TWIN TURBO 385 BUILD UP

COOLING SYSTEM

Source: www.grapeaperacing.com

COOLANT FLOW

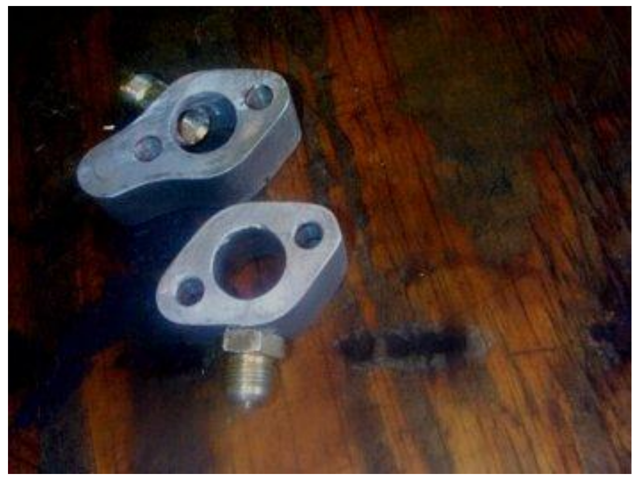
The stock cooling system does not provide very even water distribution or temperatures across the engine. For a stock engine, this may not be a problem. When you increase performance, you increase the chances of detonation. The front cylinders always run cooler because they get the coolant first. The front combustion chambers always tend to run the hottest because they are the last to get coolant before the water exits back to the radiator. The small-block Chevy also has a problem with the area between the siamese exhaust ports running hotter.

The stock small-block Chevy water pump doesn't give even flow to each bank. It was popular in the past to partially block the right bank water pump discharge port to about 9/16" to help even out the flow, but a better solution is to simply replace the water pump with an aftermarket unit like a Stewart Warner one like I use. Stewart Warner has done a lot of research and development in water pump design.

Once the left to right bank flow is evened out, the stock cooling system also has an issue with cyclic flow from bank to bank. I did not concern myself with this too much because it is not a big problem in a drag car. Cyclic flow is a real issue in an endurance engine, but not for drag racing or everyday street driving.

In theory, it makes the most sense to start coolant flow at the chambers then flow to the cylinders, but it is not easy to reverse coolant flow in a system that was design to flow from bottom to top. Reversing the flow is easy, it just doesn't work. You get very uneven flow and trapped steam pockets. A reverse flow cooling system works great when designed from scratch, converting to one is not easy.

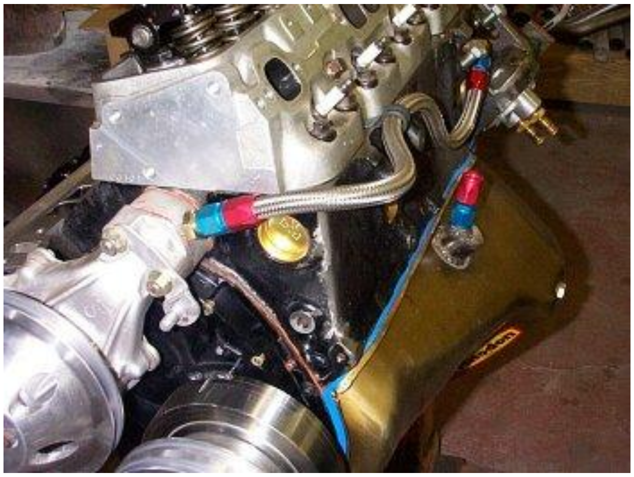
I stayed with the basic bottom to top flow in the cooling system, but added some lines to help even out the temperature differentials across the engine. The fist step is to add water the rear of the block, so you are feeding it from both the front and back. To do this you need to tap off the water pump. I used spacer blocks to convert a short pump to a long one and tapped the fittings into the blocks. To makes it work you need to put restrictions in the front of the block and profile the fittings to promote flow into them.



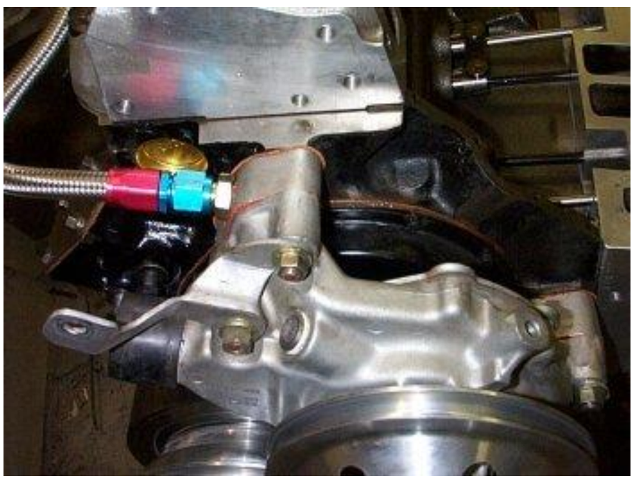
I tapped the fittings deep enough to protrude into the ports. I then ground the front away leaving a scoop to promote flow into them.

I have seen some people thread the rear freeze plug holes for a large pipe thread to be bushed down for hose fittings. This can work fine, but I simply drilled and tapped the block just under the deck as far back as I could, which let me run the hose tight against the bock. This gave me more room for the starter and exhaust. I now have water entering the front and rear of the block helping even out the cylinder temperatures.

A better setup, but not practical to do on a street car, is to totally block coolant from entering the front of the block. Then tap into three points on each side of the block, front rear and middle. As well as take coolant from three point of the intake manifold to return to the radiator. This gives very even flow from bottom to top. Still backwards from what is optimum, but about as good as you'll get from a standard flow system. This does offer some good benefits, but they are small in comparison to the work involved to package such a system in a street car.

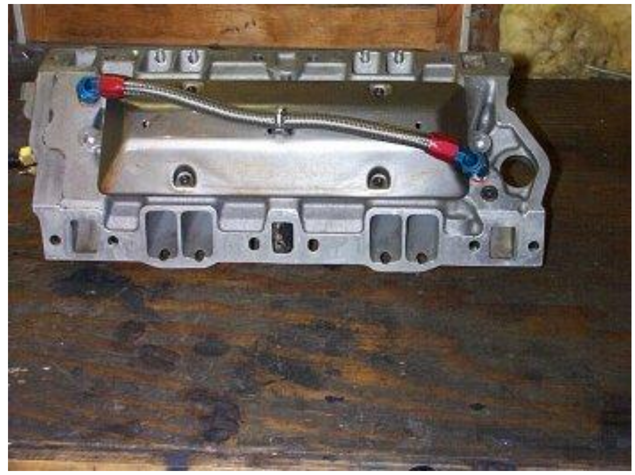


This is the left side line; it goes form the water pump to the rear of the block and fits nicely over the engine mount.



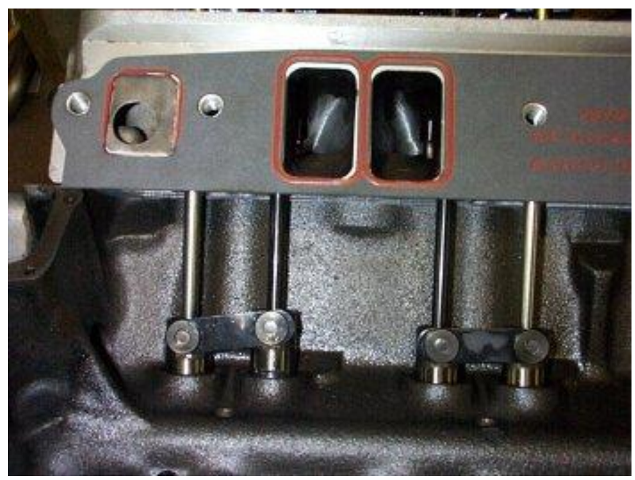
The right side line was a tighter fit, but fits fine under the alternator along with both fuel lines (not installed yet).

Now that I have more even flow into the block, it leaves the front chambers at a disadvantage because all coolant must still flow past them to get to the thermostat housing to get back to the radiator. To help this I generally tap into the rear of the intake that normally blocks off the rear water ports on the heads. Then run external lines to the front of the manifold. The Super Ram bas manifold has a rear water passage connect the two heads to equalize pressure. Equalizing pressure helps reduce cyclic flow.



Since the Super Ram base had a rear water port, I was able to run a #10 hose under the manifold to take allow coolant to leave the rear of the engine.

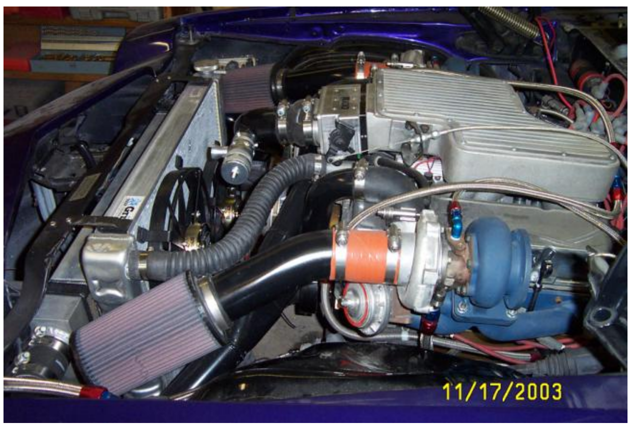
The rear of the Super Ram manifold did not make it easy to add external water hoses. There was very little rood between the manifold and distributor due to the rear water passage. The easiest solution was to go under the manifold. To promote flow from the rear of the block, I had to restrict coolant from the front ports on the heads.



Thin restrictions in the front head ports helps promote flow through the #10 hose under the manifold.

RADIATOR & ELECTRIC FANS

For a radiator, I went with the biggest aluminum one I could fit in there. It's a Griffin 19" by 31" core. In order to fit the height, I had to lower the stock mount. I made a radiator cross member that was no longer part of the factory radiator support. The radiator just fit between the frame rails. The radiator is also slightly farther back then the original to make room for the Spearco air-to-air cooler. I went with an aluminum radiator to save a little more weight. There is nothing wrong with a good copper/brass radiator. A good copper/brass radiator can get rid of heat faster than an aluminum one, so the real advantage of aluminum is weight savings. Both copper and brass dissipate heat faster than aluminum. Stock copper/brass radiators are not very good, so a quality aluminum one may be a step up. The problem with most stock radiators is that they are soldered together with cheap solder. While the copper fins can dissipate the heat faster, the solder that holds them is transfers the heat slower. Any decent aftermarket copper radiator will be silver soldered together. This of course makes them quite expensive. Chances are that a good aluminum radiator will be all that is needed. When it comes to a cooling system, it's better to have too much than not enough. You can always keep temperatures up with a thermostat.



The radiator and air-to-air cooler fit quite nicely. They didn't leave enough room for a clutch fan though.

After the radiator was installed, it was obvious that I needed electric fans if I was going to fit the 3" intake pipe from the intercooler to the throttle body. Electric fans cannot flow as much air as a good clutch fan and shroud, but I could get enough airflow with two 14" electric fans. The main purpose of all these cooling system modifications is to even out temperatures and allow the engine to safely run hotter before detonation is a problem. The hotter the engine runs, the less cooling system capacity is needed. By increasing the engine temperature you reduce the amount of heat the cooling system must dissipate, which increases thermal efficiency adding horsepower. I normally run this engine at 220º without any signs of detonation at 15 psi of boost.

It is a common misconception that running cooler makes more power. The only thing you want cool is the intake air, cooler denser air contains more oxygen and gives the potential for more power. Heat is what pushes the pistons down, any lost heat reduces efficiency. A cooling system robs power, but without it, the engine would overheat and detonate itself to scrap in a short time. A cooling system is necessary, even though it hurts power.

COOLANT

Regular ethylene glycol is a fairly good coolant for most street engines. For extremely high output engines it may not have a high enough boiling point to cool the combustion chambers. You can decrease the chances of the coolant boiling by increasing pressure and/or speeding up the flow. Increase flow is limited to water pump cavitation. An alternative is to use a straight propylene glycol coolant, which has a much higher boiling point and resists cavitation much better that ethylene glycol. One issue with propylene glycol is that is likes a faster flow rate, so over driving the pump is necessary.

People tend to lean towards under driving water pumps looking for less parasitic power loss. A stock small-block water pump sucks up a mere 7 horsepower at 5000 rpm when 15% overdriven, so there are no real power gains from under driving it. It will actually hurt more power than it frees up by lowering the detonation threshold. A higher detonation threshold will allow more cylinder pressure before detonation sets in. That means more boost, nitrous, compression, etc. can be used. What is really going to determine the best pump drive ratio will be the rpm range of the engine.

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