

DIY Walnut Shell Blasting for About \$70!!!

This write up will describe how to remove carbon build up on a second generation MINI by **walnut shell blasting**. The actual cleaning process only takes about 5 minutes of blasting per cylinder for "squeaky clean", like new, valves!! Of course getting to the valves is where all the time is spent. Depending on how fast you work and how familiar you are with removing and reinstalling the intake manifold, the overall process will take 3 to 4 hours. It took me about 4 hours - and this was my first time.

First of all, **thanks** to Texasmontego of NAM for the incredible write up for using chemical cleaners to remove carbon buildup! Follow his excellent step-by-step write up to gain access to the intake valves: (<http://www.northamericanmotoring.com/forums/attachments/how-to/55397d1315164535-carbon-build-up-cleaning-the-right-way-r56-carbon-build-up-cleaning-procedure.pdf>).

The only things I did differently from his write up besides using walnut shells were:

1. I removed the right front wheel to gain better access to the **10mm bolt that is on a knee brace beneath the intake manifold**. This bolt is omitted from his write up. With the wheel off you can see this bolt and access it with a socket. You do NOT have to remove the fender liner to gain access.
2. I used a small 3/4 "hole saw to make an access port to allow me to put a socket wrench on the crankshaft pulley bolt to turn the engine to close the valves of the cylinder on which you are working. I did not use the starter to rotate the engine.
3. **It is INCREDIBLY IMPORTANT that you make sure the intake valves on the cylinder on which you are working are fully closed or you can fill the cylinder with walnut shells and do major damage!** This is about the only way you can really screw this up.
4. I have a Costco Whistler fiber optic camera with a detachable display. I merely placed the camera in the cylinder intake such that I could see the intake valve. I set the video display on the floor where I could see it and watch the intake valves to that cylinder as I rotated the engine crankshaft with the socket wrench. This camera was handy - but not required - particularly if you have a helper.

I bought everything I needed to perform a walnut blast at Harbor Freight for less than about \$70. I found a [great post](#) by e90man on www.n54tech.com (thanks e90man!) detailing which Harbor Freight gun to buy etc.

Here is a link to his pdf:

<http://www.n54tech.com/forums/attachment.php?attachmentid=10333&d=1344569400> . This will link you to a pdf file that listed how to modify the Harbor Freight gun. This poster was cleaning a BMW engine but the tools and process are the same. He ordered the special vacuum adapter that BMW/MINI uses to connect the vacuum to the intake port and a special wand. If you want to order these special tools he has the links to do it, but I was able to easily adapt the Harbor Freight items and make my own vacuum adapter/attachment and wand.

Basically, I made a modification to a Harbor Freight media blasting gun and built a vacuum adapter that would connect to one cylinder intake port at a time. This adapter connects to a shop vacuum and removes the walnut shells. The adapter is fastened to the head using the same bolts that secure the intake manifold to the head. The adapter also has a hole in the back of it to allow insertion of the blasting gun nozzle and to provide an air intake for the vacuum air. Since the valves are closed you have to have an air source or the vacuum can't remove the walnut shells.

Buy/order the following from Harbor Freight:



- Portable Abrasive Media Blaster Item #37025 (was about \$35)
- 25 lbs Fine Walnut Shell Blasting Media Item # 92155 (about \$25)
- Air Blow Gun With Extension Item # 68257 (about \$4)

Other items needed:

- You will also need a 1 HP or larger air compressor. Mine was 1 HP and did fine. The HF Media Blaster needs a minimum of 3.5 CFM @ 50 psig
- Shop vacuum - larger the better
- I also used a 1 1/2" PVC "street elbow" to build a vacuum adapter. This is a 90 degree pipe elbow that has a male socket weld joint on one end and female socket weld joint on the other end. There are many other ways to rig a shop vacuum pick up but this worked well for me. If you can't find a street elbow use a regular socket weld elbow and a short piece of PVC pipe that extends about 1/2" from the female socket. A 1 1/4" PVC elbow would also probably work just fine.
- Piece of 1/2" scrap wood (I used a piece of PVC plate that I had to fabricate a "flange" to fit on the individual cylinder intake.)
- Watts A-390 1/2" barb x 1/2" female pipe thread (Lowe's, Home Depot etc.)
- Watts A-827 threaded pipe reducing bushing 1/2" male pipe x 1/4" female pipe
- Electrical tape

Step-By-Step Instructions to Fabricate the Tools:

1. Review the pdf by e90man where he shows you how you remove the ceramic nozzle in the HF Media Blaster gun and insert the 1/2" brass barbed fitting in its place. Insert the barbed fitting as far into the gun as it will go. Don't over tighten the allen screw. You do not have to do the flaring step he mentions unless you plan on ordering the gun extension from BMW.
2. Thread the reducing bushing into the female 1/2" thread on the barbed adapter fitting.
3. I bought Item #68257 air blow gun extension solely for its aluminum tubing since it was the right diameter. If the tubing is too small the venturi in the gun will not pick up the media. I bent it into a smooth bend being careful not to kink the tubing as I bent it. The tubing was cut to about 11" long.



I had planned on making a more professional tool but noted that with a few wraps of electrical tape on the wand extension tubing it would fit snugly inside of the $\frac{1}{4}$ " female pipe thread of the bushing. Time was running short so I used the tape and wrapped the outside of the joint too as shown.

4. Do not let the aluminum tubing extend beyond the barbed end of the barbed adapter. It should be flush with the end of the barbs. The tubing is small enough that you can extend it past the barbs. If you do this the tubing will be too close to the internal gun venturi and it will not pick up the media. The barbed end of the brass adapter is the correct distance from the venturi when it is fully inserted into the gun.
5. I took a Sharpie and made numbered index marks on the wand about an inch apart so that I had an idea of how deeply the wand was inserted – you will pull it in and out as you blast.
6. I found that the 1 $\frac{1}{2}$ " schedule 80 PVC street elbow was a good match for my shop vacuum hose and made the connection with highly professional duct tape. I drilled a $\frac{3}{4}$ " diameter hole in the back of the elbow. This is the hole you use to insert the blasting nozzle.

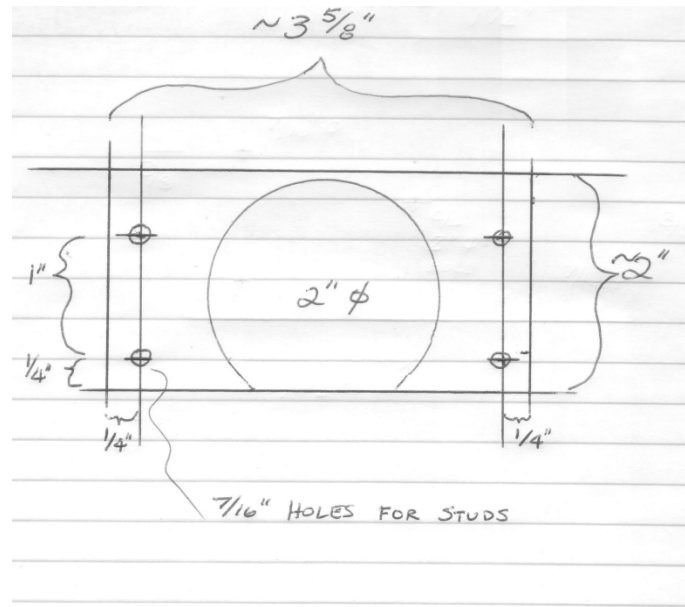


7. The "flange" below is held to the cylinder you are planning to clean by the same nuts that hold the intake manifold in place. You need some air inlet for the vacuum to get its air, so don't worry about a gasket or getting a tight seal.

You will turn the vacuum on before you start the flow of the walnut shells and the large negative air flow will overcome leaks – and then some. The flange that I rigged is embarrassingly ugly as I had to modify it on the run. It can't be any wider than shown or it will not fit into the recessed area of the intake manifold.

As you can see – I initially made mine too wide and had to introduce it to a belt sander. It is ugly but I had NO walnut shell mess in the engine compartment and it worked great. The sketch below will give you a rough estimate of the size to make it. You can use plywood or other scraps. The four 7/16" holes are oversize as the nuts have a built-in wide washer base.





The above dimensions are approximate. Making the four holes $7/16''$ in diameter makes this very forgiving. The nuts have wide washers built in, so you do not have to be perfect. I believe a $1\ 1/4''$ elbow would also work well but I did not test it.

8. Cut a 2" hole in the flange (if you use a $1\ 1/2''$ street elbow) with a hole saw to receive the street elbow. With a $1\ 1/2''$ street elbow the male end fit into a 2" hole with a few rounds of electrical tape to snug things up a bit. The resultant fit was snug but removable. The vacuum hose is routed such that it comes out of the bottom, under the car and into the shop vac.

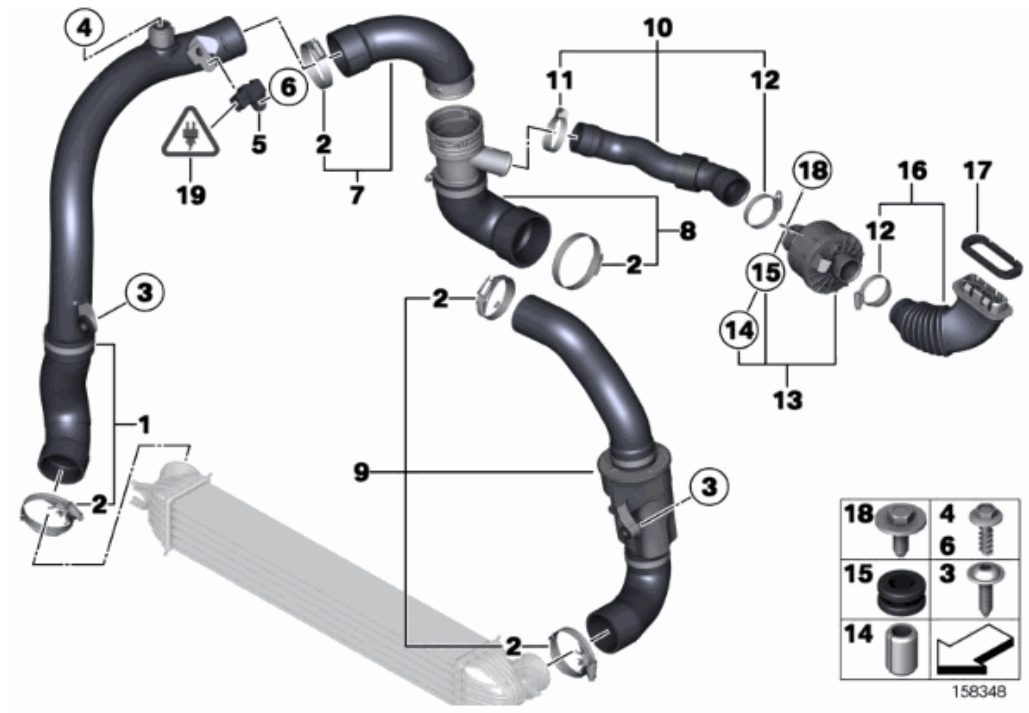


9. You have now got all the goodies and spent less than \$70 for the walnut shells and the materials (assuming you already have an air compressor and shop vac). I used less than 10# of walnut shells but they came in a 25# box.

Step-By-Step Instructions to Clean the Valves

1. Remove the manifold as detailed in Texasmontego's write up. Remember the 10 mm bolt for a knee brace underneath the manifold. Remove the right front wheel to gain access to this bolt. The manifold seals are all o-rings and therefore there are no gaskets that require replacement during this procedure.
2. Make sure you disconnect the battery as Texasmontego advises. The starter and starter solenoid are below the intake manifold and the red cable on the starter solenoid is always hot. You will be swinging wrenches in this area and you can't see that well. Unless you like fireworks, disconnecting the battery is important.
3. The rubber intake duct from the intercooler to the intake manifold (items 7 and 8 below) can be a real pain as they can stick to the connection even with the clamp loosened and access is tight. This was the most aggravating part of the whole job to me!

I actually pulled the clip on the horizontal swivel joint (see bottom of item 7 below) next to the wheel well as I could not get the duct off of the intake manifold (see below where item 8 attaches to manifold). There is also a lot of "junk" that hangs below the manifold but just follow Texasmontego's pictures and you will be OK. Go easy so you don't damage any of the small gauge wiring.



4. Remove the right wheel and use hole saw to make an access hole to allow socket wrench with extension to access the crankshaft pulley bolt. Insert a jack stand to hold up right side of car.



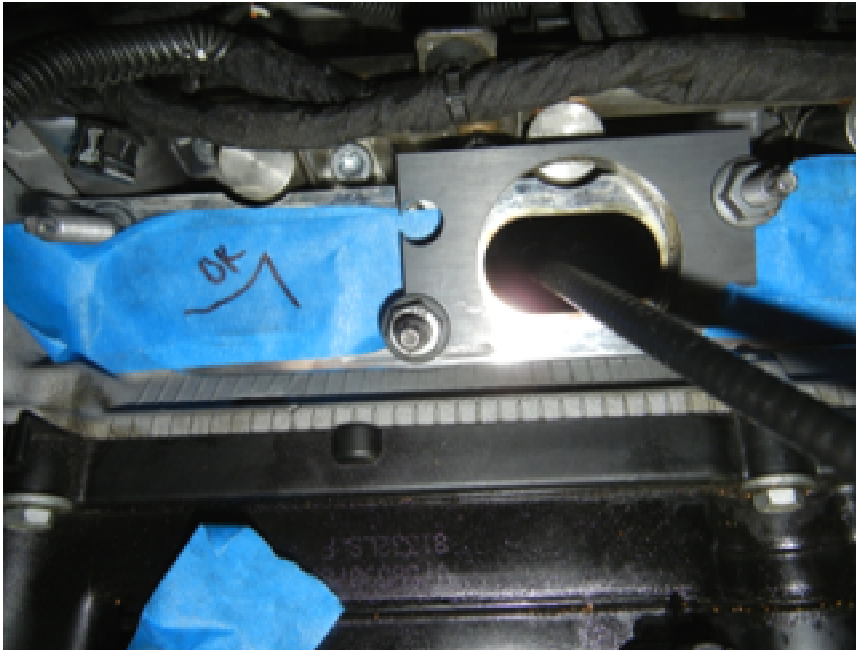
5. Set up the air compressor, shop vac and walnut shell blaster.
- 6. IMPORTANT! Be very careful to make sure that NOTHING gets into the intake manifold. I covered all intake ports by sealing with duct tape or masking tape. I only had one port uncovered at a time. If you drop a small washer or something that can slip past a valve into the intake manifold you may have to remove the head to recover!**

You have heard of "Hydraulic Lock" where water is ingested into the engine from deep standing water after a flood etc. Since water is incompressible when you start, or try to start, the engine, the piston will hit the incompressible fluid and stop suddenly – possibly bending the connecting rod – very ugly. Remember the WWII movies where they always hand turn the propellers before starting those monster radial engines? – They are clearing oil from the lower cylinder to prevent hydraulic lock damage upon start up.

I have never heard the term "walnut shell lock" but if two intake valves on the cylinder on which you are not fully closed and you blast with walnut shells they will enter the cylinder.

7. I used my fiber optic camera to confirm that the valves were closed on the cylinder on which I was preparing to work - but you can do this with a mirror and strong flashlight.
8. The openings to the intake manifold face the firewall so you will be leaning over – a lot. I rolled a towel up and placed on the cowling so that I could lean over and rest my forehead on the towel for greater comfort.
9. Turn the engine with the socket on the crankshaft bolt and confirm that the valves are closed on your target cylinder (the two valves on that cylinder work together – they are both closed at the same time). The engine is set up where two cylinders work together – when you have one cylinder's valves closed you will find that another cylinder's valves are also closed. Therefore, you only have to position the crankshaft twice and you will get all 4 cylinders – just VERIFY, VERIFY, VERIFY before blasting each cylinder.

10. Attach the flange you made using two of the four nuts that hold the manifold in place. Tighten them finger tight. Route the vacuum hose from below the car and insert it into the flange. Below you can see the flange in place. Note masking tape to cover all other intake ports to eliminate entry of foreign objects. The OK means that I have already cleaned that cylinder's valves.



11. Start the air compressor and vacuum. Ear plugs are nice as you will be listening to this "music" for a while.

12. Some pointers:

- a. The vacuum will suck walnut shells out of the wand even when you are not pulling the trigger that applies the compressed air – just remove the wand quickly to eliminate the dribble and mess in the engine compartment.
- b. You can pull the aggregate (walnut shell) hose loose from the gun quite easily and this is important. You need to remove the aggregate hose about every 20 seconds or so of blasting with the aggregate and spray compressed air only through wand to clear the aggregate off of the back of the valves where it tends to pool up. If you have walnut shells pooled up and protecting the valve surface the blasting media can't impact the back of the valves which is what removes the carbon build up.

Routine blasting with compressed air only (no walnut shells being fed) agitates the pool of walnut shells off the backs of the valves and allows the vacuum to remove the buildup. Blast with air only for about 10 seconds, reattach the aggregate hose, and resume blasting walnut shells.

The fiber optic camera made it very easy to take a peek and see how things were going without having to remove the vacuum adapter. You just pull the blasting gun out and insert the fiber optic camera through the same 3/4" hole you drilled. If you don't have the camera you can pull the vacuum adapter and use the flashlight and mirror trick (however, this job is a great way to justify the purchase of a fiber optic camera (about \$140 at Costco for one with wireless monitor) ..."Honey, I saved over \$700 by doing this myself so I HAD to buy the camera").

13. **Make sure the vacuum is running at all times the gun is inserted!** I inserted the gun into the hole and blasted for only about 2 seconds the first time for each cylinder, removed the gun, and inserted the camera to confirm that there was a pool of walnut covering the back of the valves to once again confirm that walnut shells were **not** entering the cylinder. Yeah, I know, I am overly paranoid about this - but better safe than sorry.
14. Pull the gun trigger while moving the gun in and out and round and round. You will feel the tip enter one of the two inlets to the left valve (for example). Pull it out and move it to the other inlet and clean the right valve in that cylinder. You will get the hang of it quite quickly. The index marks you made on the gun help you keep track. The walnut shells are soft enough that they will not hurt the aluminum intake runners or the valves - that is why the dealer uses walnut shell blasting.
15. Remember to periodically pull the aggregate line off of the gun and blow with compressed air only to remove the accumulated pool of walnut shells as mentioned above. If you don't index the gun in and out you will not hit all areas with walnut shells. Changing the angle and insertion depth changes the angle at which the walnut shells hit the valves and intake runners. You want them to bounce around randomly to hit all areas. Pay particular attention to the build up on the opposite side of the valve stem. This will be the last place that will come clean as the valve stem partially shields the back of the valve.

16. Inspect your progress. With a bit of practice I was getting a cylinder's intake runners and valves clean with only about 3 to 5 minutes of "trigger time". My valves were pretty bad. The valve shaft was about 4 times normal diameter and covered with carbon buildup. The backs of the valves had about 1/4" to 3/8" of build up.

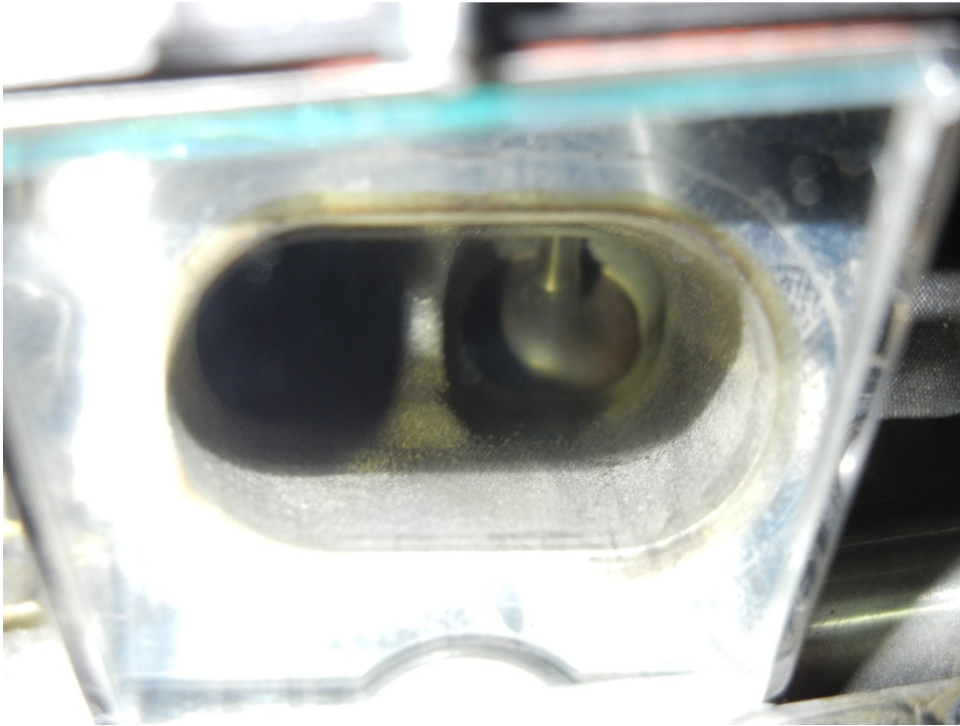
The buildup was not consistent from cylinder to cylinder meaning that some cylinders were breathing more freely than others and thus working harder. This contributes to an increased engine vibration level and an uneven idle – totally gone after the valves were cleaned!



The valve above is not my valve but the buildup was almost this bad. Below is pretty much what a "before" picture of my valves would have looked like (Unfortunately, I did not get a good "before" picture):



Below is an actual "after" picture of my valves after cleaning:



17. After blasting, the surface of the aluminum intake runners will be covered with a very light walnut dust. This is soft and will not hurt anything but I used a brush with carburetor cleaner to remove it anyway.
18. Once finished with the cylinder, seal the intake on which you have been working with tape to prevent foreign objects from entering. Make sure the valves are closed on the next cylinder and repeat.
19. Reassemble the intake following Texasmontego's instructions.

Was it worth it? **Absolutely!!** Like the frog in water slowly brought to a boil, I did not realize how much responsiveness I had lost over the 33,000 miles. I live only 3 miles from work so I have a lot of short trips where the oil doesn't have a change to get really hot and I think this accelerates the buildup. The car now idles like new and the engine vibration level is less since all 4 cylinders are spreading the load more evenly. Partial throttle acceleration is notable smoother and far more linear. Overall power increase is also quite noticeable.

After cleaning the valves I plugged the rear PCV port (numerous posts here in NAM on this) and installed a BSH catch can. I know the jury is out on if a catch can makes a real difference on carbon buildup. As an engineer, I realize that a catch can is really just an air/oil separator that works by slowing the air flow down when it reaches the large diameter can to allow the oil particles to fall out of suspension. The better cans have internal baffles to assist in this separation.

In my case, the drink bottle below contains what I caught in the catch can in the first month of operation. Most of it is water due to winter temps and short trips, but look at the amount of oil it caught in 4 weeks and less than 400 miles (again – with many cold starts)!



Below is the BSH (bought from Way Motors Works) installed. With the rear PCV hose removed all the crankcase blow by goes through the catch can an into the turbo inlet PCV inlet which was not altered.



Good luck on your adventures in walnut blasting and Happy Motoring!

