Air standard cycles problems and solutions

Section 1: Engine terminology 7-1-1 [4cyl-4000rpm] A four-cylinder four-speed engine runs at 4000 rpm. The hole and stroke are 100 mm each, the MEP is measured as 0.6 MPa and the thermal efficiency is 35%. Determine (a) the power produced by the engine in kW, (b) the waste heat in kW, (c) and the volumetric air intake in L/s. [Edit Problem] Answers: See web edition Reciprocating Cycle 7-1-2 [6cyl-3000rpm] A six-cylinder four-stroke engine operating at 3000 rpm produces 200 kW of total brake power. If the movement of the cycler is 1 L, determine a) the net output in kJ per cylinder per cycle, b) the MEP c) the fuel consumption rate in kg/h. Suppose the heat release per kg of fuel is 30 MJ and the thermal efficiency is 40%. [Edit Issue] [Manual Solution] Answers: See web edition 7-1-3 [6cyl-3000rpm] A six-cylinder engine with 90% volumetric efficiency and 38% thermal efficiency produces 200 kW of power at 3000 rpm. The hole and the cylinder stroke are 100 mm and 200 mm respectively. If the air state in the intake manifold is 95 kPa and 300 K, determine a) the mass flow of air in kg/s, b) the fuel consumption rate in kg/s and c) the specific fuel consumption in kg/kW.hr. Suppose the fuel heating value is 35 MJ/kg fuel. [Edit Issue] [Manual Solution] Answers: See web edition Section-2: Carnot Cycles 7-2-1 [pmax-1900kPa] A Carnot cycle running on a closed system has 1.5 kg of air. The temperature limits are 300 K and 1000 K and the pressure limits are 20 kPa and 1900 kPa. Determine a) efficiency and b) net production. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-2-1(click) 7-2-2 [pmax-1700kPa] Consider a Carnot cycle performed in a closed system with 0.003 kg of air. The temperature limits are 25 or C and 730 or C and the pressure limits are 15 kPa and 1700 kPa. Determine a) efficiency and b) net production per cycle. Use the PG model for air. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-2-3 [tmax-1000K] A standard Carnot air cycle is performed in a closed system between the temperature limits of 300 K and 1000 K. The pressure before and after isothermal compression is 100 kPa and 300 kPa respectively. If the net power per cycle is 0.22 kJ, determine a) the maximum pressure in the cycle, b) the heat transfer to the air and c) the air mass. Use the PG model. (d) What-if scenario: what would be the air mass if you use the IG model? [Edit Issue] [Manual Solution] [TEST Solution] Answers: (a) 20.2 MPa, (b) 0.315 kJ, 0.001 kg, (d) 0.001 kg 7-2-4 [tmax-1200K] A standard Carnot air cycle is performed in a closed system between the temperature limits of 350 K and 1200 K. The pressure before and after isothermal compression is 150 kPa and 300 kPa kPa If the net production per cycle is 0.5 kJ, determine a) the maximum pressure in the cycle, b) the transfer of heat to air and c) the air mass. Take specific variable heat for air. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Section-3: Otto Cycles 7-3-1 [t-80F] An ideal Otto cycle has a compression ratio of 9. At the beginning of compression, the air is at 14.4 psia and 80 or F. During the addition of heat at constant volume, 450 Btu/lbm of heat is transferred. Calculate a) the maximum temperature, b) efficiency and c) net production. Use the IG model. d) Scenario of what would happen: what would be the efficiency if the air were at 100 or F at the beginning of compression? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-3-1(click) 7-3-2 [tmax-1000C] An ideal Otto cycle with air as the working fluid has a compression ratio of 8. The minimum and maximum temperatures of the cycle are 25 or C and 1000 or C respectively. Using the IG model, determine a) the amount of heat transferred to air during the heat addition process, b) thermal efficiency and c) the average effective pressure. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-3 [p-98kPa] An ideal Otto cycle has a compression ratio of 7. At the beginning of the compression process, the air is at 98 kPa, 30 or C and 766 kJ/kg heat is transferred to air during the process of adding heat at constant volume. Determine a) the pressure and temperature at the end of the heat addition process, b) net production, c) thermal efficiency and d) the average effective pressure for the cycle. Use the IG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-4 [tmax-1100C] An engine equipped with a single cylinder with a hole of 12 cm and a stroke of 50 cm operates on an Otto cycle. At the beginning of the compression stroke the air is at 100 kPa, 25 or C. The maximum temperature in the cycle is 1100 or C. (a) If the game volume is 1500 cc, determine the standard air efficiency. b) At 300 rpm, determine the output of the engine in kW. Use the PG model. (c) Scenario of what would happen: what would be the efficiency and output of the engine if the game volume were reduced to 1200 cc? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-5 [tmax-1726C] The temperature at the beginning of the compression process of a standard Otto air cycle with a compression ratio of 8 is 27 or C, the pressure is 101 kPa and the cylinder volume is 566 cm 3. The maximum temperature during the cycle is 1726 or C. Determine (a) thermal efficiency and b) the average effective pressure. Use the PG model for air. What-if scenario: What would be the answers if you used the IG model? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-6 [t-900K] The compression ratio of an air air standard cycle is 8. Before isentropic compression, the air is at 100 kPa, 20 or C and 500 cm 3 . The temperature at the end of the combustion process is 900 K. Determine (a) the highest pressure of the cycle, (b) the amount of heat transferred to kJ, c) thermal efficiency and (d) M.E.P. Use the PG template. (c) What-if scenario: what would be the efficiency if the compression ratio were increased to 10? Explain the change with the help of a T-s. diagram [Edit Problem] [Manual Solution] [TEST Solution] Answers: See Web edition Anim. 7-3-6(click) 7-3-7 [tmax-2000C] At the beginning of the compression process of a standard Otto air cycle, the pressure is 100 kPa, the temperature is 16 or C and the volume is 300 cm 3. The maximum temperature in the cycle is 2000 or C and the compression ratio is 9. Determine a) the addition of heat in kJ, b) the network in kJ, c) thermal efficiency and (d) M.E.P. Use the PG template. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-8 [t-289K] The compression ratio in a standard Eight air cycle is 8. At the beginning of the compression stroke, the pressure is 101 kPa and the temperature is 289 K. The heat transfer to air per cycle is 1860 kJ/kg. Determine a) thermal efficiency and b) the average effective pressure. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-9 [tmax-750C] A standard Eight air cycle has a compression ratio of 9. At the beginning of compression, the pressure is 95 kPa and the temperature is 30 or C. The addition of heat to the air is 1 kJ and the maximum temperature in the cycle is 750 or C. Using the IG model for air, determine (a) the network in kJ, b) thermal efficiency and (c) M.E.P. Take air mass as 0.005 kg. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-10 [t-810K] The compression ratio of a standard Air Otto cycle is 8.7. Before the isentropic compression process, the air is at 120 kPa, 19 or C and 660 cm 3 . The temperature at the end of the isentropic expansion process is 810 K. Using the PG model, determine (a) the highest temperature and pressure of the cycle, (b) the amount of heat transfer in kJ, (c) thermal efficiency, and (d) M.E.P. [Edit Problem] [Manual Solution] [TEST Solution] Answers: See web edition Anim. 7-3-10(click) 7-3-11 [t-21C] The compression ratio in a standard Eight Air cycle is 8. At the beginning of the compression stroke the pressure is 0.1 MPa and the temperature is 21 or C. The heat transfer to air per cycle is 2000 kJ/kg. Determine a) thermal efficiency and b) the average effective pressure. Use the PG model for air. [Edit Issue] [Manual Solution] [TEST Solution] See web edition 7-3-12 [tmax-1630K] An ideal Otto cycle with argon as the working fluid has a compression ratio of 8.5. The minimum and maximum temperatures of the cycle are 350 K and 1630 K. Accounting Accounting variation of specific heat with temperature (i.e. using the IG model for air), determine (a) the amount of heat transferred to air during the heat addition process, (b) the thermal efficiency and (c) the thermal efficiency of a Carnot cycle operating between the same temperature limits. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-13 [heat-1000kJ] An ideal Otto cycle has a compression ratio of 8.3. At the beginning of the compression process, the air is at 100 kPa and 25 or C and 1000 kJ/kg heat are transferred to air during the process of adding heat at constant volume. Using the IG model for air, determine (a) the maximum temperature and pressure occurring during the cycle, b) thermal efficiency and (c) the average effective pressure for the cycle. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-3-14 [ter-1700C] In 7-3-13 , suppose the heat addition can be modeled as heat transfer from a source to 1700 or C. Using the PG model for air, determine (a) the transferred esergy from the tank and (b) the esergia rejected into the atmosphere by the gas mass unit engine. Suppose the weather conditions are 100 kPa and 25 or C. [Edit Problem] [TEST Solution] Answers: See web edition 7-3-15 [1cyl-300rpm] An engine equipped with a single cylinder with a 12 cm hole and a 50 cm stroke operates on an Otto cycle. At the beginning of the compression run the air is at atmospheric conditions of 100 kPa, 25 or C. The maximum cycle temperature is 1100 or C and it can be assumed that the addition of heat will take place from a tank at 1500 or C. If the game volume is 1500 cm 3 and the engine operates at 300 rpm, determine a) the output of the engine in kW, b) the destruction of the ertgy over an entire cycle and c) the rate of destruction of the kWsergy. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Section-4: Diesel Cycles 7-4-1 [tmax-2000C] A standard diesel cycle ideal for cold air has a compression ratio of 20. At the beginning of compression, the air is at 95 kPa and 20 or C. If the maximum temperature during the cycle is 2000 or C, determine a) the thermal efficiency and b) the average effective pressure. Use the PG model. (c) Scenario of what would happen: what would the MEP be if the compression ratio were reduced to 10? Explain the change with the help of a T-s. diagram [Edit Problem] [Manual Solution] [TEST Solution] Answers: See Anim web edition. 7-4-1(click) 7-4-2 [vol-3L] The displacement volume of an internal combustion engine is 3 L. The processes inside each engine cylinder are modeled as a standard air diesel cycle with a ratio of of 2. The state of the air at the beginning of the compression is fixed by p1= 100 kPa, T1= 25 or C, and Vol1= 3.5 L. Determine (a) the network per cycle, b) efficiency and c) the power developed by the engine, engine, the cycle runs 1500 times per minute. (d) What-if scenario: what would be the efficiency and power developed if the break ratio were 2.5? Explain the changes with the help of a T-s. diagram [Edit Problem] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-3 [p-97kPa] A standard air diesel cycle has a compression ratio of 15 and a cutting ratio of 3. At the beginning of the compression process, the air is at 97 kPa and 30 or C. Using the PG model for air, determine a) the temperature after the heat addition process, b) thermal efficiency and c) the actual average pressure. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-4-3(click) 7-4-4 [cr-16] A standard air diesel cycle has a compression ratio of 16 and a cutting ratio of 2. At the beginning of the compression process, the air is at 100 kPa, 15 or C and has a volume of 0.014 m 3. Determine a) the temperature after the heat addition process, b) thermal efficiency and c) the average effective pressure. Use the PG model. (d) What-if scenario: what would be the efficiency if you used the IG model? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-5 [cr-10] At the beginning of the compression process of a standard air diesel cycle that works with a compression ratio of 10, the temperature is 25 or C and the pressure is 100 kPa. The cycle cut ratio is 2. Determine a) thermal efficiency and b) the average effective pressure. Use the PG model. (d) E-if scenario: what would be the efficiency if the compression ratio had increased to 15? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-6 [p-150kPa] The conditions at the beginning of the compression process of a standard air diesel cycle are 150 kPa and 100 or C. The compression ratio is 15 and the addition of heat per unit mass is 750 kJ/kg Determine (a) the maximum temperature, b) the maximum pressure, c) the cutting ratio, d) the network per unit air mass and c) thermal efficiency. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-7 [temp-3100R] A standard air diesel cycle has a compression ratio of 17.9. The air is at 85 or F and 15.8 psia at the beginning of the compression process and at 3100 or R at the end of the heat addition process. By accounting for the variation in specific heat with temperature, determine a) the cutting ratio, b) heat loss per unit mass and c) thermal efficiency. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-8 [cr-20] An ideal diesel engine has a compression ratio of 20 and uses nitrogen gas as a working fluid. The state of the nitrogen at the beginning of the compression process is 95 kPa and 20 or C. If the maximum cycle temperature does not exceed 2200 K, determine a) the thermal efficiency and b) the average efficiency Use the PG model for nitrogen. (c) Scenario of what would happen: what would be the efficiency and the MEP if carbon dioxide were used as a working substance? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-9 [cr-22] An ideal diesel engine has a compression ratio of 22 and uses air as a working fluid. The air state at the beginning of the compression process is 95 kPa and 22 or C. If the maximum cycle temperature does not exceed 1900 or C, determine a) the thermal efficiency and b) the average effective pressure. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-10 [4cyl-3L] A 3-L four-cylinder diesel engine (maximum volume per cylinder) that runs on an ideal Diesel cycle has a compression ratio of 18 and a cutting ratio of 3. The air is at 25 or C and 95 kPa at the beginning of the compression process. Using standard cold air assumptions, determine (a) how much power the engine will provide at 1700 rpm. (b) Scenario of what would happen: what would be the power if the engine speed decreased to 1500 rpm? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-4-11 [heat-2000kJ] A standard air diesel cycle has a compression ratio of 19 and the heat transfer to the working fluid per cycle is 2000 kJ/kg. At the beginning of the compression process the pressure is 105 kPa and the temperature is 20 or C. Determine a) the network, b) the thermal efficiency and c) the average effective pressure. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Section-5: Other alternative power cycles 7-5-1 [dual-2200K] An ideal dual cycle has a compression ratio of 14 and uses air as a working fluid. The air state at the beginning of the compression process is 100 kPa and 300 K The pressure ratio is 1.5 during the constant volume head addition process If the maximum temperature in the cycle is 2200 K, determine (a) the thermal efficiency and (b) the average effective pressure. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-2 [dual-cr18] At the beginning of the compression process of a standard double air cycle with a compression ratio of 18, p = 100 kPa and T = 300 K. The pressure ratio for the constant volume part of the heating process is 1.5 and the volume ratio of the constant pressure part is 1.2. Determine a) thermal efficiency and b) MEP. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Fig. 7-5-2 7-5-3 [dual-1400C] A standard double air cycle has a compression ratio of 17. At the beginning of compression, p1 = kPa and T1 = 15 or C and the volume is 0.5 ft 3 . The pressure doubles during the process of adding heat at constant volume. For a maximum cycle temperature of 1400 or C, determine a) thermal efficiency and b) MEP. Suppose you c_p (IG model). [Change Problem] Issue] Solution] [TEST Solution] Answers: See web edition 7-5-4 [dual-1bar] A standard double air cycle has a compression ratio of 15 and a cutting ratio of 1.5. At the beginning of compression, p1 = 1 bar and T1 = 290 K. The pressure doubles during the process of adding heat at constant volume. If the air mass is 0.5 kg, determine a) the cycle network, b) thermal efficiency and c) MEP. Use the PG model. d) Scenario of what would happen: what would be the network and efficiency if the compression ratio were increased to 18? Explain the changes with the help of a T-s. diagram [Edit Problem] [Manual Solution] [TEST Solution] Answers: See Web Edition Fig. 7-5-4 7-5-5 [aria-3stroke] A 3-stroke cycle is performed in a closed system with 1 kg of air, and consists of the following three processes: (1) Isentropic compression from 100 kPa, 300 K to 800 kPa, (2) p = constant when adding heat in amounts of 2000 kJ , (3) p = cV during heat waste in its initial state. Calculate (a) the maximum temperature and b) the efficiency. Shows the loop in the T-s and p-v diagrams. Use the PG model for air. (c) Scenario of what would happen: what would be the efficiency if the addition of heat at constant pressure amounted to 1000 kJ? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Fig. 7-5-5 7-5-6 [air-2kJ] A standard air cycle is performed in a closed system with 0.005 kg of air, It consists of the following three processes: (1) isentropic compression from 200 kPa, 30 or C to 2 MPa, (2) p = constant when adding heat in the amount of 2 kJ, (3) p = c1v c2 during heat waste in the initial state. Calculate (a) the rejected heat and (b) the thermal efficiency. Take constant specific heat at room temperature. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-7 [air-0001kg] A standard air cycle is performed in a closed system with 0.001 kg of air, It consists of the following three processes: (1) v = constant when adding heat from 95 kPa 20 or C to 450 kPa, (2) isentropic compression of 95 kPa, (3) p = constant during heat rejection in the initial state. Using the PG model calculate (a) the network per cycle in kJ and (b) thermal efficiency. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-8 [air-700kPa] A standard air cycle is performed in a closed system with 1 kg of air, It consists of the following three processes: (1) Isentropic compression from 100 kPa, 27 or C to 700 kPa, (2) p = constant during heat in addition to the initial specific volume, (3) v = constant during heat rejection in the initial state. Calculate (a) the maximum temperature and b) the efficiency. Shows the loop in the T-s and p-v diagrams. the PG model. c) Scenario of what would happen: what would be the maximum temperature if isentropic compression occurred from 100 kPa, 27 or C to 500 kPa? [Edit Issue] [Manual Solution] [TEST Solution] Answers: Answers: Web edition Fig. 7-5-8 7-5-9 [air-27C] A standard air cycle is performed in a closed system with 1 kg of air, It consists of the following three processes: (1) Isentropic compression from 100 kPa, 27 or C to 700 kPa, (2) p = constant during heat added to the initial specific volume, (3) v = constant during heat rejection in the initial state. Calculate (a) the maximum temperature and b) the efficiency. Shows the loop in the T-s and p-v diagrams. Use the IG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-10 [air-3000kJkg] A standard air cycle is performed in a close system and consists of the following four processes: (1) 1-2: isentropic compression of 110 kPa and 30 or C at 900 kpa, (2) 2-3: p = constant when adding heat in the amount of 3000 kJ/kg, (3) 3-4: v = constant during heat waste at 110 kPa, (4) 4-1: p = constant during heat waste in the initial state. (a) Calculate the maximum temperature in the cycle and b) determine the thermal efficiency. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Fig. 7-5-10 7-5-11 [air-15psia] A standard air cycle is performed in a close system and consists of the following four processes: (1) 1-2: v =constant during the addition of heat of 15 psia and 85 or F in the amount of 320 Btu/lbm, (2) 2-3: p =constant during heat added to 3500 or R, (3) 3-4: isentropic expansions at 15 psia, (4) 4-1: p =constant during heat rejection in the initial state. (a) Calculate the amount of heat added in the cycle and b) determine the thermal efficiency. Use the IG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-12 [air-95kPa] A standard air cycle with specific variable heats is performed in a close system and consists of the following four processes: (1) 1-2: isentropic compression from 95 kPa and 25 or C to 900 kPa, (2) 2-3: v = constant during heat added to 1200 or C, (3) 3-4: isentropic expansions at 95 kPa, (4) 4-1: p =constant during heat rejection in the initial state. (a) Calculate net production per unit mass and b) determine thermal efficiency. Use the IG model for air. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-13 [air-110kPa] A standard air cycle is performed in a close system with 0.001 kg of air and consists of the following three processes: (1) 1-2: isentropic compression from 110 kPa and 30 or C to 1 1.1MPa (2) 2-3: p = constant during thermal addition in the amount of 1.73 kJ (3) 3-1: p=c1*v c2 during heat waste in the initial state (c1 and c2 are constant) (a) Calculate the rejected heat and (b) determine thermal efficiency. the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-14 [stirling-800kJkg] An ideal Stirling cycle that runs on a closed system has air at 200 kPa, 300 K at the beginning of the compression process. The heat supplied by a source of 1700 K is 800 kJ/kg. Determine a) efficiency and b) net production per kg of air. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-5-14(click) 7-5-15 [stirling-cr5] Considers an ideal Stirling cycle engine where the pressure and temperature at the beginning of the isothermal compression process are 95 kPa, 20 or C, the compression ratio is 5 and the maximum temperature in the cycle is 1000 or C. Determine (a) the maximum pressure and (b) the thermal efficiency of the cycle. Use the PG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-16 [stirling-102kPa] An ideal Stirling engine that uses helium as a working fluid operates between the temperature limits of 38 or C and 850 or C and the pressure limits of 102 kPa and 1020 kPa. Assuming that the mass used in the cycle is 1 kg, determine a) the thermal efficiency of the cycle and b) the network. c) Simulation scenario: what would be the efficiency and network if argon were used as a working fluid? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-17 [stirling-650C] Consider an ideal Stirling cycle engine where pressure, temperature and volume at the beginning of the isothermal compression process are 100 kPa, 15 or C and 0.03 m 3 , the compression ratio is 8 and the maximum temperature in the cycle is 650 or C. Determine a) the network, b) thermal efficiency and c) the actual average pressure. Use the PG model. [Edit Problem] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-18 [stirling-50g] Fifty grams of air undergo a Stirling cycle with a compression ratio of 4. At the beginning of the isothermal process, the pressure and volume are 100 kPa and 0.05 m 3 respectively. The temperature during isothermal expansion is 990 K. Determine a) net production per kg and b) the average effective pressure. Use the IG model. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-5-19 [stirling-1800K] An ideal Stirling engine that uses helium as a working fluid operates between the temperature limits of 300 K and 1800 K and the pressure limits of 150 and 1200 kPa. Assuming that the mass used in the cycle is 1.5 kg, determine a) the thermal efficiency of the cycle, b) the amount of heat transfer in the regenerator and c) the production of work per cycle. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Section-6: Exergy Analysis of Reciprocating Power Cycles 7-6-1 [carnot-1900kPa] A Carnot cycle running on a closed system has 1 kg of air and performs 20 cycles every second. The temperature limits are 300 K and 1000 K and the pressure limits are 20 and 1900 kPa. The weather conditions are 100 kPa and 300 K. (a) perform a complete inventory of the exegy and and a desertion flowchart for the speed-based cycle (kW). b) What is the performance efficiency of the Carnot engine? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See Anim web edition. 7-6-1(click) 7-6-2 [carnot-750C] Consider a Carnot cycle performed in a closed system with 0.5 kg of air. The temperature limits are 50 or C and 750 or C and the pressure limits are 15 kPa and 1700 kPa. Heat is added from a tank at 775 or C and heat is wasted in the atmosphere at 100 kPa, 25 or C. Using the PG model for air, (a) perform a complete inventory of the hesergy and draw a flowchart of executors for the cycle on a unit mass basis (kJ/kg). b) What is the performance efficiency of the Carnot engine? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-6-3 [eight-1500C] In problem 7-3-2 , (a) perform a complete inventory of thesergy and draw a flowchart of exegies for the cycle on a unit mass basis (kJ/kg). Suppose that the addition of heat takes place from a tank at 1500 or C and that the heat waste is in the atmosphere at 100 kPa, 25 or C. Use the PG model for air. b) What is the overall executor efficiency of the engine? [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-6-4 [4cyl-3000rpm] A 4-cylinder IC engine runs at 3000 rpm in a standard Otto cycle. Data for a single cylinder are shown as follows. The compression ratio is 8.7. Before the isentropic compression process, the air is located at atmospheric conditions of 100 kPa, 20 or C and 660 cm 3 . The temperature at the end of the isentropic expansion process is 810 K. Suppose the addition of heat takes place from a tank at 1500 or C and the rejection of heat in the atmosphere. Using the PG model, (a) perform a complete inventory of the esergy and draw the exegy flow diagram on a speed basis (kW). Determine (b) the overall performer efficiency and c) the thermal (energy) efficiency of the cycle. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-6-4(click) 7-6-5 [eight-50cm] For each process in problem 7-3-15 , (a) develop a speed-based inventory (in kW) and draw a diagram of the extensible flow for the cycle and (b) determine the extensible efficiency of the engine. Suppose that the addition of heat and heat waste are set respectively with tanks at the maximum and minimum temperature of the cycle. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-6-6 [diesel-3L] A 3-L four-cylinder diesel engine (maximum volume per cylinder) that runs on an ideal Diesel cycle has a compression ratio of 18 and a cutting ratio of 3. is at 25 or C and 100 kPa (weather conditions) at the beginning of the compression process. Suppose that heat is added from a tank at 1500 or C and heat is wasted in the atmosphere. Using the PG model, (a) perform a complete extensible inventory and draw drawing speed-basedsergy flow diagram (kW). Determine (b) the overall performer efficiency and c) the thermal (energy) efficiency of the cycle. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See anim web edition. 7-6-6(click) 7-6-7 [diesel-1800C] In problem 7-4-11 suppose that heat is added from a tank at 1800 or C and weather conditions are 100 kPa and 20 or C. (a) Determine the process that involves the greatest penalty in terms of destruction of the extension. (b) Also develop an exergy balance for the entire rate-based cycle (kW), including an energy flow chart. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition 7-6-8 [air-2000C] In problem 7-5-8 suppose that heat is added from a tank at 2000 or C and that the weather conditions are 100 kPa and 27 or C. Determine (a) thermal efficiency and (b) cycle efficiency. (c) Also develop an externalization balance for the entire unit mass cycle (kJ/kg) complete with an extensification flow diagram. [Edit Issue] [Manual Solution] [TEST Solution] Answers: See web edition Version 3; Last Updated: 2010-10am-31 am 11:02:08