Module 5: Cylinder Blocks and Liners

Terms and Definitions

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- 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

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- 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

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- Wet liner/sleeve
- Dry liner/sleeve
- Integral bore (cast-in-block)
- Combination wet/dry liner
- Air-cooled sleeve

Characteristics of Cylinder Liners

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- 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.