A Highly Accurate Numerical Method to Determine Equilibrium Properties in Fluids from Speed of Sound Data

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We show a new method to derived thermodynamics properties of fluids from speed-of-sound data by performing a numerical integration of the equations that links speed of sound with the compression factor and heat capacity at constant volume. These equations form a coupled system of non-linear partial differential equations which we have transformed into a quasi-linear second order partial differential equation in the compression factor which is solved under specified boundary conditions. The numerical method is discussed in detail and our solution is compared with an analytical equation of state. This analysis proved that very accurate values for the thermodynamics properties are obtained from our algorithm and we also explored the effects that small uncertanties in the speed of sound and boundary conditions might have into the solution. As a working example, the gaseous region of argon is shown in a temperature range from the critical temperature up to four times this temperature and in a density region that starts at zero and reaches about three quarters of the critical density. Values of compression factors and heat capacities are obtained from the same solution.