

$$\theta_{exit} = \theta_{nozzle} = \theta_{w_{max}} \neq 0$$

$$v_{\{a,d\}} = v_{throat} + \theta_{max}$$

$$v_{throat} = v_{m=1} = 0$$

$$v_{\{a,d\}} = v_{throat} + \theta_{max}$$

$$\theta_{cl} - v_{cl} = \theta_{exit} - v_{exit} \rightarrow \theta_{cl} = 0$$

$$v_{cl} = v_{exit} - \theta_{exit} = v_{exit} - \theta_{w_{max}}$$

$$\theta_{w_{max}} + v_a = \theta_{cl} + v_{cl} \rightarrow \theta_{cl} = 0$$

$$\boxed{\theta_{w_{max}} + v_a = v_{cl}}$$

$$\boxed{\rightarrow v_a = v_d}$$

$$(-\theta_{w_{max}}) - v_d = \theta_{cl} - v_{cl} \rightarrow \theta_{cl} = 0$$

$$\boxed{\theta_{w_{max}} + v_d = v_{cl}}$$

$$\theta_{max} + v_{max} = v_{cl}$$

$$\theta_{max} + \theta_{max} = v_{cl}$$

$$2\theta_{max} = v_{cl} \rightarrow \boxed{\theta_{max} = \frac{v_{cl}}{2} =}$$

Right Char

$$\theta_{cl} + v_{cl} = \theta_{exit} + v_{exit} \rightarrow \theta_{cl} = 0 \rightarrow v_{cl} = \theta_{exit} + v_{exit} =$$

$$\boxed{\theta_{max} = \frac{v_{exit} + (-\theta_{exit})}{2}}$$

Left Char

$$\theta_{cl} - v_{cl} = \theta_{exit} - v_{exit} \rightarrow \theta_{cl} = 0 \rightarrow -v_{cl} = \theta_{exit} - v_{exit} \rightarrow v_{cl} = v_{exit} - \theta_{exit}$$

$$\boxed{\theta_{max} = \frac{v_{exit} - \theta_{exit}}{2}} \rightarrow \theta_{exit} = 0 \rightarrow \boxed{\theta_{max} = \frac{v_{exit}}{2}} \rightarrow \text{Bell}$$

$$\theta_{max} = \frac{v_{exit} - \theta_{max}}{2} = \theta_{max} + \frac{\theta_{max}}{2} = \frac{v_{exit}}{2} \rightarrow \boxed{\theta_{max} = \frac{v_{exit}}{2} \cdot \frac{2}{3} = \frac{v_{exit}}{3}} \rightarrow \text{conical}$$