

Module 10: Air Induction and Exhaust Systems

- TERMS AND DEFINITIONS
- BASIC AIR INDUCTION COMPONENTS
- TYPES OF AIR INDUCTION SYSTEMS
- STARTING AID DEVICES
- BASIC EXHAUST SYSTEM COMPONENTS
- OPERATION OF AN INDUCTION AND EXHAUST SYSTEM
- DIESEL ENGINE SCAVENGING
- EXHAUST SYSTEMS
- PARTS AND OPERATION OF A CATALYTIC CONVERTER

Terms and Definitions

READY FOR REVIEW

- Air restriction indicator indicates increasing restriction in the induction system due to a dirty filter element or a damaged component.
- Blower is a mechanically driven supercharger.
- Naturally aspirated engine is one that does not use superchargers or turbochargers.
- Scavenging is using fresh intake air to evacuate burnt exhaust gases from the cylinder.
- Supercharging is forcing air into the cylinders above atmospheric pressure and usually applies to devices that have a direct mechanical connection to the engine.
- Turbocharging is using an exhaust-driven compressor unit to force air into the cylinders and applies to devices (turbochargers) that have no direct mechanical connection to the engine.

Basic Air Induction Components

READY FOR REVIEW

- A prefilter (or precleaner) removes large dust particles from the intake air before it enters the air filter.
- An air filter removes grit and fine dust particles and provides the engine with the required volume of clean air.
- A compressor pressurizes the air entering the engine and provides greater cylinder filling.
- An intercooler (or aftercooler) cools the compressed air before sending it into the intake manifold and provides a denser air charge that improves combustion.
- An intake manifold channels the air to the individual cylinder intake ports.

Types of Air Induction Systems

READY FOR REVIEW

- Normally aspirated
- Supercharged
- Turbocharged
- Turbocharged and intercooled
- Air-to-air charger aftercooler or intercooler

Starting Aid Devices

READY FOR REVIEW

- Block heaters/preheaters
- Glow plugs
- Starting fluid injection

Basic Exhaust System Components

READY FOR REVIEW

- An exhaust manifold routes hot gases from the exhaust ports to the inlet side of the turbocharger turbine.
- An exhaust pipe channels exhaust gases from the discharge side of the turbocharger turbine to the muffler (if equipped) or to the atmosphere.
- A muffler absorbs and redirects the sound waves from the exhaust gases and greatly reduces exhaust noise.
- A turbine uses exhaust gas heat and pressure to rotate and drive the compressor on the other side of the turbocharger.

Operation of an Induction and Exhaust System

READY FOR REVIEW

- Hot, expanding exhaust gases leave the exhaust port and are channeled through the exhaust manifold to the turbine side of the turbocharger. These gases strike the turbine blades, causing them to spin at 70,000-145,000 revolutions per minute (RPM).
- The exhaust flow exits the turbine housing and flows through the muffler where it is quieted.
- Exhaust is then sent to the tailpipe or exhaust stack, and the spinning turbine is connected by a shaft to the compressor, which is also turning at 70,000-145,000 RPM.
- The compressor pulls in filtered air and compresses it.
- The compressed (and heated) air is sent to the intercooler, where it is cooled and condensed.
- The dense, compressed air flows from the intercooler, through the intake manifold, to each cylinder intake port.
- Inside the cylinder, the air is mixed with fuel, burned, and then pushed out the exhaust port.

Diesel Engine Scavenging

READY FOR REVIEW

- Two-stroke engines
 - As the piston nears the end of the power stroke, the exhaust valves open, allowing exhaust gases to begin leaving the cylinder.
 - As the piston continues to move downward, the inlet ports are uncovered.
 - Compressed air from the blower enters the cylinder through the inlet ports, driving out the remaining exhaust gas.
- Four-stroke engines
 - At the end of the power stroke, just before the piston reaches bottom dead center (BDC), the exhaust valves open.
 - The piston rises, pushing the exhaust gases out of the cylinder.
 - Just before the piston reaches top dead center (TDC), the intake valves open, and because of valve overlap, the exhaust valves are still open. This allows fresh compressed air to enter the cylinder, driving out the remaining exhaust gases.

Exhaust Systems

READY FOR REVIEW

- Motor vehicles
 - Effective mufflers are required to reduce sound levels to acceptable limits.
 - Tailpipes must route exhaust gases away from the underside of the vehicle to prevent trapping carbon monoxide (CO).
- Agricultural/industrial
 - Sound dampening is not as critical in the middle of farm land as it is on a city street, and some turbocharged engines do not use mufflers at all.
 - Exhaust pipes are typically used to carry smoke and noise away from the immediate area of the engine.

Parts and Operation of a Catalytic Converter

READY FOR REVIEW

- Exhaust gas enters the converter and passes through the reducing catalyst. This reduces the oxides of nitrogen (NO_x) level.
- The exhaust gas next passes through the oxidizing part of the converter, and this area converts the hydrocarbons (HC) and CO into water (H₂O) and carbon dioxide (CO₂).
- As this reduction reaction takes place, the converter generates tremendous amounts of heat, and most catalytic converters operate around 1,500°F.
- The exhaust gas leaves the catalytic converter as harmless water vapor, CO₂, and low-level NO_x.