CHAPTER V

RESULT

From the mathematical derivation of diffusion drying, the equation is

$$\frac{m_o - \bar{\bar{m}}}{\sqrt{\theta}} = \frac{2}{\sqrt{\pi}} \cdot \frac{3}{r_s\,\psi} \cdot \sqrt{\mathcal{D}}\,(m_o - m_s) - \frac{f''(0)}{2\,!}\left(\frac{3}{r_s\,\psi}\right)^2 \mathcal{D}\,(m_o - m_o)\sqrt{\theta} \qquad (2.2.52)$$

or it is reduced to

$$k = k_o - b\sqrt{\theta} \qquad (2.2.53)$$

where

$$k = \frac{m_o - \bar{\bar{m}}}{\sqrt{\theta}} \qquad (2.2.54)$$

$$k_o = \frac{2}{\sqrt{\pi}} \cdot \frac{3}{r_s\,\psi} \cdot \sqrt{\mathcal{D}} \cdot (m_o - m_s) \qquad (2.2.55)$$

$$b = \frac{f''(0)}{2\,!} \cdot \left(\frac{3}{r_s\,\psi}\right)^2 \mathcal{D}\,(m_o - m_s) \qquad (2.2.56)$$

All the constants in the equations were determined from the experimental data and the result was obtained step by step as follows.

5.1 Let k_o and b in equation (2.2.53) be constant, from the plot of k against $\sqrt{\theta}$, k_o and b are intercept and slope, respectively. So, at constant temperature and constant initial moisture content, k_o and b were obtained from the plot.

t (°C)	m_o (gm/gm)	k_o X 10^4 (sec^{-1})	b X 10^6 (sec^{-1})
40	0.2191	8.52	2.06
	0.2469	12.12	2.80
	0.2605	14.34	3.26
45	0.2038	7.64	1.84
	0.2256	10.79	3.31
	0.2339	12.26	3.68
	0.2462	14.50	4.11
50	0.2016	8.36	3.14
	0.2070	11.05	3.66
	0.2208	12.73	4.27
	0.2412	16.39	6.25

5.2 From equation (2.2.55), it is shown that, when k_o approaches zero, m_o will be equal to m_s. Therefore, at constant temperature, the plot of k_o against m_o gives m_s at $k_o = 0$. Alternatively, m_s is obtained from equation (2.2.56) when b approaches zero.

t (°C)	m_s (gm/gm)	
	$k_o = 0$	$b = 0$
40	0.1535	0.1630
45	0.1525	0.1675
50	0.1495	0.1615
average	0.1518	0.1640

5.3 When m_s was evaluated from equation (2.2.55), the diffusion coeffiecient, $\mathcal{D}$, at each temperature was then calculated.

t (°C)	$\mathcal{D} \times 10^7$ (cm^2/sec)
40	7.726
45	10.360
50	15.800

5.4 From the plot of $\log \mathcal{D}$ against $\frac{1}{T}$, where T is an absolute temperature, a straight line was obtained. So, the relation between the diffusion coefficient and the reciprocal absolute temperature follows the Arrhenius-type equation:

$$\mathcal{D} = \mathcal{D}_o \exp\left(\frac{-E}{\mathcal{R}T}\right)$$

where $\mathcal{D}_o$ = 4080 cm^2/sec

E = 13.93 kcal/mole

5.5 $\frac{f''(0)}{2!}$ in equation (2.2.52) was determined by substituting the known values of $b, \mathcal{D}, r_s, \Psi, m_o$, and m_s at each temperature into equation (2.2.56).

t (^oC)	$\frac{f''(0)}{2}$
40	0.231
45	0.242
50	0.236
Average	0.236

5.6 By substitution of the average value of $\frac{f''(0)}{2}$ into equation (2.2.46), the drying equation becomes

$$\overline{\overline{M}} = 1 - \frac{2}{\sqrt{\pi}} X + 0.236\, X^2$$

where $\overline{\overline{M}} = \frac{\overline{\overline{m}} - m_s}{m_o - m_s}$

$X = \frac{S}{V} \cdot \sqrt{\mathcal{D}\,\theta}$