

# TDI Injector/Nozzle Swap Howto

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Special thanks to KERMA for supplying the nozzles, to GeWilli for last-minute advice, to GoFaster, eidie2, Betzel, Boundless, and The Ripster for constructive criticism and to the good folks of Fred's (<http://www.tdiclub.com>)

This document explains injector removal, nozzle swap, and injector reinstallation on a VW TDI. The car used was a 2001 Golf (ALH engine). The instructions should be similar for earlier TDI engines (AHU and 1Z). I welcome email with comments or questions about the content of this howto!

**Anything you do to your own car is AT YOUR OWN RISK! I deny any responsibility or liability for anything that you may do to your car. I'm not a professional mechanic; I just like tinkering with my car. Don't do any of this if you aren't comfortable with modifying your engine and be prepared to deal with the consequences if you screw something up.**

If you intend to use this document as a guide, READ THE WHOLE THING FIRST. Required tools and procedures are sprinkled throughout, so make sure that you have all required tools beforehand, AND that you are comfortable with every required procedure.

I've broken the job down into four sections: removing injectors, swapping nozzles, installing injectors, and ECU adjustments. If you just want to install new injectors and aren't doing a nozzle swap, just skip that part. It's recommended that after installing nozzles you get them pop-tested by a local Bosch shop (<http://www.boschservice.com>) certified on VE equipment. Any shop knowledgeable about Dodge/Cummins diesels should be able to help. They can set the spring preloads in the nozzles and make sure that the spray pattern is good. These shops can only set one of the two springs in the injector, but that's better than nothing.

KERMA (<http://www.kermatdi.com>) has a tool that can set both spring preloads. If you want perfectly set nozzles, he's the guy to get in contact with.

Before you start, make sure you have:

- 17mm wrench
- 15mm wrench
- 13mm socket
- 10mm socket
- Ratchet and various extensions
- Torque wrench
- Paper/shop towels. Lots of them if you're swapping nozzles.
- Diesel fuel or biodiesel for cleaning (if you're swapping nozzles)
- Toothbrush (if you're swapping nozzles)
- 4 new sealing washers (046 130 219 A)

It would be ideal to have (but not absolutely necessary):

- 17mm flare-nut (line) wrench – This is the best tool to use on the brass fuel line fittings. A standard 17mm wrench will work, but be careful not to round off corners. If you can get an offset one, even better.
- 17mm crows-foot wrench – For setting torque on the fuel lines
- Extra braided fuel line in case the stuff you have disintegrates

**VERY IMPORTANT!!!!** You must do this on a **COLD** engine! Be sure to let the engine cool for at least four hours before removing the injectors.

## Injector Removal

Pop your hood and remove the engine cover (the three 10mm bolts under the round plastic covers). You should see something like the photo below.



Clean the nuts on the ends of the metal fuel lines, both at the injectors and at the pump. Cleanliness is important here. You don't want dirt getting into the fuel system! Then, remove the two black plastic clips holding each pair of fuel lines together. You need to use a flat screwdriver to pop them open, and then they can be pushed off the lines. Remove the braided fuel return line going back to the fuel pump off of the number 4 injector (on the far right). Be careful not to damage the nipple on the injector! Unclip it from the plastic clip on the vacuum reservoir (sphere on the right) and put it somewhere out of the way. You might want to put a paper towel around the end to catch any fuel that drips out.

Now, move the metal fuel lines out of the way in order to make room to do other things...

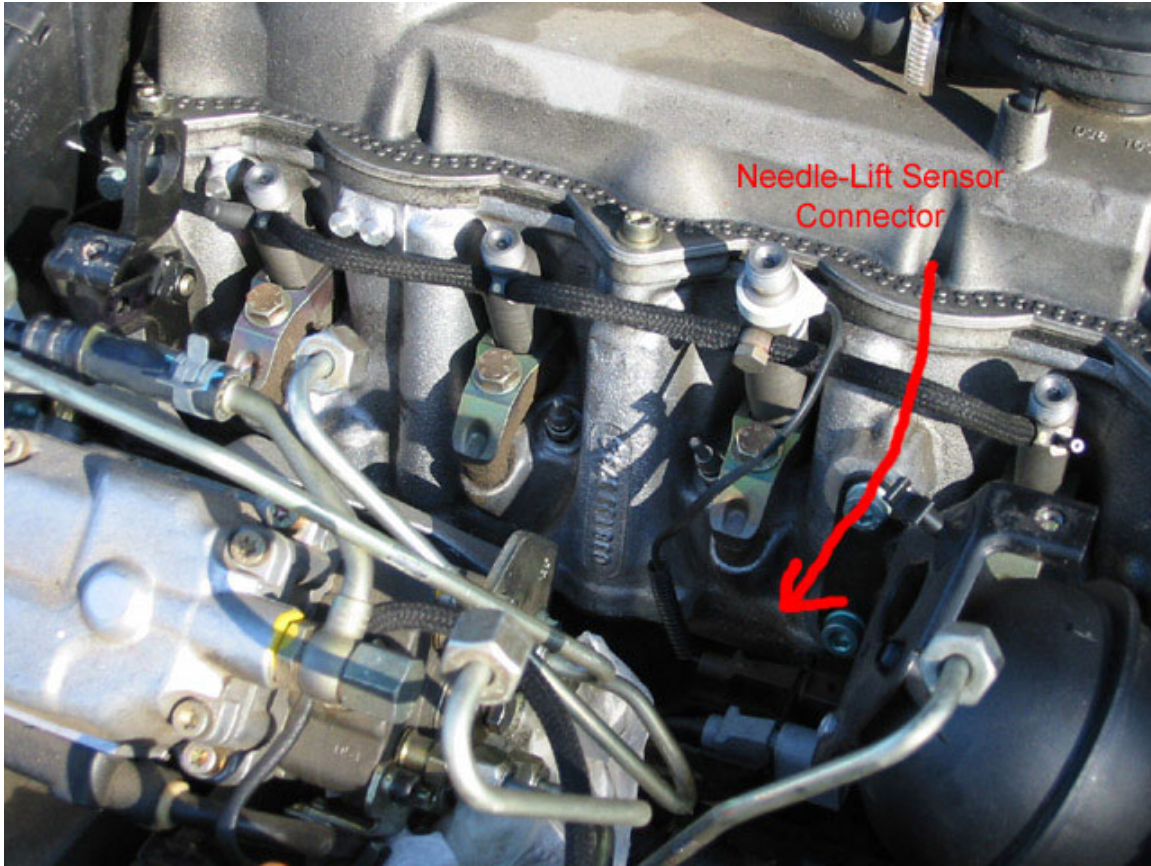
NOTE: At this point I'll mention that there are two schools of thought in removing injectors... doing all four at once or two at a time. I discuss this in the installation section at the end. But that's OK, because you're going to read this whole document before taking anything apart, aren't you?!



Use a 17mm flare-nut wrench (or your regular 17mm wrench) to crack the fuel lines at the pump. You won't take these off the pump, you'll just rotate the lines away from the injectors to get them out of the way, so just loosen the nuts about half a turn. You might want to put a towel underneath the pump to catch any drips. I didn't see any on mine, but there's lots of rubber underneath there, so it would be a good precaution.



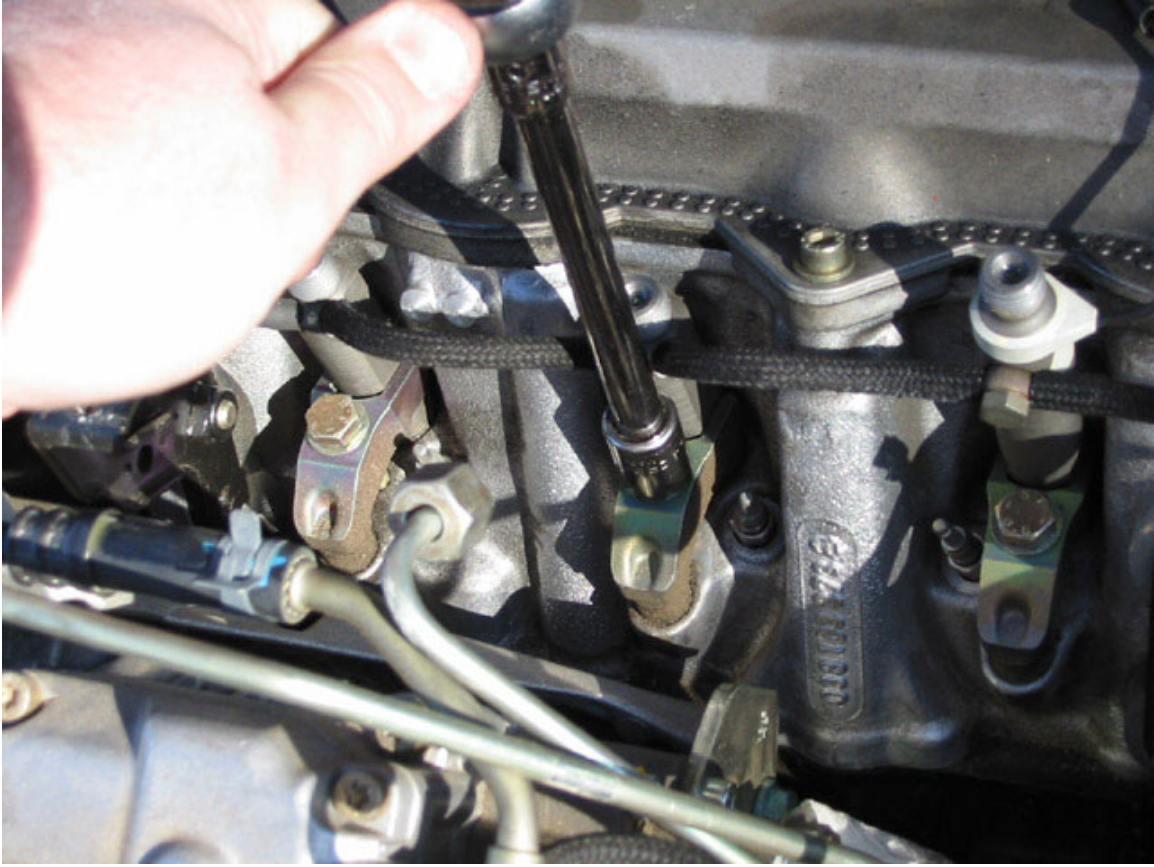
Now do the same thing at the injectors. These are going to come off, but loosen them all first. You should just need to crack them with the wrench and then loosen them by hand.



When all the lines are loose, lift them up and away from the injectors. Let them hang off of the pump. Be VERY careful with the lines when you move them... some need to be moved before others due to their shape. You'll see. It's very important that the lines not be bent or stressed too much! Keep this in mind during the next few steps as well.

Notice that the black bus bar for the glow plugs has been removed and put to the side. The glow plugs sit in the head right next to each injector. If you've ever changed spark plugs on a gasser (ugh!), the connector is very similar. Just pull on it and it'll pop off.

Injector three is larger than the rest and has a wire coming off the top of it. This is the wire for the needle-lift sensor. It leads to a brown connector, anchored to a metal clip, which is then plugged into the engine wiring harness. If you look down underneath injector 3, you'll see it next to a gray connector (the engine speed sender). Disconnect the harness from the brown connector (you need to push in the metal retaining clips on either side of the harness plug) and lift the brown connector out of the clip. This was very difficult on my engine! I think that some pollen and gook had gotten in there and the brown connector wasn't budging. Push up from below on both sides; wiggle it if necessary, but BE GENTLE. Breaking this means buying a new #3 injector.



Using a 13mm socket and ratchet, remove the retaining bolt from each of the injector holders. Remove each holder, being careful not to drop the nut and the special washer.



Here's one of the injector holders. Notice the crud buildup. I gave these a good cleaning along with the dimple in the head to make sure that the mating surfaces were clean on reinstall.



Now the fun part... getting the injectors out of the head. This is a diesel, so there's going to be a lot of soot caked on the end of the injector in the head, so it's going to take some persuasion. If you have a source of compressed air, it wouldn't hurt to blow out the area around each injector to get out any gook that may have built up. Use a 15mm wrench on the flat part of the injector body and try to rotate it left and right in the head. You're basically trying to work it loose. At the same time, pull up on the injector. This is tricky, because you don't want to pull on the return nipples, and you want to be careful not to get dirt into the feedhole in the top of the injector. As an afterthought, it would be nice if you bought threaded caps ahead of time that you could install on the injectors to prevent dirt from getting in. I don't know the size that would be needed; if anyone knows please email me and I'll note it here.

Once the injector has worked loose and you can lift it out of the head, leave it there and do the other three. You'll notice that I didn't remove the inter-injector fuel return lines. I decided to take all four injectors out hooked together and then remove the lines on the bench. It was much easier to remove them once out of the engine.



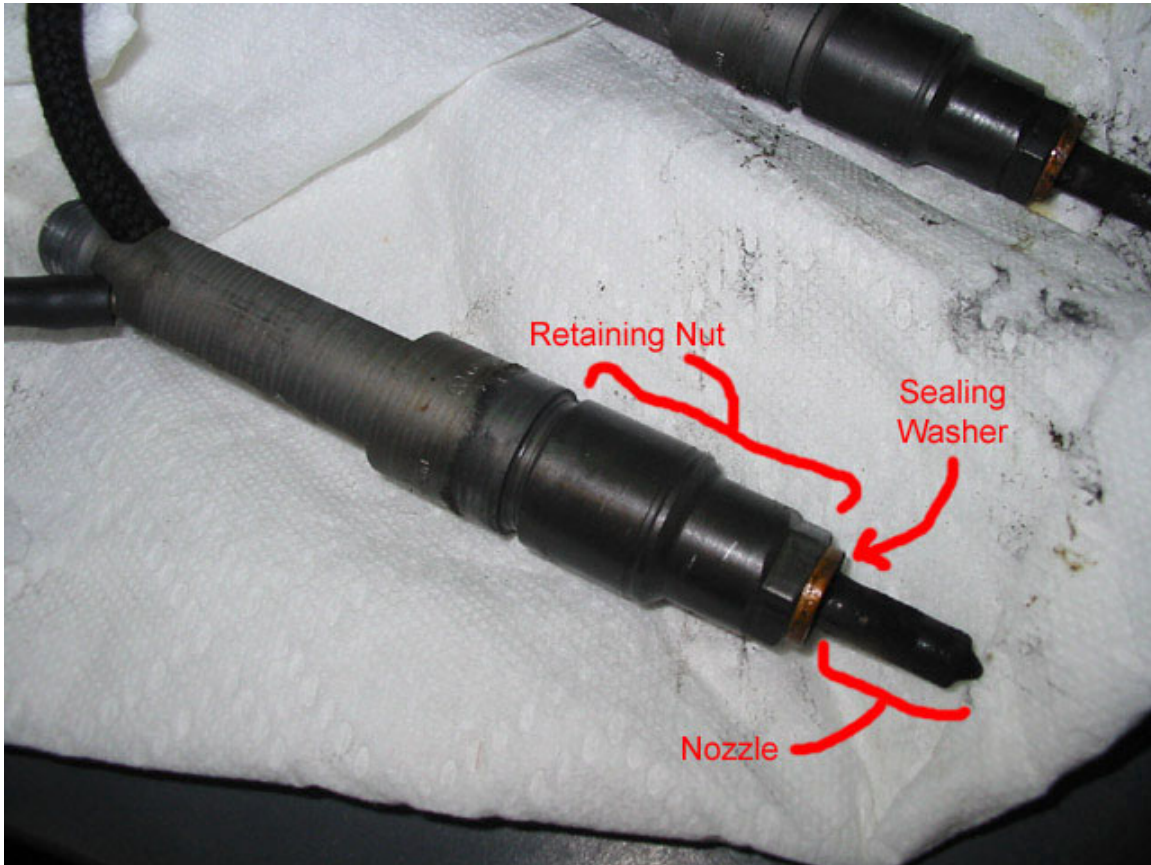


Here are the four injectors out of the engine, with the return lines still attached. All done! If you're swapping nozzles, continue on, but if not just go on to the installation part at the end.

Hint: if you close the hood at this point, **REMEMBER THE FUEL LINES!** Bent fuel lines will ruin your day. Lower them back against the engine and rest each against a towel so that dirt doesn't get in the lines.

## Swapping Nozzles

Make sure that you have a clean work area. A metal work surface is better than a wood workbench, since you don't want sawdust getting into the bits and pieces. Cleanliness is of **UTMOST IMPORTANCE** here! The injectors are very precision pieces of equipment. Keep everything that touches the injector clean!



This is clearly a “before” photo of one of my injectors. What a mess! Notice all the soot caked on the nozzle. This soot has caked inside the sealing washer, which now won't come off. I removed the retaining nut and nozzle from the injector before trying to remove the sealing washer, but you can do that step first if you're so inclined.

The retaining nut is what holds the nozzle against the body of the injector. It needs to come off, the nozzle needs to be taken out, the new nozzle needs to be installed on the injector body, and the retaining nut screwed back down. And everything must be **CLEANED** of soot and residue as well as possible.



I cannot stress enough how helpful a vise is to have here. It keeps the injector stable, upright, and given that I had to use a cheater bar to crack two of the retaining nuts, allows for more leverage than you can get by using two wrenches.

Place the injector nozzle-side up in a vise. Be VERY careful of the fuel-return nipples. Don't bend them or crack them off. The number 3 injector can be a little tricky to get in there, but I did it, so you can too. Use a 15mm wrench to loosen the retaining nut. A 15mm deep socket can also be used. When the nut comes off, diesel will drip out the bottom of the injector, so some towels would be a good idea.



(note: if the above image looks different... it's because it is! I forgot to take a pic of the injector body without the nozzle. Thanks to KERMA for this pic...)

**IMPORTANT!** When you get close to the end of the threads **BE CAREFUL AND WORK SLOWLY**. You don't want bits of the injector falling out. There will be a bushing on top of the injector (the disk sitting on top in the pic above) when you lift off the retaining nut. Be careful with it! Don't let it fall off. It might have lifted off its base as you removed the retaining nut. If so, gently (and with clean fingers) rotate it until it seats into the injector again.

At this point, you should clean the threads on the injector with your diesel or biodiesel and a toothbrush. Try to get them as clean as possible, and then dry them.

Note the two pegs sticking out of the top of the bushing, slightly offset from the center. If you look at the bottom of the nozzle you just took off, you'll see two corresponding holes. Later on, when you install the new nozzle, you'll line up the holes with the pegs. But first... cleaning!



The washer can be a real pain to get off from around the base of the nozzle. Just be persistent. Soak the end in diesel/biodiesel, use the toothbrush, and use a small flat-blade screwdriver to scrape the soot out from the INSIDE of the washer surface. Try to rotate the nozzle against the retaining nut. Keep doing this until things start to come apart.

Removing the plunger might be a good idea while doing all this. If you want to reuse these nozzles at some point, don't follow my lead by putting it down on a dirty soot-and-diesel soaked rag. Out of all of the parts where cleanliness is important, the plunger and inside of the nozzle are the most important!

Also, do NOT try to get the washer off by prying at the junction between it and the retaining nut. The surface of the retaining nut that touches the sealing washer should not be marred! If so, you may not get a good seal when you reinstall that injector. Be patient with the solvent and toothbrush.

Once the washer is off, the nozzle may still not want to come out of the retaining nut. Give it some solvent and toothbrush action, and give it a couple of good whacks (nozzle side up of course!) against a block of wood. This is the GeWilli method, and works like a charm.



See, I told you that patience pays off! Here's the nozzle separated from the nut. Put the plunger back in the nozzle if you removed it, and set them aside.

Now, get to work on the retaining nut with the solvent and toothbrush. Clean the threads on the inside of the nut and clean the area around the nozzle opening inside and out. Get ALL of the soot out of there. This thing should be pristine when you're done with it!!!



Once everything is clean (the entire retaining nut and the threads of the injector), get out your shiny new nozzle and install it on the top of the injector. Do NOT touch the tip with anything and do NOT take out the plunger! Remember the two offset pins in the top of the bushing sitting on the top of the injector? You'll see three holes in the bottom of the new nozzle; two slip over these pins and the third is a fuel port. You'll be able to figure out how it's installed (it will only go on one way).

Once you slip it on, there will be a slight gap between the bottom of the nozzle and the surface of the bushing. Don't worry... when you install the retaining nut, it will push the nozzle down and set preload on the springs in the injector.



Once the new nozzle is in place, carefully put the retaining nut over the nozzle (being careful NOT to touch the nozzle tip!!!) and screw it down. If you've done a good job of cleaning everything, you should be able to easily screw the nut down by hand. When you get to the last thread or two, you may feel resistance, but you should still be able to screw it down by hand. When you get out the wrench, it won't take much effort to bring it down to the end of the threads. When you start feeling serious resistance, tighten it, but NOT TOO TIGHT. You might get 20-30 degrees out of it, max. Just use a standard 15mm wrench... don't go crazy with a cheater bar. If you have a deep socket, a Bosch service shop recommended tightening to 33 ft-lb; just be careful not to touch the brand new, shiny nozzle tip with any tools!

There it is... repeat for the other three, clean up, and get ready for the reinstall.



## Injector Installation

Whether you've installed new nozzles or just have a shiny new OEM set of injectors, now's time to pop them back in the engine. There's only one photo in this section, since the procedure is pretty much the opposite of the removal, spelled out in the first part.



Clean the holes in the head, being careful not to let any soot down into the combustion chamber. A tiny vacuum works wonders. The most important part of this is to clean the sealing surface down in each hole where the copper sealing washer sits. If this isn't clean, you can get a compression leak. There are a couple of methods that different people have recommended to get the soot off the sealing surfaces. You can use a little flat-blade screwdriver to GENTLY loosen the soot. Remember, this is an aluminum head and you don't want to mar the surface. A thin wooden chisel dipped in diesel fuel would also work, as would a toothbrush dipped in diesel. How you do it is up to you... just remember, try not to get anything down in the combustion chamber, and DON'T mar the sealing surface!!!

Once everything is clean, install the injectors. Use a tiny dab of grease to keep the new sealing washer on the injector, and lower it into the head. It should go in pretty easily and seat well if you did a good job of cleaning. Try not to scrape the nozzle tip against anything on the way down. Reinstall the holders and torque the bolts to 20 N-m. Reattach the inter-injector fuel return lines, but don't reinstall the final line back to the pump yet. Reinstall the glow plug harness. Clip the number three electrical connector back into the metal bracket, and plug the harness connector back in (the metal clips on the harness connector must be squeezed when attaching it as well).

Lower the fuel lines towards the injectors, and while pressing the ferrule of the line into the injector, tighten the nuts by hand. Make sure that the lines at the fuel pump end are seated well and that the nuts are finger tight. Now, torque down the injector-side nuts first. You DON'T need a lot of torque! Spec is 25 N-m,

which you can get close to with a crow's-foot wrench and a torque wrench, but if you don't have one, just go easy on it. When the injector-side nuts are torqued, do the same for the pump-side nuts. Reinstall the return line from the pump to the last injector, and make sure that all lines and electrical connections are clipped back in where they're supposed to be. Install the two plastic clips on the two pairs of fuel lines.

Now to start the engine. Some fuel has drained out of the system, so you need to get fuel to the injectors ASAP. Just cranking the engine forever is not a good idea. Slightly loosen the nut on injector three (maybe half a turn) and wrap a rag around it. Crank for a few seconds, remove the rag, and make sure that it's wet with fuel; if not, crank a little more. Torque the nut back down to spec. Repeat this process with injector two. An alternate method is to remove and install two injectors at a time (2&3 and then 1&4 is the recommended procedure), and run the engine until the idle stabilizes after the first pair is replaced. This gives the engine two working injectors right from the get-go when starting the engine each time. Which is better? All-at-once requires less wrenching on the engine, two-at-a-time ensures an easy startup. The choice is yours.

Now, start the engine. It shouldn't take very much cranking for it to start. It will shudder and stutter for a bit as fuel gets to the other two injectors. Wait for the idle to settle out and check the engine bay. Make sure there isn't fuel spraying everywhere and make a final check to make sure you didn't forget to hook anything up or secure anything properly.

## ECU Adjustments

There are two ECU adjustments relating to fuel and air delivery that are relevant when changing to larger injectors: idle injection quantity and EGR adjustment. Adjustment details are lifted blatantly from the TDI FAQ at Fred's (<http://www.tdiclub.com/TDIFAQ>)... thanks to the folks that put that together. Both of these adjustments require a VagCom (<http://www.ross-tech.com>) or VAG scan-tool. You might also want to check injection timing while you're at it.

**Idle Injection Quantity:** Larger nozzles will deliver more fuel than the ECU thinks that it's delivering. By changing the idle injection quantity (which is sort of a misnomer), you're recalibrating some constants in the ECU relating to fuel delivery which results in better idle speed control and, depending on the state of your particular engine, less smoke.

With your engine idling and **warm** (very important!) and all accessories off, hook up your VagCom and go to 01 – Engine. Login using 12233. Go to “Adaptation” and select Block 1. The adaptation value should be at a default of 32768, and you should see a field indicating the amount of fuel being injected in mg/R. It's a good idea to get the injected quantity in the range 3.0 – 5.0 mg/R. Modify the adaptation value by 100 at a time and press “Test” to see what happens to the injected quantity. To make the injected quantity go **up**, you **reduce** the adaptation value by 100. Play with this until you get in the range, and hit “Save”. If you can't get within the range, get as close as possible (there is a minimum and maximum adaptation value), and as long as your engine runs OK, don't worry about it.

**EGR Adjustment:** At idle and part-load situations, the EGR system recycles some of the exhaust gas into the intake. This reduces NOx emissions. It's possible to reduce the amount of EGR so that there is less exhaust recirculated and more fresh air. More air is good, because your larger nozzles mean more fuel! (Note: this is a good idea even for stock engines, since less EGR means less soot to gunk up the intake... do a search for “manifold clogging” on Fred's for details if you're not familiar with the problem.)

With your engine idling and **warm** (very important!) and all accessories off, hook up your VagCom and go to 01 – Engine. Login using 12233. Go to “Adaptation” and select Block 3. Give the throttle a quick punch to the floor (if the car idles too long the EGR system turns off... this turns it back on.) The default adaptation should be 32768, and the screen should indicate an actual flow rate of around 250 mg/R. Enter 33768 as the new value, hit “Test”, and the flow rate should increase. Hit “Save” and you're done.

Legal note: This is an emissions control device, so some of you are saying “heey... are we supposed to be messing with this?” Well, the shop manual states that acceptable idle flow rates of up to 370 mg/R are acceptable. So, if you adjust the flow rate to be no more than 370 mg/R, you’re within factory specs, and no laws are being broken.