

**【1.6】**

BC 間においてパイプ内径は  $x$  方向に一定の変化率で減少するため、各区間に分けて考える.

## 1) AB 間

$$\text{半径: } r_{AB} = \sqrt{3}r \text{ とする.}$$

$$\text{断面積: } A_{AB} = \pi r_{AB}^2 = 3\pi r^2$$

$$\text{流速: } u_{AB} = u$$

$$\text{流量: } Q_{AB} = A_{AB}u_{AB} = 3\pi r^2u$$

$$\text{移流加速度: } u \frac{\partial u}{\partial x} \Big|_{AB} = u \times 0 = 0$$

## 2) CD 間

$$\text{半径: } r_{CD} = r \text{ とする.}$$

$$\text{断面積: } A_{CD} = \pi r_{CD}^2 = \pi r^2$$

$$\text{流量: } Q_{CD} = A_{CD}u_{CD} = Q_{AB} = 3\pi r^2u$$

$$\text{流速: } u_{CD} = \frac{Q_{CD}}{A_{CD}} = \frac{3\pi r^2u}{\pi r^2} = 3u$$

$$\text{移流加速度: } u \frac{\partial u}{\partial x} \Big|_{CD} = 3u \times 0 = 0$$

## 3) BC 間

$$\text{半径: } r_{BC} = \frac{r - \sqrt{3}r}{L}x + (2\sqrt{3} - 1)r = \alpha r \text{ とする. } \left( \alpha = ax + b, a = \frac{1 - \sqrt{3}}{L}, b = 2\sqrt{3} - 1 \right)$$

$$\text{断面積: } A_{BC} = \pi r_{BC}^2 = \pi \alpha^2 r^2$$

$$\text{流量: } Q_{BC} = A_{BC}u_{BC} = Q_{AB} = 3\pi r^2u$$

$$\text{流速: } u_{BC} = \frac{Q_{BC}}{A_{BC}} = \frac{3\pi r^2u}{\pi \alpha^2 r^2} = \frac{3}{\alpha^2}u$$

$$\text{移流加速度: } u \frac{\partial u}{\partial x} \Big|_{BC} = \frac{3}{\alpha^2}u \left( -\frac{6\alpha}{\alpha^4} \frac{d\alpha}{dx} \right) = -\frac{18a}{\alpha^5}x$$

以上の各式に  $L = 1, u = 1$  を代入すれば、以下の図が得られる.

$$u_{AB} = 1, u_{BC} = \frac{3}{\{(1 - \sqrt{3})x + 2\sqrt{3} - 1\}^2}, u_{CD} = 3$$

$$u \frac{\partial u}{\partial x} \Big|_{AB} = 2 - \frac{\sqrt{3}}{3}, u \frac{\partial u}{\partial x} \Big|_{BC} = \frac{18(1 - \sqrt{3})}{\{(1 - \sqrt{3})x + 2\sqrt{3} - 1\}^5}x, u \frac{\partial u}{\partial x} \Big|_{CD} = 36(\sqrt{3} - 1)$$

