

'Wet' Cylinder Liner Cavitation Problems

This information sheet has been reproduced from an original Caterpillar publication and refers to their engines, however the content details are relevant to all engines fitted with 'Wet' cylinder liners.

The references to water quality, anti-freeze and inhibitors is just as relevant today as it was when written in the 1970's.

Good quality Blue or Green Ethylene Glycol anti-freeze should be used and changed every two years. This type of anti-freeze is toxic and can cause harm to animals. It should be disposed of properly.

It's not necessary to use **Organic Acid Technology** (OAT) anti-freeze, although it only needs changing every 5 years. Typically OAT antifreeze contains an orange dye to differentiate it from the conventional glycol-based coolants.

Questions and Answers About Cylinder Wall Pitting



Questions and Answers About Cylinder Wall Pitting

Q. The cylinder wall on my diesel engine pitted through causing a very expensive bore and sleeve job. What caused this, a faulty block casting?

A. Probably not. Pitting is generally caused by improper maintenance of the cooling system and is common to most diesel engines.



Pitted cylinder wall cut from diesel engine block

Q. Well, we use clean water and check the anti-freeze each winter, what more can we do?

A. What you have done is protect the block from freezing. That's good. But you have not added chemicals to prevent corrosion which leads to pitting.

Q. How does corrosion lead to pitting?

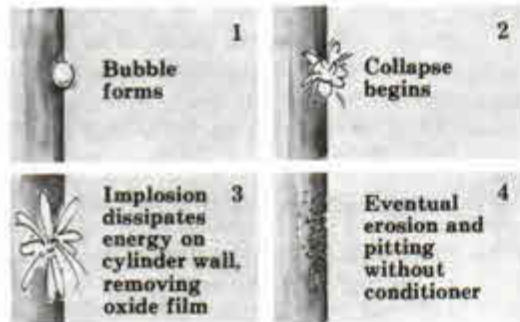
A. Corrosion is a form of electrolysis which causes cylinder wall material to deteriorate. As this happens, an oxide film forms on the outside of cylinder walls. If left alone, this film would protect the cylinder wall from further corrosion and pitting.

Q. Well, what happens to this film?

A. The oxide film is cleaned off by air bubbles which form on the outside of the cylinder wall and then implode (explode inward). As they implode sufficient energy is released to physically clean the cylinder wall, remove the oxide film (which is slow to re-form) and allow corrosion and pitting to take place at a high rate.

Q. What causes these air bubbles?

A. Air bubbles are the result of cylinder wall vibration caused by the motion or flexing of the cylinder wall when the piston fires. An increase in the number of air bubbles is caused by reduced cooling system pressure which results from a loose or faulty radiator cap or leaks in the cooling system. The greater the vibration, the more bubbles are formed. Vibration is greater when the engine is cold, because of increased piston to cylinder clearance, and when an engine is lugged.



Q. Are there any engine applications where pitting is more common than others?

A. Yes, in engines where loads fluctuate rapidly such as fire trucks, school buses, garbage trucks, etc., plus engines operating in cold geographical areas.

Q. What can I do to help prevent cylinder wall pitting?

A. Add Caterpillar cooling system conditioner in the recommended amounts every 250 service meter hours or whenever the oil filters are changed.

Q. What does this do?

A. It coats the cylinder wall with a protective film to prevent the metal from being eaten away by corrosion and pitting. As this protective coating is removed by imploding air bubbles, it is constantly being replaced by the corrosion inhibitor contained in the cooling system conditioner.

Q. Why won't the corrosion inhibitor in the anti-freeze do?

A. Antifreeze that contains cooling system conditioner will prevent corrosion and subsequent pitting. However, this conditioner gradually becomes depleted through normal operation and has to be replenished.

Q. Does all antifreeze contain corrosion inhibitors?

A. No. Pitting is only a major problem with diesel engines, which make up a relatively small portion of the engines in use today. Gasoline engines are still the most popular form of internal combustion. Most manufac-

turers cannot justify adding inhibitor to antifreeze for a relatively small number of diesel engines.

Q. Well, if we buy antifreeze with corrosion inhibitor will that solve our problems?

A. No, not unless you replenish the inhibitor at the recommended intervals.

Q. Why do I ever need to replenish corrosion inhibitor? Does it evaporate?

A. No, it "wears out" while preventing corrosion, erosion, and pitting through chemical and physical molecular breakdown of the liquid.

Q. If my engine has not had Caterpillar cooling system conditioner added on a regular basis, will it help to start now?

A. Yes. However, before the cooling system conditioner can effectively coat the cylinder liner or wall, all scale and rust must be flushed from the system.

Q. Can I do this myself?

A. If your engine is not overheating and no green slime (chromium hydroxide) or heavy rust is present, you can prepare the engine by using Caterpillar cooling system cleaner (part number 6V4511). Follow the directions printed on the container.

Q. What if the cooling system is beyond using this cleaning method?

A. If the cooling system is that bad, see your Caterpillar dealer service manager. The engine will probably have to be given a thorough cleaning with special chemicals. Also, ask your Cat dealer for a copy of the booklet — "Know Your Cooling System — SEBD0518."

Q. How do I know if the engine is beyond cleaning with Caterpillar cooling system cleaner?

A. There are several ways you can get an indication if your engine needs more than a mild cleaning. They are:

1. Flow restrictions — remove the radiator cap and see if the cooling tubes are plugged. If plugged, using just a mild cleaner such as Caterpillar cooling system cleaner (6V4511) will not be satisfactory.
2. Constant overheating — if the fan belts, thermostats and water pump are functioning properly, but your engine continues to experience overheating problems then your cooling system may be badly plugged.

3. Water pump failure — if your water pump fails and upon inspection heavy rust is found in the bearing, seal and shaft area, chances are your cooling system needs a thorough cleaning with special chemicals.
4. Heavy rust and green slime (chromium hydroxide) obviously visible in the coolant —if the green slime is evident on the bottom of your radiator cap and the coolant is so cloudy that an antifreeze tester cannot be read, then see your Caterpillar dealer about a thorough cooling system cleaning.

Q. How do I know if, or how badly, my engine is pitted?

A. If the cooling system has been properly maintained, there should be no problem. However, if you have some question about the cylinder wall condition, an in-frame inspection can be performed. For example, any Cat 3208 which is pitted will have some pitting between number 6 and number 8 cylinders. Here is how to inspect that area:

1. Remove all freeze plugs on the left cylinder bank.



2. Inspect the area between No. 6 & 8 cylinders and between No. 4 & 6 cylinders.



This is easily done by using a flashlight and observing the cylinder wall areas through the freeze plug holes. If the cylinder walls show no signs of corrosion and pitting, you can assume the block is reusable as is.



3. If corrosion damage is observed, use a flexible inspection light to inspect the remaining cylinders on both banks. This can be accomplished by removing the left head and looking through the water passages on top of the block.

Attention should be given to all four sides of number 8 cylinder.

Q. If the block is badly pitted or is pitted through, what do I do, buy a new engine?

A. No, no, that should be your last resort. For a Cat 3208 you can buy a Cat Remanufactured short block, or have your Caterpillar dealer bore the block and install a Caterpillar dry sleeve. For other Caterpillar engines you can simply replace the liner. In either case you should consult your Caterpillar dealer before making any decision.



Eventually a pit can become deep enough to go clear through the cylinder wall and let coolant leak into the cylinder — contaminating the lubricating oil.



Think it can't happen? Here's an actual cylinder on which a pit goes clear through. A piece of wire has been put through the hole . . .



... which goes through the wall to the inside of the cylinder. When pitting is this severe, the block must be repaired or replaced.

Q. So, again, what is the proper way to maintain my cooling system and prevent pitting?

A. Keep the cooling system clean. Caterpillar recommends cleaning of the cooling system once a year unless a coolant filter is used. Then this period can be extended to two years. This can be accomplished by using Caterpillar cooling system cleaner (6V4511) following instructions on the container label. Use a coolant consisting of at least 50% water, 50% antifreeze. The water should meet the minimum acceptable standards in the following chart. To find out what the water characteristics are in your area, contact your city water department, an agricultural agent, or ask your Caterpillar dealer about having a sample tested.

Test	Characteristic Of Minimum Acceptable Water With 50-50 Antifreeze Solution
Mohr	Chlorides (Maximum) 100 ppm
Gravimetric	Sulfates (Maximum) 100 ppm
Calculated	Total Hardness as CaCO ₃ (Maximum) 200 ppm
Evaporation	Total Dissolved Solids (Maximum) 500 ppm
Instrument	pH (Minimum) 6.5 ppm

Minimum acceptable water used in a coolant mixture.

Add Caterpillar cooling system conditioner. It is available in 55 gallon drums, quarts or ½ pints from your Caterpillar construction equipment dealer, Caterpillar lift truck dealer, or Caterpillar engine parts and service dealer. The following chart lists minimum recommended quantities for Caterpillar engines.

Application Chart

*Caterpillar Vehicles Powered With:	First Fill	Later Addition
Cat Coolant Conditioner should be added at recommended oil change intervals or every 250 service meter hours, whichever occurs first.		
3204	1 Quart (.95 Liters) or 1 Bottle 3P2044	1/2 Pint (.237 Liters) or 1 Bottle 6V3542
3208	1 Quart (.95 Liters) or 1 Bottle 3P2044	1/2 Pint (.237 Liters) or 1 Bottle 6V3542
3304, 3306	2 Quarts (1.9 Liters) or 2 Bottles 3P2044	1/2 Quart (.47 Liters) or 1/2 Bottle 3P2044 or 2 Bottles 6V3542
3406, 3408	4 Quarts (3.8 Liters) or 4 Bottles 3P2044	1 Quart (.95 Liters) or 1 Bottle 3P2044
3412	6 Quarts (5.9 Liters) or 6 Bottles 3P2044	2 Quarts (1.9 Liters) or 2 Bottles 3P2044
5.4 Bore-6 Cyl.	4 Quarts (3.8 Liters) or 4 Bottles 3P2044	1 Quart (.95 Liters) or 1 Bottle 3P2044
5.4 Bore-8 Cyl.	5 Quarts (4.75 Liters) or 5 Bottles 3P2044	1 Quart (.95 Liters) or 1 Bottle 3P2044
5.4 Bore-12 Cyl.	8 Quarts (7.6 Liters) or 8 Bottles 3P2044	2 Quarts (1.9 Liters) or 2 Bottles 3P2044
5.75 Bore-6 Cyl.	4 Quarts (3.8 Liters) or 4 Bottles 3P2044	1 Quart (.95 Liters) or 1 Bottle 3P2044
6.25 Bore-6 Cyl.	5 Quarts (4.75 Liters) or 5 Bottles 3P2044	1 Quart (.95 Liters) or 1 Bottle 3P2044

- * For all other engine applications, at initial fill use one pint per four gallons of cooling system capacity (3% concentration). At recommended oil change intervals or 10-12,000 miles (16-19,000 km) or 250 service meter hours, whichever occurs first, add one pint of conditioner per 20 gallons of cooling system capacity. Make-up coolant should contain a 3-6% conditioner concentration.

Note:

Caterpillar coolant element assemblies are also available for use in place of the liquid cooling system conditioner, but are not recommended for marine use. See your Caterpillar dealer for more information on Caterpillar coolant conditioner elements and the hardware necessary to install one on your engine.



Details make the difference — Keep It CAT

Ask your Caterpillar Dealer for these other Question and Answer books.

- Questions and Answers About Pistons and Rings
- Questions and Answers About Turbo-charger Repair and Replacement
- Questions and Answers About Fuel Nozzles
- Questions and Answers About Oil Filters
- Questions and Answers About Engine Bearings
- Questions and Answers About Engine Valves