Emissivity for \( CO_2 \) at Elevated Pressures*

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**TOTAL** absorptivity measurements have been carried out at room temperature as a function of partial pressure of \( CO_2 \) and of total pressure using nitrogen as pressurizing gas. The results of these investigations are summarized in Fig. 1. Appropriate values at a total pressure of one atm are compared with emissivity data published by Hottel and Mangelsdorf (1935) in Figs. 2 and 3.

The principal conclusions reached as the result of the present investigations are:

(a) At atmospheric pressure and room temperature, the results of total absorptivity measurements are in reasonably good agreement with the emissivity data of Hottel and Mangelsdorf, the difference increasing somewhat as the optical density is raised.

(b) At pressures in excess of one atm, the absorptivity (and hence the emissivity) is quite insensitive to changes in total pressure. Thus, between 1.0 and 21 atm total pressure, the measured values of total absorptivity at fixed optical density are equal within the rather wide limits of error (±15 percent) of the present preliminary investigations. This result can be understood in terms of the ratio of rotational line width to rotational line spacing, which is relatively large for triatomic molecules such as \( CO_2 \). There are no apparent reasons why the observed insensitivity of emissivity to total pressure cannot be extrapolated to elevated temperatures. Thus, although the collision half-width of the rotational lines decreases roughly inversely as the square root of the absolute temperature, it also increases linearly with total pressure. Hence the ratio of half-width to line spacing at

\[ \text{Fig. 1. Absorptivity} \ a \ \text{as a function of} \ Ps \ \text{for various fractional pressures of} \ \text{CO}_2 \ \text{at room temperature. The CO}_2 \ \text{was pressurized with nitrogen.} \]

\[ \text{Fig. 2. Comparison of absorptivities for} \ \text{CO}_2 \ \text{at room temperature and atmospheric pressure with emissivities of} \ \text{Hottel and Mangelsdorf} \ (0 \leq \phi, \ \text{ft-atmos} \leq 1.0). \]

\[ \text{Fig. 3. Comparison of absorptivities for} \ \text{CO}_2 \ \text{at room temperature and atmospheric pressure with emissivities of} \ \text{Hottel and Mangelsdorf} \ (0 \leq \phi, \ \text{ft-atmos} \leq 10). \]

3000°K and 20 atm should be comparable to conditions at 300°K and 11 atm. Therefore, it appears unlikely that a large error is made if radiant heat transfer calculations involving \( CO_2 \) at elevated pressures are based on emissivity data for \( CO_2 \) determined at atmospheric pressure. The preceding statement should not be extrapolated indiscriminately to other molecules.†

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