Turbocharger troubleshooting

When Bernard Clarke of Clarke's Garage, Co. Cavan, was confronted with a suspected faulty Variable Nozzle Turbine (VNT), he eliminated all other possibilities before deciding to replace this costly item. Here is what he did and learned along the way.

Bernard Clarke

Bernard Clarke of Clarke's Garage, Annagharnet, Co. Cavan was presented with a 2000 Mercedes E220 CDI (diesel) that was running poorly and bogging down on acceleration. A check of the basics and a scan of the trouble codes gave only one realistic fault: Implausible Air Flow. (There was a fault code for the auxiliary heater, which the car did not have, so this code was ignored.) After checking the voltage and signal from the air flow sensor, Bernard could see that the sensor signal was out of its expected range slightly, so he replaced the sensor. After clearing the trouble codes and test driving the car, the car drove much better, but was still bogging down on acceleration.

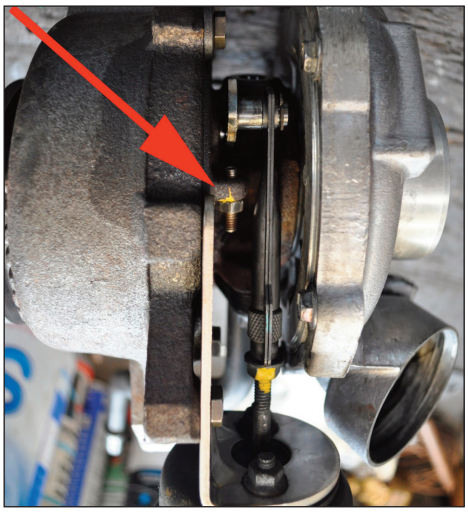
This problem was only present during the first few seconds of acceleration, and then the boost from the turbo would kick in. Live data from a Bosch KTS showed that the turbo boost was about 1.8 bars.

The EGR system was examined and found to be generally OK, but it was cleaned out anyway. The exhaust was examined for any blockages or restrictions. If the exhaust was partially plugged, it could have been causing the initial lack of acceleration.

The next step in checking for any exhaust restrictions, involved installing a pressure port on the upstream side of the particulate trap, just behind the turbo. Bernard has a handy kit that allows him to drill a 9.5mm (3/8") hole in any part of the exhaust, insert a threaded fitting and use a custom tool that crimps a port firmly into position. The port is permanent and threaded for either a pressure gage or a stainless steel plug and washer. The pressure at the upstream side of the particulate trap was 0 psi at idle and 2.5 psi at wide open throttle. These readings showed that the exhaust was not resricted at any point. If a high reading was found, Bernard could have installed more pressure ports along the exhaust until the pressure dropped. The restriction would then be upstream of the first normal reading. After testing, the port is sealed with a stainless steel bolt and washer, which can be removed for future testing.

At this point, the nature and source of the acceleration problem became more complex. Other than the interior of the turbo, everything was known to be in good working order, and the car should have been running normally. But it wasn't, and the diagnosing of the problem went deeper.

The turbo on this particular engine is a variable nozzle turbine (VNT) and operates slightly different than an ordinary turbo. A VNT has a set of vanes that controls the angle at which the exhaust gasses hit the impeller to spin it. The impeller on the exhaust side of the turbo is connected by a shaft to the impeller on the intake side. The faster the exhaust impeller turns, the more inlet air is sucked into the intake side and forced into the combustion chamber, boosting power. The position of the vanes on this turbo are controlled by a vacuum solenoid. At idle, the vanes are positioned to provide maximum boost, in anticipation of acceleration demand by the driver. On acceleration, manifold pressure drops, releasing the turbo vacuum solenoid, and moves the vanes so that turbo boost drops. The vanes change the direction of the exhaust gasses as they hit the impeller. The further away from the centre that exhaust gasses strike the impeller, the faster the impeller spins, and the more boost is created. Maximum boost occurs when the air is striking the impeller at an angle almost perpendicular to its radius and at the outer radius. The vanes continually adjust the amount of boost to meet demand, and eliminate the need for a waste gate.

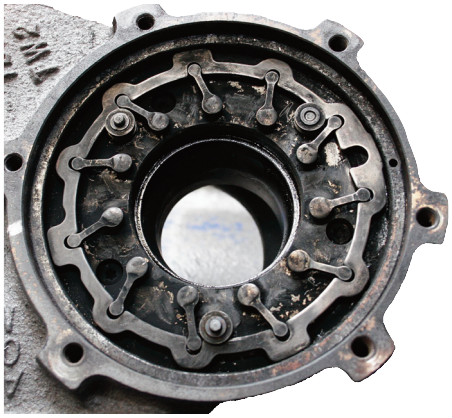


The old VNT turbo and the adjustment for the vanes, at arrow

To get a better understanding for how this works, think of a water hose spraying on a paddle wheel. A water stream applied near the centre might cause the wheel to spin slowly or not at all, at some angles of application. When the stream hits the very outer edge of the paddles, the wheel spins faster. It will spin fastest when applied to the outer edge of the paddles, and at an angle perpendicular to the radius.

There is a way to adjust the vanes on this turbo, but it was only intended for adjustment at the time of manufacture, not during service or repair. Bernard suspected that the turbo was faulty, but wanted to make sure he was on the right track, so he adjusted the vanes to see the effect it would have. Adjusting the vanes is not a way to fix a turbo problem, it was used as a test method only. He initially installed a 2mm thick metal bar that prevented the vanes from going all the way back to the idle position, and then took the car for a test drive. The acceleration problem was gone and the car ran perfectly. Bernard had the evidence he needed to make the correct decision and he replaced the turbo. The car ran perfectly with a new turbo installed.

The old turbo was taken apart to see what was going on to cause the fault. The vanes are controlled by a single ring that is rotated by the vacuum solenoid and moves all of the vanes in unison. All of the vanes and the ring looked fine, but if comparing them to a turbo in good condition, you would see that there was a bit of slop in every connection from the solenoid to each vane. The accumulated wear was causing the turbo to raise the exhaust pressure, causing a restriction, rather than a boost.



A view of the ring that controls the postion of the vanes, which change the boost provided by the turbo

Seen anything strange?

If you have come across a strange, puzzling or odd fault or repair, your experiences can be shared and help others facing the same or similar problems. All you need to do is give us a call, and we'll do all the rest.

Contact Autobiz on 091-523 292 and ask for John.