ME543

Project Report

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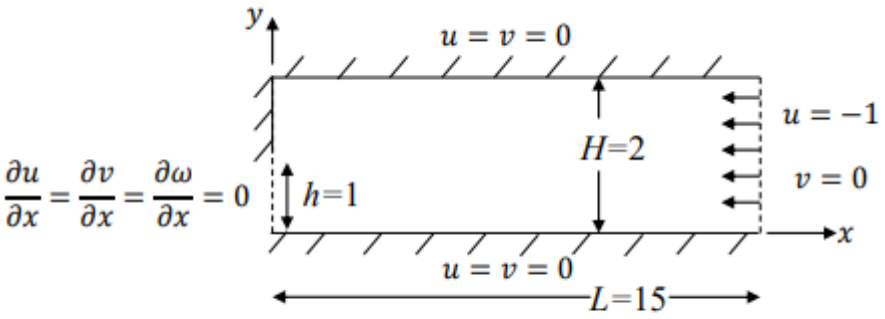

Figure: Flow through a sudden contraction

- Governing equations

$$\frac{\partial^2\psi}{\partial x^2}+\frac{\partial^2\psi}{\partial y^2}=-\omega$$

$$u\frac{\partial\omega}{\partial x}+v\frac{\partial\omega}{\partial y}=\frac{1}{\mathrm{Re}}\left(\frac{\partial^2\omega}{\partial x^2}+\frac{\partial^2\omega}{\partial y^2}\right)$$

$$u=\frac{\partial\psi}{\partial y},\quad v=-\frac{\partial\psi}{\partial x}$$

- Discretized Equations

$$\psi[i][j]=\frac{0.5\cdot \mathrm{delx}^2\cdot\omega[i][j]}{1+\beta^2}+\frac{\beta^2\cdot(\psi[i][j+1]+\psi[i][j-1])}{1+\beta^2}+\frac{\psi[i+1][j]+\psi[i-1][j]}{1+\beta^2}$$

1. For $u[i][j]$:

$$u[i][j] = \frac{\psi[i][j+1]-\psi[i][j-1]}{2.0\times \text{dely}}$$

2. For $v[i][j]$:

$$v[i][j] = -\frac{\psi[i+1][j]-\psi[i-1][j]}{2.0\times \text{delx}}$$

$$\begin{aligned}\omega[i][j] = {} & \tfrac{1-z}{1+\beta^2} \times \Big[\tfrac{1}{2}\left(1-(\psi[i][j+1]-\psi[i][j-1])\times\tfrac{\beta\times\text{Re}}{4.0}\right)\times\omega[i+1][j] \\ & + \left(1+(\psi[i][j+1]-\psi[i][j-1])\times\tfrac{\beta\times\text{Re}}{4.0}\right)\times\omega[i-1][j] \\ & + \left(1+(\psi[i+1][j]-\psi[i-1][j])\times\tfrac{\text{Re}}{4.0\times\beta}\right)\times\beta^2\times\omega[i][j+1] \\ & + \left(1-(\psi[i+1][j]-\psi[i-1][j])\times\tfrac{\text{Re}}{4.0\times\beta}\right)\times\beta^2\times\omega[i][j-1]\Big] \\ & + z\times\omega_{\text{old}}[i][j]\end{aligned}$$

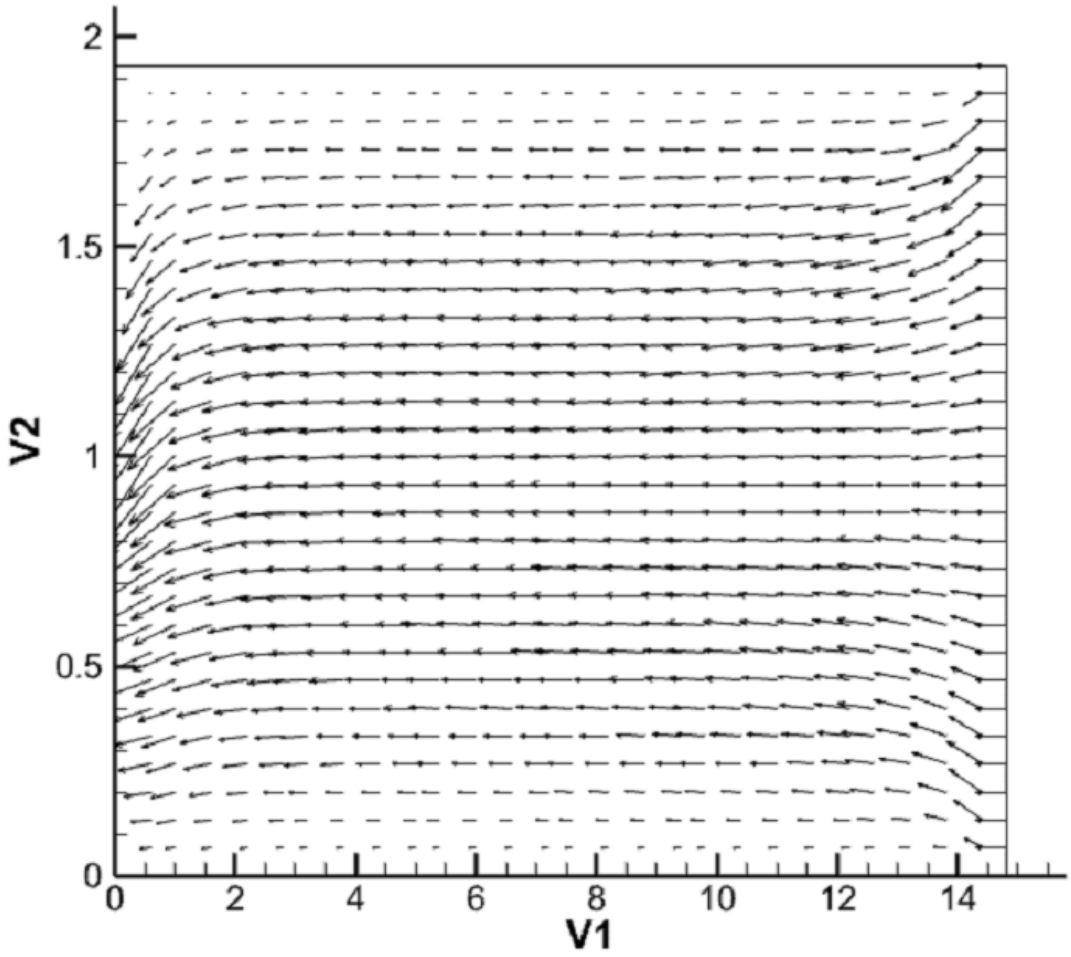

Fig-Velocity vectors

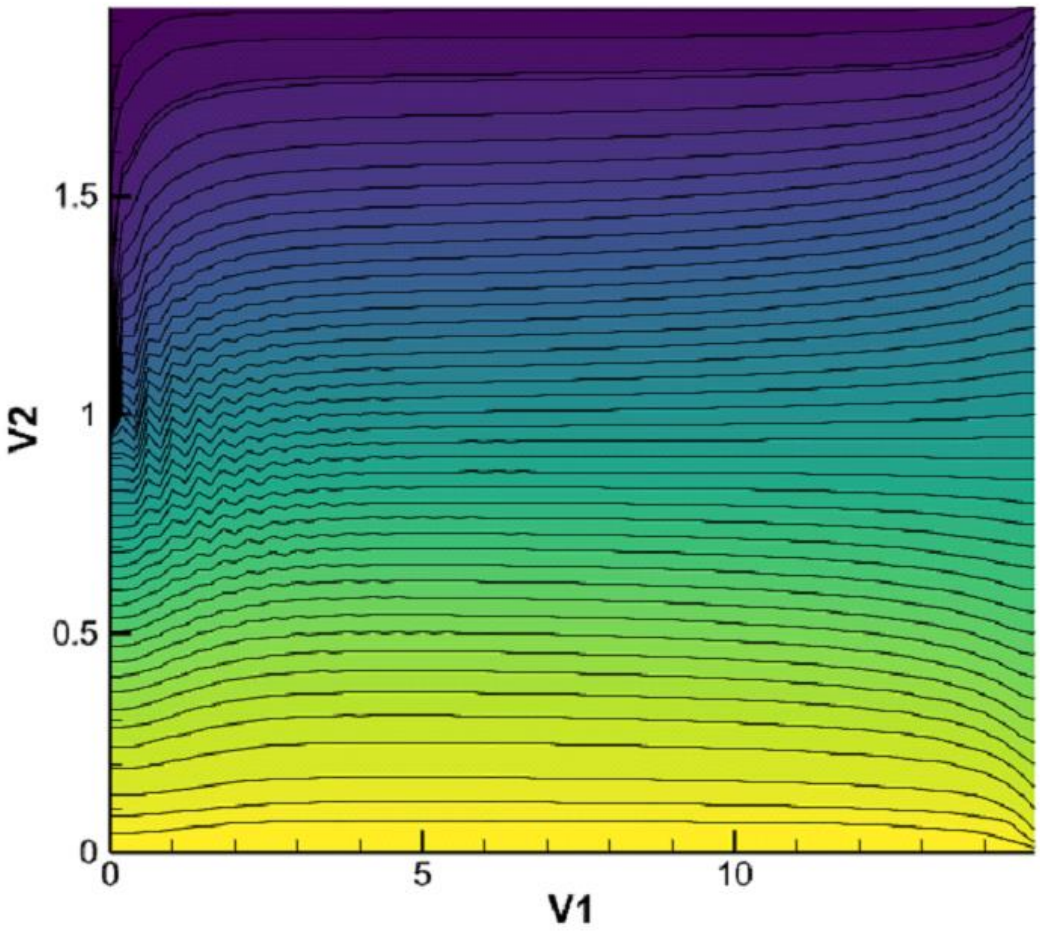

Fig-Stream lines

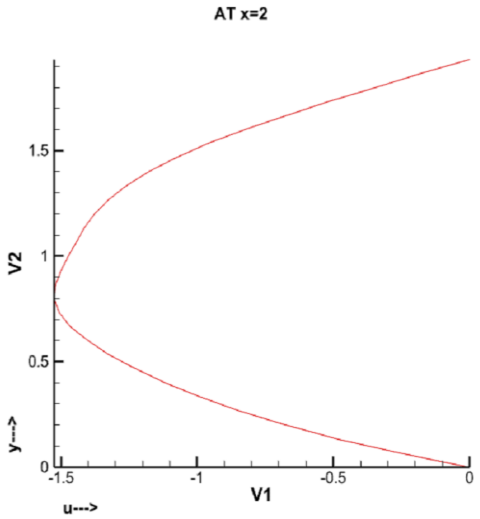

Fig-Velocity at X=2

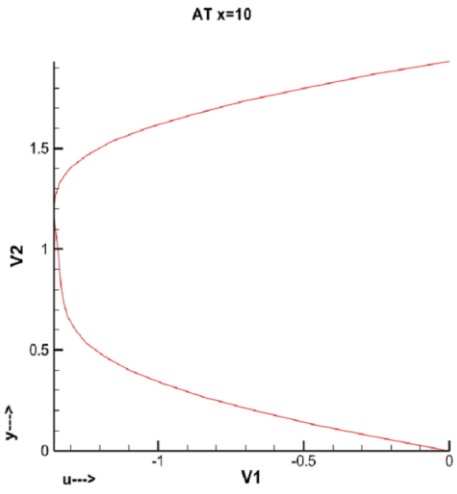

Fig- Velocity at X =10