The Equation for the Isochoric Heat Capacity of Water Vapor

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In the present work an equation for description of the temperature dependence of water vapor isochoric heat capacity above the critical temperature is offered:

$$C_v = a + b(T - T_{CR}) + \exp[c + d(T - T_{CR})] , \qquad (1)$$

where a, b, c and d are coefficients, T is absolute temperature, T_{CR} is critical temperature.

Tables are presented of the temperature dependence C_v for isochores $v = 21.94$ cm^3/g and $v = 10.78$ cm^3/g , compared with data C_v calculated by the equation (1) with experimental data and conclusions are made.

First, the isochoric heat capacity of water vapor exponentialy decreases down to a minimum value above the critical temperature, then linearly increases like $C_{v\,\infty}$. In the near-critical region the water-vapor is a totality of infinitely disintegrated and formed-again associative composites of water molecules. For each temperature the number of simultaneously disintegrated and formed-again composites is equalized, i.e. a dynamic equilibrium is established between them. The division of associates is continuing till creation of trimers, dimers, and monomers of water vapor during an increase of temperature.

The number of broken bonds rises and the number of unbroken bonds falls exponentially. Correspondingly, the energy absorbed by the vapor on heating by one degree and spent in breaking of intermolecular bonds decreases exponentially. So an exponential decrease of the heat capacity down to a minimum value occurs in this region. An exponential decrease C_v is described by the third member of the equation (1), and a contribution of the linear dependence is expressed by two first members.

Root-mean-square deviation of the heat capacity value calculated by equation (1) does not exceed 4.56% for $v = 21.94$ cm^3/g and 3.2% for $v = 10.78$ cm^3/g.