Ultrasonic Power Delivery Through Steel Wall - Water Interface

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INTRODUCTION:

Ultrasonic power delivery by low-frequency (20-50 kHz) high-power ultrasound actuation into a fluid through a steel wall was analyzed.

The objective was to evaluate the impact of transducer head diameter on acoustic power transmission and sound directivity.

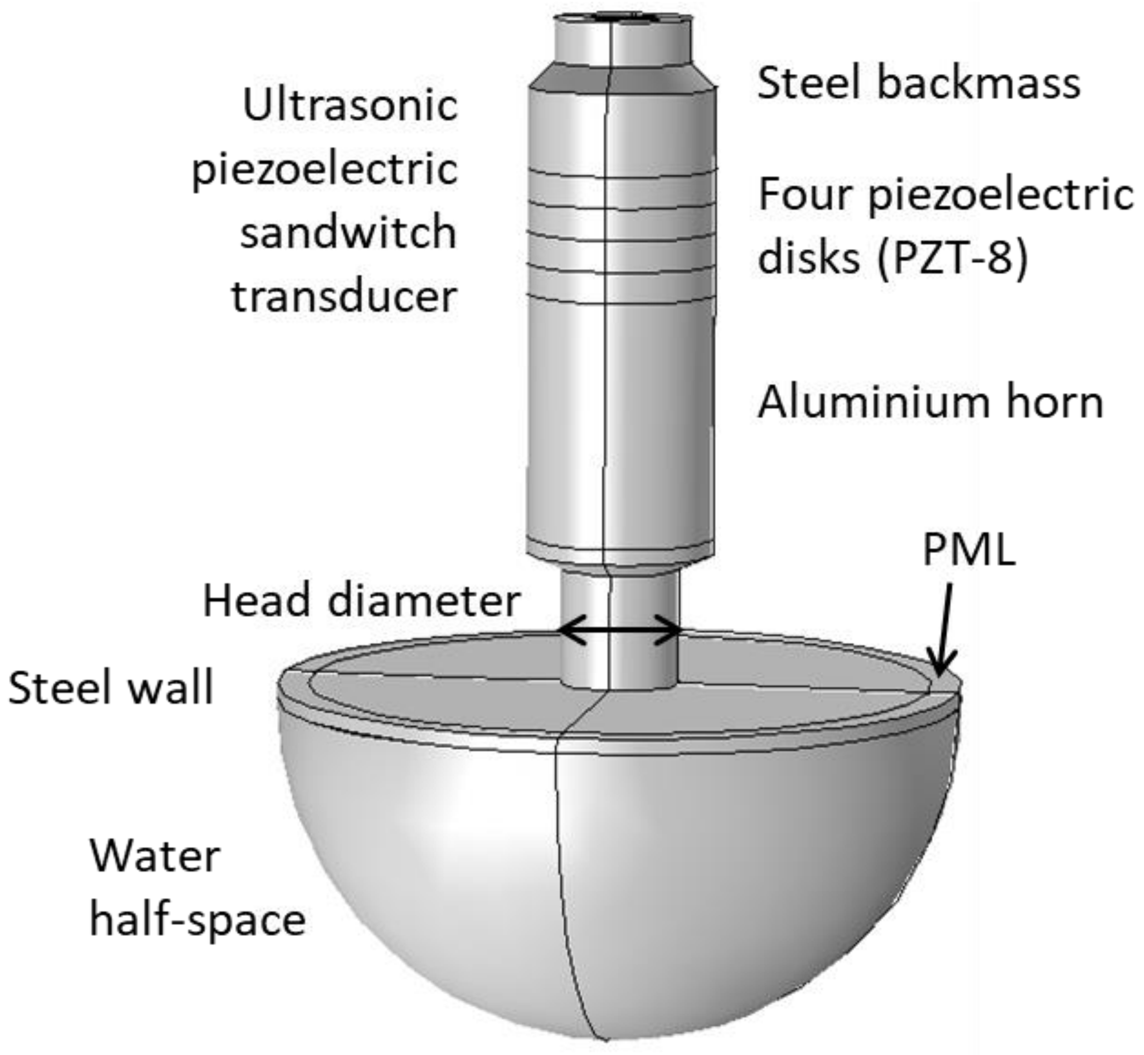

Figure 1. Simulation geometry.

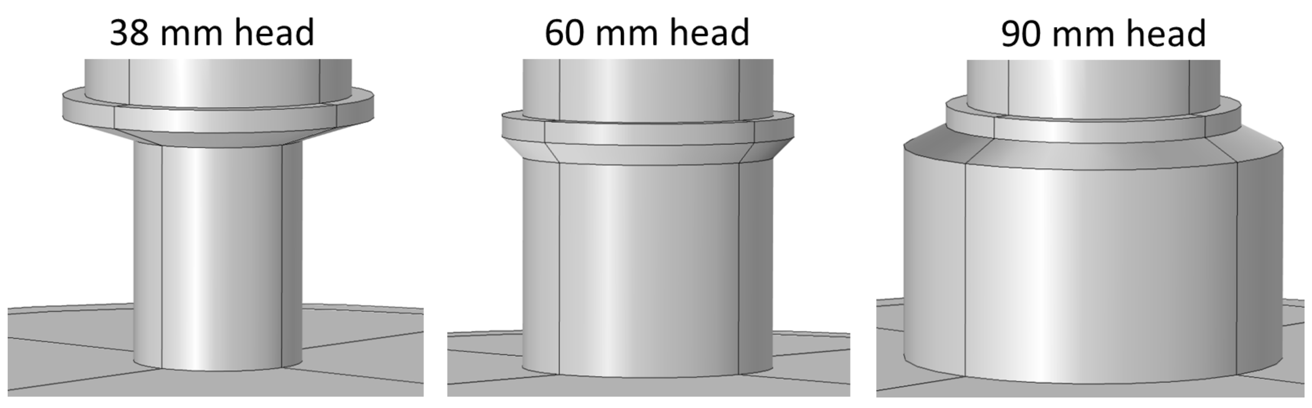

Figure 2. Close-up views of the transducer heads.

COMPUTATIONAL METHODS:

The Acoustic-Piezoelectric Interaction and Frequency Domain Interface of the COMSOL® Acoustics Module were employed.

Figure 1 shows the simulation geometry. The model was characterized by the following details:

- Transducer featured a 20 kHz centre frequency.
- Steel wall was modeled as a 5 mm thick flat plate.
- Steel and water geometries were surrounded by perfectly matched layers (PML).
- Head diameter was altered within a 38-90 mm range (Fig. 2).
- Acoustic power delivered to fluid and that delivered to the plate were determined as surface integrals of the intensity at the fluid-PML boundary and plate-PML boundary, respectively.

RESULTS:

For the 38 mm head, the acoustic radiation field was relatively spherical, whereas that for the 90 mm head was directive (Fig. 3). Directivity index and acoustic power delivery ratio increased as functions of head diameter (Fig. 4).

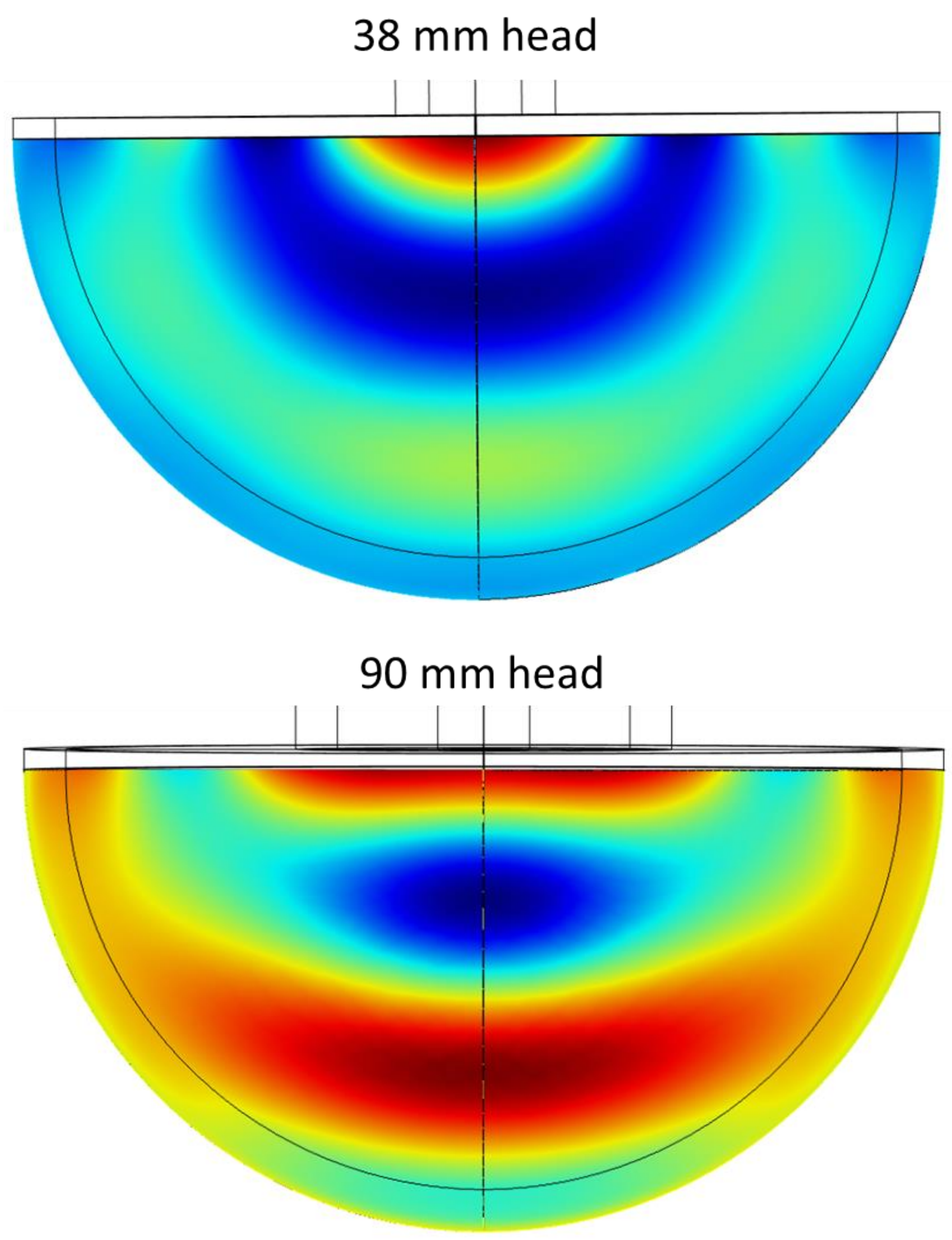

Figure 3. Acoustic pressure field produced by 38 mm and 90 mm heads.

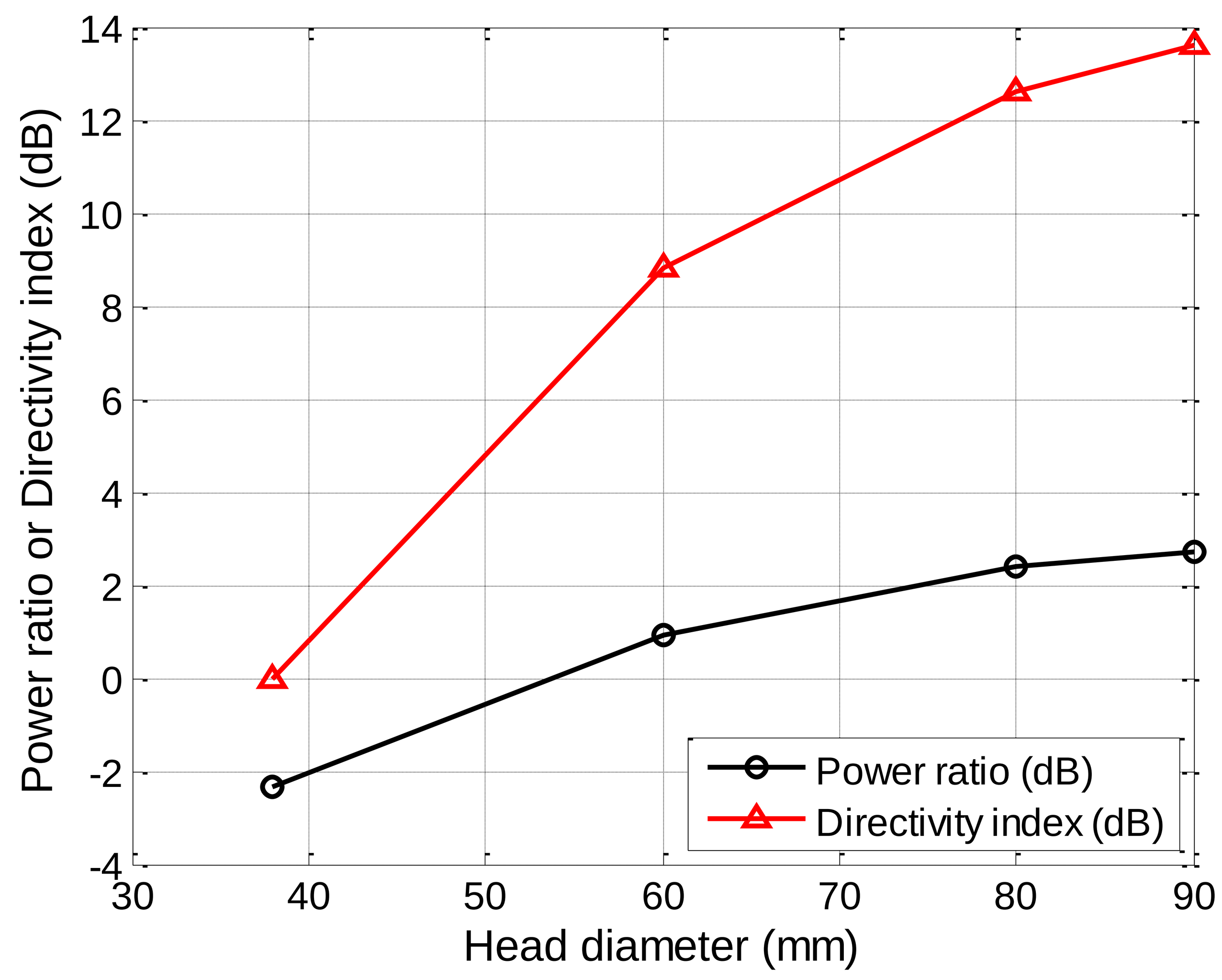

Figure 4. Power delivery ratio and directivity index as function of head diameter.

CONCLUSIONS:

These simulations predict that adjusting the ultrasonic radiator diameter could significantly increase power delivery in low-frequency and high-power ultrasonic applications, such as ultrasonic cleaning or processing in containers that feature thick-walls.