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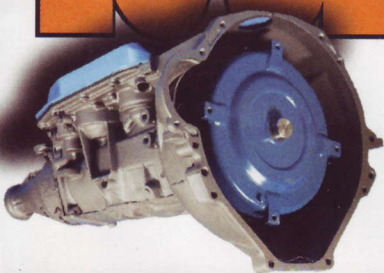
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Cool Under Pressure

THE TRUTH ABOUT AUTOMOTIVE COOLING

Text and photography by Brion Gluck

While the internal combustion engine is a marvel of engineering, no physicist would describe even the best as being particularly efficient. A lot of the energy liberated by burning gasoline is wasted as heat, either flying straight out the tailpipe or raising the temperature of the engine itself.

Getting rid of this excess heat is both an absolute necessity and an occasional mystery. The water temperature gauge in the dash is the only mechanism most Mustang owners have to judge what the cooling system is doing. A temp gauge is well, but doesn't help much in diagnosing problems. The problems can stem from water pumps, water passages, thermostats, radiator and various hoses and valves. Anyone who has spent days trying to track down an overheating problem can testify to that.

"The design of the cooling system is to remove heat that is generated from friction and combustion within the engine and there is a fine line of where an operating range should be for an engine," said Rodney Brenner, manager of cooling products for AFco Racing

burned by them:

If you want to keep your car from overheating, you need to have as much water capacity as possible, right? Not so fast. "The fact of the matter is unless you are removing heat from the system, you are going to overheat the system no

Where there are mysteries, there are myths, and Brenner has seen and heard most of the ones floating around about cooling systems. We'll counter fallacy with fact to keep you from getting burned by them:

operate efficiently within that range." "The goal of the cooling system is to same. The goal of the cooling system is to problems, and if it is too hot, does the low or too cold, it can cause failures and it within that operating range. If it is too the goal of the cooling system to keep Products (www.afcoracing.com). "It is

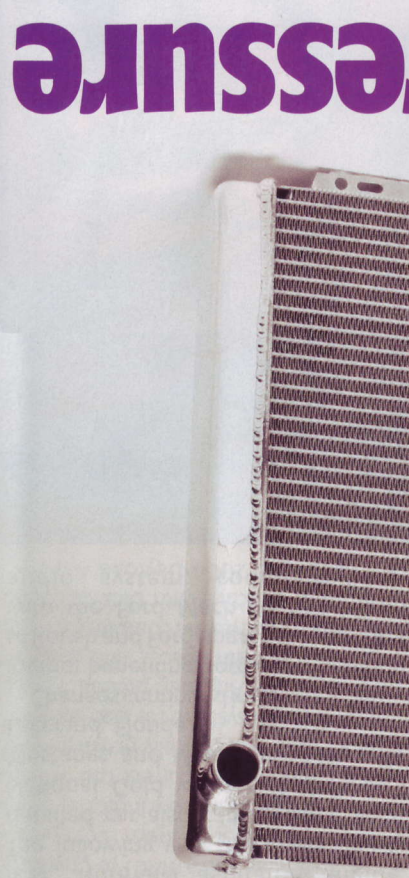
Myth 1: Bigger is Better

Double-pass designs use an internal baffle that splits the radiator into two sections, top and bottom. Coolant enters from the left side on top, flows across to the right side, down to the bottom half, then over again to exit on the bottom left. "That effectively allows the water to pass through the radiator twice," Brenner said.

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Brenner says AFco has heard of people buying thick NASCAR-surplus radiators with huge capacities designed for superspeedway use and installing them in their street cars. "You cannot pass enough airflow through (them) with a conventional fan system or electrical fan system. That can cause problems."

AFco has been emphasizing smaller, lighter-weight aluminum radiators for the last 10 years or so that feature a double-pass design and customized applications for different types of racing, instead of the one-size-fits-all approach prevalent in earlier years.



matter how much water you would have," Brenner said. "An example would be if you had a 50-gallon drum of water that you carried with you, but you did not exchange any heat out of that system, eventually you are going to overheat that water no matter how big the cooling system is."

In a conventional single-pass radiator, coolant flows from top to bottom, making only one trip through the unit.



heat exchange," Brenner explained. have a better contact area and a better water itself and if we can do that, we can the suspended air molecules within the system, we are effectively squeezing higher pressure a higher pressure 190 to 210 degrees. So why do it?

"By running a higher pressure for a street car, the optimal temperature is higher temperatures, but not so. Just like higher pressure because they operate at You might think race cars run with over a long time ago," Brenner said.

even close to that, you should have pulled degrees. "If you are boiling over anywhere the coolant temperature exceeds 260 so a street system won't boil over until the boiling point of water three degrees, pound cap. Each pound of pressure raises with race cars often using a 22 to 25 cooling system to 16 pounds of pressure, A street car typically pressurizes the outlet should be used.

tank mounted higher than the motor those installations, a pressurized surge point in the system," Brenner warns. For be, then you are not filling at the highest words, where the thermostat area would is below the outlet of the motor, in other and then topped off. "If your radiator cap circulate and air bubbles to bleed out, radiator cap off to allow the coolant to highest point, the engine started with the The system should be filled from the inside heads and high spot areas."

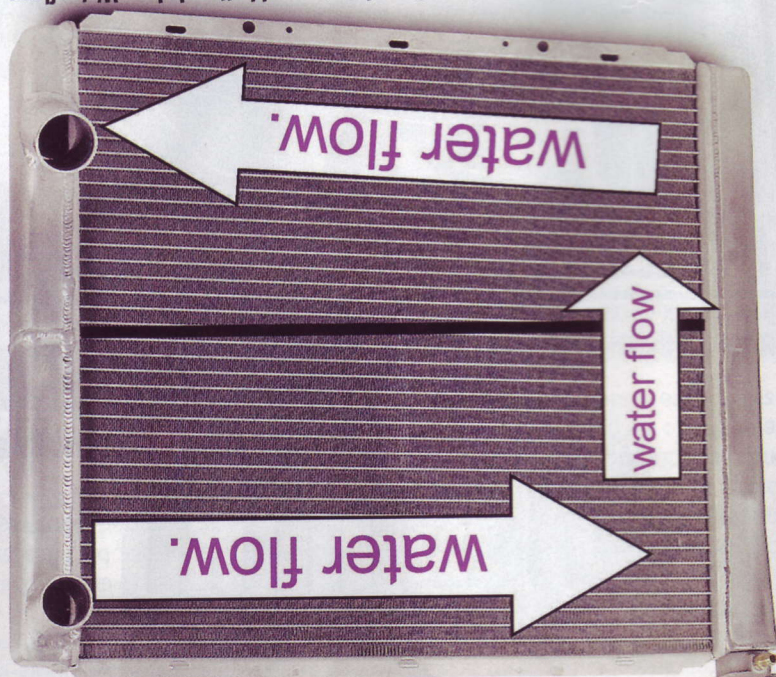
to remove air pockets that get trapped cycle out the water through the system it and go race," he said. "We have to the radiator, and put the cap back on the fresh system up with water to top would be to open the radiator cap, fill

source of issues. "The improper way out of the cooling system is a major Brenner says failure to bleed the air

Myth 4: No Need to Bleed

believes provides the best cooling. a restrictor of coolant flow, which Brenner the radiator to become the ultimate lead to hot spots which can be bad, bad in the motor longer," he said. This can but you are also leaving the hot water leave water in the radiator longer, it is

A double-pass unit effectively splits the radiator into top and bottom halves. Water flows across the top half, down, then across the bottom half. The second pass gives an extra 10-20 degree temperature drop compared to a single-pass unit of the same size and weight.



giving more efficient cooling.

Myth 2: Copper/Brass Beats Aluminum

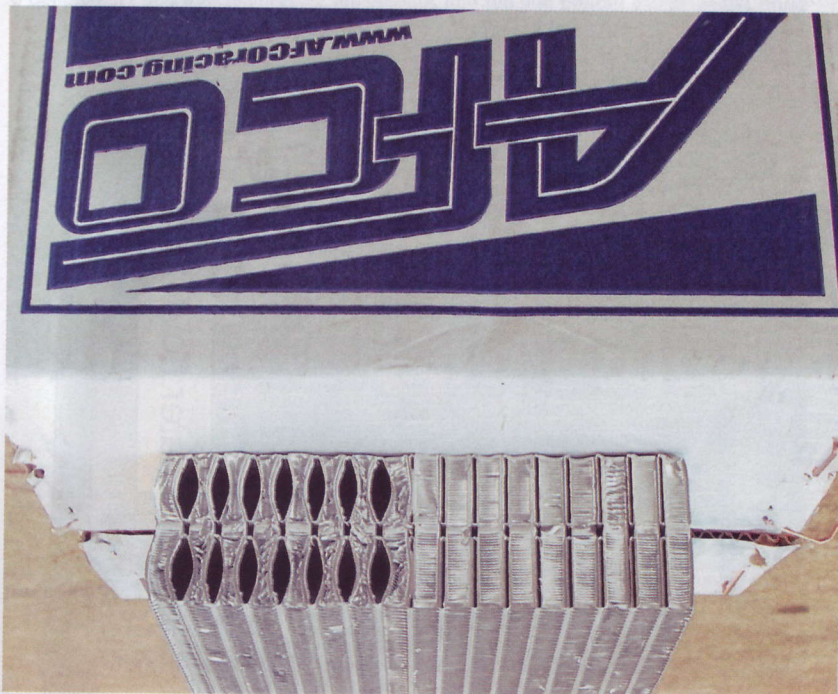
New copper/brass radiator designs are appearing on the market, claiming superiority over conventional aluminum. While copper/brass is a better thermal conductor, Brenner said aluminum still makes for a lighter, more efficient radiator.

"With aluminum, because of the metallurgy, we can make a wide one-inch row and we can stack those two-row designs into a racing type radiator or a street radiator versus a copper/brass, that if you compare the same thickness, you would have a four row copper/brass design, but the tubes themselves are a smaller tube," he said. The aluminum design has more contact area, and thus a better ability to transfer heat.

Myth 3: Always Use a Thermostat or Restrictor

Thermostats and restrictors are a major point of contention for car owners. One theory says a restrictor will help regulate the flow of coolant through the radiator, making sure that it stays in the core long enough to cool off. And, of course, thermostats are useful in helping street cars come up to operating temperature quickly. But for racing applications, Brenner is unequivocal: Don't use them. "If you

> TECHNICAL Cool Under Pressure



A blown head gasket at racing speeds can also cause a "blown" radiator. The nearly-instantaneous pressure rise in the cooling system blew up the tubes on the top half of this AFCO double-pass unit like balloons, crushing the fins. Venting caps can't always release pressure quickly enough to prevent this, so the radiator should always be inspected for damage after a head gasket is blown.

Higher pressure lets more heat be moved using the same amount of coolant. Radiator failures can easily occur when an engine has a hot spot or a blown head gasket. When a head gasket fails, the pressure in the cooling systems shoots up more rapidly than a radiator in the radiator can inflate like balloons under the pressure, crushing the fins and destroying the cooling ability. "Of course, it is something that goes overlooked, so basically anytime there has been a head gasket failure or you experienced an overheated motor, you need to inspect the radiator to make sure that has not occurred," Brenner said.

Myth 5: One Size Fits All

Because different applications have different cooling needs, fans and water pumps should be matched to the intended usage. Brenner said many racers ignore the tuning of the cooling system, and may be throwing away horsepower or risking mechanical failure by treating the moving parts as constants. He's no fan of the common practice of putting a pusher fan on the front of the radiator. "In designing a cooling system, your idea is to create a low pressure area behind the radiator so you can take

for their pump. Double-pass radiators can require more water pump pressure to operate at the night volume and the right flow than a single-pass unit. "It may be the case that the water pump is already being turned at an ideal speed and that switching to a double pass doesn't require a pump change or a pulley change," Brenner said, "but it is something that needs to be inspected." AFCO suggests getting recommendations from the manufacturer on the ideal operating range

anything up front is going to help." as creating a square duct going to the radiator," he said. "But in most cases the proper ducting, it is not as simple as research done on the proper angles and careful design. "There has been a lot of circumstances, Brenner noted, but require into the radiator can be helpful in some NASCAR-style air boxes that duct air excessive cooling.

keep from wasting precious horses on the airflow needs for the race to power, the output should be matched Since a mechanical fan is always robbing should be paid to the fan's rpm and size. If a mechanical fan is used, attention superior in airflow at race speeds.

A pusher fan "creates a blockage under high speed driving." Puller fans are far advantage of the ram air," Brenner said.

for their pump. Double-pass radiators can require more water pump pressure to operate at the night volume and the right flow than a single-pass unit. "It may be the case that the water pump is already being turned at an ideal speed and that switching to a double pass doesn't require a pump change or a pulley change," Brenner said, "but it is something that needs to be inspected." AFCO suggests getting recommendations from the manufacturer on the ideal operating range

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but for racing units like AFCO's, Brenner recommends simply using a pair of lot of bent fins, or there is debris stuck in it, all that is going to restrict the airflow. If I reduce my airflow by 20 percent, it is going to have a tremendous impact on the cooling ability of the radiator." ■

"Most people replace their radiators not because they fail or leak, but because the efficiency has dropped," Brenner said. "If you have a radiator that has a system is operating correctly and you have the ability to create a low-pressure area behind the radiator, then you can allow some angles to be put into the radiator and still operate efficiently," he said.

Road racers trying to minimize frontal area sometimes install radiators leaned back 30, 45, even as much as 90 degrees. This must be done with care to preserve the airflow, Brenner cautions. "If the cooling system is operating correctly and you have the ability to create a low-pressure area behind the radiator, then you can allow some angles to be put into the radiator and still operate efficiently," he said.

Myth 6: Radiators are Maintenance-free

How long can a radiator last? Brenner has seen AFCO units in service for 10 years or more, but proper care is the key to a long life. Here are his top maintenance tips:

1. Keep debris from damaging the core by mounting a screen or other guard in front of the radiator.
2. Periodically remove and backflush the unit with low-pressure water (i.e., a garden hose). High-pressure water from car wash wands and the like can bend the fins.
3. Use distilled water and an anti-rust/water pump lubricant additive on the fill to prevent scaling.
4. Every two weeks, inspect the radiator and straighten any bent fins. For an OEM radiator, you can use a fin comb

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renner said. Package under fans are far needs. d, attention m and size. ways robbing the race to s horses on hat duct air ful in some but require een a lot of angles and as simple going to the most cases require more "help." at the night a single- hat the water at an ideal double pass or a pulley is something CO suggests from the erating range

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