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The formula \( \varepsilon - n^2 = \frac{2\pi \eta^* M}{V_c k T_c (\varepsilon - 1)} \cdot \frac{B}{B + 1} \) is derived for sufficiently small \( T - T_c \) and large \( \varepsilon \) on the basis of the general Fröhlich relation.

Here \( \varepsilon \) is the dielectric constant, \( n \) is the refractive index, \( N \) is the number of cells in the volume \( V \) of molecules or molecule groups with equal mean polarisability in an external field, \( M \) is the moment of the cell in the substance which is determined by the configuration of more closely interacting molecules, \( \varepsilon^* \) is the moment of an arbitrary sphere polarised by a cell \( m \) in it. The subscripts \( c \) indicate the critical values, \( \tau = T/T_c \) is the reduced temperature, \( B \) is a constant depending on \( \epsilon \).

Thermodynamics of the critical...

the equation of state (\( B = 2/3 \) for van der Waals). It can be seen that \( \varepsilon \) passes a maximum for \( V = V_c \) and \( T = T_c \). Scaife (Proc. Phys. Soc., 69B, 153, 1956) has given a formula for the pressure \( p \) in a uniform electric field \( E \). This formula is used to derive an expression for the modulus of compression 1/\( \kappa \), which contains a factor of \((\tau - 1)^2\) squared and which therefore has to vanish when the critical values for two values of \( \tau_1 \) and \( \tau_2 \) have been reached.

\[
\tau_{1,2} - 1 = AE^2 \pm \sqrt{(AE)^2 + B^2}, \quad A = \frac{(n^2 - 1)(n^2 + 2)}{72\kappa p_c}, \quad B = \frac{N^2 M^*}{6p_c V_c k T_c}.
\]

For nonpolar substances a slight variation ensues in proportion to \( E^2 \). For highly polar substances (\( B > A \)) the displacement of the critical temperature goes linearly with the field strength. For molecules with a strong dipole an estimation gives \( BE \sim \frac{\mu E}{3/2 k T_c} \) and \( AE^2 \sim \frac{a E^2}{3/2 k T_c \cdot 10^4} \), where \( \mu \) is the dipole moment.
Thermodynamics of the critical... moment of the free molecule, \( \alpha \) is the polarisability. The increase of \( P_0 \) in an electric field is proportional to the ratio of the energy of the molecular dipole to the energy of the rotational degrees of freedom. The above estimates yield \( RT_0 / V_0 P_0 \approx 0.293 \). This value agrees to three decimal places with the empirical results for noble gases as obtained by Guggenheim (Thermodynamics North Holl. publ. Co., 1957). An estimate gives \( \alpha \approx 0.0001 \text{ deg} / \text{v} \) and

\[
B = \frac{10^{-2}}{2 \pi} \approx 10^{-4} \left[ \cos \theta \right]^{-1}.
\]

It is supposed that condensation in the presence of an electric field along and across the field takes place at different temperatures. \( v_1 \) is reached first which corresponds to a two-dimensional condensation in a plane perpendicular to the field. A meniscus does not appear when the electric field and the gravitational field have the same direction. When the fields are crossed condensation occurs immediately. This state is described exactly by the Onsager theory (Phys. Rev., 65, 117, 1944).

Card 3/4