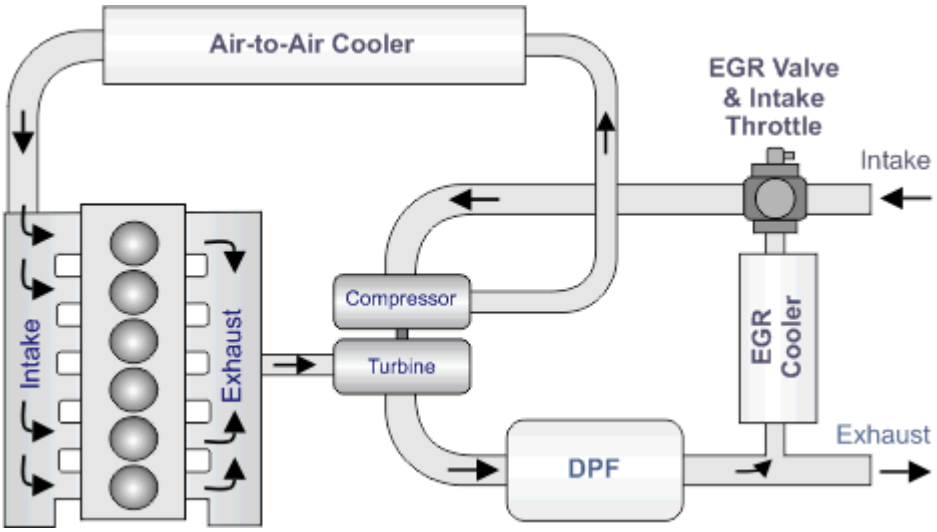
EGR – Exhaust Gas Recirculation

An EGR valve helps to reduce the NOx emissions from an internal combustion engine by recirculating part of the exhaust gas back into the combustion chamber. The recirculated exhaust gases act as a barrier, an inert material that can absorb the heat of combustion to reduce the peak in-cylinder temperatures.
The recirculated gas helps in diluting the Oxygen levels found in the incoming fresh airstream, thereby reducing the amount of NOx generation. Typically, NOx emission generation takes place when a reaction occurs in an environment with high Nitrogen and Oxygen mass fractions and at elevated temperatures. It just so happens, that this perfect condition is produced inside a combustion chamber !

In a diesel engine, the air/fuel mixture is placed inside a combustion chamber. The air mixture is highly pressurized such that the fuel upon introduction does not need to a spark plug to ignite. This high pressure and high temperature environment produces Nitric Oxide (NO) and Nitrogen Dioxide (NO2), commonly referred to as NOx. These chemical compounds have been identified as air pollutants because they contribute to the formation of smog and acid rain and also affect the tropospheric zone.

In order to reduce the emission of these harmful byproduct pollutants from the combustion engine, the EGR technology was invented. In the early stages of its conception, crude and simple methods like an orifice were used between the exhaust and intake tracts to help mix the two streams. But the orifice method did not provide a very tight control over the mix ratio in different conditions (start-up, shut-down etc.), and it resulted in difficult starting, rough idling, reduced performance. As automakers gained more experience, they developed more sophisticated EGR valve technology. Coolant controlled exhaust gas recirculation and the introduction of the backpressure transducers were added into the EGR valve assembly. Today, electronic exhaust valves have been developed that can very precisely adjust the mix ratio and move the valve in the right position to get the highest efficiency possible. All this while reducing drivability problems and abiding by the emissions laws.



One method of the working of an EGR valve. *Reference www.dieselnet.com*

As seen above, in modern diesel engines the intake air is mixed with the EGR gas through the valve. This mixture continues on to the compressor and is then cooled down to allow for an introduction of a greater mass of air/EGR gas mixture. This mixture is then fed to the combustion chambers, compressed to a very high pressure and then combusted by the introduction of diesel fuel. The exhaust gas and uncombusted fuel leave the chamber on the exhaust side through a turbine and on into a DPF (Diesel Particulate Filter) which reduces the amount of carbon particulates.

For diesel engines in particular, because they are not SI (spark ignited) engines, they are not limited by the need for a contiguous flamefront; and since diesel engines operate with excess air, they benefit greatly from EGR systems. The EGR gas rate on diesel engines can be as high as 50% to control NOx emissions. Another advantage of the EGR system is that the EGR gas recirculated back into the diesel engine can increase the life of the engine as it washes out carbon particulates past the rings and into the oil. Diesel engine are also not affected by throttling losses because they are unthrottled.

The application of EGR comes at a cost though and needs to be used in conjunction with other technologies. With a decrease in NOx emissions, the EGR on the other hand increases PM (particulate matter), HC (hydrocarbons) and CO (Carbon Monoxide) levels.

The addition of EGR to a diesel engine will reduce the specific heat ratio of the combustion gases in he power stroke. Emission gases – nitrogen, carbon monoxide and water vapor have higher specific heat capacity than air. And thus with a lower peak-combustion temperature on the power stroke, an EGR equipped diesel engine may extract lower power through each piston. This lower power generation has been investigated and studied deeply by various people and the use of EGR in conjunction with other technologies has been proposed.

The reduction in power stroke also amounts to unburned fuel and is treated as wasted energy – particulate matter. Very strict regulation on the emissions of particulate matter have been placed by various agencies and all diesel engine vehicles must abide by them. To reduce the particulate matter in the exhaust stream, a DPF (diesel particulate filter) is placed after the exhaust manifold to capture the unburned carbon matter. Various kinds of catalysts and filters are used within this technology to reduce its affect on the performance of the engine – due to the back pressure created on the combustion chambers. The primary oxidizer of the carbon soot caught in the diesel particulate filter in NOx emissions, at normal operating conditions. This is known as passive regeneration and increasing EGR rates causes passive regeneration to be less effective.

Thus, passive regeneration necessitates cyclic active regeneration of the DPF by burning diesel fuel in the oxidation catalyst to significantly increase exhaust gas temperatures.

Other drawbacks of EGR are increased fuel consumption and decrease in engine durability. A combination of other technologies are used in conjunction with the EGR to handle these drawbacks – reduction in lubricating oil consumption, increases in fuel injection pressure, increased use of diesel oxidation catalysts, increase intake manifold boost pressure.

The EGR valve is thus a very important and integral part for the performance of a diesel engine vehicle. You should routinely be checking and cleaning the exhaust system to be in compliance with the regulations and also to increase the performance of your diesel engine vehicle.

There are many ways for an EGR valve to fail and many more factors that can cause harm to the valve. A few of those reasons and factors have been listed below:

- EGR system flow is insufficient
- EGR system flow is excessive

If your EGR system flow is insufficient be sure to check for the following repair ideas –
EGR passageway is clogged by soot or other particulate matter. This can happen most often when routine maintenance is not done on the exhausts system and a complete clean out is not executed properly.
The EGR valve may be stuck or closed or non-functioning. This can happen if the valve has a broken pin or assembly or is unable to communicate with the on-board electronics. There could also be a build-up of particulate matter or solids on the seat of the valve preventing it from moving in place.
Problems with the DPFE sensor or hoses that lead back to the unit (specific for Ford vehicles)
Problem with the EGR vacuum switching valve which is specific to Toyota vehicles
A clogged catalytic converter or Diesel Particulate Filter (DPF)
Carbon build up on EGR temperature sensor
Vacuum supply issues at the (Vacuum operated EGR valve)
Electrical problems with the EGR valve control circuit

If your EGR system flow is excessive be sure to check for the following repair ideas –
The EGR valve mechanism is stuck open
The air filter is clogged or dirty
There are intake leaks
There could be a problem with the turbocharger
An incorrect vacuum hose connection
The DPE sensor may be bad or damaged which is specific to the Ford or Mazda vehicles
There may be a fault with the EGR Control Back Pressure Transducer valve (EGRC-BPT) which is specific to the Nissan vehicles
There may be a fault with the EGR temperature sensor
There is a damaged or missing EGR valve gasket
There could be some problems with the EGR vacuum control
There could be some problems with the EGR switching valve
The EGR valve control circuit may be having electrical problems
The catalytic Converter may be clogged
The EGR vacuum Solenoid may be defective
There may be a restriction in the EGR passages, its usually caused by carbon buildup

You can also keep an eye out for failing EGR valves by watching out for the following symptoms –
Rough idling - when the EGR valve mechanism stays open when the engine is at a low RPM or idling (stopped at one space). The extra addition of exhaust gases will then cause the engine to go haywire.
Fuel detonation noise - when the EGR valve mechanism remains shut when the engine is at a high RPM. This causes a high temperature in the combustion chamber due to the absent exhaust gas cooling effects, the production of the nitrogen compounds will further lead into more detonation which is burning the fuel without any ignition. This would cause detonation knocking noises in the engine.
Increase in emission of NOx gases - when there is a spike in the emission of NOx gases.

A little about me and my business
My name is Brandon Mendell. Owner, leader and diesel engine enthusiast at Brandell Diesel Inc. I take great pride in running, fixing and appreciating diesel engines. As a boy growing up on the farmlands on Southern Alberta with my father I developed a love for these machines and have carried on, on the path for the past 20+ years.

We proudly serve companies, fleets and individual owners of diesel engine vehicles and personally look to it that we do whatever it takes of save our customers any downtime. We are known all across the province of Alberta for our fast turn around times on diesel engine vehicle repairs and the rescue service we provide on the roads with our trucks.
Don't hesitate to call me at 403 271 0101 for repairs or consultation on your diesel engine vehicles.

I look forward to hearing from you my friend !!