

# A Linear First-Order Differential Equation for Vapor Pressure as a Function of Temperature

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The Clapeyron equation relates the slope of a vapor pressure curve on a pressure-temperature diagram to the enthalpy of vaporization, saturation temperature, and the volume change of vaporization. In this study, the slope is divided by saturation pressure and multiplied by saturation temperature; and the resultant term and logarithm of reduced pressure multiplied by a coefficient are added together and placed on the left-hand side of a first-order differential equation. The coefficient, a function of temperature, is determined such that the solution of the homogeneous differential equation made so far is a term which appears in an existing vapor pressure equation. Next, the behavior of an inhomogeneous function on the right-hand side of the differential equation is observed using reliable vapor-liquid equilibrium data from NIST Chemistry Webbook for water, carbon dioxide and methane, respectively. The observation suggests that the inhomogeneous function is essentially linear to reciprocal reduced temperature and/or to the logarithm of reduced pressure, which finally makes a complete description of a linear first-order differential equation. The method of variation of parameters enables us to solve the differential equation giving a new vapor pressure equation in a closed form with 3 to 5 adjustable parameters. Vapor pressure data for 75 substances are fitted to the new equation. Performance of the equation is compared with those of existing equations such as Riedel, Wagner, Xiang-Tan, and others.