

Fick's first law

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This article has been translated from WikiSkripta; the **translation** needs to be checked.

This article has been translated from WikiSkripta; ready for the **editor's review**.

Diffusive flux

1. Fick's law determines the density and direction of the diffusion flux j - so let's first define what it is: It is a vector quantity, the size of which tells us how many moles of a given substance will pass through a unit area S per unit time t :

$$j = \frac{n}{S \cdot t}$$

As can be seen, the unit of diffusive flux density in the SI system is $\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$.

The direction of the diffusion flux then tells us the mean direction of the particle flow. So it is clear that it must be a vector quantity. It formally becomes this if we multiply the value from the previous equation by the unit vector in the flow direction.

The flow density over a surface can also be expressed from the average velocity of particles flowing over this surface and the particle concentration:

$$\mathbf{j} = c \cdot \mathbf{v}$$

1. Fick's law

1. Fick's law states that the diffusion flux density j is proportional to the negative concentration gradient :

$$\mathbf{j} = -D \cdot \text{grad } c$$

A gradient can be intuitively understood as a mathematical operation that receives as an argument a scalar function in space, i.e. a scalar field, and returns a vector function in space, i.e. a vector field. The gradient at a given point is actually a vector in the direction of greatest gradient. Diffusion coefficient D is a constant characterizing how easily a given substance diffuses through a given environment.

Worth mentioning the fact that the diffusive flux j is a vector quantity, nevertheless is not surprising even with a cursory thought, because in diffusion process it is not only important how much substance is moved, but also where it is moved.

For the one-dimensional case and for the approximation of the gradient by small but final changes, a much simpler shape can be used:

$$j = -D \cdot \frac{\Delta c}{\Delta x}$$

, where Δc is the difference in molar concentrations of two nearby locations Δx away from each other . the unit of the concentration gradient is therefore $\text{mol} \cdot \text{m}^{-4}$.

Diffusion coefficient

The proportionality constant in Fick's 1st law is the so-called *diffusion coefficient* D expressing the number of moles of a substance that pass through a cross-section of 1 m^2 in a time of 1 s at a concentration gradient of 1 mol/m .