# Bulk modulus = K = B

@wikipedia

A measure of relative change in density $\rho$ or molar volume $V_m$ under a unit pressure $p$ variation:

(1) $$K = \rho \cdot \left( \frac{\partial p}{\partial \rho} \right) = -V_m \cdot \left( \frac{\partial p}{\partial V_m} \right)$$

| Symbol | Dimension | SI units | Oil metric units | Oil field units |
|---|---|---|---|---|
| $K$ or $B$ | $M^1 L^{-1} T^{-2}$ | Pa | GPa | psi |

Bulk modulus measures resistance of Continuum body to deformation and is inverse to compressibility $c$:

(2) $$K = \frac{1}{c}$$

Bulk modulus depends on the thermodynamic conditions at which it is measured and as such is not a material property.

The two major deformation processes of the medium are isothermal and isentropic which result in different values of Bulk modulus:

| Isothermal bulk modulus | Isentropic bulk modulus |
|---|---|
| $T = \text{const}$ | $S = \text{const}$ |
| (3) $K_T = \rho \cdot \left( \frac{\partial p}{\partial \rho} \right)_T$ | (4) $K_S = \rho \cdot \left( \frac{\partial p}{\partial \rho} \right)_S$ |

Both $K_T$ and $K_S$ are not dependent on the amount of chemical substance and defined under specific conditions of thermodynamic process and as such are the material properties and properly tabulated for the vast majority of materials.

In engineering practise, when the term Bulk modulus is used as material property it normally means Isothermal Compressibility: $K = K_T$ .

For isotropic materials it is related to Young modulus (E) and Poisson's ratio () as:

(5) $$K_T = \frac{E}{3\,(1 - 2\,\nu)}$$

## See also

Physics / Mechanics / Continuum mechanics / Continuum Body / Deformation

[ Solid Mechanics ] [ Fluid Mechanics]

[Compressibility] [ Young modulus (E) ][ Poisson's ratio () ]

[ Isothermal Compressibility ][ Isentropic Compressibility ]

[Fluid compressibility] [Pore compressibility] [Total compressibility]