

Individual homework assignment #5.

1. Nitrogen gas flows into a convergent nozzle at $(200+N)$ kPa, $(400+N)$ K and very low velocity. It flows out of the nozzle at $(100-N)$ kPa, $(300-N)$ K. If the nozzle is insulated (no thermal losses appear), find the outlet velocity.
2. A small, high-speed turbine operating on compressed air produces a power output of $(N*100)$ kW. The inlet state is $(400+N)$ kPa at $(50+N)$ °C while the outlet state is $(150-N)$ kPa at $(30-N)$ °C. Assuming the velocities to be low and the process to be adiabatic, find the required mass flow rate of air through the turbine. If we consider turbine efficiency to be equal to $(88-N/10)$ % and inlet parameters and outlet pressure to be the same, define final temperature on the outlet of turbine and mass flow rate at same power.
3. The compressor of a large gas turbine receives air from the ambient at $(95+N)$ kPa, 20°C, with a low velocity. At the compressor discharge, air exists at $(1,5+N/10)$ MPa, $(430+N)$ °C, with a velocity of $(100+N)$ m/s. The power input to the compressor is 5000 kW. Determine the mass flow rate of air through the unit. If compressor efficiency is $(70+N)$ %, inlet parameters stay the same as well as outlet pressure, define mass flow rate and outlet temperature in this case by considering compression process to be adiabatic.
4. Water pump compresses boiling water (with quality equal to 0) from $(10+N)$ kPa to $(10+N/10)$ MPa with efficiency $(80+N)$ %. Define the power consumed in ideal adiabatic process, real process and by simplified equation: $l=v*(p_2-p_1)$.
5. Steam expands into steam turbine from $(5+N/2)$ MPa and $(300+N)$ °C to $(5+N)$ kPa. Define technical work produced by steam during:
 - a. Adiabatic expansion.
 - b. Polytropic expansion with $\eta_{oit}=(0,8+N/100)$.
 - c. Polytropic expansion with $\eta_{oit}=(0,8+N/100)$ and $(50+N)$ kPa pressure losses in inlet valves.
 - d. Two-staged polytropic expansion with $\eta_{oit}=(0,8+N/100)$ and $(50+N)$ kPa pressure losses in inlet valves of each stage and intermediate superheating at pressure $(0,5+N/10)$ MPa to temperature $(200+N)$ °C.