TKP3501
Farm Mechanization

Topic 2: Internal Combustion Engines

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Outlines

- Internal vs external combustion engines
- Engine structure
- Combustion cycle
  - 4 stroke engine - Explain the 4 processes
  - 2 stroke engine - Explain the 2 processes
- Ignition system
- Advantages and disadvantages
Learning Outcome

- Understand the principle of internal combustion engine
- Know the differences of petrol and diesel engines
- Ability to identify basic engine components and know their function
Combustion
Internal vs External Combustion Engines

- Heat engines burn fuel (petrol, diesel, ethanol, biodiesel) and convert the heat energy into mechanical energy

- Internal combustion engine – combustion of fuel occurs inside the engine (almost all modern engines fitted to cars, trucks and tractors)

- External combustion engine – combustion occurs outside of the engine (steam engine)
The four processes

1. Take an empty milk can
2. Make a small hole at the bottom
3. Dig a hole in the soil
4. Insert a firecracker into the can with fuse sticking out of the hole
5. Place the can in the hole and pad down the soil around it
6. Light the fuse and run away
7. Firecracker explodes
8. Can flies into the air
9. Retrieve the can
10. Repeat steps 4 – 9 until we get chased away
The four processes

- Is a fuel used?
- Is it alright not to pad the soil around the can?
- Is there combustion?
- What causes the can to fly upwards?
- What happens when the can fly up?
The four processes

- The four basic processes
- **Intake** - putting the firecracker into the can
- **Compression** - putting the can into the hole and padding the soil around it
- **Power** - the explosion after the fuse is lit
- **Exhaust** - can flying upward leaves exhaust gas behind
Engine structure
Gasoline Engine

Figure 5.1. Parts of an internal combustion gasoline engine.
FIGURE 5.6. Parts of diesel engine.
Main Engine Components

Cylinder

- Space where piston moves
- Gas and air mixture is brought into the space
  - petrol - gas + compressed air, burn
  - diesel - compressed air, diesel, burn
- Cooled by circulating water in spaces around cylinder air cooled
Cylinder head

- May be separated from engine block
- Place where combustion chamber is located
- Place where valves, guide, retainer, spring
- Use of gasket between two cylinder head and engine block.
- Consists spaces for cooling liquid
Crank case
- Part under the cylinder block
- Contains crankshaft, cam shaft, etc

Oil pan
- Under the crankcase
- Where the engine oil is held

Piston
- Moves, transmit power from combustion of fuel air mix through connecting rod
- Shape – cylindrical, closed at the top and open at bottom
- There is clearance between cylinder wall and piston skin, avoid
- Jamming or too loose – loss of power and cause excessive smoke
Connecting rod

- fixed at lower end by pin
- function, transmit power by oscillation motion
- Convert linear motion becomes rotary motion
- is fixed to connecting rod below by split bearing

Piston ring

- pressure ring – to maintain pressure and reduce gap between cylinder wall and piston surface, reduce wear and the loss of power
- oil ring – for ensuring oil is evenly applied
- lubricate and transfer heat
- slightly larger then the size of piston

Piston pin

- connects connecting rod to bottom of piston
- allow the connecting rod to move along its rotation

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Crankshaft

- Includes crank pin, crank arm journal bearing and counter weight.
- Counter weight is positioned opposite to crank pin such that it will balance up the weight of connecting rod and piston.
- Connecting rod is fixed to crank pin.
- Journal bearing support crank shaft to cylinder block.
- Results in steady rotary motion.

Flywheel

- Saves the inertial energy.
- When the piston do not receive power it drives the piston to complete its oscillation.
- If the engine have multiple pistons / cylinder the flywheel is smaller in size.

Timing gear

- It is to ensure that the motion of every components is well timed, eg. the valve opens when piston is at top of motion.
4-stroke engine
- Engine used for commercial vehicles, tractor and fishing boats.
- The source of power for most tractor since fuel is cheaper, durable despite the cost of engine is more expensive.
- Petrol or diesel engines operates by two methods 2 strokes or 4 strokes.
Operating cycles-valve opening

**Figure 5.2.** The four strokes of the four-stroke cycle.
Intake Stroke

- Piston moves down from top dead center
- Volume increases, pressure drops
- Intake valve opens
- Air moves in from outside, picking up petrol at carburetor
- Ends when piston reaches bottom dead center
Compression Stroke

- Piston moves up from bottom dead center
- Both intake and exhaust valves closed
- Trapped fuel-air mixture compressed
- Compression helps in improving combustion and pressure development
- Ends with piston at top dead center
Power Stroke

- Spark towards end of compression stroke
- Ignites fuel-air-mixture
- Explosive increase in pressure
- Both valves still closed
- Piston forced down from top dead center to bottom dead center
Exhaust Stroke

- Cylinder filled with waste gas
- Piston moves upward from bottom dead center
- Exhaust valve is open
- Waste gas leaves by exhaust valve
- Ends with piston at top dead center
- Next downward stroke will be intake of next cycle
Two revolution are needed to complete one cycle.

Piston movement and events must occur at precise moment. E.g. air and fuel intake into the cylinder as well as exhaust gasses expulsion.

Stroke 1 and stroke 4 involves the opening and the closing of valves.

The valves is activated by camshaft which is moved by and time by the rotation of crankshaft. The timing of valve action is synchronized with the movement of piston.

For every two crankshaft revolution – camshaft revolves once.

Intake stroke; piston moves downward, aspirating (sucking) in fuel and air into the cylinder through the opened intake valve. Air fuel mix occur in carburetor at predetermined rates.
Continued upward piston motion causes compression of fuel air mix. Intake valve closes. Mix is compressed in small combustion chamber at cylinder head.

Spark plug fires by electric sparks which ignites compressed fuel air mix causing explosion and expansion of gasses.

Piston is limited to only moves downward. This is the Power stroke.

Exhaust stroke. The last event in the cycle. Exhaust valves open. Piston moves upward force in burnt gas out from cylinder to exhaust manifold.

The cylinder is ready for next cycle with the intake stroke.

The combustion sequence (see ignition section)
Diesel Engine
Diesel Engine

- The main difference with petrol engine is that there is no spark plugs instead it is replaced by diesel injector and on intake stroke only air is drawn into the cylinder.

- Events during four stroke diesel engine cycle

Lejang pengambilan
Lejang mampatan
Lejang kuasa
Lejang ekzos
FIGURE 5.6. Parts of diesel engine.
The temperature rises to 1000° F (538 deg. C). Diesel is sprayed by injector into the cylinder, the mist explodes.
2-stroke engine
The Two Stroke Engine

- Designed to complete an entire cycle in two strokes of the piston
- Combines two processes in a stroke
- Two strokes are:
  a) Intake-compression
  b) Power-exhaust
2 stroke engine structure

FIGURE 5.3. Parts of a two-stroke cycle engine.
Two stroke petrol engines

- Used as small and light engine such as mobile engines eg knapsack grass cutter, outboard engine, chain saw, motor cycle engine.

- Engine block made from aluminum alloy for lightness.
  - Compared to 4 stroke petrol engines, only one revolution is required to complete all the four events in the engine cycle.
  - No mechanical vales but holes at cylinder wall which functions as the valves when the piston closes and opens the holes.
1. Lejang mampat  Lejang kuasa  Lejang pengambilan dan ekzos

Acara didalam enjin petrol dua lejang
Construction of 2 stroke engine

- No valves
- Ports cut into cylinder wall
- Crankcase airtight
- Fuel-air mixture first drawn into crankcase via 1-way reed valve
- Crankcase connected to intake port by transfer duct
Intake-compression Stroke

- Piston at bottom dead center (at the end of the previous cycle)
- Transfer port uncovered
- Pressurized fuel-air mixture from crankcase enters via transfer duct
- Piston moves up
- Transfer port and then exhaust port closed
- Fuel-air mixture compressed
- Ends with piston at top dead center
- Upward movement of piston causes the volume in crankcase to increase. Pressure drops and fuel-air mixture drawn in through 1-way reed valve
Power-exhaust Stroke

- Spark given out at the end of the previous stroke
- Fuel-air mixture ignites, resulting in explosion
- Piston forced downward
- Exhaust port uncovered
- Waste gas leaves cylinder through exhaust port
- As piston moves down, fuel-air mixture in crankcase is compressed
- A little later, transfer port is uncovered and intake-power stroke of next cycle begins
Comparing 2 and 4 stroke engines

- 2 stroke engines normally found in very light (mistblowers or lawnmowers) or extremely heavy applications (trawlers). Medium applications (cars, tractors, trucks) are fitted with 4 stroke engine.

- Comparing at same capacity and engine speed, 2 stroke receives power impulse more often – smoother, greater power output

- 2 stroke lighter – better power: weight ratio

- 2 stroke wears out faster, less fuel-efficient, more polluting
FIGURE 5.4. Two stroke cycles.
In Figure (above) the fuel, air and lubrication oil is brought into the engine crank case.

Carburetor mixes fuel and air that feeds to the crankcase input valve which open when pressure becomes low as the piston moves upward.

Under differences in air pressure the mixture moves into the cylinder.

Light duty lubricating oil (2T) is mixed with petrol either in petrol tank or on its way to carburetor.

In the Figure (above) compression strokes occur when piston moves upward, all holes are closed that causes fuel, air and oil mix become compressed. At the same time fresh mix is supplied from carburetor to engine crankcase.

At that optimum compression the spark plug fires.
Power Stroke. Gas explodes and expands causing the piston to move downward. As it moves all holes are opened. Fresh fuel, air and oil mix replace the burnt gasses inside the cylinder from the engine crankcase.

At the same moment spent gasses and unburn oil and fuel escape through the exhaust.
Figure 5.8. Cylinder pressure example.
## Differences

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2-stroke</th>
<th>4-stroke Petrol</th>
<th>4-stroke Diesel</th>
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QUESTIONS

- Why does two stroke engine have a lot of smoke, what is the color of the smoke?
- What moves the piston in the power stroke?
- What moves the piston in the intake, compression and exhaust strokes?
- Can we swap different fuel into different engine systems?
- How many revolution required to get 1 energy stroke in 2-stroke, and 4-stroke engine?
**Group Discussion**

- Name the machine suitable based on the engine type (2 or 4 stroke engine) for each operation below;

<table>
<thead>
<tr>
<th>Operation</th>
<th>Engine type</th>
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<tbody>
<tr>
<td>Grass trimming and cutting</td>
<td>2 stroke engine (light) or 4 stroke (heavy)</td>
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<td>Pruning</td>
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<td>Transporting the goods</td>
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<td>Water pump for irrigation</td>
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<td>Planting</td>
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