Automotive Engines

Matthew Whitten
Brookhaven College

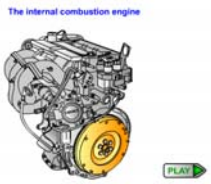
Introduction

- This course explains:
  - The four stroke process
  - Engine components
  - Function of components
  - Operation of components

Power Source

- Automobiles use multiple sources of power:
  - Electrical
    - Induction
  - Chemical
    - Battery
    - Fuel
  - Mechanical
    - Brakes

Purpose of an Engine

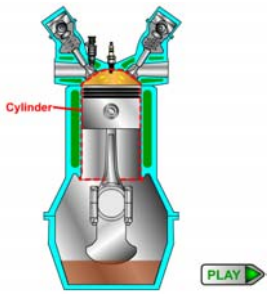


- The internal combustion engine is used to propel our cars.
- It turns chemical energy into mechanical motion

Internal Combustion

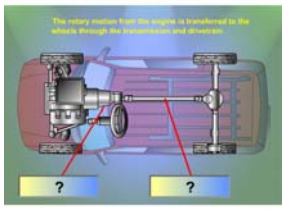
- Internal Combustion:
  - An explosion that is within a confined space.
- The combustion is kept within the cylinders of the engine.
- Combustion is created with an air/fuel mixture and a spark.

Combustion to Motion



- The combustion process is what drives the vehicle.
- The reciprocal motion of a piston moving up and down has its energy transformed to rotary motion with the use of a connecting rod and crankshaft.

Transfer of Power



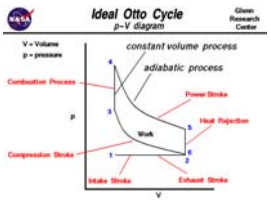
- The power created by the engine is directed to the drive wheels with the use of a transmission and driveline.
- Three main types:
  - FWD
  - RWD
  - 4/AWD

- Break 5 minutes

Cycles

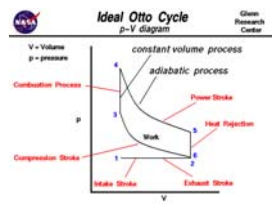
- The process in which an air/fuel mixture is ingested, compressed, exploded, and exhausted is the “Cycle”.
- There are more than one type of cycles used on modern cars:
  - Otto (premixed air/fuel)
  - Diesel (air fuel mix in combustion)
  - Miller
  - Atkinson
  - Wankel
  - Scuderi

Otto Cycle



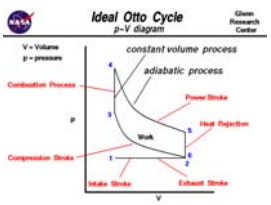
- The Otto Cycle is what powers 90% of all cars on the road today.
- Associated with Nicolaus Otto and Alfonse Beau de Rochas.
- Consists of four strokes.
- The Otto Cycle has the combustion process started by a spark ignition.

Otto Cycle



- Stroke: 1
  - Intake (1-2)
    - During this state the piston is being drawn out of the cylinder.
    - When the piston is moving down the intake valve is open allowing atmospheric pressure to fill the cylinder.
    - During intake the pressure stays constant at atmospheric.
    - The volume of the cylinder increases.

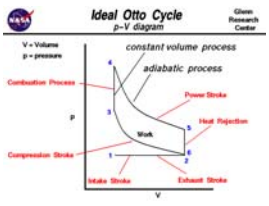
Otto Cycle



- Stroke: 2
  - Compression (2-3)
    - The piston is being forced up by either a momentum of the crankshaft or by rotational torque of a starter or power stroke.
    - In either case work must be done.
    - Both intake and exhaust valves are closed during this creating a pressure increase.
    - Being that the piston it traveling into the bore volume decreases.
    - Not only does the piston cause pressure increase but internal friction causes the gasses to expand.

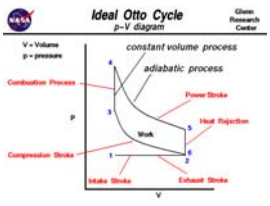
Otto Cycle

- Stroke: 3
  - Power (3-5)
    - The cycle in which power is produced
    - Combustion is created by a spark ignition.
    - Combustion begins slightly before TDC, so as the pressure increases due to the explosion volume will not start to increase immediately.
    - As the piston passes TDC it begins to travel down and as it travels down the volume decreases.
    - Before BDC much of the heat energy within the gasses is transferred to the cylinder walls, this causes a decrease in pressure in volume.

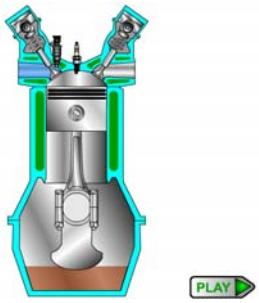


Otto Cycle

- Stroke:4
  - Exhaust (6-1)
    - After the piston passes BDC the exhaust valve opens to allow the gasses to escape.
    - The piston travels upward forcing the gasses out of the cylinder.
    - Before the piston reaches TDC the exhaust valve begins to close. Once at TDC the intake valve begins to open and the exhaust valve finally closes.
    - This is the end and the beginning of the OTTO cycle.



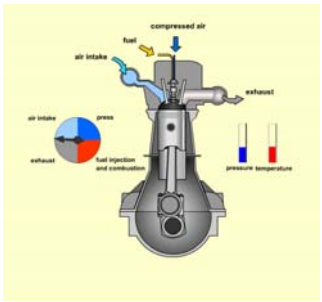
The Complete Otto Cycle



Diesel

- The Diesel engine is very similar to the OTTO. The difference lies within the ignition process and fuel mixing.
- The Diesel cycle uses high compression pressures to heat the air/fuel mixture to the point of it igniting. Therefore this cycle requires no spark plugs.
- The Diesel cycle runs best when the air/fuel mixture is mixed in the cylinder. In most cases the fuel is injected during the compression stroke. The time and amount of injection controls ignition timing and power.
- There are some systems which continue to inject fuel during the power stroke to lengthen and increase the power output from that stroke.
- Fuel injection systems of Diesel cycle engines often run at pressures of 25,000psi to overcome the pressure in the cylinder.

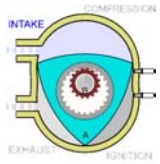
Complete Diesel Cycle



Other Cycles

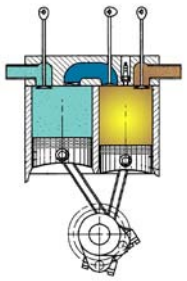
- Atkinson
  - This cycle resembles the Otto very closely. There is one main difference:
    - The intake valve remains open for a portion of the compression stroke
    - This effectively lowers the compression of the engine.
    - Hybrid Escape
- Miller
  - This cycle resembles the Otto very closely. There are two main differences:
    - The intake valve remains open for a portion of the compression stroke
    - There is a supercharger to force more air in during the beginning of the compression stroke.
    - The extra shot of air increases the power output of the engine. Instead of high boost a Miller cycle can run lower boost pressures with same effect.

Wankel



- Wankel
  - The Wankel engine uses the Otto cycle but instead of a reciprocal motion it uses a rotary piston device.
- Components
  - Rotor/internal gear
  - Stationary gear
  - Rotor housing
  - Eccentric

Scuderi



- Scuderi
  - The Scuderi uses two interconnected pistons which work together. The four strokes of the Otto are split between the two pistons. One performs the intake and compression while the other takes the power and exhaust strokes. The first piston ingests air and pressurizes it to compression pressure. The pressurized air is the pumped through a cross-over port. The 2nd piston has the air forced into it during the end of the exhaust stroke. Once the piston reaches TDC the cylinder fires and power is produced. One power stroke is produced per crank revolution.

Bore, Stroke, and Displacement

- An engine is most often referred to by its displacement.
- Displacement is a measurement of the engines cylinder volume
- Cylinder volume is bore x stroke.
- Bore is related to the cylinder
- Stroke is related to the crankshaft

Bore

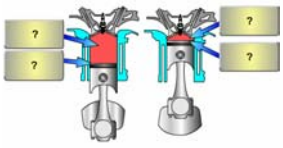
- The diameter of the cylinder in the engine block.
- The cylinder is where the piston moves up and down.
- Can be measured in inches or mm

Stroke

PLAY

- The stroke is controlled by the crankshaft.
- It is the amount of travel that the piston makes. From TDC to BDC.

Displacement



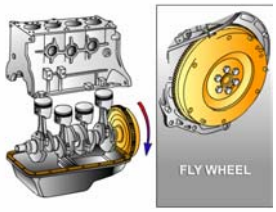
- The engine's displacement is the cylinder volume with the piston at BDC multiplied by the number of cylinders.
- The ratio of TDC volume to BDC volume it the compression ratio.

Summary of the Four Stroke Cycle

- What type of cycle do most engines use?
  - Otto
- What stroke expels spent gasses?
  - Exhaust
- Which cycle uses a supercharger for operation?
  - Miller

PLAY

Energy Storage



- In between engine power pulses there is little power present. To continue the power flywheels or flexplate/torque converters are used to continue.
- The heavy mass has momentum to carry to each pulse.