Cooling System Operation and Diagnosis

FIGURE 19.1 Typical combustion and exhaust temperatures.

FIGURE 19.2 Coolant flow through a typical engine cooling system.
FIGURE 19.3 Coolant circulates through the water jackets in the engine block and cylinder head.

FIGURE 19.4 A cross section of a typical wax-actuated thermostat showing the position of the wax pellet and spring.

FIGURE 19.5 (a) When the engine is cold, the coolant flows through the bypass. (b) When the thermostat opens, the coolant can flow to the radiator.
FIGURE 19.6 A thermostat stuck in the open position caused the engine to operate too cold. A P0128 diagnostic trouble code (DTC) was set, failed an emission test, and suffered from poor fuel economy because of this defect. If a thermostat is stuck closed, this can cause the engine to overheat.

FIGURE 19.7 This internal bypass passage in the thermostat housing allows cold coolant to the water pump.
Cooling System Operation and Diagnosis

FIGURE 19.8 A cutaway of a small-block Chevrolet V8 showing the passage from the cylinder head through the front of the intake manifold to the thermostat.

FIGURE 19.9 Setup used to check the opening temperature of a thermostat.

FIGURE 19.10 Some thermostats are an integral part of the housing. This thermostat and radiator hoses housing is serviced as an assembly. Note the thermostat deeply snap into the engine radiator fill tube underneath the pressure cap.
FIGURE 19.11: Graph showing the relationship of the freezing point of the coolant to the percentage of antifreeze used in the coolant.

FIGURE 19.12: Graph showing how the boiling point of the coolant increases as the percentage of antifreeze in the coolant increases.

CHART 19.2: Chart showing the freezing point of different coolant mixtures.

The freezing point depends on the concentration of antifreeze in the coolant.
COOLING SYSTEM OPERATION AND DIAGNOSIS

CHART 19.3

<table>
<thead>
<tr>
<th>Coolant Type</th>
<th>Boiling Point at Sea Level</th>
<th>Boiling Point with 15 PSI Pressure Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure water</td>
<td>212°F (100°C)</td>
<td>257°F (125°C)</td>
</tr>
<tr>
<td>50:50 mixture</td>
<td>219°F (103°C)</td>
<td>285°F (140°C)</td>
</tr>
<tr>
<td>70:30 mixture</td>
<td>225°F (107°C)</td>
<td>276°F (130°C)</td>
</tr>
</tbody>
</table>

The boiling point depends on the concentration of antifreeze in the coolant.

FIGURE 19.13 Checking the freezing and boiling protection levels of the coolant using a hydrometer.

FIGURE 19.14 The tubes and fins of the radiator core.
Chapter 19

**Cooling System Operation and Diagnosis**

**FIGURE 19.15** A radiator may be either a down-flow or a cross-flow type.

**FIGURE 19.16** A heavily corroded radiator from a vehicle that was overheating. A visual inspection discovered that the corrosion had eaten away many of the cooling fins, yet did not leak. This radiator was replaced and solved the overheating problem.

**FIGURE 19.17** Many vehicles equipped with an automatic transmission use transmission fluid cooler inserted in one of the radiator tanks.
FIGURE 19.18 The pressure valve maintains the system pressure and allows excess pressure to vent. The vacuum valve allows coolant to return to the system from the recovery tank.

FIGURE 19.19 Some vehicles use a surge tank, which is located at the highest level of the cooling system, with a radiator cap.

CHART 19.4

<table>
<thead>
<tr>
<th>BAR or Atmospheres</th>
<th>Pounds per Square Inch (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>16</td>
</tr>
<tr>
<td>1.0</td>
<td>15</td>
</tr>
<tr>
<td>0.9</td>
<td>13</td>
</tr>
<tr>
<td>0.8</td>
<td>12</td>
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<tr>
<td>0.7</td>
<td>10</td>
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<tr>
<td>0.6</td>
<td>9</td>
</tr>
<tr>
<td>0.5</td>
<td>7</td>
</tr>
</tbody>
</table>

Conversion from BAR to PSI rating of radiator caps.
FIGURE 19.20 The level in the coolant recovery system raises and lowers with engine temperature.

FIGURE 19.21 Pressure testing the cooling system. A typical hand-operated pressure tester applies pressure equal to the radiator cap pressure. The pressure should hold; if it drops, this indicates a leak somewhere in the cooling system. An adapter is used to attach the pump to the cap to determine if the radiator can hold pressure, and release it when pressure rises above its maximum rated pressure setting.

FIGURE 19.22 The pressure cap should be checked for proper operation using a pressure tester as part of the cooling system diagnosis.
FIGURE 19.23 Use dye specifically made for coolant when checking for leaks using a black light.

FIGURE 19.24 Coolant flow through the impeller and scroll of a coolant pump for a V-type engine.

FIGURE 19.25 A demonstration engine showing the amount of water that can be circulated through the cooling system.
FIGURE 19.26 This severely corroded water pump could not circulate enough coolant to keep the engine cool. As a result, the engine overheated and blew a head gasket.

FIGURE 19.27 The bleed weep hole in the water pump allows coolant to leak out of the pump and not be forced into the bearing. If the bearing failed, more serious damage could result.

FIGURE 19.28 A cutaway of a typical water pump showing the long bearing assembly and the seal. The weep hole is located between the seal and the bearing. If the seal fails, then coolant flows out of the weep hole to prevent the coolant from damaging the bearing.
FIGURE 19.29 A typical engine-driven cooling fan.

FIGURE 19.30 A typical electric cooling fan assembly showing the radiator and related components.

FIGURE 19.31 Flexible cooling fan blades change shape as the engine speed changes.
FIGURE 19.32 The bimetallic temperature sensor spring controls the amount of silicone that is allowed into the drive unit, which controls the speed of the fan.

FIGURE 19.33 A typical electric cooling fan assembly after being removed from the vehicle.

FIGURE 19.34 When an engine overheats, often the coolant overflows and leaks.
Chrysler recommends that the bleeder valve be opened whenever refilling the cooling system. Also, Chrysler recommends that a clear plastic hose (1/4" ID) be attached to the bleeder valve and directed into a suitable container to keep from spilling coolant onto the ground and on the engine and to allow the technician to observe the flow of coolant for any remaining oil bubbles.

All cooling system hoses should be checked for wear or damage.