16
CHAPTER

Impulse of Jets

Q.1 The force exerted by a jet of water on a stationary vertical plate in the direction of jet is given by
(a) $\rho a v$ (b) $\rho a v^2$
(c) $\rho a^2 v$ (d) $\rho a^2 v^2$

Q.2 The force exerted by a jet of water on a moving vertical plate, in the direction of motion of plate is given by
(a) $\rho a v^2$ (b) $\rho a v^3$
(c) $\rho a(v-u)^2$ (d) $\rho a(v-u)^3$

Q.3 When a steady jet strikes on a fixed inclined surface
(a) the flow is divided into parts proportional to the angle of inclination of the surface
(b) no force is exerted by the jet on the vane
(c) the momentum component remains unchanged parallel to the surface
(d) None of the above

Q.4 For maximum efficiency of a series of curved vanes, the speed is
(a) equal to the jet speed
(b) $\frac{3}{4}$ of the jet speed
(c) $\frac{1}{2}$ of the jet speed
(d) $\frac{1}{3}$ of the jet speed

Q.5 The efficiency of jet propulsion with inlet orifices at right angles to the direction of motion of ship is given by
(a) $\frac{2u}{V+u}$ (b) $\frac{2V}{(V+u)^2}$
(c) $\frac{2Vu}{(V+u)^2}$ (d) $\frac{2u(V-u)}{V^3}$

Q.6 The efficiency of jet propulsion when the inlet orifices face the direction of motion of the ship is given by
(a) $\frac{2V}{V+u}$ (b) $\frac{2u}{V+2u}$
(c) $\frac{2Vu}{V+u}$ (d) $\frac{2V}{V+u}$

Q.7 A two-dimensional jet strikes a fixed two-dimensional plane at 45° to the normal to the plane. This causes the jet to split into two streams whose discharges are in the ratio
(a) 1.0 (b) 2.41
(c) 5.83 (d) 1.414

Q.8 A jet of water issues from a 5 cm diameter nozzle, held vertically upwards, at a velocity of 20 m/sec. If air resistance consumes 10% of the initial energy of the jet, then it would reach a height; above the nozzle, of
(a) 18.35 m (b) 19.14 m
(c) 19.92 m (d) 20.00 m

Q.9 In case of jet striking on a series of flat plate mounted on the periphery of wheel, the maximum efficiency of the wheel can be
(a) 50% (b) 67%
(c) 75% (d) 100%

Q.10 In case of semicircular vanes, the theoretical maximum efficiency of the wheel can be
(a) 50% (b) 67%
(c) 75% (d) 100%

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Answers Impulse of Jets

1. (b) 2. (c) 3. (a) 4. (c) 5. (c) 6. (b) 7. (c) 8. (a) 9. (a) 10. (d)

Explanations Impulse of Jets

1. (b)
Applying the impulse-momentum equation, the force F exerted by the stationary plate on the jet of fluid in direction normal to the plate may be determined as;

$$-F = \rho a V(0-V)$$

or, $$F = \rho a V^2$$

4. (c)
Efficiency of wheel,

$$\eta = \frac{\text{Work done per second}}{\text{Kinetic energy of jet per second}}$$

or, $$\eta = \frac{2u(v-u)(1+\cos\theta)}{V^2}$$

The jet of constant velocity V, striking a given wheel, the efficiency will be maximum when

$$\frac{d\eta}{du} = 0$$

$$= \frac{2u(v-2u)(1+\cos\theta)}{V^2} = 0$$

$v - 2u = 0$, or $V = 2u$

$$\eta_{max} = \left(\frac{1+\cos\theta}{2}\right)$$

7. (c)

$$\frac{Q_2}{Q_1} = \frac{1-\cos\theta}{1+\cos\theta}$$

$$= \frac{1-\cos 45°}{1+\cos 45°} = 0.1716$$

$$\therefore \quad \frac{Q_1}{Q_2} = \frac{1}{0.716} = 5.83$$

8. (a)

$$h = \frac{0.9v^2}{2g} = \frac{0.9\times 20^2}{2\times 9.81} = 18.35$$

10. (d)
Maximum efficiency,

$$\eta_{max} = \left(\frac{1+\cos\theta}{2}\right)$$

For $\theta = 0°$, the curved vanes will become semi-circular and $\eta_{max} = 1$ or 100%.

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