S2000 Intake Manifold Spacer/Insulator

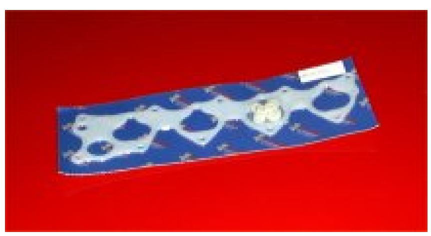
Author: Todd Marcucci

Why?
An intake manifold spacer/insulator will help keep your intake manifold cooler. What will this do for you? Improve power. A cooler intake charge helps to produce more power, as you have probably seen on cool days or when your car is first warming up. Removing sources of heat to the manifold will lower it's temperatures, as will isolating it from the largest heat source, the head. How much more power will it make? Mugen has implied that as little as 5 degrees (F) will result in a 1% power gain. That means that a 25 degree reduction would result in a 5% power gain. Keep in mind that removing heat adds power not only by increasing air density, but also by helping prevent the ECU from retarding the timing to help prevent detonation. Anyone who has driven an S2000 in hot weather knows this affect and can attest to the power loss.

How hot does the manifold get? My own temperature testing showed that the intake air temp went as high as 125 degrees in mixed driving after 20 minutes (with a 70 degree ambient) once the engine was warmed up. I also found that the head is essentially the water temp, at least, while I was checking exterior head temps the fans kicked on when the head hit about 190 degrees. The fan switch is set to engage at about that point, maybe a few degrees higher. That means the outside surface of the head is probably no more than 5 degrees cooler than the coolant. I also checked the temperature of the manifold (near where I checked on the head) and found it to be no more than 5 degrees cooler than the head. That means that once your car is warmed up, your head and manifold are both very hot!

If the heating the manifold reduces power, why would Honda heat the manifold in the first place? Heating the intake manifold is beneficial in extremely cold climates where ambient temperatures are below freezing frequently. As temperatures go below freezing, any moisture present in the throttle body or IACV valve may freeze and cause them to stick or freeze up. This could have potentially annoying or dangerous consequences. Heating the throttle body and IACV (and manifold) can help prevent this. This is rare, though, and downright unnecessary in warmer climates. Unless you park your car under snow drifts overnight, you should not need coolant passed through these two items. If you do live in cold climates, you should open up the hole that provides coolant to the IACV and throttle body to be safe (see below). You will still recieve the benefits of having the insulator in place of the stock gasket which provides no insulation at all.

Where can you get the manifold insulator? The good people at Hondata manufacture these, which is who I obtained the one in this article from. See Hondata's web site for more information as well as pricing and availability. You can also download a PDF file here. I was very impressed with their knowledge, pricing, and professionalism.



What You Need
- Flathead and phillips screwdrivers
- 10, 12, and 14mm sockets, driver, and 3", 6" (2) extensions
- 10, 12, 14, and 22mm wrenches
- U-joint for your ratchet
- Torque wrench
- Pliers (for hose clamps)
- Dremel and grinding bit/stone
- Loctite or Permatex medium-strength threadlocker ("blue")
- 2 gal. Genuine Honda Coolant
- Fuel Damper washers (see "Reassembly")

Removing the Manifold
The first step is to jack up the car. You will only need to get under it on the drivers side, so you can either just jack up that side or jack up the whole front end. You can use the center lift point to lift it, but be sure to put it on jack stands and chock the back wheels before you get under it. Never get under a car with only a jack supporting it, they DO fail.

Using the "show car" position for the hood prop will greatly simplify things:

By twisting/turning the prop you can liberate it from the stock mounting point, then insert it into the slot by the under-hood fuse box. Then just use the prop point on that side of the hood like the other, and you've got twice the space to work!

Since we will have to remove the fuel rail, you want to relive the pressure in the fuel system. In the in-cabin fuse box, by the driver's left knee, remove the 15A fuel pump fuse...

...and then start the car. You'll notice it doesn't "catch" and start running- you've interrupted the fuel supply. Just a second or two, the time it would normally take to start the car, is enough to bleed off all the fuel pressure. This insures you won't leak gas all over the place when you remove the supply line to the fuel rail (and that the rail will be empty).

We'll start with removing the intake tube and airbox lid. In the case of an aftermarket intake you will need to remove the pipe at the throttle body, perhaps more:

There are a few vacuum lines that are attached to the intake tube and airbox lid that you will need to remove. The large hose near the throttle body is for the air (smog) pump. The smaller one is for the PCV to the valve cover. Use pliers to remove the two clamps and tubes. There are a few lines "snapped" to the back of the airbox lid you can see here:

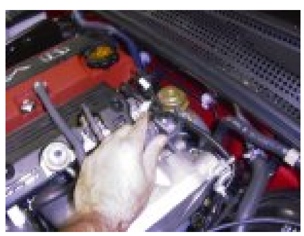
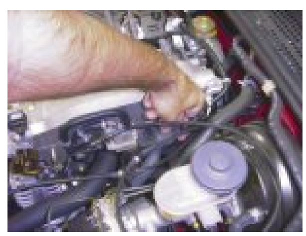
These do not need to be removed here, but at the fuel rail. To get to them, remove the PCV valve from the valve cover (it just pops out) and the beauty trim from the top of the fuel rail with a 10mm socket:

Underneath it, you can see the two lines that you need to disconnect so you can remove the intake hose:

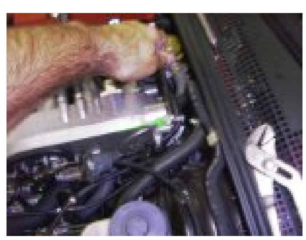
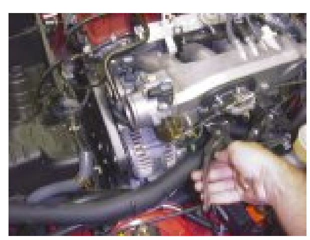
In this instance, we marked the upper and lower hoses so they would go back in the proper place. Once you remove these, you should have everything free:

Next, remove the following vacuum and coolant lines with a pair of pliers:

The lines might be a little stubborn, give them a gentle tug and try prying them carefully with a flathead screwdriver. Be careful not to tear them. Now, disconnect the intake air temperature sensor (IAT) connector, and Idle Air Control Valve (IACV) connector:

The connectors should just take a gentle pinch and pull to release them. The IACV connector is covered with a boot, just press on the flat portion that faces down and it should release. Now we need to remove the fuel rail, so we will be able to get at the bolts that hold the manifold on. There are similar connectors on the injectors- remove them like you did the others, then use a 10mm wrench to remove the cable stay on the back of the manifold (near the IACV):

Pay close attention to the coolant supply line going to the IACV in the third picture above. It is close to a same-sized vacuum connector to the left of it, and if mixed up, you will suck coolant into the intake (very bad!). Marking these hoses and their locations is a good idea.

Now, using the 22mm wrench, remove the fuel rail "damper." It's the hat shaped piece shown below. Be careful not to lose the two crush washers on either side of the banjo fitting. You will not reuse these (they will have to be replaced) but you don't need them loose in the engine bay, either.

Now we can remove the last of the myriad of hoses- the airbox vacuum lines, the air pump hose, the brake booster hose, and the IACV coolant lines:

We sure hope you don't mind the smell of antifreeze, since you probably just got some of it on you. Instead of draining the coolant and wasting all of it, we recommned losing a little and just topping off afterwards.

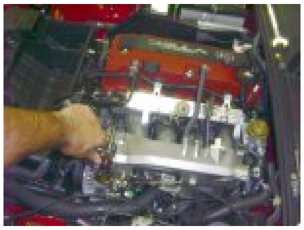
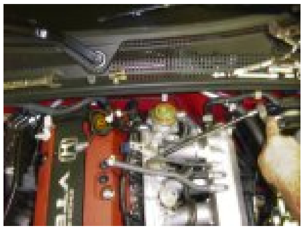
Finally, the fuel rail. Disconnect the vacuum lines shown, then remove the bolts/nuts shown:

And then one last coolant line:

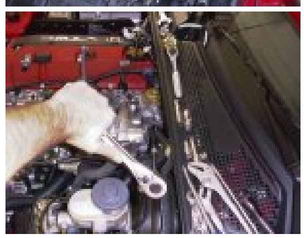
And you can simply pull the fuel rail away from the head/manifold:

Now we can start on the manifold itself. Using a 12mm socket, extenstions, and a U-joint, start removing the top nuts/bolts:

Note that you have to remove a cable clip to get to the last nut on the top. I also found that I could only get to it with a wrench, not with a socket.

Now you can get to the lower bolts. It's hard to see, but in order from front to back, this is how I got to them:

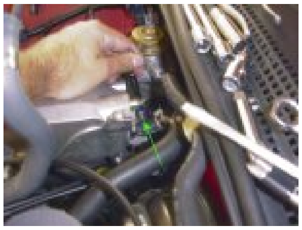
  


The process for the #4 port bolt is similar to the #3 one (sorry, no picture). To get the manifold free, You must remove the support brackets:

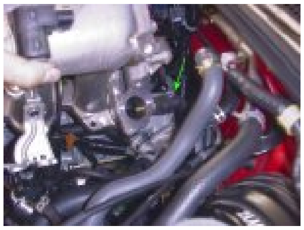
This uses two 14mm bolts up top and one below on the block. There is also a front bracket (sorry I don't have pictures) that "lifts" the manifold up from the block. Unfortunately the block bolts are inaccessible due to the alternator mount- you can, however, remove the manifold bolts with the 14mm wrench. These screw up into the bottom of the manifold. You will have to do it by feel, but these two can be removed without too much trouble.

Once you do this the manifold will be mostly free. If you are just replace the factory gasket with the insulator, you can pull the manifold away from the head enough to remove the old one and insert the Hondata. If you want to actually remove the manifold, you still need to disconnect the water outlet housing and hoses, though. The simplest way to do this is to just remove the housing and leave the hoses connected to it. Using a 10mm wrench, loosen these bolts. There are two- one on top (in the picture) and one directly below it, underneath the hoses. This one you will unfortunately have to do by feel:



Now we have a few miscellaneous clips that you can remove or disconnect the hoses from, and the coolant temperature sensor. The sensor is like the others, press in on the flat section (towards you) and pull gently.






Last, we have the throttle cable. The throttle cable is on the driver's side and is secured by a 12mm locknut:

You should now be able to pull the manifold up and out. Be careful, there might be a few lines that hang up on the manifold-check to make sure everything is clear. When you get it out, set it aside.

<u>The Hondata Spacer/Insulator</u>

The Hondata spacer is an exact copy of the of the factory gasket, excepting that the Hondata spacer is thicker, blocks a coolant hole, and is made of a vinyl-"ish" material (as opposed to the thin steel factory one):


Simply slide it in place where the stock one was, between the manifold and the head. A few random facts for you regarding the installation:

- The stock Honda gasket measures .012" thick at the compression ring at the ports. It is likely about .010" thick, compressed. The Hondata is .106" thick and compresses to around .102-.104".
- An attempted port match shows that ports are factory matched with about 1/16" overlap on the head ports, indicating an excellent factory port match with anti-reversion.
- Intake ports very smooth with some minor casting marks, very small. The head has small casting marks, with deburr marks where larger ones were removed by hand.
- Honda did a good job on early (00-01) models and has grown progressively sloppier as time goes on.
- The presence of deburr marks indicates that the head was touched up but the manifold was not, suggesting that Honda's casting process is good enough to port match the head and manifold without additional labor.

- The Hondata spacer blocks coolant flow to stub that supplies TB and ultimately the IACV. This will not affect idle (the IACV is not temperature dependent in any way) and should keep the manifold much cooler. The tubing for the TB and IACV heating is not needed, but there is no point in removing it (it is no longer functional).
- There is no "thermal valve" built into the throttle body like there is on other Honda models. You do not have to worry about idle quality when blocking coolant flow through the throttle body.
- The water outlet is built in to the intake manifold. The #4 runner is coupled to it in the casting by about 4"x.25" or 1" square of aluminum. There is no way to get around this, but 1" sq. is not much area (coupling is minimal).

In case you are curious about the cooling path, here is a primer:



Coolant flows from the small hole in the head, through the gasket and into the manifold, to the stub near the #1 runner. This is the hole you will need to create in the insulator if you wish to allow coolant to flow from the head into the throttle body and IACV. A soft hose joins this stub to a hard line (on a "tree" with others), then to another soft line that connects this to the throttle body (at the base). Coolant flows through a small piece of the TB at the base of it. It flows out of the TB through a small stub which connects to a soft line going to another hard line, then another soft line, to the IACV. This valve controls the cold-start fast-idle bypass of the TB. In short, it kicks the throttle when the engine is cold. It does NOT use the coolant for this purpose, though, it is controlled via an electrical connection by the ECU. The coolant runs into the IACV, then into a "pocket" machined into the side of the manifold under the IACV housing, then back out the IACV through a stub and another assortment of hard and soft lines. It exits this pointing down and heads to the thermostat housing where it rejoins the rest of the engine coolant.

For those of you who would like to see the ports. First, the head (starting with #1):




And the manifold, again, starting with the #1 cylinder runner/port:




No, this isn't a mysterious 5th cylinder port. It's the port for the water outlet, the one that's coupled to runner #4. Note the proximity. There is about 1" square of aluminum webbing between them on the runner side.

Reassembly

The first thing we need to do is open up the mounting holes on the forward bracket. This bracket is important in keeping the manifold from vibrating and possibly loosening the flange mounting bolts. It also keeps the factory "fit" of the manifold and won't arouse suspicion at a dealer.

Using the dremel and grinding bit, slot the forward bracket holes further towards the edge on the driver's side. The idea is to allow for the bolts/manifold to move further away from the head, since the Hondata insulator is thicker:

You do not need to slot it much, about .1" (1/16" to 1/8") is plenty.

Rather than re-explain the disassembly process in reverse order, here's a short list of the reassembly steps (basically reverse what you have just done):

1) Slide on manifold (checking to make sure nothing is pinched!)
2) Apply Loctite to and install top row of manifold mounting bolts (hand-tight)
3) Apply Loctite to and install bottom row of manifold mounting bolts (hand-tight)
4) Tighten manifold mounting bolts EVENLY to about 10 ft-lbs
5) Tighten manifold mounting bolts EVENLY and SLOWLY to 20 ft-lbs, then go back and torque them all again
6) Re-install water outlet, two 10mm bolts, to 8.7 ft-lbs
7) Install support brackets and bolts to 32 ft-lbs
8) Route top manifold hoses, connect PCV and hard line to TB
9) Install temperature sensor connector
10) Connect air pump and brake booster hoses
11) Re-install fuel rail bolts (8.7 ft-lbs), hoses, and damper (16 ft-lbs)
Note: You need to replace the two crush washers (see below)!
12) Connect the IACV and remaining TB hoses (careful not to mix up the IACV/vacuum lines)
13) Connect the two small vacuum lines that attach to the intake box
14) Connect electrical plugs to the fuel injectors, IAT, and IACV
15) Re-install intake hose and airbox
16) Re-install the fuel pump fuse

You will likely have a fuel leak if you reuse the crush washers that go on either side of the fuel line, under the "damper" (even if you overtorque them). You will need to replace these washers to prevent a leak at the fitting and a fire hazard. You can order them from Majestic Honda using the following info:

Item No.	Description	Price
16705-PD1-003	W-GASKET, MUFFLER	$1.76
90428-PD6-003	WASHER, SEALING (12MM)	$1.86

Enter in the part numbers using their parts lookup, and you can buy them online. If you want to browse their catalog for them, they are number 2 and 39 respectively on the "FUEL PIPE" parts page. Your local dealer should also be able to get them, but will likely NOT have the first one in stock. Some large dealers will stock these since they are used on a few other Hondas.

It is recommended to allow the Loctite to cure at least 12 hours before running the car. In instances where the car was driven immediately following installation, the Loctite may not have had enough time to set and the bolts lost torque. You will need to reapply the Loctite for it to work properly if you re-torque which is not an easy task. It is recommended you allow the Loctite to set the first time so you do not have to worry about it later.

Before driving off, you will need to top off the coolant. Honda Genuine Coolant is now all pre-mixed (50/50) so you will not need to add any water. Fill the system to the top and close the radiator cap tightly. Before taking the car anywhere, let it warm up (until the fans come on), then run the heat a minute or two and turn everything off. Let the car cool and check the overflow tank and radiator levels. Add any coolant if necessary. It may be necessary to do this once or twice to be sure you have all the air purged out of the system. I have not had good luck with using the bleed valves that Honda provides so I do not recommend even trying them.

Temperature Differences

The temperature data I took is very basic, but yields very obvious results. The data was collected with a Tektronix thermocouple meter, with one thermocouple as an ambient reference (outside temperature), and the other located in the manifold itself. It was placed in the manifold via a slit in one of the vacuum lines located next to the factory intake air temperature (IAT) sensor. I felt this would give not only the most accurate readings, but also the most repeatable ones (compared to an OBD2 diagnostic tool). It also gave me a reliable ambient reference.

The data is in the table below. Measurements were taken with an ambient of 68°F to 70°F, for both data sets, throughout the testing. The same path was driven, with the same speeds and even same gears used. The driving was kept as consistent as possible. The times for events were also approximately the same. Essentially, the testing "variables" were kept as consistent as possible.

Test Description	Factory Temp. (°F)	"Insulated" Temp. (°F)
Ambient	70	69
2 Bars on Gauge	80	73
3 Bars on Gauge	83	73
3 Min. (30mph, part throttle)	85	74
0-70mph	0:95 70:105	0:82 70:100
15 Sec. Idle	Start:108 Stop:115	Start:89 Stop:89
2 Min. (40mph, part throttle)	Start:105 Stop:115	Start:89 Stop:91
15 Sec. Lift Throttle (in gear)	Start:110 Stop:120	Start:108 Stop:110
Head/Manifold delta (see notes)	Start:9 Stop:5	Start:50 Stop:50

The numbers point to an obvious trend: reduced temperature in the manifold. The only numbers that don't make sense at this point is the 0-70mph run. I'm not sure why there was an 18°F rise with the insulator compared to the stock numbers. Honestly, I'm not sure why the temperature rises at all, I would think that the airflow through the manifold would reduce the temperature quickly. It might be that the slowing down and idling I did (less than 10 seconds) before the 0-70mph run was enough to heat soak the manifold such that the air temps rise, but that still doesn't explain the higher differential with the insulator.

The most startling number is the head/manifold "delta" temperature, the difference in temperature between the head/manifold junction. While this does not entirely determine the IAT or even the temperature of the manifold, it is a large factor- it tells you how much insulation or resistance the manifold has from the heating effects of the head itself. Since the surface area where the head contacts the manifold (the flange) is the largest area for heat exchange, this is an important bit of information. For this test, it was measured here:

There is a "dimple" in the head and a crease in the manifold that are no more than 1" apart. Since they are the closest areas to the gasket while still having some "meat" between them (and were easy to get to!), I decided to measure there. The results as you can see are astonishing. The "start" condition was after a 20 minute test drive (seperate from the others) with mixed 70mph freeway and 30-40 start/stop driving. The route was the same and the ambient temp was within the range for the other tests (i.e. the variables were as similar as possible). The "stop" condition was when the fans kicked on. In both cases, this was exactly 185°F, and start-to-stop took between 1 and 2 minutes. I considered this a good test as it mimicked "average" driving and insured that the fans did kick on, which would happen in moderate traffic or at a stoplight. The highest differential is obviously preferred, since it means the greatest resistance to heating through the head.

Stock, there was an 8°F temperature differential at the start, and a 5°F one when the fans kicked on. **There was a 50°F difference with the insulator, and it was consistent for almost 2 minutes**. The difference in temperature did not rise, meaning that while it did get warmer, the insulator kept the differential- something that you simply cannot do when stock.

For the remainder of the "tests," and for both average driving and average overall temperature, the numbers are clear: at least a 10°F drop, closer to 25°F in "hot" conditions such as idling. With the spacer the intake took noticeably longer to heat when both warming up and idling, and seemed to have a higher resistance to "heat soak." At the end of the testing, when stock, the IAT didn't seem to want to go above 130°F (that was the most I saw after 20 minutes of testing and mixed driving). With the spacer, it seemed to still want to creep, though I never saw above 110°F. On top of that, the manifold cooled more quickly with the spacer, and came back down to the high 80's with part throttle driving. Stock, the temperatures never went below 115°F after seeing 130°F. In all, I would say that a 25°F+ drop in IAT, or a poten