Key Concepts

Chapter 5

Gauge pressure

Density

Atmospheric pressure

$P_{total} = P_{atm} + \rho_{fluid}gh$

Takeaways

The gauge pressure of a solution is the pressure due only to the weight of the solution pushing down from above. It does not include the effect of the atmosphere pushing down.

Gauge Pressure

A certain saltwater solution has a density 10% greater than that of water. At what depth in this solution does the gauge pressure equal 2.5 times atmospheric pressure? (ρ_{water} = 1 g/cm^3; P_{atm} = 101 kPa.)

1) Find the density of the saltwater solution.

$\rho_{saltwater} = \rho_{water} \times 1.1 = 1.1$ g/cm^3

The density of the solution is 10% greater than that of water. This is a factor of 1.1.

Convert this density to kg/m^3 so that it is in SI units.

$1.1 \text{ g/cm}^3 \times (1 \text{ kg}/1{,}000 \text{ g}) \times (100 \text{ cm/m})^3 = 1{,}100 \text{ kg/m}^3$

2) Write the expression for pressure.

$P_{total} = P_{atm} + \rho_{fluid}gh$

$P_{gauge} = P_{total} - P_{atm} = \rho_{fluid}gh$

The gauge pressure of a solution is the total pressure minus atmospheric pressure. This is simply $\rho_{fluid}gh$, where h is the depth in the solution.

3) Solve for the depth.

Set the gauge pressure equal to 2.5 times atmospheric pressure. Solve for h.

$2.5\,(101{,}000) = 1{,}100\,(9.8)(h)$

$z = 2.5\,\dfrac{(101{,}000)}{[1{,}100(9.8)]} = 23.4$ meters

Similar Questions

1) The gauge pressure of a solution at a depth of 1 m equals twice the atmospheric pressure. What is the density of this solution?
2) What is the pressure at a depth of 50 m below the surface of a pool of freshwater?
3) By what factor does the gauge pressure increase in going from a depth of 30 m to a depth of 40 m in pure water?