$$I_{rad} = 2I_o \frac{R_1}{r} \quad (18)$$

$$I_d = \pi I_o \quad (19)$$

Average light intensities over the whole reactor diameter ($\mu = 0$):

$$\overline{I}_{pd} = \frac{2I_o}{\pi R_1^2 \sin\theta_1} \left[\int_{R_2}^{R_1} \theta 2\pi\, rdr + \frac{\pi^2 R_2^2}{2} \right] \quad (20)$$

$$\overline{I}_{rad} = 4\, I_o \quad (21)$$

$$\overline{I}_d = \pi\, I_o \quad (22)$$

In conclusion, the following correction is to be applied in order to substitute I_o for I_w in the expressions of I or I_a:

$$\frac{I_o}{I_{w,\lambda}} = \frac{R_1}{R_2} \text{Arc} \sin \frac{R_2}{R_1} \quad (23)$$

This factor varies from 1 for the radial case to 1.57 for the diffuse case.

What are the consequences of this correction upon MS's conclusions concerning intensity calculations by actinometry and rate constants?

The correction factors

$$f = \frac{[\Omega_\lambda]_{pd}^{corr}}{[\Omega_\lambda]_{pd}}$$

remain unchanged because the θ_1 factor cancels out in the ratio.

Let $I^o{}_{b,tot}$ be defined similarly to I_o as the total photon flux density across the reactor's wall, whereas $I_{b,tot}$ is related to I_w, as in MS's paper.

Then, the function $g(r)$ in Equation (24 MS) has to be corrected according to (23):

$$\overline{r} = \frac{I^o{}_{b,tot}}{\pi R_1^2} C_a \sum_\lambda (\phi_a)_\lambda \alpha_\lambda \frac{F_\lambda}{F_{tot}} T_\lambda \int_o^{R_1} g(r)\ 2\pi r dr \quad (24\text{ MS})$$

The calculated ratio $I_{b,tot}/\overline{r}$ is thus modified. $\overline{r}$, being an experimental quantity, $I_{b,tot}/\overline{r}$ has to be corrected by a factor which is the reciprocal of (23), namely R_2/R_1 Arcsin (R_2/R_1). By applying this correction to the data of Figure 4 MS, it is found that $I_{b,tot}/\overline{r}$ exhibits only a slight variation as a function of R_2 and remains almost constant in the range 1.78 to 1.91 einstein × cm/g mole.

At last, the conclusions of MS relative to the effect of light distribution on reaction rate constants (Table 1 MS) remain true thanks to a fortunate compensation effect: the denominator of Equation (25 MS) is the product of two factors to which reciprocal corrections have to be applied.

In conclusion, it must be emphasized that the maximum divergence between the two formulations occurs for the diffuse light model (namely a factor 1.57), which is likely to be frequently encountered in practice.

Such confusions in the treatment of photoreactor models should be avoided by a careful utilization of photometry concepts and/or by using the analogy between fluxes of photons and fluxes of molecules for which the kinetic theory of gases yields elaborated results.

NOTATIONS

Those of Matsuura and Smith except for J, I_o, ϕ and ψ which have been defined in the text.

LITERATURE CITED

Markl, H., and D. Vortmeyer, "Berechnung der Verteilung von Bestrahlungsstarke und Absorption in einem diffus von aussen beleuchteten zylindrischen Photoreaktor," *Chem. Ing. Techn.*, **47**, 31 (1975).

Matsuura, T., J. M. Smith, "Light Distribution in Cylindrical Photoreactors," *AIChE J.*, **16**, 321 (1970).

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Reply to the Note of Roger and Villermaux

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We cannot agree with the statement of Roger and Villermaux that the derivation of our partially diffuse-light model (Matsuura and Smith, 1970) is ambiguous. Their entire discussion is based on their definition of $I_{w,\lambda}$ which is different from ours.

Let us denote for convenience $I_{w,\lambda}$ defined by Roger and Villermaux as $I_{w,\lambda}{}^{RV}$, and that defined by us as $I_{w,\lambda}{}^{MS}$.

The definition of $I_{w,\lambda}{}^{MS}$ is very clear in our paper. *The intensity at point A is $2I_{w,\lambda}{}^{MS}$ if there is no light absorption in the reactor*, as stated in the ninth line, second column of page 321.

This is also shown by Equation (MS10). At point A, $r = R_1$ and $\theta = \theta_1$, therefore

$$[I_\lambda(R_1)]_{pd} = 2I_{w,\lambda}{}^{MS}$$

According to the corresponding equation of R and V, (17), this becomes

$$[I_\lambda(R_1)]_{pd} = \frac{2I_{w,\lambda}{}^{RV}\,\theta_1}{\sin\theta_1}$$

Since the intensity at point A is the same for both

$$I_{w,\lambda}{}^{RV} = I_{w,\lambda}{}^{MS}\frac{\sin\theta_1}{\theta_1} = I_{w,\lambda}{}^{MS} \Big/ \left[\frac{R_1}{R_2}\text{Arcsin}\frac{R_2}{R_1}\right]$$

This difference in the definition of $I_{w,\lambda}$ applies throughout the whole paper. The so-called correction of I_{MS} by equation (RV23) is simply a reflection of the ratio of $I_{w,\lambda}{}^{MS}$ to $I_{w,\lambda}{}^{RV}$. It is meaningless because intensity I does not change through a change in definition of $I_{w,\lambda}$.

Since the meaning of $I_{b,tot}$ is the same as that of $I_{w,\lambda}$, except that $I_{b,tot}$ is the summation for all wavelengths and without filter solution, it is quite natural that $I_{b,tot}{}^{MS}/\overline{r}$ has to be divided by $\left(\frac{R_1}{R_2}\text{arcsin}\frac{R_2}{R_1}\right)$ in order to obtain $I_{b,tot}{}^{RV}/\overline{r}$.

The intensity distribution in the reactor remains unchanged by the difference in the definition of $I_{w,\lambda}$. Therefore, our correction factor f and reaction rate constant k have intrinsically correct values.