SOLVING COOLING WOES

Anyone with cooling problems may be interested in the following questions.

1) How much better / worse does a two row aluminium radiator with 1 inch tubes work in place of the same size radiator with four rows of 3/8 inch brass tubes and everything else in the cooling system remaining constant?

2) What about high performance water pumps versus stock for a real world temperature reduction?

3) What works better in the real world: a 17 inch seven blade flex fan at an engine idle speed of 675 RPM or a 2,360 cfm or thereabouts 17 inch electric fan?

4) Is straight water or 50/50 coolant better?

Taking the basic question first ----- brass and copper radiators theoretically should offer conductivity advantages over aluminium except for two flies in the ointment:

a) the lead used to solder together the brass and copper is a poor heat conductor; and

b) brass radiators are limited to a maximum tube diameter of 5/8 to 3/4 inch.

Brass and copper are very soft, so larger tubes made from these materials can't handle the pressure. Modern high tensile aluminium radiators can be built up to 1 1/2 inch tubes. The larger tubes allow radiator manufacturers to increase the tubes / inch density. That reduces the thickness of the radiator while improving airflow through the radiator. This is because the most important criterion for any radiator is it's total surface area. You should increase core thickness only after surface area is maximized.

Beyond three rows the efficiency of the added rows at the back greatly diminishes. Generally a two row large-tube aluminium radiator is preferred for a low speed street cooling as this configuration minimizes pressure drop through the core and the fan power thereby required to pull air through the core.

In fact, an aluminium radiator with two rows of 1 1/2 inch coolant tubes is roughly equivalent to a copper / brass radiator with five rows of 1/2 inch tubes. Besides that, multi row brass / copper radiator is not only heavier, it's added thickness also presents a more restrictive path for the air to travel, especially at low vehicle and engine speeds. Crossflow radiators are more efficient than downflow radiators. If your car has an old school downflow radiator, it may pay to upgrade to a later design. Assuming the fill cap is on the radiator, on the crossflow design the cap should always be on the outlet side. Upright (downflow) radiators have the cap on the inlet side; this subjects the filler cap to the pressure drop of the radiator's core in addition to the system pressure, effectively lowering the pressure of a 22 psi rated cap to as low as 10 psi. Higher coolant system pressures raise the coolant's vapour point and thus it's ability to absorb heat. Always use the highest rated pressure cap available. The radiator filler cap must be located at the highest point in the cooling system. If the engine's coolant inlet is the highest point, air pockets will form. To prevent air pocket formation under such a circumstance, relocate the filler cap to a surge tank mounted higher than the engine and the radiator.

Radiators become less efficient as the coolant temperature approaches ambient. A low flow rate keeps coolant in the radiator longer; the longer the coolant stays in the radiator, the lower the radiator's efficiency. As radiator engineers put it -- "non-laminar or turbulent coolant flow must be maintained within the radiator core". One way to accomplish this is to insert baffles in the tanks to force the water to go through the radiator twice. The water spends the same amount of time in the radiator but must travel twice the distance, thereby doubling the speed of the water. This is known as dual-pass radiator design. Radiator fin density also dovetails with fan and blade angle configuration. Some experts say high-fin density radiators work best with engine driven fans with steep blade angles. When comparing electric and mechanical fan rpm at idle, remember that with a mechanical fan the drive pulley ratio comes into play.

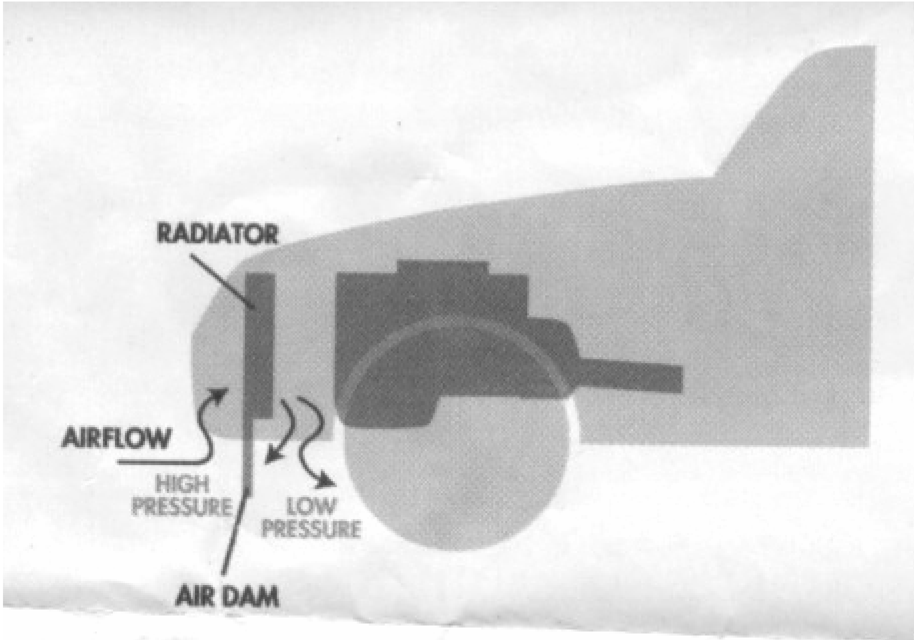
Only if the crank and water pump pulleys are the same size is the fan rpm the same as engine rpm. No doubt in nearly every case, the electric fan will spin faster at idle than an engine driven fan, so if you have a low-speed cooling problem I'd lean toward an efficient electric fan design. Placing the fan behind the radiator is more efficient than a pusher fan placed in front of the radiator. Sometimes multiple small diameter electric fans work better than one large electric fan. The goal is to cover as much of the core face as possible. Failing that, custom fabricate a shroud to duct all air through the fan. If you are towing and / or have a high speed cooling problem, mechanical fans are still preferred.

Flex fans vary widely in quality, but even the best flex fan is nowhere near as efficient as a factory style, thermostatically controlled clutch fan. That's the best you can get. Remember that a fan is designed to create negative pressure behind the radiator to pull air through. The further away it is from the radiator, the less efficient it is. If you're not running a shroud it is recommended the fan blades be within one inch of the radiator and no more than two inches away. Better of course is to use a shroud that covers the entire radiator area. Position mechanical fan blades so that about half the blade depth projects into the shroud.

Fan to shroud blade tip clearance should be 3/4 inch max, less if you can get away with it without causing interference (remember to allow for engine / chassis movement). Although a performance water pump may show some improvement, we have not seen significant benefits from full race water pumps for low rpm street use. Optimized as they are for sustained high rpm engines, they may actually be less efficient at low rpm. One thing you can do if you have a low speed cooling problem is to change the drive pulley ratio to overdrive the water pump 20 to 30 percent. Certainly don’t underdrive the pump in your application and check that the fan belt(s) have good pulley contact with no slippage.

Water is the most efficient coolant medium. Only run coolant if your engine will be exposed to freezing conditions. If running pure water, add a corrosion inhibitor.

Finally, there is airflow management through the grill and engine compartment. There should be 3/8 to 1/2 inch maximum spacing between the A/C condenser and radiator. If there is too much space, the air will go around the condenser reducing it’s efficiency. But you can get around this by fabricating an air dam and underchassis plate to scoop air from under the car directly into the radiator. Take a look at late model cars, even stock sedans these days are bottom feeders and have some sort of air dam. Getting air out of a tightly cowled engine compartment is also important. Consider hood louvres or fender extractors.



> An air dam mounted below the radiator deflects air into the radiator and creates a low-pressure area behind it. This helps pull air through the radiator while preventing air exiting the radiator from re-entering it at the front. For max effectiveness, fabricate the air dam from plastic or flexible material and hang it as close to ground level as possible.

Summing up: a modern high – fin density, dual pass aluminium radiator (two rows or two inch core thickness max) fed by ducted under vehicle air and backed by either high efficiency electric fans with a blade angle optimized for the radiator core design or a thermostatically controlled clutch driven mechanical fan properly shrouded, should solve your problems assuming the engine is sound and properly tuned.

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