

ON DEPENDENCE OF EFFECTIVE SEPARATION FACTOR ON DEGREE OF DISTILLATION

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By using the example of the experimental data of the distillation of Pb-Sb (with Pb as the base) it is shown that the efficiency of distillation purification can be determined not only by the dependence of the effective separation factor on the degree of distillation, in the known distillation equation, but also by two others parameters: the equilibrium separation factor and the Peclet number.

INTRODUCTION

Distillation is one of the main methods for obtaining high-purity substances, and therefore there is an interest to the theory of this method [1–10].

Until some time, it was believed that the dependence of the efficiency of distillation purification on the degree of distillation is determined by a simple equation

$$\frac{C}{C_0} = \frac{1 - (1 - g)^\beta}{g}, \quad (1)$$

where C_0 is the initial impurity concentration in the refined substance; C is the average impurity concentration in the condensate; g is the degree of distillation (the ratio of the condensate mass to the initial mass of the substance); β is the effective separation coefficient (as the ratio of the impurity concentrations in the vapor leaving the evaporation surface and in the evaporated liquid near the evaporation surface).

Using equation (1), an analysis of the experimental data on the distillation of the Pb-Sb substance (with Pb as the basis) was carried out [11]. In this article the rare experimental data on the dependence of C/C_0 on g was analyzed: $C/C_0 = 0.08, 0.18$, and 0.32 at the corresponding values of $g = 0.14, 0.22$, and 0.35 – with an ideal separation factor $\beta_i = 0.06$. It was found that the experimental values of C/C_0 do not belong to the dependence of C/C_0 on g according to equation (1) at any constant value of β , and it was concluded that the dependence $\beta(g)$ exists: $\beta = 0.08, 0.18$, and 0.28 at noted values of g correspondently.

Meanwhile, it was later shown that the efficiency of distillation or sublimation refining is determined by two parameters: β and the Peclet number

$$Pe = wX / \rho D,$$

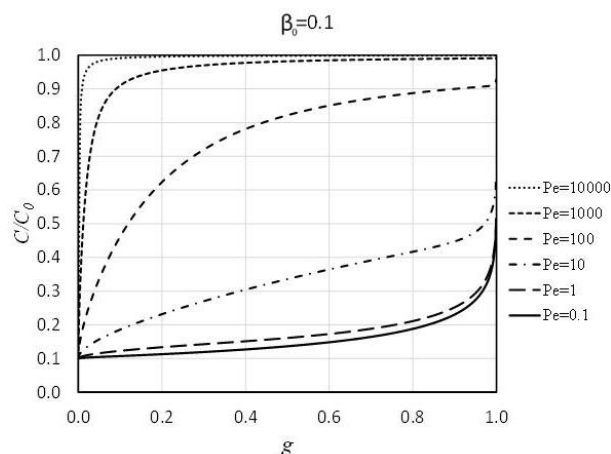
where w is the rate of evaporation of the substance from a unit surface; D is the diffusion coefficient of the impurity; ρ is the density of the substance; X is the size factor of the evaporated material (for example, the thickness of the material layer in the crucible and the radius of the evaporated ball at sublimation) [5–10]. In this case, the dependence of C/C_0 on g is determined by equation (1) if $Pe = 0$.

Taking into account the existence of two parameters of the evaporation process (β_0 and Pe) makes it possible to take a new approach to the conclusion of the work on the existence of the dependence $\beta(g)$ in [11].

The purpose of this work was to take into account the Pe number in considering the dependence of C/C_0 on g in the process of distillation of Pb-Sb.

CALCULATIONS

Taking into account the fact that in the process under consideration $\beta \approx \beta_i \approx 0.1$, we considered graphs of C/C_0 dependence on g at $\beta_0 = 0.1$ and different values of Pe (Figure) [7, 10, 12]. The question was studied whether the experimental values of C/C_0 belong to the same graph with given values of β_0 and Pe .



Dependence C/C_0 on g for the material in the form of a flat layer during its one-sided evaporation in vacuum – at various values of Pe and $\beta_0 = 0.1$

RESULTS AND DISCUSSION

With the help of the graphs presented in Figure, a good agreement was established between the experimental and calculated data on the distillation of Pb-Sb at $\beta_0 = 0.1$ and $Pe = 100$. This allows one to judge the role of the parameters β , β_0 , and Pe in distillation calculations.

CONCLUSIONS

On the example of the experimental data of the distillation of Pb-Sb (with Pb as the base) it is shown that the efficiency of distillation purification can be determined not only by the dependence of the effective separation factor on the degree of distillation, in the known distillation equation, but also by two others parameters: β_0 and Pe .

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ПРО ЗАЛЕЖНІСТЬ ЕФЕКТИВНОГО КОЕФІЦІЄНТА ПОДІЛУ ВІД СТУПЕНЯ ДИСТИЛЯЦІЇ

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Шляхом використання експериментальних даних про дистиляцію речовини Pb-Sb (Pb – основа) показано, що ефективність дистиляційного очищення може визначатися не тільки залежністю ефективного коефіцієнта поділу від ступеня дистиляції у відомому дистиляційному рівнянні, а й двома іншими параметрами: рівноважним коефіцієнтом поділу і числом Пекле.