

November 2, 2012

NAME

Fluids-ID

Quiz 11. The force D , that is exerted on a spherical particle moving slowly through a liquid is assumed to be a function of the particle diameter d and velocity V and the fluid viscosity μ . Determine a suitable set of dimensionless parameters.

$$D = f(\mu, d, V)$$

where,

$$D \doteq MLT^{-2}; \mu \doteq ML^{-1}T^{-1}; d \doteq L; V \doteq LT^{-1}$$

Solution:

From the Buckingham Pi theorem, $k - r = 4 - 3 = 1$ pi term is needed.

$$\Pi = D\mu^a d^b V^c$$

and in terms of dimensions

$$M^0 L^0 T^0 \doteq (MLT^{-2})(ML^{-1}T^{-1})^a (L)^b (LT^{-1})^c$$

or

$$M^0 L^0 T^0 \doteq M^{(1+a)} L^{(1-a+b+c)} T^{(-2-a-c)}$$

(+3 points)

To be dimensionless it follows that

$$\begin{aligned} M: \quad 1 + a &= 0 \\ L: \quad 1 - a + b + c &= 0 \\ T: \quad -2 - a - c &= 0 \end{aligned}$$

(+5 points)

therefore, $a = -1$, $b = -1$, $c = -1$. The pi term then becomes

$$\therefore \Pi = \frac{D}{\mu d V}$$

(+2 points)