

Measuring the absolute nonlinearity parameters of fluids in pulse-echo mode considering receiver load impedance

Shengyang Zeng¹, Shuzeng Zhang¹, Xiongbing Li¹, Hyunjo Jeong²

¹Department of Traffic & Transportation Engineering, Central South University, China, ²Department of Mechanical Engineering, Wonkwang University, Republic of Korea

The nonlinearity parameter (β) is sensitive to microstructures of materials, and accurate measurement of absolute nonlinearity parameter is helpful for quantitatively evaluating material properties, and currently pitch-catch method and pulse-echo method based on self-reciprocity calibration method are usually used for determining material nonlinearity parameters. When the pulse-echo method is applied in a nonlinear measurement, it shows that the impedances of the electronic system which the receive transducer connects will alter the energy conversion efficiency, i.e. the transducer calibration function and make it inaccuracy to measure the nonlinear waves. Recent research shows that nonlinearity parameter can be measured when the 50 Ohm load impedance is connected between the amplifier and the current probe using pulse-echo mode, however, it's usually hard to make the receiver section have 50 Ohm impedance. For this reason, this paper proposes experimental techniques to precisely measure the fluid nonlinearity parameter (β) in the pulse-echo mode. The theory of self-reciprocity calibration method is reviewed to examine the effect of load impedance and the experiment setup is described and the effects of different electronic components assembly sequence are analyzed to get the proper configuration. A plane transducer is employed in pulse-echo mode to measuring measure the water β in a rigid boundary condition. The accurate calibration functions of the transducer in different configuration are acquired to obtain the precise absolute pressure. The β is calculated by correcting the effects of beam diffraction and material attenuation. The results agree well with the literature reference values which reveal the validity of the proposed method.