Calculation task № 24

Determine the liquid flow capacity of the vertical gravitational separator for the following data: the diameter of the separator is 2.35 m, the density of liquid is 840 kg/m^3, the density of gas under conditions of separation is 21 kg/m^3, the dynamic viscosity of liquid is 2.7 mPa·s , the estimated diameter of gas bubbles is 0.15 mm.

Data :

$D_s = 2.35$ m

$\rho_{g.s} = 21 \quad \frac{kg}{m^3}$

$d_{g.b.} := 0.15 \cdot 10^{-3}$ m

$\mu_L = 2.7$ mPa ·s

$\rho_L = 840 \quad \frac{kg}{m^3}$

$g := 9.81 \quad \frac{m}{s^2}$

Determine : $Q_{L.v.s.}$ – ?

Solution

The liquid flow capacity of the vertical gravitational separator :

$$Q_{L.v.s.} = \frac{\pi \cdot D_s^{\,2}}{4} \cdot \frac{d_{g.b.}^{\,2} \cdot \left(\rho_L - \rho_{g.s}\right) \cdot g}{18 \cdot \mu_L \cdot 10^{-3}} \qquad (1)$$

where D_s is diameter of the separator, m ; ρ_L is density of liquid, kg/m^3; $\rho_{g.s}$ is the density of gas under conditions of separation, kg/m^3; μ_L is the dynamic viscosity of liquid, Pa·s; $d_{g.b.}$ is the estimated diameter of gas bubbles, m ; $Q_{L.v.s.}$ is liquid flow capacity of the vertical gravitational separator, m^3/s.

$$Q_{L.v.s.} = \frac{\pi \cdot 2.35^2}{4} \cdot \frac{\left(1.5 \times 10^{-4}\right)^2 \cdot (840 - 21) \cdot 9.81}{18 \cdot 2.7 \cdot 10^{-3}} = 0.016 \quad \frac{m^3}{s} =$$

$$= 0.016 \cdot 86400 = 1382.4 \quad \frac{m^3}{day}$$

Answer : $Q_{L.v.s.} = 0.016 \quad \frac{m^3}{s} = 1382.4 \quad \frac{m^3}{day}$