In previous theoretical studies, expressions have been obtained between infrared gas absorptivities and emissivities for several descriptions of vibration-rotation bands. Although these expressions provide a good correlation of the (limited) available experimental data, it is of interest to supplement the earlier results by the relation corresponding to absorption by molecular vibration-rotation bands composed of randomly distributed dispersion lines with arbitrary intensity probability distribution function.

The absorptivity \( \alpha_{\text{abs}} \) of a gas at temperature \( T_p \) and of optical depth \( X \) for blackbody radiation at temperature \( T_s \) is given by the relation

\[
\alpha_{\text{abs}} \approx \frac{1}{\sigma T_s^4} \sum_i \left( \frac{C}{R_{\text{gas}}(T_p)} \right) \int_{\Delta \omega_i(T_s)} \{1 - \exp \left( - \left[ P_{\omega_i}(T_p) X \right] \right) \} d\omega_i \tag{1}
\]

where \( \sigma \) represents the Stefan-Boltzmann constant, \( C \) is the blackbody radiance at the wave number corresponding to the center of the \( i \)th band and \( P_{\omega_i} \) is the spectral absorption coefficient of the gas. For the statistical model corresponding to a wave number interval of effective width \( \Delta \omega_i \),

\[
\alpha_{\text{abs}} \approx \frac{1}{\sigma T_s^4} \sum_i \left( \frac{C}{R_{\text{gas}}(T_p)} \right) \int_{\Delta \omega_i(T_s)} \{1 - \exp \left[ - \frac{A_i(T_s)}{d_i^*(T_s)} \right] \} d\omega_i \tag{2}
\]

where

\[
A_i = \int_0^{\infty} P(S_i/S) A L d(S_i/S)
\]

is the weighted mean value of the line absorption \( A_L \) computed with respect to the normalized intensity probability distribution function \( P(S_i/S) \), and \( d_i^* \) is the mean line spacing for lines in the \( i \)th band. For dispersion lines of half-width \( b \), the line absorption is \( A_L \approx S X \) for \( SX/2b < 2/\pi \) and \( A_L \approx 2(SbX)^{1/2} \) for \( SX/2b > 2/\pi \). For the line region

\[
\alpha_{\text{abs}} = \frac{(SbX)^{1/2}}{T_s^4} (T_p/T_s)^X \tag{3}
\]

On the other hand, for the square root region,

\[
\tilde{A}_i = 2(bX)^{1/2} \left[ \int_0^{\infty} P(S_i/S) S^2 d(S_i/S) \right] = \text{constant} (SbX)^{1/2} \tag{4}
\]

Hence, assuming that \( \tilde{S}_i = \alpha_i/(\Delta \omega_i/d_i^*) \), where \( \alpha_i \) is the integrated absorption for the \( i \)th band, \( \Delta \omega_i(T) \) proportional to \( T^4 \), \( \alpha_i \) proportional to \( T^{-1} \), \( b_i \) proportional to \( T^{-1} \), and

\[
d_i^*(T_s)/d_i^*(T) = \left( \frac{T_p}{T_s} \right)^{1/4},
\]

we obtain

\[
\tilde{A}_i \approx \text{constant} \left[ \frac{\tilde{S}_i(T_s)}{b_i(T_s)} X (T_p/T_s)^{(1-\eta)/4} \right]
\]

whence Eq. (2) becomes

\[
\alpha_{\text{abs}} \approx (T_p/T_s)^\eta X (T_p/T_s)^{(1-\eta)/4}. \tag{5}
\]

For water vapor \( \eta \) is about unity \( -4 \) and Eq. (5) reduces to

\[
\alpha_{\text{abs}} \approx (T_p/T_s)^{(1-\eta)/4} X (T_p/T_s)^{(1-\eta)/4} \tag{6}
\]

which is very nearly the same as Hottel's empirical formula for water vapor, viz.,

\[
\alpha_{\text{abs}} \approx (T_p/T_s)^{(1-\eta)/4} X (T_p/T_s)^{(1-\eta)/4} \tag{7}
\]

For well overlapped and "just overlapping" lines it has been shown previously \( -4 \) that

\[
\alpha_{\text{abs}} \approx (T_p/T_s)^{1/2} X (T_p/T_s)^{1/2} \tag{8}
\]

wheras, for nonoverlapping dispersion lines with \( \eta = 1 \),

\[
\alpha_{\text{abs}} = (T_p/T_s)^X X (T_p/T_s)^X \tag{8}
\]

A representative comparison of observed and calculated results is shown in Fig. 1 for water vapor. Reference to Fig. 1, and to data for larger values of \( X \) which are not plotted, shows that Eq. (6) gives a fair representation for \( X \) greater than about 0.1 or 0.2 ft-atmos; Eq. (7) holds for very small values of \( X \) and also for \( X \) greater than about 0.5 ft-atmos; Eq. (8) applies for \( X \) less than than about 0.2 ft-atmos. These results are consistent with the approximations involved in the derivation of Eqs. (6) to (8). Equation (6) should apply when the absorption is dominated by dispersion lines in the square root region irrespective of the extent of overlapping between lines.

**Errata**: Note on Stress Rupture in Glass

[J. Appl. Phys. 29, 1382 (1958)]

EUGENE F. PONCELET
Stanford Research Institute, Menlo Park, California

The following reference should be added to the note:

E. F. Poncelet, Glass Ind. 38, 551 to 558, 617 to 623 (1957).

**Books Reviewed**


This volume is another in the McGraw-Hill series of texts on electrical engineering. It is essentially an extension of the book entitled "Electronics" by Millman and Seely to include more material on semiconductors. The increasing applications...