

Thermodynamic tables are allowed

1. A rigid tank of volume 0.2 m^3 initially contains 0.652 kg of H_2O at 2 bar . A heat reservoir at 500°C is used to heat the tank until the pressure inside it reaches 10 bar . Find initial and final temperatures inside the tank, heat and work exchanged by H_2O , entropy change of the universe as well as availability change due to this process (ambient temperature 27°C). Is the process reversible?
2. In a jet engine (محرك نفاث) enters 0.3 kg/s of fuel (وقود) as well as 3.6 kg/s of air. After combustion (الاحتراق) exhaust gases (غازات العادم) are at 6 bar and 517°C . Their properties may be considered as those of air, semi-ideal. Gases expand in a nozzle in a reversible adiabatic process to exit from it at 1 bar and very high speed to produce a thrust (قوة دفع). Find exit temperature and exit velocity. Find exit density as well as exit cross-sectional area. What is the entropy change during expansion?
3. Ocean (المحيط) temperature at its surface is 27°C . Temperature decreases as we go deep inside the ocean (في أعماق المحيط), because solar rays are absorbed (امتصاص أشعة الشمس) to reach 17°C . It is possible to use this temperature difference to produce electricity, by placing a thermocouple between those temperatures. Two models exist in the market; each of them absorbs 30 W of heat at the hot temperature. Catalog of model 1 states it delivers 0.72 W of electricity, while catalog of model 2 states 1 W of electricity. Which one would you recommend?
4. In an insulated mixer, 0.2 kg/s of CO_2 enter at 1.1 bar and 50°C as well as 0.3 kg/s of N_2 at 1.05 bar at 40°C . Mixture exits at 1 bar . Find exit temperature, partial pressure of each gas at exit, heat and work exchanged, and entropy production due to this process. If ambient temperature was 27°C , what is the availability loss due to this process?
5. In order to measure the dryness fraction of steam flowing in a pipe, part of this steam is extracted to flow through a throttle valve (called throttling calorimeter) before exiting to atmosphere. If steam pressure inside the pipe was 20 bar , while conditions at exit of the throttle valve were 1 bar and 120°C , what is the dryness fraction of steam in the pipe? What is the entropy production due to throttling? If outside air temperature was 27°C , what is the availability loss due to throttling?

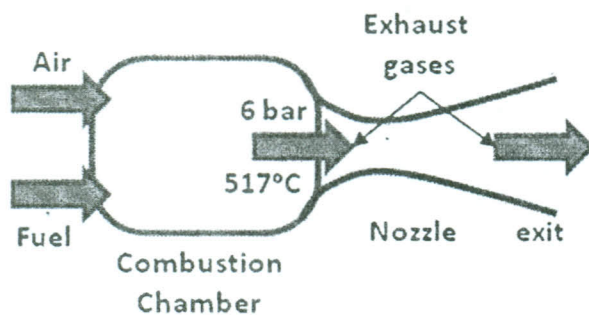


Figure problem 2

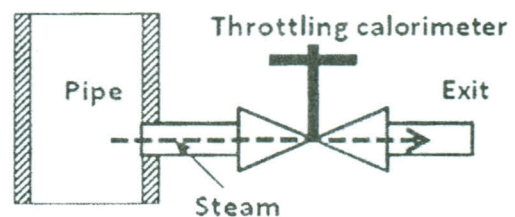


Figure problem 5