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MATHEMATICAL MODELLING OF ABSORPTION COLUMNS III.
THE PRACTICAL USE OF THE PARAMETER SENSITIVITY CONCEPT

P. ÁRVA and F. SZEIFERT

(Department of Chemical Process Engineering,
Veszprém University of Chemical Engineering)

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The numerical values of parameter sensitivity based on the data of the previously discussed experiments and the practical use of these values are discussed here.

The sensitivity of concentrations existing either in liquid or in the gas phases were calculated on the base of the Piston Flow (P.F.) model. In these calculations the values of the transfer coefficient of the unit volume and the flow rates of the phases were taken into account. A valuation method is presented which can be used for the calculation of errors in the determination of the parameters. Such errors are due to inaccuracy in the determination of the concentrations. The data of the parameter sensitivity are applied in the valuation of the effects of changes in the operation of absorption columns.

Valuating the Axial Dispersed Plug-Flow (A.D.P.F.) model, the numerical values of the sensitivity as the function of both the mixing and mass transfer coefficients of the phases are presented, and the approximate calculation errors of these data are given. A comparison was drawn between the P.F. and A.D.P.F. models using the sensitivity data calculated by the mixing coefficients determined in a given experiment.

In the first paper of this series [1] an experimental method was discussed which can be used for the determination of the component concentration of phases existing in a packed absorption column.

The mathematical description of counter-current absorption was presented, based on both the P.F. and A.D.P.F. models. The determined and calculated concentration distribution data were compared.

In the second paper, the parameter sensitivity of the models of two phase operation units was discussed and its method of determination was presented.

The parameter sensitivity was defined by the partial change ratio of the concentrations existing in the phases:

$$e_{j,i}(z,p_1, \dots p_n) = \frac{\partial x_j(z,p_1,p_2 \dots p_n)}{\partial p_i} \qquad (1)$$

where x_j is one of the dependent variables (e.g. the concentration of the absorbed component in the liquid phase), and p_i is the i-th parameter (e.g. the mass transfer coefficient). Eq. 1. shows that the sensitivity of the j-th variable from the i-th parameter ($e_{j,i}$) depends on the locus co-ordinate (z) and on the values of the other parameters. It is often more expedient to write the sensitivity in dimensionless form:

$$E_{j,i} = \frac{p_i}{x_j(z,p_1,p_2, \dots p_n)} e_{j,i} \qquad (2)$$

In this paper the practical use of the parameter sensitivity [illegible] is discussed, the data of the previously published experiments were utilized in the examples.

Based on the P.F. model, the transfer coefficient $(\beta\omega)_i$ was calculated at given liquid and gas feed rates. Knowing these, both for the liquid and gas phases the sensitivity of the soluble component concentration was determined at different parameters [$(\beta\omega)_i$, v_L, v_G].

Using the A.D.P.F. model, similar calculations were carried out, but here in addition to the transfer coefficient $(\beta\omega)_D$ the axial mixing coefficients of both phases (D_L and D_G) were also utilized as parameters.

The calculated values of the $x(z)$, $y(z)$ and $e_{j,i}(z)$ functions of three runs are presented in Figs.1 to 6. If the volumetric feed rate of the absorbent is 100 litres per hour and the flow rate of the gas is 2,000 litres per hour, the value of the mean transfer coefficient calculated by the A.D.P.F. model was $(\overline{\beta\omega})_i = 3.81\times10^{-3}$ one per second ($St_L = 2.3$, $St_G = 7.6$). The calculated concentration distributions $x(z)$ and $y(z)$ are presented in Figs. 1 and 2. If the alteration of St numbers is caused by the variation of the transfer coefficient, the sensitivities at different St_L and St_G dimensionless values as the functions of the column height are presented in Fig. 2, but in this case the St numbers change due to the flux of the given phase.

The construction of Figs. 3, 4, and 5, and 6, are the same, but they are valid for different working characteristics of the column. E.g. Figs. 3 and 4 represent the conditions if the feed rates of the phases are B_L = 100 litres per hour, B_G = 6,000 litres per hour; and Figs. 5 and 6 if B_L = 50 litres per hour and B_G = = 8,000 litres per hour.

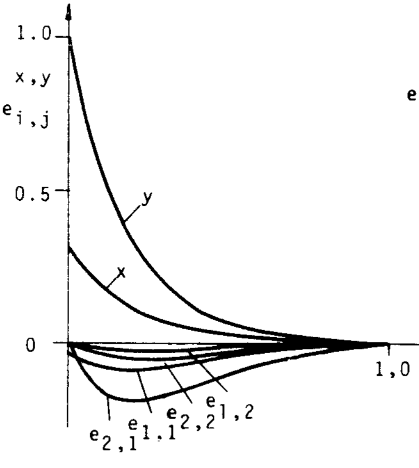

Fig.1. The alteration of liquid and gas phase concentration sensitivity with the transfer coefficient $(\overline{\beta\omega})_i$ $St_L = 2.30$; $St_G = 7.60$

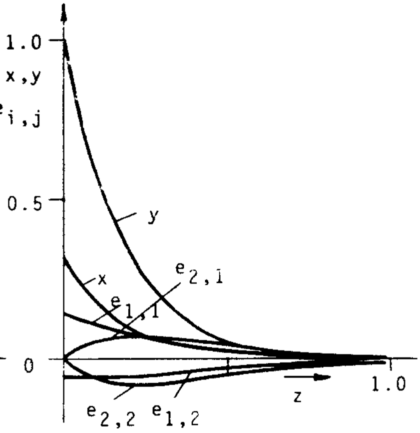

Fig.2. The alteration of liquid and gas phase concentration sensitivity with the flow rates of the phases; $St_L = 2.30$; $St_G = 7.60$

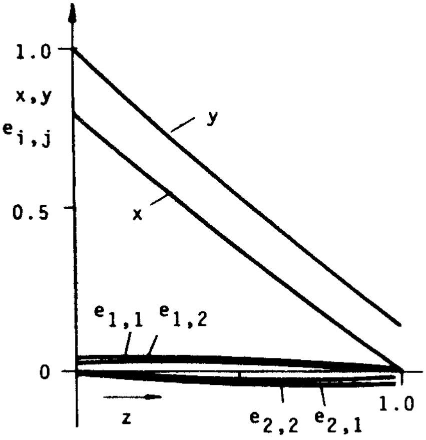

Fig.3. The alteration of liquid and gas phase concentration sensitivity with the mean transfer coefficient $(\overline{\beta\omega})_i$; $St_L = 4.08$ $St_G = 4.51$

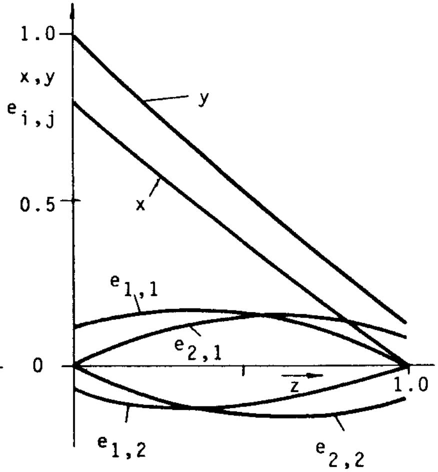

Fig.4. The alteration of liquid and gas phase concentration sensitivity with the flow rates of the phases; $St_L = 4.08$ $St_G = 4.51$

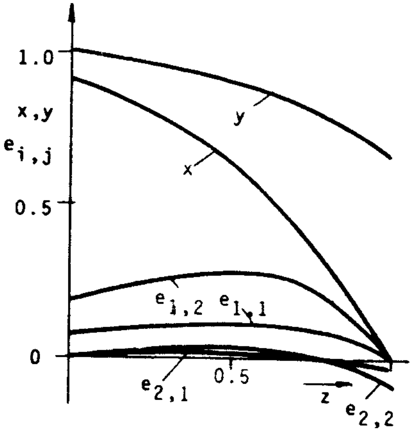

Fig.5. The alteration of liquid and gas phase concentration sensitivity with the mean transfer coefficient $(\overline{\beta\omega})_i$; $St_L = 2.70$; $St_G = 1.12$

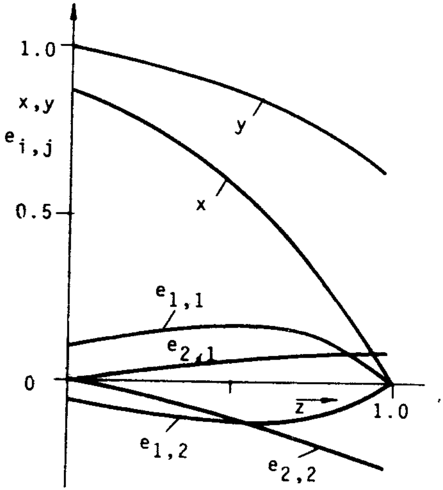

Fig.6. The alteration of liquid and gas phase concentration sensitivity with the flow rates of the phases; $St_L = 2.70$; $St_G = 1.12$

The data of the run characterized by the feed rates $B_L = 100$ litres per hour and $B_G = 6{,}000$ litres per hour were also evaluated based on the A.D.P.F.model.In Table 1 and 2 the following data are listed: the calculated dimensionless parameters, the concentration distribution and the data of dimensionless sensitivities calculated at some parameters.

1. The Piston Flow Model

Based on the examination of functions presented in Figs. 1 to 6, the following can be stated:

If the changes of the St number are due to the alteration of the $(\beta\omega)_i$ then for the sensitivities being valid at the top and bottom of the packed height, the following inequalities hold:

$$e_{1,St_L} = e_{1,1}(0) > 0$$

$$e_{2,St_L} = e_{2,1}(1) < 0$$

$$e_{1,St_G} = e_{1,2}(0) > 0$$

$$e_{2,St_G} = e_{2,2}(1) < 0$$

The sensitivity data calculated by the use of St_L or St_G can be transformed to each other:

$$e_{1,1}(0) = e_{1,2}(0)\,\frac{St_G}{St_L}$$

and

$$e_{2,1}(1) = e_{2,2}(1)\,\frac{St_G}{St_L}$$

It is also stated that if $St_L > St_G$ then the sensitivity curves reach maximum in the range of $0 < z < 1$, and if $St_L < St_G$ then they reach minimum; in the previous case e_{2,St_L} and e_{2,St_G} and in the latter case e_{1,St_L} and e_{1,St_G} reverse their signs.

For the extreme values the following inequalities hold:

Table 1. B_L = 100 (litres per hour); B_G = 6,000 (litres per hour); Pe_L = 33.3; Pe_G = 234.2; St_L = 5.92; St_G = 6.56; $(\beta\omega)_D = 9.19\times10^{-3}$ (one per second)

z	x	y	E_{1,D_L}	E_{2,D_L}	E_{1,D_G}	E_{2,D_G}	$E_{1,\beta\omega}$	$E_{2,\beta\omega}$
0.0	0.819	0.995	-0.013	-0.001	-0.004	-0.005	0.139	-0.001
0.1	0.752	0.894	0.013	0.005	-0.003	-0.004	0.131	-0.023
0.2	0.666	0.798	0.017	0.009	-0.003	-0.004	0.122	-0.048
0.3	0.580	0.705	0.024	0.014	-0.003	-0.003	0.115	-0.077
0.4	0.496	0.613	0.031	0.020	-0.003	-0.003	0.107	-0.112
0.5	0.413	0.522	0.042	0.028	-0.002	-0.003	0.099	-0.156
0.6	0.332	0.433	0.056	0.039	-0.002	-0.003	0.091	-0.214
0.7	0.252	0.346	0.079	0.054	-0.002	-0.002	0.084	-0.296
0.8	0.174	0.261	0.120	0.077	-0.001	-0.002	0.076	-0.424
0.9	0.097	0.171	0.222	0.120	-0.000	-0.002	0.069	-0.664
1.0	0.022	0.098	0.993	0.228	+0.004	+0.036	0.064	-1.254

Table 2. B_L = 50 (litres per hour); B_G = 6,000 (litres per hour); Pe_L = 29.1; Pe_G = 255; St_L = 6.67; St_G = 3.67; $(\beta\omega)_D = 5.82\times10^{-3}$ (one per second)

z	x	y	E_{1,D_L}	E_{2,D_L}	E_{1,D_G}	E_{2,D_G}	$E_{1,\beta\omega}$	$E_{2,\beta\omega}$
0.0	0.964	0.999	-0.013	-0.000	-0.001	-0.001	0.082	0.001
0.1	0.948	0.986	-0.012	-0.003	-0.001	-0.001	0.103	0.016
0.2	0.921	0.970	-0.016	-0.006	-0.002	-0.001	0.141	0.034
0.3	0.886	0.948	-0.021	-0.010	-0.002	-0.001	0.183	0.054
0.4	0.841	0.921	-0.025	-0.014	-0.003	-0.002	0.232	0.075
0.5	0.782	0.885	-0.027	-0.018	-0.004	-0.003	0.288	0.095
0.6	0.705	0.838	-0.028	-0.021	-0.005	-0.004	0.351	0.113
0.7	0.605	0.778	-0.021	-0.023	-0.006	-0.005	0.422	0.122
0.8	0.475	0.699	0.002	-0.021	-0.007	-0.006	0.500	0.112
0.9	0.305	0.596	0.086	-0.011	-0.009	-0.009	0.587	0.060
1.0	0.086	0.469	0.790	0.020	+0.013	+0.011	0.661	-0.104

$$|(e_{2,St})_{max}| < |(e_{1,St})_{max}|$$

or

$$|(e_{2,St})_{min}| > |(e_{1,St})_{min}|$$

Consequently, the sensitivity curves show that the sensitivity of the dependent variables of the examined system changes sharply along the packed height of the column due to the alteration of the parameter. There are also cases in which the concentrations existing inside the section show a marked change - due to the variation of the parameter and the concentrations existing at the top and bottom of the column - remain nearly the same. The quantitative examination of this fact will be discussed later.

The St numbers also alter with the flow rates of the phases. In this case $e_{1,1}(0) > 0$ and $e_{1,2}(0) < 0$, moreover $e_{2,1}(1) > 0$ and $e_{2,2}(1) < 0$. The sensitivities as the function of the z can also have extreme values in the range of $0 < z < 1$, i.e. it is often the case that the concentration existing inside the packed section changes more rapidly - due to the flow rate of the phases - than it changes at the end of the column.

1.1. The Error of the Transfer Coefficient Determination

Generally the experimental data are processed for the calculation of the transfer coefficients being valid in the given unit volume of the absorber $(\beta\omega)_i$. This method was applied in the previous paper [1]. The data published in literature were usually determined as follows: the concentrations of the phases leaving the column were measured, using these data, the driving force, the mean driving force and finally the values of $(\beta\omega)_i$ were calculated. The calculated $(\beta\omega)_i$ is the function of the concentration, i.e. if the concentration determination can be carried out with a definite error so the calculation of the $(\beta\omega)_i$ is also accompanied by another and definite error.

It is assumed that the exact inlet concentration of the phases $y(0)$ and $x(1)$ are known, but the concentration of the produced liquid was analyzed with an error of three per cent. If the sensitivity is known so the evaluation of the error is:

$$h_{1,\beta\omega} = \frac{100}{e_{1,\beta\omega}(0)} \frac{\Delta x(0)}{(\overline{\beta\omega})_i} = h_{1,St_L} = \frac{\Delta x(0)}{St_L e_{1,1}(0)} \cdot 100\ \% \qquad (3)$$

where $h_{1,\beta\omega}$ is the relative error (per cent) of the $(\beta\omega)_i$ determination, and Δx is the absolute error of the concentration determination of the liquid.

E.g. taking the data presented in Fig. 5, where $B_L = 50$ litres per hour and $B_G = 8{,}000$ litres per hour. The calculated $(\overline{\beta\omega})_i$ value was $2.24\ 10^{-3}$ (sec^{-1}).

Corresponding with the given flow rates and transfer coefficient, the $St_L = 2.7$ and $St_G = 1.12$. Using the P.F. model and the mentioned parameters and the boundary conditions of $y(0) = 1$ and $x(1) = 0$, the calculated value of $x(0)$ is 0.885. If the latter is determined with an error of three per cent, $\Delta x = \pm 0.0266$. The value of the sensitivity is $e_{1,1}(0) = 0.0808$, (c.f. Fig. 5). The error in the determination of $(\beta\omega)_i$ can be calculated by Eq. (3):

$$h_{1,\beta\omega} = \frac{1}{0.0808} \frac{\pm 0.0226}{2.70} \cdot 100 = \pm 12.5 \text{ per cent}$$

Using the parameters of the same run, the concentration of the exit gas phase is analyzed and worked up in the calculations so that the different error values can be obtained, again assuming three per cent error in the sampling and gas analysis.

Since $e_{2,1}(1) = -0.0335$, the error is

$$h_{2,\beta\omega} = \frac{\pm 0.0192}{-0.0335 \cdot 2.70} \cdot 100 = \pm 21 \text{ per cent}$$

In the examined case, the determination of the concentrations can be carried out with the same accuracy when either the liquid or the gas phases are analyzed. The error of the transfer coefficient is less if the calculations are based on the concentration data of the liquid phase. This fact is to be taken into account in the experiments.

The error values of all the three runs $h_{1,\beta\omega}$ and $h_{2,\beta\omega}$ are listed in Table 3. The data in Table 3 show that the errors of $(\beta\omega)_i$ values are often higher with an order of magnitude than the errors of the concentration determinations. The selection of the examined phase also plays an important role.

As previously mentioned, the values of the sensitivity depend on z and they can also reach extreme values. This deserves attention if the $(\beta\omega)_i$ values have to be determined. E.g. if the feed rated are $B_L = 50$ litres per hour and $B_G = 8{,}000$ litres per hour, the sensitivity $[e_{1,St}(z)]$ at $z = 0.5$ reaches maximum. The sensitivity is now $e_{1,St_L}(0.5)$ and this is analyzed with an error of three per cent, the calculation of $(\beta\omega)_i$ results in a value which has an error $h_{1,\beta\omega} = 5$ per cent compared to the previously mentioned 12.5 per cent error of the same value.

It was mentioned in the previous paper that the concentrations of the phases were simultaneously determined at different heights of the packed absorber. These data were equally used in the calculations.

If the mean value of parameter sensitivity is calculated as follows

$$\overline{e_{1,1}} = \frac{1}{n} \sum_{i=1}^{n} |e_{1,1}(i)|$$

where i is the number of samples and similarly as above, the mean concentration is

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x(i)$$

and the error of the $(\overline{\beta\omega})_i$ calculation can be evaluated. E.g. taking the data of Fig. 5 where $\bar{x} = 0.531$ and $\bar{y} = 0.866$ and $\bar{e}_{1,1} = 0.086$, as well as $\bar{e}_{2,1} = 0.0125$. If the calculation of $(\overline{\beta\omega})_i$ is

Table 3

B_L	B_G	$(\overline{\beta\omega})_i$	St_L	St_G	$e_{1,1}(0)$	$e_{2,1}(1)$	$h_{1,\beta\omega}$
(litres per hour)	(litres per hour)	(one per second)	(-)	(-)	(-)	(-)	(per cent)
100	6000	7.08×10^{-3}	4.08	4.51	0.037	-0.041	16
100	2000	3.81×10^{-3}	2.30	7.60	0.0035	-0.0116	120
50	8000	2.24×10^{-3}	2.70	1.12	0.0808	-0.0335	12.5

$h_{2,\beta\omega}$	$\overline{e_{1,1}}$	$\overline{e_{2,2}}$	$x(o)$	$y(1)$	$\bar{x}$	$\bar{y}$	$\overline{h_{1,\beta\omega}}$	$\overline{h_{2,\beta\omega}}$
2	0.015	0.023	0.797	0.117	0.388	0.547	19	17.5
5	0.0166	0.07	0.318	0.010	0.07	0.21	5.5	3.9
21	0.086	0.0125	0.885	0.64	0.531	0.866	10	73

based on the liquid concentration data and the analysis was carried out with an error of three per cent, the $(\overline{\beta\omega})_i$ value can be estimated with an error of ten per cent. The error is definitely higher, 73 per cent if the gas concentration data are the basis of the calculation.

The results of similar calculations of the other runs are listed in Table 3.

1.2. The Effect of Flow Rate Changes on the Solute Concentration of the Phases

It is assumed that in a given running condition of the absorption column the liquid feed rate is altered with Δv_L. Now the concentration change of the exit phases have to be estimated. The liquid feed rate change Δv_L causes a ΔSt_L change of the St_L number. The relative alteration of the liquid concentration can be calculated as follows:

$$\frac{\Delta x(o)}{x(o)} = e_{1,1}(o)\,\frac{\Delta St_L}{x(o)} = e_{1,1}(o)\,\frac{St_L}{x(o)}\,\frac{\Delta St_L}{St_L}$$

Using Fig. 6 the deviation of $\Delta x(o)$ can be determined. It is assumed that St_L changes with ten per cent:

$$\frac{\Delta x(o)}{x(o)} = 0.11\,\frac{2.7}{0.885}\cdot 0.1 = 0.0336$$

i.e. the liquid concentration changes with 3.36 per cent. If the flow rate of the liquid phase increases with ten per cent its concentration at the exit point of the column decreases with 3.4 per cent.

The data of an other run were processed, here the flow rates of the phases were B_L = 100 litres per hour and B_G = 6,000 litres per hour, and the error was 6.15 per cent.

The concentration of the gas phase depends on the liquid feed rate. Similar calculations can de used for the determination of the gas phase concentration change effected by the liquid load.

2. The Axial Dispersed Plug-Flow Model

The sensitivity data of liquid and gas phase concentrations are listed in Tables 1 and 2. These data depend on the parameters used in the A.D.P.F. model concept, and refer to the parameter values of the given run.

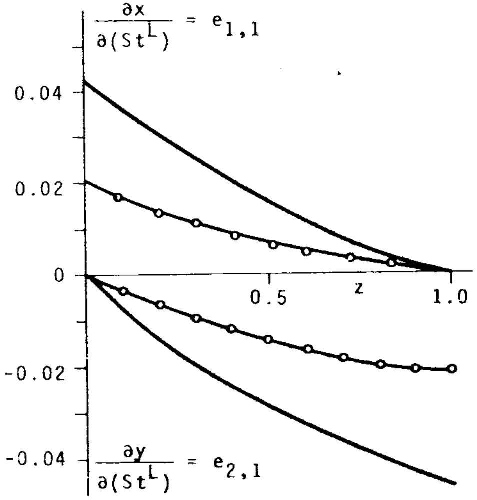

Fig. 7. The comparison between sensitivities calculated by the Piston Flow model and A.D.P.F. model.
B_L = 100 litres per hour;
B_G = 6,000 litres per hour;
— P.F. model (St_L = 4.08)
-o- A.D.P.F. model (St_L = 5.96)

In Fig. 7 the sensitivity data $e_{1,1}$ and $e_{2,1}$ are presented, both the P.F., and A.D.P.F. models were used in the calculations of these data. (The characteristic phase flow rates of the run were B_L = = 100 litres per hour and B_G = 6,000 litres per hour).

It can be seen from the data that the A.D.P.F. model is less sensible if the St number changes, i.e. the transfer coefficient calculated by the A.D.P.F. model is less accurate.

The sensitivity data listed in the above mentioned Tables are dimensionless. In this case the sensitivity data are related to the real parameters which are not dimensionless. E.g. the dimensionless sensitivity of the liquid concentration at locus z = 1 is as follows (c.f. Table 2):

$$E_{1,(\beta\omega)_D}(1) = \left.\frac{dx}{d(\beta\omega)_D}\right|_{z=1} \frac{(\beta\omega)_D}{x(1)} = 0.661$$

The $(\beta\omega)_D$ value in the given case is 5.82×10^{-3} ($\sec^{-1}$) and $x(1) = 0.086$, the sensitivity is:

$$e_{1,(\beta\omega)_D} = \left.\frac{dx}{d(\beta\omega)_D}\right|_{z=1} = 0.661 \cdot \frac{0.086}{5.82\times10^{-3}} = 9.75 \text{ sec}$$

Similarly to the method discussed concerning the P.F. model, the data of the above mentioned Table can be used for the evaluation of the calculation accuracy.

2.1. The Estimation of the Error Caused in the Determination of Transfer Coefficient

It is assumed that the absorption column is working, and the characteristic parameters are those listed in Table 2. The flow rates and concentrations of the inlet phases are known. The concentration of the outlet liquid is analyzed. This analysis can be carried out with an error of three per cent, i.e. $\Delta x/x(o) = 0.03$. Knowing the sensitivity, the error caused in the calculation of $(\beta\omega)_D$ is:

$$E_{1,(\beta\omega)_D}(0) = 0.082$$

and

$$\frac{\Delta(\beta\omega)_D}{(\beta\omega)_D} = \frac{0.03}{0.082} = 0.366$$

The three per cent error in the determination of the liquid concentration gives an error of 36.6 per cent in the calculation of $(\beta\omega)_D$.

The data listed in the mentioned Table show that $|E_{2,(\beta\omega)_D}| > |E_{1,(\beta\omega)_D}|$ and therefore it is advantageous to base the $(\beta\omega)_D$ calculations on the gas phase concentration data, in the latter case the error is less (29 per cent).

The knowledge of the sensitivity is useful in the different fields of the practical work, e.g. the efficiency of the absorption column can be calculated. It is assumed that the packing of the column is exchanged and another is used which has greater specific surface area, so the $(\beta\omega)_D$ is increased by ten per cent. If the other parameters remain constant, so:

$$\left.\frac{\Delta x}{x}\right|_{z=0} = E_{1,\beta\omega}(0) \cdot 0.1 = 0.082 \cdot 0.1 = 0.08$$

and

$$\left.\frac{\Delta y}{y}\right|_{z=1} = E_{2,\beta\omega}(1) \cdot 0.1 = -0.104 \cdot 0.1 = -0.01$$

consequently, the ten per cent increase in the packing surface area gives only one per cent growth in the column efficiency.

2.2. The Practical Application of the Sensitivity Concept Based on the Mixing Coefficients

The sensitivity data based on the mixing coefficients are also listed in Tables 1 and 2.

It can be seen that the sensitivity data valid at the given parameters change their values with one or two orders of magnitude along the length of the packed column. This refers to the fact that the concentration changes differently along the column due to the mixing. The greatest values of the sensitivity data in the mentioned Tables are those which are valid at locus z=1. In the circumstances given in Table 2, the mixing coefficient of the liquid has a marked influence on the concentration of the exit gas and the effect of the gas mixing coefficient is low. Regarding the data listed in Table 1 the same conclusion can be drawn for the concentration of the exit gas.

Similarly to the above discussed method, the mixing coefficients can be applied for different valuations of the column. These are not discussed here in detail. It is merely mentioned that if the values of the mixing coefficients have to be calculated with the data listed in Table 3 and with the data of the concentration determinations, and the analysis can be carried out with an error of one per cent (at locus $z = 0$), the results will be ± 0.8 times the liquid mixing coefficient value and ± 2.5 times the gas mixing coefficient value. It is evident that the determination of these data has to be carried out with other methods, e.g. the examination of the residence time distribution can be used.

The data in Tables 1 and 2 show equally that the Pe numbers are high, i.e. the coefficient of the second order differential quotient containing term of the A.D.P.F. model is higher compared to the coefficients of the other terms. If the term of the axial mixing is neglected, the error of the concentration values has to be valuated. (The other parameters are unchanged.) This valuation can be carried out with the data presented in Table 1. The dimensionless sensitivity values related to the converse of Pe numbers were calculated at locus $z = 0$:

$$E_{1,1/Pe_L}(0) = \frac{\partial x}{\partial(1/Pe_L)}\bigg|_{z=0} \frac{1/Pe_L}{x(0)} = 0.013;$$

$$E_{1,1/Pe_G}(0) = 0.004; \quad E_{2,1/Pe_L}(1) = 0.228; \quad E_{2,1/Pe_G}(1) = 0.036$$

The alteration of the concentration can be expressed as follows:

$$\Delta x = x\left[\frac{1/Pe_L}{x} \frac{\partial x}{\partial(1/Pe_L)} + \frac{1/Pe_G}{x} \frac{\partial x}{\partial(1/Pe_G)}\right] \tag{4}$$

and

$$\Delta y = y\left[\frac{1/Pe_L}{y} \frac{\partial y}{\partial(1/Pe_L)} + \frac{1/Pe_G}{y} \frac{\partial y}{\partial(1/Pe_G)}\right] \tag{5}$$

It is assumed that D_L and D_G are zero, i.e. $Pe_L = Pe_G = \infty$, so the Piston Flow model is valid. In this case:

$$\Delta(1/Pe_L) = 1/Pe_L$$

$$\Delta(1/Pe_G) = 1/Pe_G$$

and using Eq. (4) and (5):

$$\Delta x(0) = 0.819 \cdot (0.013 + 0.004) = 0.014$$

and

$$\Delta y(1) = 0.098 \cdot (0.228 + 0.036) = 0.026$$

and the mean value is:

$$(\Delta c)_i - (\Delta c)_D = \frac{\Delta x(0) + \Delta y(1)}{2} = 0.02$$

The results of the above calculation show that the deviation between the concentrations calculated by the use of the A.D.P.F. and P.F. models is in agreement with the previous experience [1].

SYMBOLS USED

$e_{j,i}$	parameter sensitivity
p	parameter
z	co-ordinate of locus (dimensionless)
$E_{j,i}$	parameter sensitivity (dimensionless)
v	linear flow rate of the phase (metres per second)
$(\beta\omega)_i$	transfer coefficient related to unit volume and based on the Piston Flow model (one per second)
$(\beta\omega)_D$	transfer coefficient related to unit volume and based on the Axial Dispersed Plug Flow model (one per second)
$(\beta\omega)$	transfer coefficient related to unit volume (one per second)
x	concentration of the liquid phase (dimensionless)
y	concentration of the gas phase (dimensionless)
St	Stanton number (dimensionless)
Pe	Peclet number (dimensionless)

D	axial mixing coefficient
B	feed rate (litres per hour)
h	relative error (dimensionless)
Δc	deviation of the concentrations (dimensionless)

Indices

D	A.D.P.F. model
L	liquid phase
G	gas phase
i	P.F. model

REFERENCES

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РЕЗЮМЕ

На основании данных, полученных с использованием ранее опубликованных экспериментальных методов, авторы показывают методы определения численных значений и практическое применение параметрической чувствительности.

На основании модели идеального вытеснения рассчитывалась концентрационная чувствительность для жидкой и газовой фаз по коэффициенту массопередачи, приходящемуся на единицу объема, и по скоростям фазовых потоков. Авторы указывают способ расчета ошибки, которая допускается при определении параметров вследствие ошибки измерения концентрации. Значения параметрической чувствительности используют для оценки влияния тех изменений, которые происходят в режиме работы абсорбционных установок.

Кроме того, авторы приводят численные значения произведенных на основании диффузионной модели расчетов чувствительности по коэффициенту массопередачи и по коэффициенту перемешивания внутри фаз, а также расчетов приближенного значения ошибки, допущенной в вычислениях указанных величин. В условиях проведенного эксперимента данные о чувствительности по коэффициентам перемешивания дали возможность сравнить модель идеального вытеснения с диффузионной моделью.