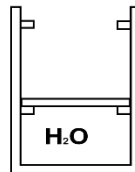


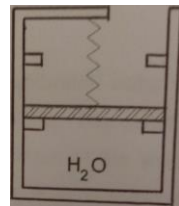
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Assignment-2

1. A piston encloses 2 kg of saturated water which has a quality of 10% initially and the initial pressure of 1.0Mpa. The water is heated in the system as shown in fig. below until the state of the water is saturated vapor. When the piston rests on the upper stops, the volume enclosed is 0.19m^3 . Determine i) the work done by the water ii) the final temperature iii) the final pressure iv) P-v and T-v diagrams and v) the amount of heat transferred. Neglect the volume occupied by the piston.



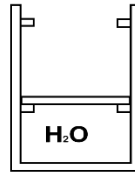
2. Three kilogram of water is contained in a piston cylinder assembly shown in fig. below. The mass of the piston is 5kg and its cross-sectional area is 0.001m^2 . Initially the volume is 0.3m^3 and the water is in equilibrium with the pressures exerted by the piston and the ambient (95kPa). At this position, the spring is just touching the piston. As the water is being heated, it hits the stop at which point the volume is 1.203m^3 and $T=600^\circ\text{C}$. Heating continues until the pressure reaches 1.5Mpa.
- a) Show the process on a P-v and T-v diagrams
 - b) Determine the final temperature
 - c) Find the work done
 - d) Find the amount of heat added during the process



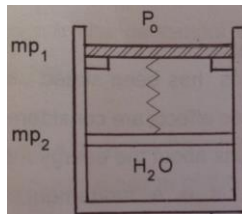
3. A piston cylinder assembly contains 1.5kg of water at 20°C with a volume of 150L. The piston initially rests on the stops as shown in fig. where the mass of the piston and the ambient pressure are such that it requires 500kPa to lift it. Determine the quality when the piston just starts to rise. If the heating is further continued until the water is saturated vapor, find the final temperature, volume, work and heat.

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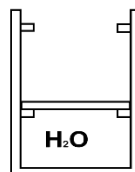
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4. A cylinder having a cross-sectional area of 7.012 cm^2 , has two pistons mounted as in fig. below. The upper one, $m_1=100\text{kg}$, initially resting on the stops. The lower piston, $m_2=0\text{kg}$, has 2kg water below it, with a spring in vacuum connecting the two pistons. The spring force is zero when the lower piston stands at the bottom, and when the lower piston hits the stops the volume is 0.3m^3 . The water, initially at 50kPa , $V=0.00206\text{m}^3$, is then heated to saturated vapor.
- a) Find the initial temperature and pressure that will lift the upper piston
 - b) Find the initial T , P , v and the work done by the water
 - c) The amount of heat added to the water
 - d) Show the process on the p - v and T - v diagram



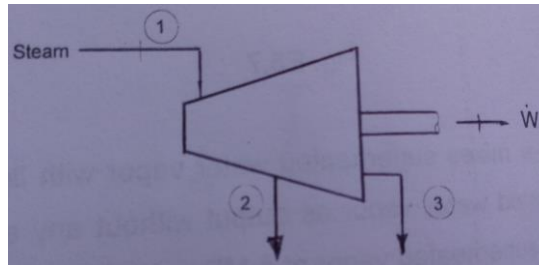
5. Consider the piston-cylinder arrangement shown in fig. below. A frictionless piston is free to move between two sets of stops. When the piston rests on the lower stops, the enclosed volume is 400L . When the piston reaches the upper stops, the volume is 600L . The cylinder initially contains water at 100kPa , 20% quality. It is heated until the water eventually exists as saturated vapor. The mass of the piston requires 300kPa pressure to move it against the outside ambient pressure. Determine the final pressure in the cylinder, the heat transfer, and the work for the overall process.



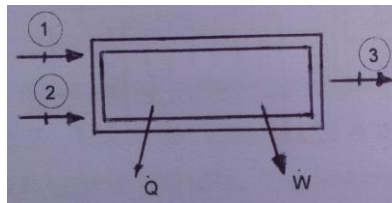
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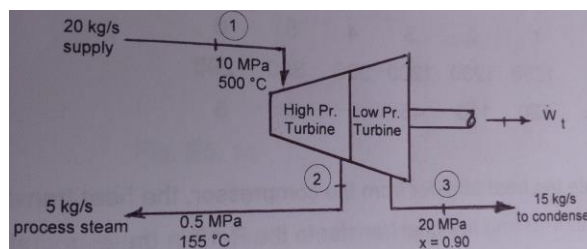
6. A steam turbine receives water at 15MPa, 600°C at a rate of 100 kg/s, shown in fig below. In the middle section, 20 kg/s is withdrawn at 2MPa, 350°C, and the rest exits the turbine at 7kPa, 95% quality. Assuming no heat transfer and no changes in kinetic energy, find the total turbine power output.



7. Two steady flows of air enter a control volume, shown in fig below. One is 0.025 kg/s flow at 350kPa, 150°C, state 1, and the other enters at 350kPa, 15°C, both flowing with low velocity. A single flow of air exits at 100kPa, -40°C through a 25mm diameter pipe, state 3. The control volume rejects 1.2 kW heat to the surroundings and produces 4.5 kW of power. Determine the flow rate of air at the inlet at state 2.



8. Cogeneration is often used where a steam supply is needed for industrial process energy. Assume a supply of 5 kg/s steam at 0.5MPa is needed. Rather than generating this from a pump and boiler, the setup in fig. below is used so the supply is extracted from the high-pressure turbine. Find the power the turbine now cogenerates in this process.

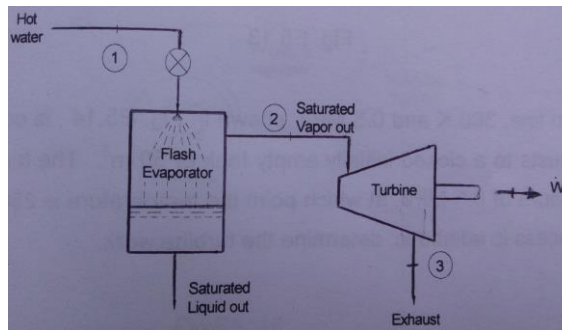


9. A proposal is made to use a geothermal supply of hot water to operate a steam turbine, as shown in fig. below. The high-pressure water at 1.5MPa, 180°C is throttled into a flash

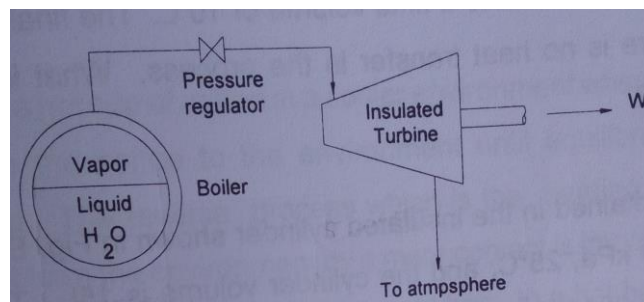
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evaporator chamber, which forms liquid and vapor at a lower pressure of 400kPa. The liquid is discarded while the saturated vapor feeds the turbine and exits at 10kPa, 90% quality. If the turbine should produce 1MW, find the required mass flow rate of hot geothermal water in kilograms per hour.



10. A steam engine based on a turbine is shown in fig. below. The boiler tank has a volume of 100L and initially contains saturated liquid with a very small amount of vapor at 100kPa. Heat is now added by the burner, and the pressure regulator does not open before the boiler pressure reaches 700kPa, which keeps constant. The saturated vapor enters the turbine at 700kPa and is discharged to the atmosphere as saturated vapor at 100kPa. The burner is turned off when no more liquid is present in the boiler. Find the total turbine work and the total heat transfer to the boiler for this process.



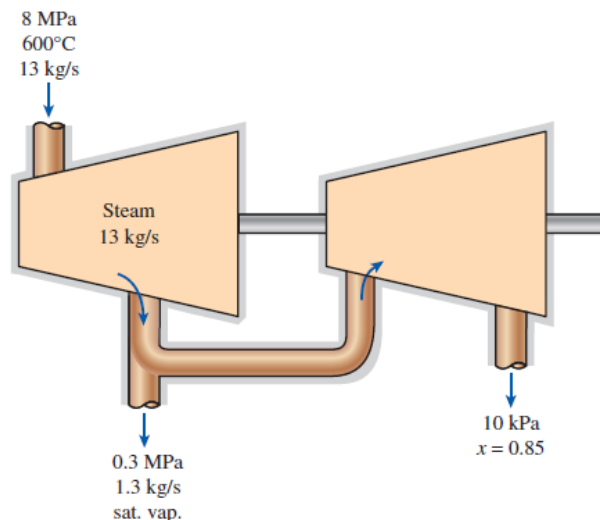
11. Steam at 4MPa and 400°C enters a nozzle steadily with a velocity of 60 m/s, and it leaves at 2MPa and 300°C. The inlet area of the nozzle is 50 cm², and heat is being lost at a rate of 75 kJ/s. Determine (a) the mass flow rate of the steam, (b) the exit velocity of the steam, and (c) the exit area of the nozzle.
12. An adiabatic gas turbine expands air at 1300kPa and 500°C to 100kPa and 127°C. Air enters the turbine through a 0.2-m² opening with an average velocity of 40 m/s, and

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exhausts through a 1-m^2 opening. Determine (a) the mass flow rate of air through the turbine and (b) the power produced by the turbine.

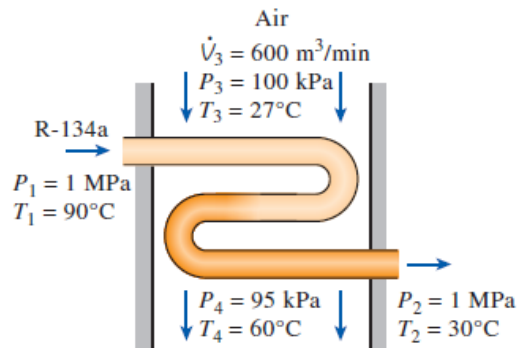
13. Steam enters a steady-flow turbine with a mass flow rate of 13 kg/s at 600°C , 8 MPa , and a negligible velocity. The steam expands in the turbine to a saturated vapor at 300 kPa where 10 percent of the steam is removed for some other use. The remainder of the steam continues to expand to the turbine exit where the pressure is 10 kPa and quality is 85 percent. If the turbine is adiabatic, determine the rate of work done by the steam during this process.



14. A stream of refrigerant-134a at 1 MPa and 20°C is mixed with another stream at 1 MPa and 80°C . If the mass flow rate of the cold stream is twice that of the hot one, determine the temperature and the quality of the exit stream.
15. Refrigerant-134a at 1 MPa and 90°C is to be cooled to 1 MPa and 30°C in a condenser by air. The air enters at 100 kPa and 27°C with a volume flow rate of $600\text{ m}^3/\text{min}$ and leaves at 95 kPa and 60°C . Determine the mass flow rate of the refrigerant.

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16. An air-conditioning system involves the mixing of cold air and warm outdoor air before the mixture is routed to the conditioned room in steady operation. Cold air enters the mixing chamber at 7°C and 105kPa at a rate of $0.55\text{m}^3/\text{s}$ while warm air enters at 34°C and 105kPa . The air leaves the room at 24°C . The ratio of the mass flow rates of the hot to cold air streams is 1.6. Using variable specific heats, determine (a) the mixture temperature at the inlet of the room and (b) the rate of heat gain of the room.

