Brayton Cycle(Joule's cycle):

The Ideal Cycle for Gas Turbine Engines

- In reality, gas turbines operate on an open cycle
- Fresh air is continuously drawn into the compressor and exhaust gases are thrown out
- The open gas-turbine cycle can be modeled as a closed cycle
- The combustion process is replaced by a constant-pressure heat-addition process and the exhaust process is replaced by a constant-pressure heat-rejection process

Thermodynamic Analysis

- The four processes of the Brayton cycle are executed in steady-flow devices
- When changes in kinetic and potential energies are neglected, the energy balance for one of the processes can be expressed as

$$\left(q_{\text{in}} - q_{\text{out}}\right) + \left(w_{\text{in}} - w_{\text{out}}\right) = h_{\text{exit}} - h_{\text{inlet}}$$

Therefore, heat transfers to and from the working fluid are

$$q_{\text{in}} = h_3 - h_2 = c_p\left(T_3 - T_2\right)$$

$$q_{\text{out}} = h_4 - h_1 = c_p\left(T_4 - T_1\right)$$

Thermal Efficiency

The thermal efficiency of the ideal Brayton cycle under the cold-air-standard assumptions becomes

$$\eta_{\text{th, Brayton}} = \frac{w_{\text{net}}}{q_{\text{in}}} = 1 - \frac{q_{\text{out}}}{q_{\text{in}}}$$

$$= 1 - \frac{c_p\left(T_4 - T_1\right)}{c_p\left(T_3 - T_2\right)}$$

$$= 1 - \frac{T_1\left(T_4/T_1 - 1\right)}{T_2\left(T_3/T_2 - 1\right)}$$

EX: A gas turbine cycle has the following working parameters temperature of air entering the compressor at (27 ^{o}C) and (1.1 bar) ,the compressor ratio =4 and maximum temperature of cycle (1000 ^{o}C),find the thermal efficiency of the cycle?

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