Module 5: Cylinder Blocks and Liners

Terms and Definitions

- **Counterbore**: is the lip machined in the top of the block bore that forms a mechanical stop for the cylinder liner.
- **Crevice seal**: is the lower water jacket seal between a wet cylinder liner and the crankcase.
- **Crocus cloth**: is flexible cloth impregnated with iron oxide particles that cleans metal surfaces without removing any material.
- **Cylinder liner**: is the removable sleeve inserted into the bore of an engine block and used as a load-bearing surface for the piston and rings.
- **Cylinder liner protrusion**: is the distance the cylinder liner stands out (protrudes) above the block deck surface when installed.
- **Cylinder pack**: is a one-cylinder kit consisting of liner, piston, and rings.

Types of Cylinder Block Cooling Methods

- **Liquid cooled**:
  - A cooling jacket is used, which adds weight, strength, and sound absorption.
  - Hot water is available for in-cab heating and defrosting.
  - Cylinder operating temperatures are more even, which is critical for emissions.
  - Cylinder replacement is less costly.
- **Air cooled**: A cooling jacket and coolant have been eliminated, which reduces weight.
  - A radiator, water pump, and thermostat are not used.
  - Cylinders are usually integral-bore design with cooling fins.
  - Engine noise is greater due to the lack of a sound-absorbing cooling jacket.
  - Cylinders and heads must be kept clean to maximize heat transfer and to minimize contamination of hot air used for heater/defroster functions inside the vehicle.

Types of Cylinder Liners

- **Wet liner/sleeve**
- **Dry liner/sleeve**
- **Integral bore (cast-in-block)**
- **Combination wet/dry liner**
- **Air-cooled sleeve**
Characteristics of Cylinder Liners

**Wet liner/sleeve**
- Individual cylinder liners fit into machined holes in the bore deck and lower block.
- The liner provides a wear surface for the piston and rings and also forms part of the water jacket.
- The liner sealing is provided by the head gasket at the top and an o-ring at the bottom. The head gasket and o-ring must be correctly installed to prevent leakage of combustion gases and coolant.

- Advantages
  - Coolant flows around the liner allowing direct heat transfer from the cylinder to the coolant. This results in better combustion control and greater efficiency.
  - Block reconditioning is easily accomplished by installing cylinder packs. Removal of the block from the vehicle is not required.
  - If required, cylinder liners can be replaced individually.
  - The cylinder block itself remains virtually unworn.

- Disadvantages
  - Seal placement and seating are critical during installation.
  - The o-ring seals used at the bottom of the liner can fail and leak, contaminating the crankcase oil.

**Dry liner/sleeve**
- Individual cylinder liners are press-fit into machined cylinders in the cylinder block.
- The liner forms an inner bore to the existing cylinder and provides a wear surface for the piston and rings.

- Advantages
  - Block reconditioning is easily accomplished by replacing the liner/piston/ring assembly.
  - If required, cylinder liners can be replaced individually.
  - Because the liner is not an integral part of the water jacket, there are no seals.
  - Installation is simplified, and potential seal failure and leakage are eliminated.

- Disadvantages
  - Coolant does not flow directly around the liner.
  - Heat transfer does not occur as quickly as in the wet liner block.

**Integral bore (cast-in-block)**
- Piston and rings ride directly in the block, and there is no sleeve.
- Typically used in light-duty automotive applications and small displacement farm/industrial motors

- Advantages
  - Eliminates the expense of parts and labor associated with liner replacement
  - Eliminates the problem of o-ring seal failure and crankcase oil contamination

- Disadvantages
  - Cylinder repair requires removal of the block from the vehicle.
  - Individual cylinder bores cannot be repaired without disassembling the engine.
  - Once the overbore limit is reached, the block must either be sleeved or replaced.

**Combination wet/dry liner**
- The upper half of the liner is directly cooled by liquid surrounding the liner.
- At the air inlet ports, the liner is cooled by the air introduced into the cylinder through equally spaced ports around the liner.
- The lower half of the liner is cooled by water inside the cylinder block water jacket surrounding the liner.
- Two seal rings, recessed in the cylinder bore, are used between the liner and block to prevent water leakage.

- Advantage
  - Cooling capacity is increased.

- Disadvantage
  - Coolant leaks and water into the intake ports are possibilities. Seals must be properly maintained.

**Air-cooled liner**
- The top portion is covered with cooling fins that are exposed to air blown by the fan.
- The bottom portion is smooth and fits in the cylinder block. This portion is surrounded by lubricant so it is cooled by the lubrication system.

- Advantage
  - Fewer moving parts result in less weight and fewer problems.

- Disadvantage
  - Harder to cool in high heat environments.
Causes of Abnormal Sleeve Wear

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- Twisted o-ring seals
  - In this condition, the o-ring does not seat correctly and therefore causes out-of-round condition in the liner. This causes the liner to bulge slightly, exerting excess pressure against the piston and rings.
  - Because of this, the liner and rings wear rapidly causing compression leakage, increased oil consumption, and blow-by.

- Incorrect liner protrusion
  - When this occurs, the liner protrusion creates a weak head gasket seal at either that liner or an adjacent one.
  - The head gasket seal quickly fails, allowing compression gas leakage into the cooling system during engine operation and coolant seepage into the cylinder when the engine sits idle.

- Compression gas in the cooling system forces coolant out of the system causing engine overheating.
- Coolant seepage into the cylinder can cause hydraulic lock on startup, destroying the piston and connecting rod.

- Cavitation erosion
  - Cavitation erosion occurs when air bubbles in the coolant flow strike the cylinder liner removing small bits of liner material.
  - This condition is caused by the depletion of supplemental coolant additives (SCAs).
  - If left uncorrected, the liner will eventually fail, causing lubrication system and cooling system contamination.