I C E, explicit pressure, single material 11/7/14

1. Compute Thermodynamic/Transport Properties C_v, k, μ, γ

2. Compute the equilibration pressure with an equation of state (ideal Gas).

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

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

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

   set boundary conditions on P_{eq}

   Compute the compressibility $\kappa = \frac{v^o}{c^2}$

3. Compute the face-centered velocities

   $\vec{U}^{*f} = \left\langle \frac{\rho \vec{U}}{\rho} \right\rangle^{n^f} - \frac{\Delta t}{<\rho^o>^f} \nabla^f P_{eq} + \Delta t \vec{g}$

   $= \frac{(\rho\vec{U})_R + (\rho\vec{U})_L}{\rho_R + \rho_L} - \Delta t \frac{2.0(v_L^o v_R^o)}{v_L^o + v_R^o} \left(\frac{P_{eq_R} - P_{eq_L}}{\Delta x} \right) + \Delta t \vec{g}$

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

4. 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 $\theta = 1.0$ set boundary conditions on P^{n+1}

5. Compute the face centered pressure

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

6. Accumulate sources

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

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

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

7. Compute Lagrangian quantities

   $m^L = \rho V$

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

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

8. Advect and Advance in time

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

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

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

9. Compute primitive Variables from n+1 conserved quantities

   $\rho^{n+1} = m^{n+1}/V$

   $\vec{U}^{n+1} = \frac{(m\vec{U})^{n+1}}{m^{n+1}}$

   $T^{n+1} = \frac{(me)^{n+1}}{m^{n+1}C_v}$

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