

1. Compute Thermodynamic/Transport Properties c_v, k, μ, γ 2. Compute the equilibration pressure with an equation of state (ideal Gas).

$$P_{eq} = (\gamma - 1)c_v \rho T$$

$$c = \sqrt{\frac{dP}{d\rho} + \frac{dP}{de} \frac{P_{eq}}{\rho^2}}$$

$$\text{where } \frac{dP}{d\rho} = (\gamma - 1)c_v T \text{ and } \frac{dP}{de} = (\gamma - 1)\rho$$

set boundary conditions on P_{eq}

3. Compute sources of energy due to chemical reactions $S_{(me)}$ 4. Compute the face-centered velocities

$$\begin{aligned} \vec{U}^{*f} &= \left\langle \frac{\rho \vec{U}}{\rho} \right\rangle^{n^f} - \frac{\Delta t}{\langle \rho^o \rangle^f} \nabla^f P_{eq} + \Delta t \vec{g} \\ &= \frac{(\rho \vec{U})_R + (\rho \vec{U})_L}{\rho_R + \rho_L} - \Delta t \frac{2.0(v_L^o v_R^o)}{v_L^o + v_R^o} \left(\frac{P_{eqR} - P_{eqL}}{\Delta x} \right) + \Delta t \vec{g} \end{aligned}$$

set boundary conditions on \vec{U}^{*f}

5. Compute ΔP

$$\Delta P = \frac{-\Delta t \overbrace{\nabla \cdot \theta \vec{U}^{*f}}^{\text{Advection}(\theta, \vec{U}^{*f})}}{\kappa}$$

where $P^{n+1} = P_{eq} + \Delta P$ for a single material $\theta = 1.0$ and $\kappa = \frac{v^o}{c^2}$

set boundary conditions on P^{n+1}

6. Compute the face centered pressure

$$P^{*f} = \frac{\frac{P}{\rho} + \frac{P_{adj}}{\rho_{adj}}}{\frac{1}{\rho} + \frac{1}{\rho_{adj}}} = \frac{P\rho_{adj} + P_{adj}\rho}{\rho + \rho_{adj}}$$

7. Accumulate sources

$$\Delta(m\vec{U}) = -\Delta t V \Delta t \nabla P^{*f} + \nabla \cdot (\tau^{*f}) + m\vec{g} \Delta t$$

$$\Delta(me) = V \kappa P \Delta P - \nabla q^{*f} + S_{(me)}$$

where $q^{*f} = -k^f \nabla T$

8. Compute Lagrangian quantities

$$m^L = \rho V$$

$$(m\vec{U})^L = (m\vec{U}) + \Delta(m\vec{U})$$

$$(me)^L = (me) + \Delta(me)$$

set boundary conditions on the primitive variables (\vec{U}, ρ, T)

Evolution of specific volume

$$(mv^o)^L = (mv^o) + \Delta t V \nabla \cdot \vec{U}^{*f}$$

$$\text{Note } \Delta t V \nabla \cdot \vec{U}^{*f} = \kappa V \Delta p$$

9. Advect and Advance in time

$$m^{n+1} = m^L - \Delta t \text{Advection}(m^L, \vec{U}_m^{*f})$$

$$(m\vec{U})^{n+1} = (m\vec{U})^L - \Delta t \text{Advection}((m\vec{U})^L, \vec{U}^{*f})$$

Transport passive scalars

$$(mf)^{n+1} = (mf)^L - \Delta t \text{Advection}((mf)^L, \vec{U}^{*f})$$

Compute $c_v(f)^{n+1}$

$$(me)^{n+1} = (me)^L - \Delta t \text{Advection}((\rho e)^L, \vec{U}^{*f})$$

$$(mv^o)^{n+1} = (mv^o)^L - \Delta t \text{Advection}((\rho v^o)^L, \vec{U}^{*f})$$

Backout the primitive variables $(T, \rho, \vec{U}, v^0, f)$

set boundary conditions on the primitive variables $(\vec{U}, \rho T)$.