PRACTICE PROBLEMS

1. A drum type steam generator operates at 160 bar. Water from the drum, subcooled by 7.3°C flows through the downcomer at 1250 kg/s. The risers and downcomers are all 15-m high. The mean density of water-steam mixture in the risers is 350 kg/m³. The pressure loss in the downcomer and riser is 0.52 bar. Calculate the power required to drive a forced circulation loop with $\eta_{pump} = 0.7$. 36.07 kW

2. A 15-m long, 75-mm dia. riser tube receives saturated water at 160-bar and velocity of 0.7 m/s. Heat is added to it uniformly. The slip ratio is 1.7. Estimate the max. heat added to the tube in kJ/m is exit void fraction is not to exceed 0.8. 1336 kJ/m

3. A stage of an impulse turbine operates close to maximum blading efficiency. The blades are equiangular, and friction effects in the blades may be neglected. The mean blade ~~is~~ velocity is 200 m/s and steam flow rate is 0.75 kg/s. Find a) discharge angle and b) diagram efficiency.

4. The velocity of steam leaving the nozzle of an impulse turbine is 900 m/s and nozzle angle is 20°. The blade velocity is 300 m/s and blade friction factor is 0.7. Calculate for a steam mass flow rate of 1 kg/s and symmetric blading (a) blade angle at inlet (b) axial thrust (c) diagram efficiency. 29.43 degrees, 92.35 N , 0.6872

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5. In an impulse turbine, nozzle angle is α. and blade friction factor is k, steam velocity at nozzle outlet is V_1. Assuming symmetric blades, show that optimum blade speed is given by

$$V_b\Big|_{opt} = \frac{V_1 \cos\alpha}{2} \quad \text{and} \quad \eta_D\Big|_{opt} = \frac{1+k}{2}\cos^2\alpha$$

6. Exhaust steam from the turbine with $x = 0.9$ enters a condenser ~~with~~ at 0.13 bar ($T_{sat} = 51^\circ C$) and leaves as water at 45°C. The cooling water enters at 30°C and leaves at 40°C. Estimate the mass ratio of cooling water to steam and condenser effectiveness.

Assume: C_p (water) = 4.2 kJ/kg-K, h_f (45°C) = 188 kJ/kg, ~~h_g~~ h_f and h_{fg} of steam at 0.13 bar = 213 kJ/kg and 2380 kJ/kg respectively.

51.6