SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF FOOD TECHNOLOGY

Four Stroke and Two Stroke Engines

1. Introduction to Internal Combustion Engines (ICEs)

- **Internal Combustion Engines** are the backbone of modern transportation and industry. They convert chemical energy from fuel into mechanical energy through combustion within the engine. ICEs are mainly classified into two categories based on their ignition methods: Compression Ignition (C.I.) engines and Spark Ignition (S.I.) engines.
- **Significance of ICEs**: Despite advancements in electric vehicles, internal combustion engines remain widely used in automotive, industrial machinery, and power generation.

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2. Spark Ignition (S.I.) Engines

2.1 Working Principle

- **Fuel Used**: S.I. engines generally use gasoline (petrol) as fuel.
- **Ignition Method**: In S.I. engines, a spark plug ignites the air-fuel mixture inside the cylinder.
- **Process**:
    1. **Intake Stroke**: The intake valve opens, allowing a mixture of air and fuel to enter the combustion chamber.
    2. **Compression Stroke**: The piston moves up, compressing the air-fuel mixture.
    3. **Power Stroke**: At the top of the compression stroke, the spark plug produces a spark that ignites the mixture, causing an explosion. The energy from the explosion forces the piston down, generating power.
    4. **Exhaust Stroke**: The exhaust valve opens, allowing the burnt gases to be expelled.

2.2 Characteristics

- **Compression Ratio**: Typically lower, around 8:1 to 12:1, as high compression could cause knocking in gasoline.
- **Thermal Efficiency**: Generally lower due to the lower compression ratio.
- **Power Output**: S.I. engines are designed for smooth operation and are known for good acceleration characteristics.
- **Fuel Economy**: Typically, these engines are less fuel-efficient compared to C.I. engines due to their lower compression ratio and the characteristics of gasoline combustion.

2.3 Applications

- **Light Vehicles**: Motorcycles, cars, and smaller trucks.
- **Power Equipment**: Lawn mowers, small generators, and other equipment where efficiency is less critical than cost and ease of maintenance.

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3. Compression Ignition (C.I.) Engines

3.1 Working Principle

- **Fuel Used**: C.I. engines use diesel fuel, which is more energy-dense than gasoline.
- **Ignition Method**: In C.I. engines, ignition is achieved through the heat generated by compressing air in the combustion chamber. When diesel is injected into this high-pressure, high-temperature air, it ignites automatically (auto-ignition).
- **Process**:
    1. **Intake Stroke**: Only air enters the combustion chamber as the intake valve opens.
    2. **Compression Stroke**: The piston compresses the air to a high pressure, raising its temperature.
    3. **Power Stroke**: At the end of the compression stroke, diesel fuel is injected into the hot air. The fuel ignites instantly, forcing the piston down to generate power.
    4. **Exhaust Stroke**: Burnt gases are expelled through the exhaust valve.

3.2 Characteristics

- **Compression Ratio**: C.I. engines have a much higher compression ratio (typically 14:1 to 25:1), leading to greater thermal efficiency.
- **Thermal Efficiency**: Significantly higher than S.I. engines due to the higher compression ratio and the nature of diesel combustion.
- **Power Output**: Higher torque output, which makes C.I. engines ideal for heavy-duty applications.

- **Fuel Economy**: Diesel engines are more fuel-efficient due to their higher compression ratios and the energy density of diesel fuel.

3.3 Applications

- **Heavy-Duty Vehicles**: Trucks, buses, and industrial machines.
- **Agriculture and Construction**: Tractors, combines, and earth-moving equipment.
- **Power Generation**: Diesel generators for backup or remote power supply.

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4. Key Differences Between C.I. and S.I. Engines

Feature	C.I. Engine	S.I. Engine
Fuel	Diesel	Gasoline
Ignition	Compression Ignition (Auto-ignition)	Spark Ignition (Spark plug)
Compression Ratio	Higher (14:1 to 25:1)	Lower (8:1 to 12:1)
Fuel Efficiency	More fuel-efficient	Less fuel-efficient
Torque Output	High torque	Moderate torque
Thermal Efficiency	Higher	Lower
Emission	Produces more NOx, soot	Produces more CO and unburnt hydrocarbons
Maintenance Cost	Higher due to complex fuel systems	Lower due to simpler ignition systems
Application	Heavy-duty vehicles, industry	Light vehicles, smaller machines

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5. Advantages and Disadvantages of C.I. and S.I. Engines

5.1 Advantages of S.I. Engines

- **Lower Emissions**: Produce fewer nitrogen oxides (NOx) and particulate matter.
- **Smoother Operation**: The combustion process is smoother, resulting in less noise.
- **Lower Initial Cost**: Gasoline engines are generally cheaper to manufacture and purchase.

5.2 Disadvantages of S.I. Engines

- **Lower Fuel Efficiency**: Gasoline engines are less fuel-efficient compared to diesel engines.
- **Knocking Risk**: Prone to engine knocking at higher compression ratios.

5.3 Advantages of C.I. Engines

- **Fuel Economy**: Diesel engines are more fuel-efficient, making them ideal for long-distance travel and heavy-duty applications.
- **High Torque**: These engines produce more torque, which is beneficial for heavy vehicles and machinery.
- **Durability**: Diesel engines are generally more robust and can operate at higher loads for longer periods.

5.4 Disadvantages of C.I. Engines

- **Higher NOx Emissions**: Due to the high temperatures during combustion, C.I. engines tend to produce more nitrogen oxides.
- **Complex Fuel System**: Diesel engines have more complex fuel injection systems, which increases maintenance costs.
- **Noise and Vibration**: C.I. engines are noisier and produce more vibrations than S.I. engines.

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6. Modern Innovations and Future Trends

6.1 Advancements in S.I. Engines

- **Turbocharging and Direct Injection**: Modern S.I. engines have adopted these technologies to improve fuel efficiency and power output.
- **Hybridization**: Combining S.I. engines with electric motors to increase fuel efficiency and reduce emissions.

6.2 Advancements in C.I. Engines

- **Common Rail Diesel Injection**: Improves the precision of fuel injection, reducing emissions and increasing fuel efficiency.
- **Selective Catalytic Reduction (SCR)**: Helps reduce NOx emissions in diesel engines by using urea-based additives.

6.3 Electrification and Alternative Fuels

- **Electric Vehicles (EVs)**: Although internal combustion engines dominate, the rise of EVs poses a challenge for the future of both S.I. and C.I. engines.
- **Biofuels and Synthetic Fuels**: Efforts to make both gasoline and diesel engines more eco-friendly by using alternative, cleaner-burning fuels.

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7. Conclusion

- **Overall Comparison**: Both C.I. and S.I. engines have distinct advantages and disadvantages. S.I. engines are better suited for light-duty applications, where cost and ease of use are more important. C.I. engines, on the other hand, dominate in applications requiring high torque and fuel efficiency.
- **Future Prospects**: As environmental regulations tighten and electrification progresses, both types of engines will likely see continued innovation to improve fuel efficiency and reduce emissions.