Entropy condition identifies the physically correct solutions among all the solutions produced by a numerical method. Physical model

Numerical methods

Solution 1

Solution 2

Solution 3

Entrophy Conditions

An entropy condition identifies the physically correct solutions among all the solutions produced by a numerical method.

Source term correction

Fluid flow is solved with conservation laws (1), an integral over a control volume

\[ \int_{-\Delta x}^{\Delta x} \left( \frac{\partial U}{\partial t} + \frac{\partial F}{\partial x} - S \right) dx = 0 \]  

(1)

Integrating \( U \) and \( F \) is “easy”, but \( S \) needs to be approximated by a constant value \( \bar{S} \) in each timestep. There are different choices

- **Differential**: Using the hydrostatic force on the walls at each cell.
  
  \[ S = -g \Delta z \]  

(2)

- **Integral**: The pressure exerted by the wall discontinuity is integrated on the section.
  
  \[ \bar{S} = \frac{1}{\Delta z} \left( -g \Delta z \right) \]  

(3)

- **Energetic**: The weighted average of the Differential and Integral formulations is taken according to energy conservation arguments.

### References


### Conclusions

- The differential and integral formulations of the source term are insufficient when dealing with large discontinuities.
- Formulating the source term based on energy conservation arguments often produces better results, except when dissipation

### Future work

- Better source term integration.
- Extension to vessel junctions.
- Calculations of stress on venous walls.
- Addition of dissipation.

### Numerical results

**Vein area**

**Flow**

- **Differential**
- **Integral**
- **Energetic**