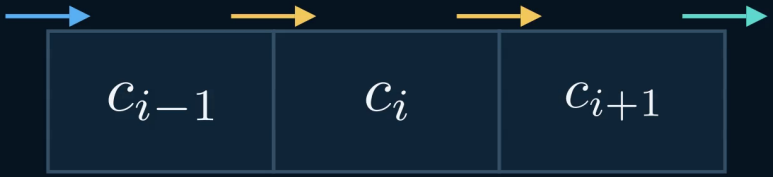
FINITE VOLUMES

One face, two opposite contributions

A flux is positive to the right; each cell uses its outward boundary orientation.



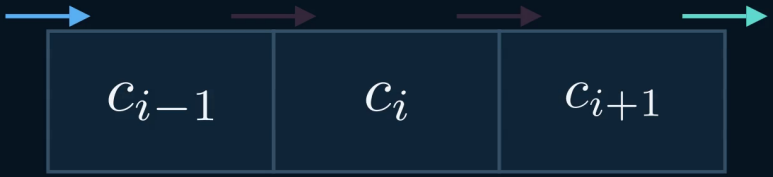
$$c_i^{n+1} = c_i^n - \frac{\Delta t}{\Delta x}\left(F_{i+1/2} - F_{i-1/2}\right)$$

Compute each shared face flux once. Its contribution changes sign in the neighboring cell balance.

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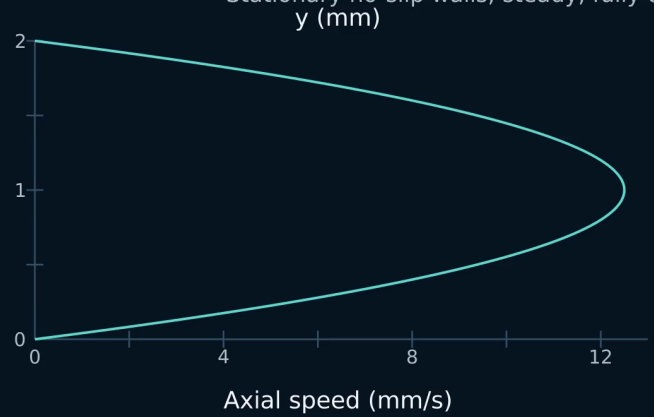
$$M^{n+1} - M^n = \Delta t\left(F_{\text{in}} - F_{\text{out}}\right), \qquad M^n = \Delta x \sum_i c_i^n$$

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VISCOUS MOMENTUM

Pressure-driven channel flow

Stationary no-slip walls; steady, fully developed motion.



$$\mu u'' = -G$$

$$u(0) = u(H) = 0$$

$$u(y) = \frac{G}{2\mu} y(H - y)$$

$$q = \frac{GH^3}{12\mu}$$

H = 2 mm; G = 100 Pa/m; viscosity = 0.004 Pa s. Here q is volume flux per width (m²/s).

ADVECTION AND DIFFUSION

A packet in a shear flow

Normalized concentration: initial 0; inlet pulse 1 for 0.3 s; impermeable walls.

t = 2.02 s



0 mm

H = 2 mm (vertical scale enlarged)

20 mm

0

1

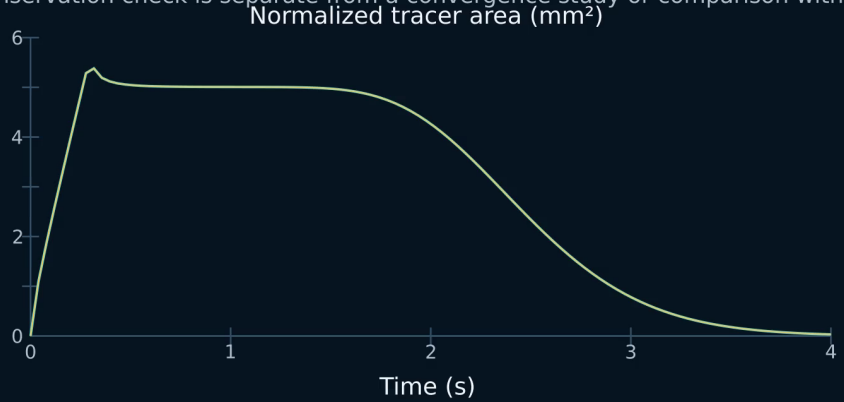
$$\partial_t c + u(y)\partial_x c = D\Delta c$$

80 × 20 cells; D = 2 × 10^{-6} m^2/s. The physical model and numerical diffusion must be tested separately.

VERIFICATION

The discrete budget closes

A conservation check is separate from a convergence study or comparison with data.



Maximum cumulative budget defect ≈ 2.4×10^{-20} m². Refine the mesh before interpreting spreading.