PHYS157 - Engines Cheat Sheet

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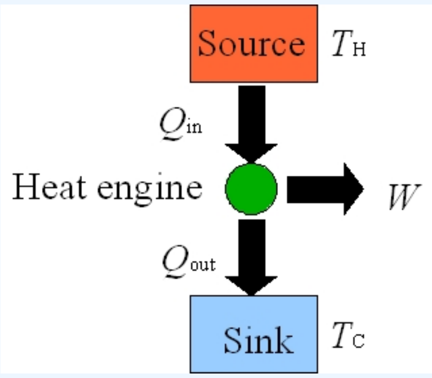
Heat Engines



Heat Engines

Heat Engine: any device that transforms heat partly into work or mechanical energy

Working Substance: a quantity of matter within the engine that undergoes inflow/outflow of heat, expansion/compression, and sometimes phase change

- Simplest kinds of heat engines undergo a cyclic process

All heat engines absorb heat from a source at relatively high temps, preform some mechanical work and then discard/reject heat at a lower temp

Hot reservoir: AKA heat source and can give working substance large amounts of heat w/o changing its own temp

- Example: in steam-turbine engine, flames and hot gasses

Cold reservoir: can absorb large amounts of heat at constant temp

- Example: in steam-turbine engine, cold water

Thermal efficiency (e) = W/Qh -> net work/heat absorbed

Heat Engine Equations

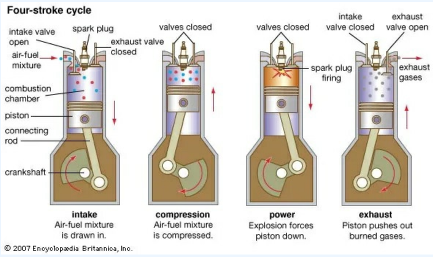
Q=W and ΔU=0

W=|Qh|-|Qc|

e=W/Qh

e=1+(Qc/Qh)

4-Stroke Internal Combustion Engine



Internal Combustion Engines [Gasoline Engines]

Cycle of a 4-Stroke Internal Combustion Engine:

1. **Intake stroke:** pistons moves down causing partial vacuum, intake valve opens and gasoline-air mixture moves in, exhaust valve is closed
2. **Compression Stroke:** intake valve closes and piston moves up to compress mixture
3. **Ignition:** spark plugs ignite mixture and both valves remain closed
4. **Power Stroke:** hot, burned mixture expands, pushing piston down
5. **Exhaust Stroke:** exhaust valve opens and piston moves up, expelling exhaust

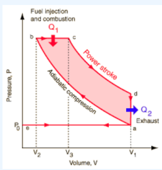
Compression Ratio

Compression Ratio (r): volume when piston is down (max) / volume when piston is up (min)

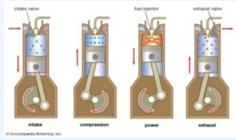
The volume when the piston is up and at its minimum is denoted V, the volume when the piston is down and at its maximum is denoted Vr

Typically between 8-10

Otto Cycle



Diesel Engine

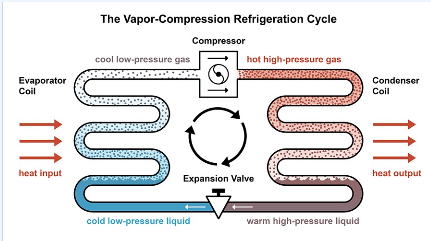


Diesel Engine

Very similar to a gasoline engine except no fuel in the cylinder at the beginning of the compression stroke

Injectors start to inject fuel just fast enough to keep the pressure approximately constant during the first part of the power stroke, because of the high temp developed during compression the fuel spontaneously ignites; therefore, there are no spark plugs

Refrigerator



Refrigerator

Refrigerators are like heat engines operating in reverse, they *require a net input of mechanical work*

Qc > 0 and **W, Qh < 0**

|Qh| = Qc + |W|

Refrigerators have a coefficient of performance denoted by K (similar to efficiency of an engine)

K = |Qc| / |W| or **K = |Qc| = (|Qh| - |Qc|)**

K can also be calculated by taking the heat removed (H) and dividing it by the power input (P)

Heat Pump: reverse refrigerator, takes heat from outside air to heat buildings