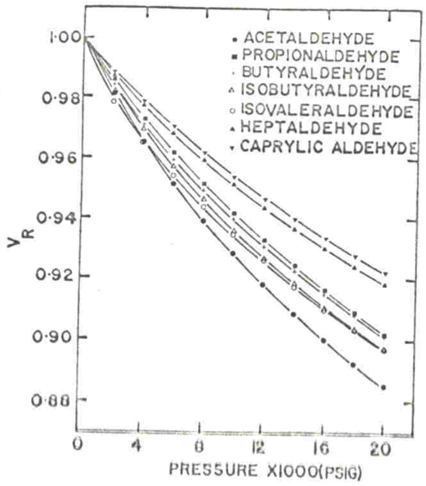

Figure 1.

If the atmospheric pressure P_0 is selected as datum, then

$$\mu/\mu_0 = \exp\,[s(P - P_0)]\ldots\ldots\ldots\ldots\ldots(9)$$

Comparing Equations (4) (7) and (9) and eliminating the viscosity terms, one arrives at

$$P - P_0 = \frac{h}{sRT}\,[(v_0/v)^4 - (v_0/v)^2]^q\ldots\ldots\ldots(10)$$

The group $\dfrac{h}{sRT}$ is an unknown function of temperature. Equation (10) may be written as

$$P - P_0 = K\left[\frac{1}{{v_R}^4} - \frac{1}{{v_R}^2}\right]^q \qquad (11)$$

where v_R is equal to (v/v_0).

Equation (11) is the proposed equation of state. This equation can also be expanded as the following power series

$$\frac{1}{q}\log\frac{P - P_0}{K} = -\,4\log v_R - {v_R}^2 - \frac{{v_R}^4}{2} - \frac{{v_R}^6}{3}\ldots(12)$$

For a very small v_R, that is, for extremely high pressure, Equation (12) reduces to

$$\left[\frac{P - P_0}{K}\right]^{-1/4q} = v_R\ldots\ldots\ldots\ldots\ldots(13)$$

Correlation of P-V-T Data

The equation of state proposed here is tested for its validity against aldehydes data that have been obtained by the authors. In addition, the literature data have been utilized to facilitate a comparison of the proposed equation with the Hudleston equation of state. The experimental data on aldehydes are presented in Figures 1 and 2. These data were obtained in a high pressure set-up capable of simultaneous compressibility and viscosity determinations. The liquid volume was measured by piston displacement while the viscosity was determined by noting the time of fall of a plummet. The pressure range investigated was from atmospheric to 20,000 psi (1.39 *kb*). The details of the experimental procedure are available elsewhere(22).

The experimental data on aldehydes were correlated by Equation (11). For the purpose of correlation, the equation was rewritten as

$$y = Kx^q\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

where $y = P$ (for $P \gg P_0$) and $x = \dfrac{1}{{v_R}^4} - \dfrac{1}{{v_R}^2}$. The coefficients of correlation were calculated between y and x. Regression analysis was performed on an IBM 1620 II computer.

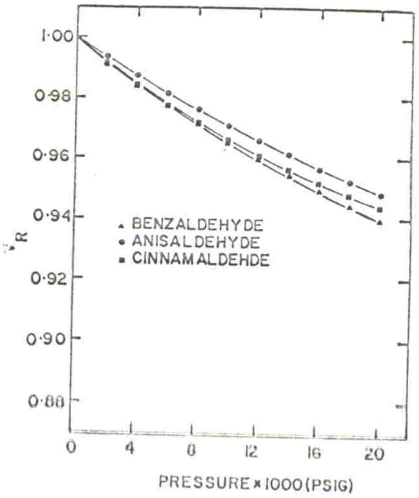

Figure 2.

The results of the analysis are presented in Table 1. The average coefficient of correlation is 0.9993.

To further test the validity of the proposed equation of state, existing data on several components were correlated. The results of the analysis are presented in Tables 2, 3 and 4. It is seen that excellent fit is obtained for all the substances in question.

TABLE 1
(PRESSURE RANGE 0 TO 20,000 PSI)

Compound	Temp. °F	*K*	*q*	Degree of Fit
Acetaldehyde	71.6	5.958×10^5	1.0587	0.9998
Propionaldehyde	74.3	7.308×10^5	1.0249	0.9999
Butyraldehyde	84.0	7.757×10^5	1.0790	0.9999
Iso-Butyraldehyde	82.8	6.820×10^5	1.0575	0.9950
Iso-Valeraldehyde	81.0	8.871×10^5	1.2234	0.9994
Heptaldehyde	71.1	9.639×10^5	1.0473	0.9998
Caprylic Aldehyde	69.3	10.383×10^5	1.0516	0.9999
Benzaldehyde	71.7	15.137×10^5	1.0669	0.9999
Anisaldehyde	76.7	17.087×10^5	1.0318	0.9999
Trans-Cinnamaldehyde	84.3	20.253×10^5	1.1719	0.9997

TABLE 2*
(PRESSURE RANGE 1–5000 ATMOSPHERES)

Compound	Temp. °C	*K*	*q*	Degree of Fit
N-Hexane	0	6.1453×10^3	1.1805	0.9996
	25	5.0727×10^3	1.1983	0.9996
	40	4.4964×10^3	1.2089	0.9997
	60	3.8053×10^3	1.2489	0.9997
N-Heptane	0	6.7270×10^3	1.1726	0.9996
	25	5.4883×10^3	1.0716	0.9735
	40	5.1068×10^3	1.1984	0.9997
	60	4.4422×10^3	1.2379	0.9998
N-Octane	0	7.3560×10^3	1.1245	0.9998
	25	6.7269×10^3	1.1750	0.9984
	40	6.0034×10^3	1.1823	0.9996
	60	5.3064×10^3	1.2252	0.9998

*Data obtained from Reference (14).