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Rauf Arif attends Dps Ringa 1. Chapter 9 Gas Power Cycle (Part 1a) Copyright © McGraw Hill Company, Inc. Permission required for unauthorized reproduction or display. Thermodynamics: Engineering Approach, 6th Edition Yunus A. Schengel, Michael A. Bolles McGraw Hill, 2008 2. 2 goals 1. Evaluate the performance of the gas power cycle. 2. Develop simplified assumptions that apply to gas power cycles. 3. Review the operation of the reciprocating engine. 4. Analyze both closed and open gas power cycles. 5. Solve problems according to auto and diesel cycles. 6. Solve problems according to Brayton cycle; Playingbrayton cycles; and provide brayton cycles through mutual cooling, reheating and regeneration. 7. Simplify, identify assumptions and perform a second law analysis on gas power cycles. 3. Basic considerations of power cycle analysis Analysis Analysis of many complex processes can be reduced to a manageable level by utilizing some idealization. Most power-producing devices operate in cycles. Ideal cycle: A cycle that closely resembles a real cycle, but is completely configured as an internally reversible process, is called an ideal cycle. Recall: The thermal efficiency of thermal engines such as carnot cycles has the highest thermal efficiency of any thermal engine operating between the same temperature levels. Unlike an ideal cycle, it is completely reversible and does not work as a realistic model. 4. 4 1. The cycle does not contain friction. Therefore, the working fluid flows from the pipe or heat exchanger, so it does not experience pressure drop. 2. All expansion and compression processes are performed in a quasi-equilibrium manner. 3. The pipes connecting the various components of the system are well insulated, so heat transfer through them can be ignored. Exercise caution in the interpretation of the results in an ideal cycle. In both P-v and T-s diagrams, areas enclosed by process curves represent the net work of the cycle. In the T-s diagram, the ratio of the enclosed area by the circular curve to the area below the heat addition process curve represents the thermal efficiency of the cycle. Idealization (simplification) in the analysis of power cycle 5. 5 Cano cycles - the value of T-s diagrams of engineering P-v and Carnot cycles. Example: Steady Cano engine. The Carnot cycle consists of four fully reversible processes: adding isothermal columns, extending isentropic, rejecting Ethermal columns, and compressing isentropic. Both ideal and actual cycles: Increased thermal efficiency with an increase in the average temperature at which heat is supplied to the system, or a decrease in the average temperature at which heat is denied by the system. 6. The air standard home combustion process is replaced by a heat-adding process in an ideal cycle. 1. The working fluid is air, which circulates continuously. Closed loops always act as ideal gases. 2. All processes that make up the lifecycle can be reverted internally. 3. The combustion process is replaced by a heat-adding process from an external source. 4. The exhaust process is replaced by a heat rejection process that restores the working fluid to its initial state. Cold standard assumptions: When the working fluid is considered air with a certain heat at room temperature (25°C). Air standard cycle: The cycle in which the air standard assumption is applied. 7. Chapter 9 Gas Power Cycle (Part 1b) Copyright © McGraw Hill Company, Inc. Permission required for unauthorized reproduction or display. Thermodynamics: Engineering Approach, 6th Edition Yunus A. Schengel, Michael A. Bolles McGraw Hill, 20088. 8 problem autocy cycle 9-34 has the ideal auto cycle compression ratio of 8. At the beginning of the compression process, the air is 95 kPa and 27°C, and 750 kJ/kg of heat is delivered to the air during the constant volume heat addition process. Assuming that a particular heat is constant with temperature: • Pressure and temperature at the end of the heat-adding process, • Net working output, • Thermal efficiency and • Average effective pressure on the cycle. Answer: (a) 3898 kPa, 1539 K, (b) 392.4 kJ/kg, (c) 52.3%, (d) 495 kPa 9. The overview reciprocating engine (basically a piston-cylinder device) of 9 interaction engines is an invention that is highly versatile and has a wide range of applications. Round-trip engines are the powerhouse of the majority of cars, trucks, security vessels, ships, power generators and many other devices. 10. 10 Base Component Compression Ratio: Pistons reciprocate in a cylinder between two fixed positions, called the upper dead center (TDC), which is the position that forms the smallest volume in the cylinder, and the cylinder between the positions that form the largest volume in the cylinder. The distance between the TDC and the BDC is called the stroke of the engine. The diameter of the piston is called a bore. 11. Performance characteristics classification of IC engines: 1. Spark ignition (SI) or gasoline engine 2. Compressed ignition (CI) or diesel engine average effective pressure (MEP): A hypothetical pressure that generates the same amount of net work generated during a real cycle when operated on a piston during a full power stroke. Net job output per cycle: 12. 12 Autocyk: Ideal spark ignition engine cycle in spark ignition engine in P-v diagram. The piston runs four complete strokes within the cylinder. The crankshaft completes two rotations for each thermodynamic cycle. These engines are called 4-scroque IC engines. 13. 13 T-s diagram of ideal autocy cycle IC engine classification: 4 strokes 1 cycle = 4 strokes = crankshaft 2 stroke cycle 1 cycle = 2 strokes = 1 rotation of the crankshaft sequence of the process: 14. The four functions described earlier in the 14 two-stroke engine all run in two strokes: power and compression strokes. Generally less efficient, but relatively simple and inexpensive. It has a high power-to-weight and output-to-volume ratio. 2Strok IC Engine 15. 15 Heat efficiency of autocy cycle constant volume heat supply to working fluid during heating (combustion), constant volume cooling (exhaust), thermal efficiency, temperature volume relationship, compression ratio, cold air reject heat from working fluid during standard assumptions. 16 problem auto cycle 9-34B problem 9-34 to stock the ideal auto cycle. Assuming that a particular heat depends on the temperature: • Pressure and temperature at the end of the heat addition process, • net working output, • thermal efficiency and • average effective pressure on the cycle. Answer: (a) 3898 kPa, 1539 K, (b) 392.4 kJ/kg, (c) 52.3%, (d) 495 kPa 17. The compression ratio of 17 problem autocysts 9-37 air standard auto cycles is 9.5. Before the isentropic compression process, the air is 100 kPa, 35°C and 600 cm3. The temperature at the end of the isentropic expansion process is 800 K. Determined using a specific heat value at room temperature: • The highest temperature and pressure in the cycle; • the amount of heat transferred from kJ; • thermal efficiency; • Average effective pressure. Answer: (a) 1969 K, 6072 kPa, (b) 0.59 kJ, (c) 59.4%, (d) 652 kPa 18. 18 Problem 9-39E Ideal auto cycle with air as if the working fluid had a compression ratio of 8. The minimum and maximum temperatures of the cycle are 300 K and 1340 K. Accounting for changes in temperature and specific heat, determine: • The amount of heat transferred into the air during the heat addition process, • thermal efficiency, • Thermal efficiency of the Carnot cycle operating between the same temperature limits. Autocy cycle class practice 19. 19 Early ignition of fuel generates an audible noise called an engine knock. Performance is degraded and engine damage occurs. Automation lowers the upper limit on the compression ratio available in the SI engine. Certain heat costs, k, affect the thermal efficiency of the autocy cycle. Engine knock (automatic fire) 20. The 20-issue autocyclyst 9-41 four-cylinder, 4-sroke, and 2.2-L gasoline engines work on auto cycles with a compression ratio of 10. The air is 100 kPa and 60°C at the beginning of the compression process, and the maximum pressure in the cycle is 8 MPa. Compression and expansion process can be modeled as a multi-tropic with an index of 1.3. At 850 K, make a decision using a certain column. At the end of the expansion process • net working output and thermal efficiency, • Average effective pressure, • Engine speed for net output of 70 kW, • Specific fuel consumption at g/kWh, defined as the ratio of the mass of fuel consumed to the net work produced. Note: The percentage of air fuel defined by the amount of air is divided by the amount of fuel intake, which is 16. 21. Chapter 9 Gas Power Cycle (1c) Copyright © McGraw Hill Company, Inc. Permission required for unauthorized reproduction or display. Thermodynamics: Engineering Approach, 6th Edition Yunus A. Schengel, Michael A. Bolles McGraw Hill, 22, 2008. The 22-issue diesel cycle has a compression ratio of 9-47 air standard diesel cycles16 and a cutoff ratio of 2. At the beginning of the compression process, the air is 95 kPa and 27 °C. Determines by taking into account changes in temperature and specific heat: • Temperature after heat addition process, • Thermal efficiency and • Average effective pressure. Answer: (a) 1724.8 K, (b) 56.3%, (c) 675.9 kPa 23. 23 diesel cycles: The ideal cycle combustion process for CI engines is performed at longer intervals - fuel injection begins when the piston approaches the TDC and continues during the first part of the power stroke. Therefore, the combustion process of the ideal diesel cycle is approximated by a constant pressure heat addition process. In diesel engines, only air is compressed during compression strokes, eliminating the possibility of automaticization. These engines can typically be designed to operate at a higher compression ratio between 12 and 24. Less refined fuel (and therefore cheaper and more expensive) can be used in diesel engines. 24. 24 1-2 Isentropic compression 2-3 constant pressure heat added 3-4 Isentropic extension 4-1 constant volume heat rejection. Process Order: Note: Gasoline and diesel engines vary depending on how the heat-adding (or combustion) process takes place. It is approximated by a constant volume process in a gasoline engine cycle and a constant pressure process in a diesel engine cycle. 25. 25Cutoff ratio, thermal efficiency of diesel cycle heat supplied to the working fluid during constant pressure heating (combustion), constant volume cooling (exhaust), thermal efficiency of diesel cycle (general) during (general) rejected heat in working fluid - constant specific heat 26. The 26-issue diesel cycle 9-51 ideal diesel engine has a compression ratio of 20 and uses air as an operating fluid. The air conditions at the beginning of the compression process are 95 kPa and 20°C. If the maximum temperature of the cycle does not exceed 2200 K, the following is to be used: Assumes a certain specific heat to the air at room temperature. Answer: (a) 63.5%, (b) Skip 933 kPa... 27. 27 Problem Diesel Cycle The four-cylinder, two-cylinder, 2.4L diesel engine operating in an ideal diesel cycle has a compression ratio of 17 and a cut-off ratio of 2.2. The air is at 55° C and 97 kPa at the beginning of the compression process. Use cold air standard assumptions to determine how much power the engine will provide at 1500 rpm. Skip... 28. For the same compression ratio, the thermal efficiency of the autocy cycle is greater than the diesel cycle. As the cut-off rate decreases, the thermal efficiency of diesel cycles increases. Rc =1 equals the efficiency of auto and diesel cycles. Large diesel engines have a thermal efficiency of about 35-40%. Due to its high efficiency and low fuel cost, diesel engines are attractive in applications such as locomotive engines, emergency power generation devices, large ships and heavy trucks. 29. 29 Problem Diesel Cycle 9-59 6 cylinders, 4th, 4.5-L compression ignition engines work in ideal diesel cycles with a compression ratio of 17. The air is at 95 kPa and 55 °C at the beginning of the compression process, with engine speeds of 2000 rpm. The engine uses a heating value of 42,500 kJ/kg, an air fuel ratio of 24, and a light diesel fuel with combustion efficiency of 98%. Using a constant specific heat at 850 K, the crystal: a) the maximum temperature at the cycle and cutoff ratio, b) net working output and thermal efficiency per cycle, c) average effective pressure, d) net power output, and e) at g / kWh, at g / kWh, it is defined as the ratio of the mass of the fuel consumed in the net operation. Answer: (a) 2383 K, 2.7 (b) 4.36 kJ, 0.543, (c) 969 kPa, (d) 72.7 kW, (e) 159 g/kWh 30. Approximation of the 30 combustion process to a constant volume or constant pressure heat addition process is overly simple and not very realistic. A better approach is to model the combustion process in both SI and CI engines as a combination of two heat transfer processes. Based on this concept, the ideal cycle is called a double cycle. Dual cycles: Realistic ideal cycles for CI engine notes: Auto and diesel cycles can be obtained in special cases of dual cycles. Cycle.