

Chapter 5

ENTHALPY OF VAPORIZATION

Carl L. Yaws, Xiaoyan Lin, Li Bu, Sachin Nijhawan, Deepa R. Balundgi, and Saumya Tripathi
Lamar University, Beaumont, Texas

ABSTRACT

Results for enthalpy of vaporization are presented for major organic and inorganic compounds. The complete temperature range for the liquid is covered from freezing to the critical point for most of the compounds. The results are displayed in easy-to-use tabulations that are especially applicable for rapid engineering usage with the personal computer or hand calculator.

INTRODUCTION

Physical and thermodynamic property data such as enthalpy of vaporization are of special value to engineers in the chemical processing and petroleum refining industries. As an example, knowledge of the enthalpy of vaporization is required in the design of heat exchangers for vaporizing liquids. Other examples of usage include reboilers and overhead condensers in distillation. In this article, results for enthalpy of vaporization as a function of temperature are presented for a wide variety of compounds.

ENTHALPY OF VAPORIZATION CORRELATION

A modified Watson equation was selected for enthalpy of vaporization as a function of temperature:

$$\Delta H_{\text{vap}} = A (1 - T/T_C)^n \quad (5-1)$$

1)

where

ΔH_{vap} = enthalpy of vaporization, kJoule/mol

A, T_C , and n = regression coefficients for chemical compound

T = temperature, K

The results for enthalpy of vaporization are given in Tables 5-1 and 5-2. In preparing the tabulations, a literature search was conducted to identify data source publications for organics (1-41) and inorganics (1-93). Both experimental values for the property under consideration and parameter values for estimation of the property are included in the source publications. The publications were screened for appropriate data. The compilation resulting from the screening is based on both experimental data and estimated values. In the absence of experimental data, estimates were primarily based on the Riedel equation (29). Experimental data and estimates were then regressed to provide the same equation for all compounds.

The tabulation discloses the temperature range for which the equation may be used. The respective minimum and maximum temperatures are denoted by TMIN and TMAX. The temperature T_B is the normal boiling point (temperature at which the vapor pressure is 1 atm). Results for enthalpy of vaporization at the normal boiling point are provided in the last column.

A comparison of calculated and experimental data values for enthalpy of vaporization is shown in Fig. 5-1 for a representative chemical. The graph indicates good agreement of correlation and data.

EXAMPLES

The correlation results may be used for prediction and calculation of enthalpy of vaporization. Examples are given below.

Example 1 Estimate the enthalpy of vaporization of carbon tetrafluoride (CF₄) at 183.15 K.

Substitution of the regression coefficients from the table and temperature into the equation for enthalpy of vaporization yields

$$\Delta H_{\text{vap}} = 16.6594 (1 - 183.15/227.5)^{0.349}$$

$$\Delta H_{\text{vap}} = 9.415 \text{ kJoule/mol}$$

Example 2 Estimate the enthalpy of vaporization of ethane (C₂H₆) at 200 K.

Substitution of the regression coefficients from the table and temperature into the equation for enthalpy of vaporization yields

$$\Delta H_{\text{vap}} = 21.342 (1 - 200/305.42)^{0.403}$$

$$\Delta H_{\text{vap}} = 13.90 \text{ kJoule/mol}$$

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