Figure 20-1  Graph showing the relationship of the freezing point of the coolant to the percentage of antifreeze used in the coolant.

Figure 20-2  Graph showing how the boiling point of the coolant increases as the percentage of antifreeze in the coolant increases.
Figure 20-3  Havoline was the first company to make and market OAT coolant. General Motors uses the term DEX-COOL.

FREQUENTLY ASKED QUESTION:
What is a "G" Coolant?
The "G" coolants come from the trade name Glycan of BASF in Europe and Uvasol (Zerex) in the United States. The following is a summary of the types listed by G number:

- G05: different from DEX-COOL in certain amounts of additives
- G30 and G34: nonsilicate and phosphate free
- G11: blue VW used before 1997
  - HOAT formulation
  - Phosphate free
- G48: low silicate and phosphate free
  - Blue
  - Nitrates, amines, phosphate (NAP) free

Figure 20-4  Coolant used in Ford's that use Mazda engines and in Mazda vehicles. It requires the use of a PHOAT coolant which is dark green.
**FREQUENTLY ASKED QUESTION: What Is Pet Friendly Antifreeze?**

Conventional ethylene glycol antifreeze used by all vehicle manufacturers is attractive to pets and animals because it has a sweet taste. Ethylene glycol is fatal to any animal if swallowed, so any spill should be cleaned up quickly. There are two types of coolant that are safer for use around pets than the conventional type.

- **Propylene glycol (PG).** This type of antifreeze is less attractive to pets and animals because it is not as sweet, but it is still harmful if swallowed. This type of coolant, including the Sierra brand, should not be mixed with any other ethylene glycol based coolant.

  **CAUTION:** Some vehicle manufacturers do not recommend the use of propylene glycol coolant. Check the recommendation in the owner manual or service information before using it in a vehicle.

- **Embittered coolant.** This coolant has a small amount of a substance that makes it taste bitter and therefore not appealing to pets. The embittering agent used in antifreeze is usually denatonium benzoate, added at the rate of 30 ppm. Oregon and California require all coolant sold in these states since 2004 to be embittered.

**REAL WORLD FIX: If 50% Is Good, 100% Must Be Better**

A vehicle owner said that the cooling system of his vehicle would never freeze or rust. He said that he used 100% antifreeze (ethylene glycol) instead of a 50/50 mixture with water. However, after the temperatures dropped to -20°F (-29°C), the radiator froze and cracked. (Pure antifreeze freezes at about 0°F [-18°C].) After thawing, the radiator had to be repaired. The owner was lucky that the engine block did not also crack.

For best freeze protection with good heat transfer, use a 50/50 mixture of antifreeze and water. A 50/50 mixture of antifreeze and water is the best compromise between temperature protection and the heat transfer that is necessary for cooling system operation. Do not exceed 70% antifreeze (30% water), as the percentage of antifreeze increases, the boiling temperature increases, and freezing protection increases (up to 100% antifreeze), but the heat transfer performance of the mixture decreases.
FREQUENTLY ASKED QUESTION:

What Makes Some Water Bad for Coolant?

City water is treated with chloride, which, if the levels are high enough, can cause corrosion problems when used in coolants. Well water may contain iron or other minerals that can affect the coolant and may increase the corrosion or cause electrolysis. Due to the fact that the water quality is often unknown and could affect the engine, many vehicle manufacturers are specifying the use of pre-mixed coolant. In pre-mix coolant, the water is usually demineralized and meets the standards for use in coolant.

FREQUENTLY ASKED QUESTION:

Why Is Most Coolant 50/50 with Water?

According to the freezing point, it appears that the lowest freezing point of coolant is achieved when 70% antifreeze is used with 30% water. While the freezing temperature is lower, the high concentrate of antifreeze reduces the heat transferability of the coolant. Therefore, most vehicle manufacturers specify a 50/50 mixture of antifreeze and water to achieve the best balance between freeze protection and heat conductivity.
TECH TIP: Ignore the Wind Chill Factor

The wind chill factor is a temperature that combines the actual temperature and the wind speed to determine the overall heat loss effect on open skin. Because it is the heat loss factor for open skin, the wind chill temperature is not to be considered when determining antifreeze protection levels.

Although moving air makes it feel colder, the actual temperature is not changed by the wind, and the engine coolant will not be affected by the wind chill. If you are not convinced, try placing a thermometer in a room and wait until a stable reading is obtained. Now turn on a fan and have the air blow across the thermometer. The temperature will not change.

Figure 20-7
Using a refractometer is an accurate method to check the freezing point of coolant.

Figure 20-8
A meter that measures the actual pH of the coolant can be used for all coolants, unlike many test strips that cannot be used to test the pH of red or orange coolants.
Figure 20-9  Galvanic activity is created by two dissimilar metals in contact with a liquid, in this case coolant.

Figure 20-10  A test strip can be used to determine the pH and percentage of glycol of the coolant. The percentage of glycol determines the freezing and boiling temperatures, as shown on the bottle that contains the test strip.