You probably haven’t seen many late-model super-high-performance vehicles in your shop, or even late-model premium European cars (and likely won’t for a number of years to come). So, models with multiple radiators combined with variable-speed electric water pumps will not have appeared and changed your impression of cooling system design. Probably all you may have seen is the computer-controlled variable speed electric water pump, which has been used on hybrids for several years and more recently by BMW (2.0-liter four-cylinder) and Toyota on new Camry models.

But when an advanced cooling system makes its debut on “mainstream” so-called “conventional” gasoline engines, it’s time to really pay attention.

General Motors has begun a changeover to what it calls “Active Thermal Management,” on the base engine in its Silverado pickup. The engine is the 2.7-liter in-line four, which matches in displacement (although not in the number of cylinders) with the 2.7-liter V6 in the Ford F-150.

SAE International has been running a Thermal Management Systems Symposium for a number of years, and it’s been a sign of engineering to come, so MACS staff members have been attending, to be ready for the new technology.

Precision cooling isn’t limited to internal combustion engines. Battery electric vehicle cooling may be even more complex, as high-rate battery pack charging comes into use, but for the present, let’s look at GM’s new cooling system for the 2.7-liter four-cylinder, and how different it will be to service.

The system doesn’t have a thermostat, so if you suddenly are thinking, “Hey, that’s the part I’ve replaced most in cooling system service over the years, followed by radiator, hoses, belt and water pump.” Well, relax. It has lots of parts.

There’s an electric water pump on the right side of the engine. And as the illustrations show (Figures 8 and 9), there’s a lot of external hoses and piping, but the pump itself, as an electric motor-driven device, does not have a belt wrapped around it. Although the water pump’s electrical control (by the engine computer) means it’s infinitely variable and perhaps more subject to failure, it’s also more accessible for service than the integrated mechanical pumps on some conventional engines. And although the thermostat may be gone, there’s a massive coolant control valve on the left side of the engine (which is actually a combination of two valves).

One valve section is integrated with a hot coolant manifold, which controls the flow to the radiator, a bypass circuit, and engine oil and transmission oil heating or cooling circuits, using one actuator. It’s this valve that not only regulates engine warmup, but is a primary factor in eliminating the need for the...
thermostat.

The second valve, called a “block valve,” has a separate actuator that regulates coolant flow for engine block temperature control as well as to the passenger compartment heater.

The valves’ electric actuators both are on a “LIN” (Local Interconnect Network) to the engine computer (Figure 10). A LIN is a relatively simple network. Although the valves are not covered by trouble codes, the system includes trouble-code covered temperature sensors (10 of them) and along with how-it-works descriptions and which and when coolant circuits have flow and which don’t, the diagnosis should be straightforward. If the valve assembly has to be replaced, it must go through a learning curve, which is on the factory scan tool menu. At this early stage there are probably no detail parts available, such as an actuator, although eventually we suspect there will be.

We suspect that as active thermal management systems evolve, some of the external hoses and pipes will be passages within the engine, with additional trouble coding to cover the absence of external parts that can be checked by use of infrared guns and hand-feel diagnosis. At this time, we can’t tell what will be necessary to flush such a system. Obviously, its complexity makes it pretty obvious that all the piping,
hoses, passages and heat exchangers will make conventional flushing just about impossible. We probably will see scan tool routines that put the system in various modes for partial flushing of each section. Or you may have to make specific disconnections and individually flush the block, head, radiator, heater, etc.

The active system does mean that the system is in a continuous control mode, and if any of those 10 coolant temperature sensors fails, a technician will deal with new problems he has never seen before.

Right now, you check a cooling system for cold and warmed up. The 2.7-liter I-4 has up to seven, yes seven cooling modes, although not all seven are used every time; it depends on the temperature of engine and transmission components, their oils, coolants and ambient temperature. The system is designed to switch seamlessly between modes, depending on what amount of heating is selected. The engine-cold, heater-off, startup mode (No. 1) is the fastest at warming up the engine. The electric water pump is run at low speed and both valves are in low coolant flow mode, as heated coolant is allowed to stay around the combustion chamber. The low flow through the block helps speed warmup of that area.

If the driver requests heating or turns on the defroster, the water pump may speed up and from here on, through the remaining coolant flow modes, pump rpm is regulated according to engine demand. And the coolant valves are adjusted by the computer, with feedbacks from position sensors at the valves.
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