IV–8 Fick's law states that in certain diffusion processes the current density **J** is proportional to the negative of the gradient of the density ρ; that is, $\mathbf{J} = -k\nabla\rho$, where k is a positive constant If a substance of density $\rho(x, y, z, t)$ and velocity $\mathbf{v}(x, y, z, t)$ diffuses according to Fick's law, show that the flow is *irrotational* (that is, $\nabla \times \mathbf{v} = 0$).

Pf

$J = \rho V = -k\nabla\rho$ ，$V = -k\dfrac{\nabla\rho}{\rho}$ ，取$\psi = -k\ln\rho$ ，则$\nabla\psi = -k\dfrac{\nabla\rho}{\rho} = V$

所以$curlV = 0$ ，即$\nabla \times V = 0$