Additional Reading Material

Setting up a Test Case in OpenFOAM

Courant Number

The Courant–Friedrichs–Lewy or CFL condition is a condition that determines the stability of a numerical scheme. The CFL condition requires that any information, in the discretized domain, shouldn't travel more than the length of the mesh element during a time-step. The Courant number is used to quantify the CFL condition.

The Courant number for a cell is defined by

$$Co = \frac{\delta t |U|}{\delta x}$$

where δt is the time step,
$|U|$ is the magnitude of velocity, and
δx is the cell size along the direction of the velocity.

The CFL condition, therefore requires,

$$Co < 1$$

To ensure that the Courant number is less than 1, time-step should satisfy

$$\delta t < \frac{\delta x}{|U|}$$

This inequality needs to be satisfied for all the cells in the domain. Since the cell size is uniform throughout the domain, the goal is to find the cell(s) having the maximum magnitude of velocity. For the lid driven cavity flow, maximum velocity occurs in cells next to the lid. Therefore, the maximum magnitude of velocity in the domain is 1 m/s.

Now, let's consider 20 cells along the x and y directions in the domain. Since the domain is a 0.1 m edged square, the cell size is

$$\delta x = \frac{0.1}{20} = 0.005 \text{ m}$$

The time-step, therefore, to ensure that the Courant number is less than 1, should satisfy

$$\delta t < \frac{\delta x}{|U|} = \frac{0.005 \text{ m}}{1 \text{ m/s}} = 0.005 \text{ s}$$

Therefore, the time-step that satisfies the CFL condition for the lid driven cavity flow is 0.005 s or less.