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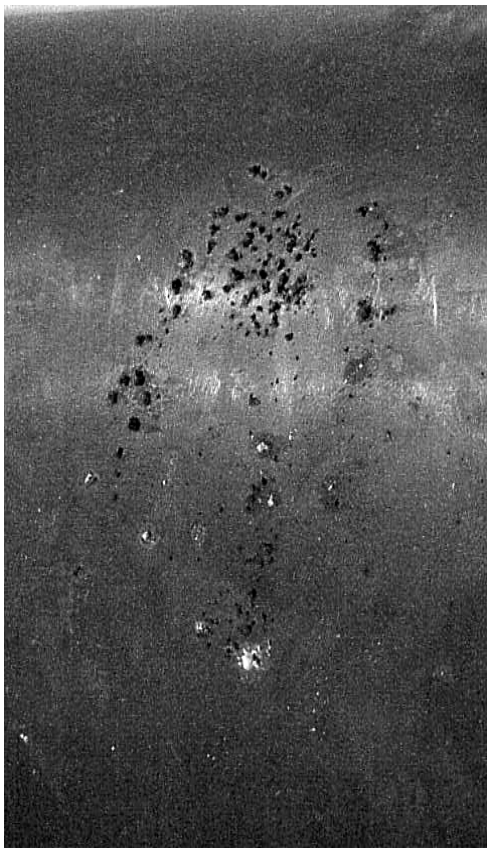
Cavitation Erosion

Also known as cavitation corrosion, cavitation-accelerated corrosion, cavitation, pitting and pinholes. Technically speaking, cavitation corrosion is a little different in that it is an accelerated variation due to the addition of corrosive conditions in the cooling system. It is also sometimes erroneously called electrolysis, which is in fact an entirely different process with similar results.



Cavitation erosion on the outside of diesel engine wet sleeves has been the subject of research by engine and component manufacturers over many years. While the causes and processes are in large understood today, ensuring the problem does not occur can be difficult at times. There are some classic engines that are notorious for the occurrence of this condition - the Mitsubishi 6D14 and Caterpillar 3300 families of engines to name just two.

Cavitation erosion typically occurs in a vertical band on the outside diameter of the sleeve, matching the major thrust side of the piston. It also often occurs around the liner 'o' ring sealing lines. There are three general causes of the phenomenon:

- high frequency sleeve wall vibration
- stagnant water pockets in the cooling system
- air leaks in the cooling system

High frequency vibrations in the cylinder wall (sometimes known as 'ringing') can be caused by any of a number of factors, some of which include:

- Oscillation in cylinder combustion pressures.
- Lateral piston forces as the result of excessive piston to bore clearance.
- Violent piston to bore contact changes at T.D.C. and B.D.C. This is mainly due to the compression height to piston length ratio and the amount of gudgeon pin offset.
- Incorrectly seated/positioned sleeve, allowing excessive movement.
- Incorrect fuel injection timing setting.
- Incorrect engine governing speed setting.
- Sleeve walls too thin.

The high frequency movement of the sleeve wall results in a momentary separation of the water film from the cylinder wall. There then exists a pressure depression around the water surface which allows small coolant and air vapour bubbles to form. When the cylinder wall moves back out again and contacts the water, the bubbles implode at extreme velocity. The bursting bubbles release surface energy that can result in pressures of up to 415,000 kPa (60,000 psi). This pressure removes minute particles of metal from the surface of the vibrating cylinder wall, which ultimately becomes pitting and pinholes.

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If the cause of cavitation erosion is a fundamental design weakness, then it can be very difficult to eliminate. However, there are some things that can help to reduce and even eliminate the occurrence of cavitation erosion. These include:

- Ensure correct cooling system conditioner levels
  e.g. corrosion inhibitor, antifreeze, anti-foam.
- Ensure correct cooling system pressures by fitting the correctly rated radiator cap and checking the radiator cap is working correctly.
- Only use distilled water in the cooling system.
- Ensure the sleeve fit is correct.
- Apply special protective coatings to the water jacket region of the sleeve outside surface
  e.g. chrome, copper, plasma, ceramic.
- Ensure there are no air leaks in the cooling system.
- Correctly bleed the cooling system when filling to ensure there are no trapped air pockets.

Corrosion is a gradual 'eating away' of metal brought about by stagnant water in crevices where the normal water flow does not reach to flush it out. This coupled with a slight electrolytic action etches the metal, allowing it to gradually sluff off. This is more often the pitting process around the liner 'o' ring sealing lines. A clean cooling system and correctly operating thermostat help promote a cooler running engine. Warmer water temperatures will reduce corrosion activity, whereas cooler operating systems tend to aggravate the cavitation problem.

Water filtration is one of the few things known to help reduce electrochemical (combined electrolysis and corrosion) pitting. Correct water conditioning is also a help.