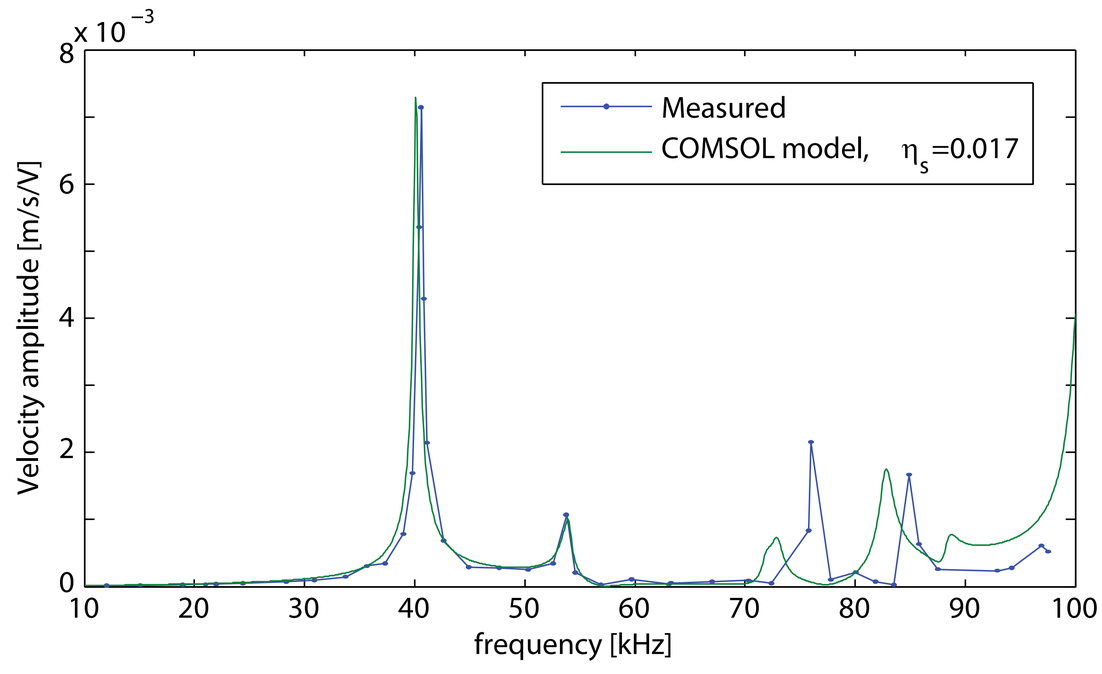

Figure 3. Comparison of LDV measurements and model predictions; η_s is the isotropic loss factor which is a model fit of the material damping. The model is accurate up to 70kHz, at higher frequencies the mode shape is not axisymmetric.

With the addition of the amplifier and the radiation plate, sound pressure level gained 7 dB, which means that the velocity amplitude more than doubled.

Conclusions: The developed COMSOL model is an effective tool to design the physical shape of the transducer. However some measurements suggest that individual components can be refined to match the resonance frequencies of transducer.

References:

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