Pressure Relief

We could all do with a little less pressure. Whether we're talking about our jobs, home life, or even our bloodstreams, reducing pressure can be a healthy improvement. What about your engine's cooling system? If you think of your coolant as the "lifeblood" of your engine, exactly how is vapor pressure affecting the "health" of your engine?

To understand the answer, we need to look at the basic purpose of a cooling system, which is to keep metal temperatures under control. Constant liquid to metal contact is critical for efficient heat transfer. Water, or water-based coolants, have been used to cool engines for almost 100 years for very good reasons. Water is inexpensive, readily available and most importantly, and has superior thermal conductive capabilities. Most coolants are a 50/50 mix of ethylene glycol (EG) and water with corrosion inhibitors. We know that the addition of ethylene glycol lowers the freezing point substantially and raises the boiling point slightly.

But the real key to raising the boiling point is the pressure cap on a cooling system. For every pound of pressure, the boiling of point is raised by about 3 degrees. If you had plain water in your cooling system with a 15 pound pressure cap the water would boil at 125°C. With a 50/50 mix of EG and water the coolant would boil at 129°C with a 15 pound cap.

If water transfers heat better than any other liquid, what reasons would there be to not use a water-based coolant?

When water boils, it turns to vapor. That's when water's performance as a heat transfer fluid drops like a cliff. Water vapor retains only 4% of the heat transfer capability of water. Put another way, when water loses 96% of its effectiveness, bad things start to happen to an engine in a hurry.

The hottest parts of the cylinder head are the likeliest locations for localized boiling and water vapor creation. If the surrounding liquid coolant is hotter than the boiling point of water, an insulating vapor barrier is formed between the hot cylinder head metal and the liquid coolant. The result is poor heat transfer, the metal temperature rises, and a "hot spot" forms. A cylinder head hot spot in any engine stresses the metal, possibly causing the head to warp or crack.

Afterboil is caused by water-based coolant that is at a temperature near its boiling point in an engine that has been stressed by running hard and then shut down. Heat stored in the cylinder head continues to dissipate into the coolant in the cooling jacket. Boiling occurs when the coolant temperature exceeds the boiling point of the coolant for the pressure of the system. Afterboil can be a cause of a mysterious loss of coolant from a non-leaking cooling system that has a pressurized expansion tank. Water vapor from the after-boiling displaces liquid coolant in the cylinder head, forcing the pressure high enough to open the pressure relief valve at the cap on the expansion tank. Liquid coolant is pushed out of the expansion tank and onto the ground.

With a boiling point of 190°C, Evans waterless coolants avoid afterboil because the coolant in the cylinder head is much colder than its boiling point. The coolant acts as a heat sink with the capability to absorb all residual cylinder head heat without boiling. There is no component of vapor in the system causing a pressure increase. Engines can safely tolerate higher coolant temperatures because hot engine metal is never insulated from liquid coolant by vapor. Excellent heat transfer to the coolant is maintained at all times.

In harsh operating environments, keeping water-based coolant below its boiling point taxes the radiator and fan to the limit. On a hot humid day, when dust and debris stick to the radiator like a magnet, the radiator is unable to reject heat into the ambient air. The fan is put into overtime. That's when you're precariously perched on the edge of that cliff, where water abruptly changes its state, from a liquid to a gas. Vapor is forming. Pressure is building. And a time bomb is ticking. What that means to your engine, in a word, is *Overheating*. What it means to your operation, in three words, is *Loss of Production.*

With higher coolant temperatures enabled by the use of Evans waterless coolant, the radiator becomes more efficient at dissipating heat and the cooling system gains a reserve capacity. Cooling systems are "air-side limited", meaning that the limiting factor for a cooling system lies in its ability to remove the heat from the radiator to the ambient air. With the engine able to safely operate with elevated coolant temperatures, the radiator metal can now be hotter, providing a greater temperature difference (the delta "T") to the ambient air.

Operation of water-based engine coolant near its boiling point also creates the conditions for cavitation erosion of cylinder liners in heavy duty engines. Each piston oscillates within its cylinder liner, vibrating the liner at the frequency of the piston movement. Locations of the liner that move away from the liquid, form low pressure areas where the coolant boils and water vapor forms. On the other half of the vibration cycle, those locations move toward the liquid, causing an increase in pressure, and the vapor condenses. The cycles repeatedly scrub these sites making them vulnerable to cavitation and erosion.

With Evans waterless coolant cavitation erosion of cylinder liners doesn't happen because the coolant will not boil. There is no vapor made and no vapor to condense, sharply reducing any surface scrubbing.

Evans waterless coolants provide a huge separation between operating temperature and its boiling point. This means that any locally generated vapor immediately condenses into nearby liquid that is much colder than the coolant's boiling point. There is no vapor to contend with, and a much lower system pressure relieving stress on the cooling system. How does your engine spell relief? E-V-A-N-S.