

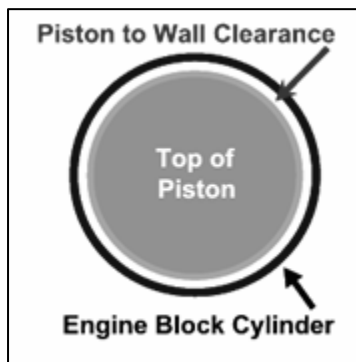
The Affects of Temperature, Pressure, Flow on Cooling System Operation

Closely monitoring the results of changes in temperature, pressure and flow is absolutely necessary to effective cooling system maintenance. The guidelines below can provide operators and maintenance personnel with a better understanding of metal expansion and contraction as well as help them better control engine damage due to boiling, deposits and/or pitting.

Metal Expansion and Contraction

It's extremely important to understand the impact that changing temperatures within an internal combustion engine have on metal expansion and contraction.

The cast iron of a 16-cylinder industrial engine will expand and contract about $\frac{1}{4}$ " at 180°F and up to $\frac{3}{8}$ " at higher operating temperatures. If aluminum, these numbers almost double depending on the alloy. Application must also be considered. The operating temperatures of large offshore towboat engines must be carefully lowered 8 to 12 hours before entering port to avoid blowing head gaskets upon shutdown.



Metal expansion and contraction is critical to piston-to-wall clearance. This is the difference between the diameter of the piston and the diameter of the cylinder wall. If an engine block is made of cast iron and the pistons are aluminum, they will each expand differently. If they are made of the same material, the piston-to-wall clearance will expand at the same rate and clearances will be different.

Expansion and contraction also affects piston ring end gap—the space between the ends of a piston ring when installed in the cylinder. The ring expands as the engine heats up and causes the end gap to get smaller. If there isn't enough end gap when the engine is put together, the ends of the ring may butt against one another when the engine gets hot and could result in serious engine damage.

Corrosion

Corrosion is the chemical reaction between an imbalanced coolant and the metals present. The imbalance can result from a variety of problems ranging from air leaks to poor source water. Compared to mechanical wear, corrosion is a much slower process.

Erosion

Erosion occurs when a liquid comes into contact with a hard surface. There is a direct relationship between the hardness of a metal and the erosion resistance of that metal. Classically, erosion only occurs in cooling systems when the metals in the engine become "soft" due to de-carbonization.

Electrolysis

Electrolysis occurs when an electrical current enters the coolant. This usually happens when an electrical ground problem develops within the engine. Since electrons follow the path of least resistance, the current typically enters the cooling system. As these electrons make contact with the system's various metals, they slowly erode the surface area causing electrolysis.

Boiling, Pitting and Deposits

The point at which coolant boils is determined by operating temperature, pressure and elevation. Pitting occurs when metal components are attacked by air, cavitation, improper coolant maintenance or when pH drops below specifications. Deposits form when scale-forming properties, such as calcium, magnesium and sulfate are present in the fluid.