UDC 669

ON TEMPERATURE DEPENDENCE OF IDEAL SEPARATION FACTOR IN SYSTEMS WITH SIMILAR VOLATILITY OF COMPONENTS

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In temperature interval 800…2400 K the temperature dependence of ideal separation factor $\alpha_i(T)$ for difference double systems with similar volatility of components (at $0.1 < \alpha_i < 10$) may be as monotonic as non-monotonic; while T is growing, the value of α_i may approach to $\alpha_i = 1$ (sometimes passing through it), but sometimes it can go away from it.

As it is known, for estimation of efficiency of separation factor $\alpha_i = p_1/p_2$ is used (where p_1 and p_2 are vapor pressure of components at process temperature) [1, 2]. The Nesmeyanov's monograph [3] is used as the basis data source of vapor pressure of elementary substances.

The knowledge of temperature dependence $\alpha_i(T)$ is important. Usually the ideal separation factor changes to $\alpha_i = 1$ when the temperature grows. Meanwhile, it was revealed that this dependence has a not-monotonic character for the Mn-Ga system with similar volatility of components. When the temperature is grows, the value of α_i approaches the maximum $\alpha_i = 4$ (at temperature of 1400 K), and maximum value of α_i is 2 times bigger than the value of α_i at 800 and 2300 K [4].

The objective of this work was detailed investigation of temperature dependence of ideal separation factor at systems with similar volatility, i. e. for systems with components that are difficult to split (at $0.1 < \alpha_i < 10$).

Temperature dependences of ideal separation factor at such systems, which calculated using reference data [3] are shown in Tables 1–3. To compare the data for systems In-Mn, In-Ga, Mn-Al, Cu-Fe, Mn-Lu with big difference of vapor pressure and with monotone approximation of α_i to $\alpha_i = 1$ are shown too. The information about the character of temperature dependences $\alpha_i(T)$ is summarized in Table 4. On the whole, a dependences $\alpha_i(T)$ have different character in different systems but dependences $\alpha_i(T)$ for Co-Cu, Si-Ge, and Mn-Ga have similar character: they pass through maximum.

Some values of $\alpha_i(T)$ in systems Ni-Cu, In-Mn, Cr-Fe (at temperatures of 1300, 2100, and 2200 K respectively) stand out on the background of smooth change, that points on possible uncertainty of correspondent values of vapor pressure. In connection with that, there is the supposition that calculation of temperature dependences of the ideal separation factor can be used for verification of certainty of the experimental data of volatility of substances.

Different character of temperature dependences $\alpha_i(T)$ for different systems basic-impurity should be taken into account during development of distillation purification. It is not excluded that for certain systems with similar volatility of components the effective separation factor may also show a complex temperature dependence in real processes.

Table 1

Temperature dependence of ideal separation factor $\alpha_i = p_1/p_2$ in systems Eu-Ca, Tl-Ca, Ge-Cr, Tl-Eu, Eu-Ba, Au-Ge, Co-Cu, Be-Co, Au-Cr

T, K	$\frac{p(Eu)}{p(Ca)}$	$\frac{p(Tl)}{p(Ca)}$	$\frac{p(Ge)}{p(Cr)}$	$\frac{p(Tl)}{p(Eu)}$	$\frac{p(Eu)}{p(Ba)}$	$\frac{p(Au)}{p(Ge)}$	$\frac{p(Co)}{p(Cu)}$	$\frac{p(Be)}{p(Co)}$	$\frac{p(Au)}{p(Cr)}$
800	0.6	0.7	1.0	1.2	1.3	–	–	–	–
900	1.4	1.3	0.8	0.9	1.4	–	1.8	2.0	–
1000	1.3	1.1	0.6	0.9	1.6	1.7	2.8	1.2	2.0
1100	1.3	1.2	0.6	0.9	1.9	1.3	3.1	0.9	2.0
1200	0.9	0.8	0.5	0.9	2.0	1.1	3.3	0.8	1.4
1300	0.9	0.8	0.4	0.9	2.1	1.1	3.4	0.7	1.1
1400	1.0	0.9	0.4	0.9	2.3	1.2	3.7	0.6	1.0
1500	1.0	1.0	0.4	0.9	2.3	1.2	4.3	0.5	0.8
1600	1.1	1.1	–	1.0	2.4	1.2	4.8	0.5	0.7
1700	1.1	1.1	0.3	1.0	2.5	1.3	6.3	0.4	0.6
1800	–	–	–	–	–	1.2	5.2	0.4	0.5
1900	–	–	–	–	–	1.2	5.2	0.4	0.5
2000	–	–	–	–	–	1.2	5.2	0.4	0.4
2100	–	–	–	–	–	1.2	5.3	0.4	–
2200	–	–	–	–	–	1.2	5.3	0.4	0.4
2300	–	–	–	–	–	1.1	5.4	0.3	–
2400	–	–	–	–	–	1.1	5.3	0.3	0.4

Table 2

Temperature dependence of ideal separation factor $\alpha_i = p_1/p_2$ in systems Sr-Yb, Mn-Ga, Ca-Ba, Si-Ge, Sr-Ra, Al-Lu, Si-Cr, Ni-Be, Cr-Fe

T, K	$\frac{p(Sr)}{p(Yb)}$	$\frac{p(Mn)}{p(Ga)}$	$\frac{p(Ca)}{p(Ba)}$	$\frac{p(Si)}{p(Ge)}$	$\frac{p(Sr)}{p(Ra)}$	$\frac{p(Al)}{p(Lu)}$	$\frac{p(Si)}{p(Cr)}$	$\frac{p(Ni)}{p(Be)}$	$\frac{p(Cr)}{p(Fe)}$
800	2.0	2.0	2.1	–	2.0	–	–	–	–
900	1.9	2.5	1.0	–	2.2	2.4	–	2.6	–
1000	1.7	2.9	1.3	2.1	2.4	2.0	2.6	2.8	–
1100	1.5	3.3	1.4	2.1	2.5	1.7	2.6	3.3	3.2
1200	1.6	3.6	2.3	2.0	3.0	1.4	2.5	3.6	3.1
1300	1.3	3.8	2.3	2.7	2.5	1.2	2.5	6.4	3.0
1400	1.2	4.0	2.3	3.3	2.5	1.1	2.5	4.1	2.7
1500	1.2	4.0	2.3	3.7	2.6	1.0	2.4	4.5	2.6
1600	1.2	3.5	2.2	3.5	2.5	0.8	2.0	4.8	2.5
1700	–	3.2	2.2	4.8	–	0.8	2.3	5.3	2.5
1800	–	3.0	–	4.4	–	0.8	1.9	5.4	2.4
1900	–	2.8	–	4.1	–	0.7	1.6	5.6	2.4
2000	–	2.6	–	4.0	–	0.7	1.5	5.7	2.4
2100	–	3.0	–	3.7	–	0.3	–	5.8	–
2200	–	2.2	–	3.6	–	0.2	1.1	5.7	2.9
2300	–	2.0	–	3.4	–	–	–	5.8	–
2400	–	1.7	–	3.3	–	–	1.0	5.8	2.5

Table 3

Temperature dependence of ideal separation factor $\alpha_i = p_1/p_2$ in systems Be-Cu, Ge-Fe, Au-Fe, Ni-Cu, In-Mn, In-Ga, Mn-Al, Cu-Fe, Mn-Lu

T, K	$\frac{p(Be)}{p(Cu)}$	$\frac{p(Ge)}{p(Fe)}$	$\frac{p(Au)}{p(Fe)}$	$\frac{p(Ni)}{p(Cu)}$	$\frac{p(In)}{p(Mn)}$	$\frac{p(In)}{p(Ga)}$	$\frac{p(Mn)}{p(Al)}$	$\frac{p(Cu)}{p(Fe)}$	$\frac{p(Mn)}{p(Lu)}$
800	–	–	–	–	36	72	–	–	–
900	3.6	–	–	10	17	41	83	–	190
1000	3.3	–	–	9	9	25	58	–	115
1100	2.8	4.2	6	9	6	17	44	130	75
1200	2.6	3.8	4	9	4	13	36	75	50
1300	2.3	2.9	3	15	3	10	29	55	36
1400	2.3	2.1	2.6	10	2	8	25	30	27
1500	2.3	1.7	2.1	10	1.8	7	21	21	20
1600	2.3	1.4	1.7	11	1.7	6	15	14	13
1700	2.2	1.1	1.4	12	1.6	5	12	11	10
1800	2.1	1.0	1.2	12	1.5	4.6	10	8	8
1900	2.0	0.9	1.1	11	1.5	4.0	8.2	7	6
2000	1.9	0.9	1.0	11	1.4	3.7	6.9	6	5
2100	1.9	0.9	1.0	11	1.0	3.0	7.4	5	2.3
2200	1.8	0.9	1.1	11	1.4	3.1	5.0	5	0.9
2300	1.8	0.8	0.9	10	1.4	2.8	4.2	4	–
2400	1.8	0.8	0.9	10	–	–	3.5	4	–

Table 4

Character of temperature dependence of ideal separation factor $\alpha_i=p_1/p_2$ at difference systems

System	Character of dependence $\alpha_i(T)$ when T grows
Be-Cu (Sr-Yb, Cr-Fe, Ni-Cu)	Monotonic (or almost monotonic) with change toward line $\alpha_i = 1$
Eu-Ba	Monotonic with change from line $\alpha_i = 1$
Ge-Cr, Be-Co, Au-Cr, Al-Lu	Monotonic with passing through $\alpha_i = 1$
Tl-Ca, Ca-Ba, Eu-Ca, Si-Cr (Si-Ge, Mn-Ga, Sr-Ra, Co-Cu, Ni-Be, Co-Cu, Au-Ge, Ge-Fe, Au-Fe, Tl-Eu)	Not-monotonic with (or without) passing through $\alpha_i = 1$

CONCLUSION

In temperature interval of 800…2400 K the temperature dependence of the ideal separation factor $\alpha_i(T)$ for difference double systems with similar volatility of components (at $0.1 < \alpha_i < 10$) may be as monotonic as non-monotonic; when T is growing the value of α_i may approach to $\alpha_i = 1$ (sometimes passing through it)), but sometimes it can go away from it.

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О ТЕМПЕРАТУРНОЙ ЗАВИСИМОСТИ ИДЕАЛЬНОГО КОЭФФИЦИЕНТА РАЗДЕЛЕНИЯ В СИСТЕМАХ С БЛИЗКОЙ ЛЕТУЧЕСТЬЮ КОМПОНЕНТОВ

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В температурном интервале 800…2400 К температурная зависимость идеального коэффициента разделения $\alpha_i(T)$ для разных двухкомпонентных систем с близкой летучестью компонентов (при $0{,}1 < \alpha_i < 10$) может быть как монотонной, так и немонотонной; с ростом Т значение α_i может как приближаться к значению $\alpha_i = 1$ (иногда проходя через него), так и удаляться от него.

ПРО ТЕМПЕРАТУРНУ ЗАЛЕЖНІСТЬ ІДЕАЛЬНОГО КОЕФІЦІЄНТА РОЗПОДІЛУ В СИСТЕМАХ З БЛИЗЬКОЮ ЛЕТЮЧІСТЮ КОМПОНЕНТІВ

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У температурному інтервалі 800…2400 К температурна залежність ідеального коефіцієнта розподілу $\alpha_i(T)$ для різних двокомпонентних систем з близькою летючістю компонентів (при $0{,}1 < \alpha_i < 10$) може бути як монотонною, так і немонотонною; з ростом Т значення α_i може як приближатися до значення $\alpha_i = 1$ (іноді проходжуючи через нього), так і віддалятися від нього.