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 $x_0 = -\frac{k_1}{k_2} = \frac{1}{\alpha - 1} \neq 0$. $\lim\limits_{x \to x_0 - 0} \frac{x}{k_1 + k_2 x} = +\infty$, $\lim\limits_{x \to x_0 + 0} \frac{x}{k_1 + k_2 x} = -\infty$. Hence, the line $x = -\frac{k_1}{k_2}$ is a vertical two-sided asymptote. We found non-vertical asymptotes:

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

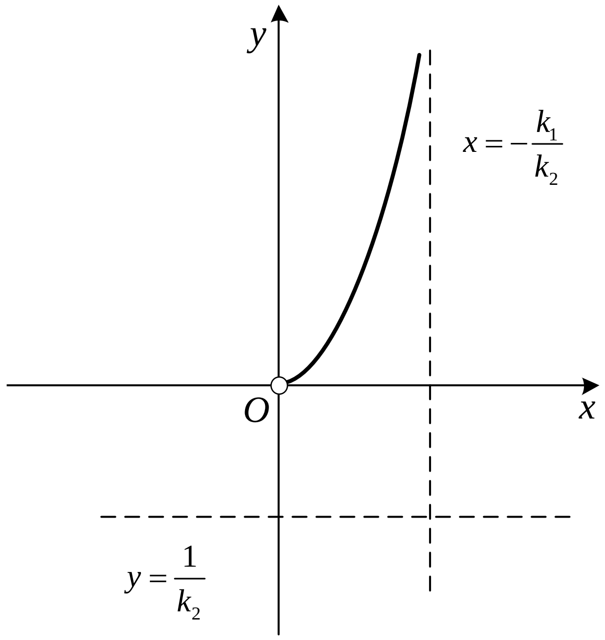

Fig. 1

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