

Open

Opened 7 months ago by  **Alan Stagg**

0 of 2 tasks completed

## implement multimaterial framework in restructured FLEXO

Task

### What Needs to be Done?

- ☐ implement data structures and code logic to support multimaterial problems.
- ☐ add multimaterial test problems.

### Done Criteria

### Weight

Question	Points
$Q_1$ : Is this story time consuming to program or develop? Yes = 5, No = 1	3
$Q_2$ : Is this story difficult to test? Yes = 3, No = 0	1
$Q_3$ : Will the completion of this story rely on other people? Yes = 3, No = 0	0
$Q_4$ : Is this body of work brand new to you? Yes = 5, No = 1	1
<b>Total:</b> $(Q_1 + Q_2) \cdot (Q_3 + Q_4)$	4



**Alan Stagg** @akstagg added 

Task

 label 7 months ago



**tevoth** @tevoth · 7 months ago

Owner

Implemented ( [@akstagg](#) , [@bngranz](#) , [@micpowe](#) , [@tevoth](#) ) 5-equation, uniform strain, multi-material capability in FLEXO (currently p=0 elements).

$$\left\{ \begin{array}{l} \frac{\partial \alpha_1}{\partial t} + u \frac{\partial \alpha_1}{\partial x} = 0 \\ \frac{\partial (\alpha \rho)_1}{\partial t} + \frac{\partial (\alpha \rho)_1 u}{\partial x} = 0 \\ \frac{\partial (\alpha \rho)_2}{\partial t} + \frac{\partial (\alpha \rho)_2 u}{\partial x} = 0 \\ \frac{\partial (\rho u)}{\partial t} + \frac{\partial (\rho u^2 + p)}{\partial x} = 0 \\ \frac{\partial (\rho E)}{\partial t} + \frac{\partial (\rho E + p)u}{\partial x} = 0 \end{array} \right.$$

$$\rho = (\alpha \rho)_1 + (\alpha \rho)_2$$
$$e = m_1 e_1 + m_2 e_2$$
$$p = \frac{\rho e}{\frac{\alpha_1}{\gamma_1 - 1} + \frac{\alpha_2}{\gamma_2 - 1}}$$
$$E = e + \frac{1}{2} u^2$$
$$m_k = \frac{(\alpha \rho)_k}{\rho}$$

see LA-UR-11-04985.

Movie below shows Sod problem:

```
in.gamma(0) = 2.0
in.gamma(1) = 1.4
in.rho[0] = 1.0
in.rho[1] = 0.125
```

```
in.vf[0] = (x[0] < 0.5) ? 1.0 : 1.0e-8
in.vf[1] = (x[0] < 0.5) ? 1.0e-08 : 1.0
in.v = {0, 0, 0}
in.p = (x[0] < 0.5) ? 1.0 : 0.1
```



0:00 / 0:10

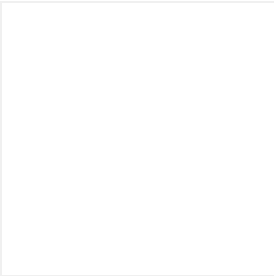
[sod\\_diffgamma](#)



**tevoth @tevoth** · 6 months ago

Owner

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0:00 / 0:10

[sod\\_diffgamma](#)



**tevoth @tevoth** · 6 months ago

Owner

Had been having issues with p > 0 where oscillations quickly killed those simulations. Tried SUPG-like stabilization

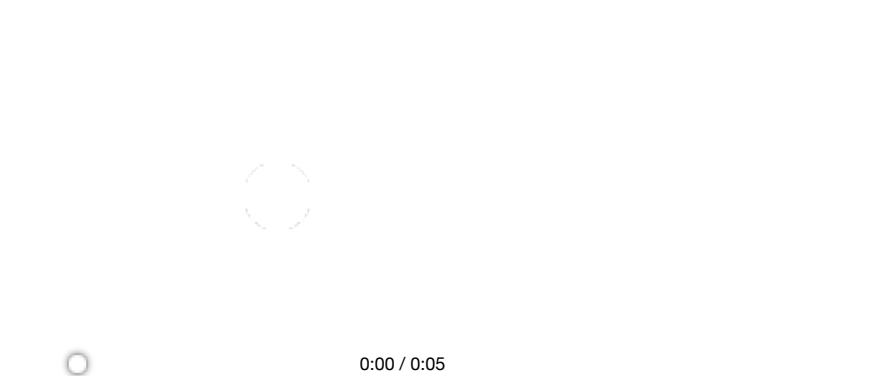
without much luck. Added (primitive variable based) limiting (no additional stabilization) and now can run initially unmixed, two material (same gamma) Sod shock-tube problem and see no oscillations. This is the same problem as described in [the above](#) with the exception that gammas are 1.4.

Below is a movie of the total density (sum of partial densities). Note that p=1 element is sharper in the contact (as well as at the shock).



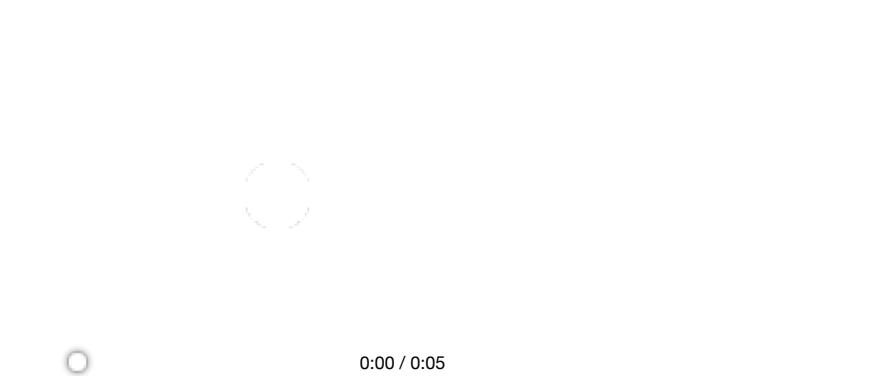
[POvsP1\\_density\\_total](#)

Next is the partial density of material 0 for p = 0 and p = 1 (black and red lines resp.). Again p = 1 produces sharper resolution of the contact.



[POvsP1\\_density0](#)

And finally the partial density of material 1 p = 0 and p = 1 (black and red lines resp.). Note the different scale here (material 1 is the lower (thermodynamic) density material).



[POvsP1\\_density1](#)

Edited by [tevoth](#) 6 months ago



**Alan Stagg** @akstagg · 6 months ago

Owner

Adding exact Riemann solution data for single material Sod problem (1000 data points) at t=0.2:

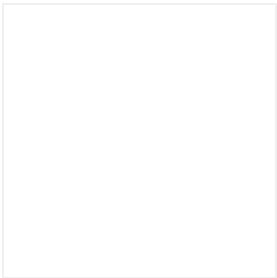
- [density.csv](#)
- [pressure.csv](#)
- [velocity.csv](#)

initial conditions:  
rho\_left = 1, rho\_right = 0.125  
vel\_left = 0, vel\_right = 0  
p\_left = 1.0, p\_right = 0.1  
gamma\_left = 1.4, gamma\_right = 1.4  
domain extent = [0,1]  
contact location = 0.5

Data can be imported into Paraview for comparison within PlotOverLine:

first load data: % paraview density.csv  
then: use TableToStructuredGrid filter. Whole Extent is 0 to 999 for X and 0 for other entries. Set X column to xcoord, and Y and Z columns to zero. Then create PlotOverLine, etc.

Sample comparison to Flexo p0 solution with 1000 elements:



**Alan Stagg** @akstagg · 6 months ago

Owner

Two-material Sod problem calculation compared to exact Riemann solution. Same initial conditions as above, but with left and right initial states corresponding to different materials (and with gamma\_left = 2.0).

