

STUDY OF THE EQUILIBRIUM LINE OF A BINARY MIXTURE

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Let us investigate the equilibrium line of a binary mixture of components A and B, obeying Raoult's law, and plot its graph. Let us write the equation

$$y = \frac{x}{k_1 + k_2 x},$$

where $y = y_A$, $x = x_A$, $k_1 = \frac{1}{\alpha}$, $k_2 = 1 - \frac{1}{\alpha} \neq 0$, and examine the function

$f(x) = \frac{x}{k_1 + k_2 x}$ given that $k_1 > 0$ и $k_2 < 0$. Function scope

$x \in \left(-\infty; -\frac{k_1}{k_2}\right) \cup \left(-\frac{k_1}{k_2}; +\infty\right)$. Find the limits of the function to the left and right at

the point $x_0 = -\frac{k_1}{k_2} = \frac{1}{\alpha - 1} \neq 0$. $\lim_{x \rightarrow x_0 - 0} \frac{x}{k_1 + k_2 x} = +\infty$, $\lim_{x \rightarrow x_0 + 0} \frac{x}{k_1 + k_2 x} = -\infty$. Hence, the

line $x = -\frac{k_1}{k_2}$ is a vertical two-sided asymptote. We found non-vertical asymptotes:

$$k = \lim_{x \rightarrow \pm\infty} \frac{1}{k_1 + k_2 x} = 0, \quad \lim_{x \rightarrow \pm\infty} \frac{x}{k_1 + k_2 x} = \frac{1}{k_2}.$$

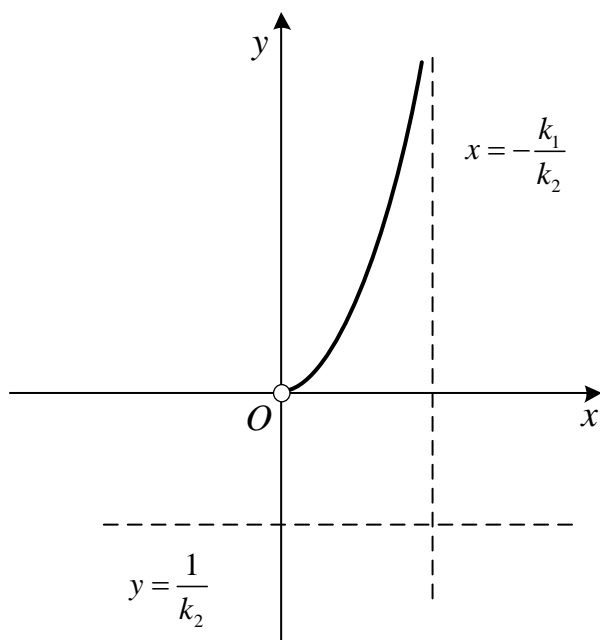


Fig. 1

will be located in the first quadrant (Fig. 1).

So, this $y = \frac{1}{k_2}$ line is a horizontal

asymptote. So as $y' = \frac{k_1}{(k_1 + k_2 x)^2} > 0$,

the function being studied is growing.

Knowing the second derivative

$y'' = \frac{-2k_1 k_2}{(k_1 + k_2 x)^3}$, we find the intervals

of the direction of the concavity of the

graph of the function, namely $x < -\frac{k_1}{k_2}$,

the concavity is directed upward, and

for $x > -\frac{k_1}{k_2}$ – downward. Since $x > 0$

and $y < 0$ (as mole fractions), the

equilibrium line of the binary mixture