

Problem 210C

A pressure transducer is to be used to measure the unsteady or fluctuating pressures in a vessel containing an incompressible liquid of density 1000 kg/m^3 . The transducer contains a fluid-filled cavity, one side of which is comprised of a diaphragm which deflects when the pressure in the cavity changes. (This deflection is used as the measure of the pressure.) The area of the diaphragm is 1.0 cm^2 and its stiffness is such that a change in the cavity pressure of 1 atmosphere causes a deflection of 0.1 mm (assumed uniform over the diaphragm area).

The transducer cavity is connected to the liquid in the vessel by a 1 mm diameter, 2 cm long hole (pressure tap) in the side of the vessel and a piece of rigid metal tubing which is 30 cm long and 5 mm internal diameter.

Neglecting the effects of fluid friction and assuming all of the structure with the exception of the diaphragm is rigid determine the natural frequency of oscillation of this measuring system (in Hz).

In practice one must be very careful to purge the cavity and tubing of all air bubbles. If the average pressure in the cavity is about 1 atmosphere determine the natural frequency of the system if a 3 mm diameter air bubble is trapped in the transducer cavity.