

Blue Tec

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Abstract - BlueTec is DaimlerChrysler's name for its two nitrogen oxide (NO_x) reducing systems, for use in their Diesel automobile engines. One is a urea catalyst called AdBlue; the other is called DeNO_x and uses an oxidizing catalytic converter and particulate filter combined with other NO_x reducing systems. Both systems were designed to slash emissions further than ever before. BlueTec is both an umbrella term that includes different emissions post-treatment technologies and applications of technologies to solve the basic problem of emissions reduction as well as a descriptor applied to the various solutions of reducing oxides of nitrogen underneath the larger BlueTec banner.

Key Words: AdBlue, DeNO_x, Urea, etc...

1. INTRODUCTION

BlueTec is Daimler AG's name for its two nitrogen oxide (NO_x) reducing systems, for use in their diesel automobile engines. One is called DeNO_x and uses an oxidizing catalytic converter and particulate filter combined with other NO_x reducing systems. The other is a urea-based system called AdBlue. Both systems are designed to reduce pollutant emissions. BlueTec is both an umbrella term that includes different emissions post-treatment technologies and applications of technologies to solve the basic problem of emissions reduction as well as a descriptor applied to the various solutions of reducing oxides of nitrogen underneath the larger BlueTec banner. BlueTec is a trademark name used by Mercedes-Benz to describe its diesel engine exhaust treatment system. In order to keep up with the steadily evolving and increasingly demanding emissions laws of North America and Europe, the company has designed and released two versions of this system. Version one was released for the U.S. market in the form of the 2007 E320 BlueTec sedan and was designed to utilize, the newly introduced, Ultra Low Sulphur Diesel (ULSD). As a next step, Mercedes-Benz has released the more sophisticated R, ML and GL 320 series BlueTec with AdBlue injection diesels that meet America's demanding BIN 5 emissions standards and are on-track to qualify for Europe's EU6 parameters.

2. WHY BLUETEC?

The BlueTec system was created because the processes that gives diesel engines efficient fuel economy also creates extra emissions of certain pollutants. High compression ratios and lean air-fuel mixtures make high combustion temperatures, which results in more nitrogen oxides and Diesel Particulate Matter (also known as soot) being released into the atmosphere. While the particulate matter can be controlled with higher injection pressures and particulate filters, the big challenge is limiting NO_x (Tier 2 regulations in the US are 0.05 grams of NO_x per mile, which is 1/8 of the 0.40 limit in the European Union). Consisting of many different elements, BlueTec most notably relies upon particulate traps to eliminate soot/smoke throughout the engine's operating range, and upon urea injection from a stored canister (Mercedes calls this AdBlue) into the exhaust stream. AdBlue injection begins a chemical chain reaction which, in conjunction with an additional catalytic converter, converts nearly all remaining NO_x into water vapor and nitrogen.

Exhaust components like nitrogen oxide, carbon monoxide, hydrocarbons and combustion residue in the form of particulates can all be reduced through exhaust gas treatment - in some cases to the point where they are barely detectable. This is where the innovative, modular exhaust gas purification system BlueTec comes into its own. BlueTec gives diesel vehicles the technology they need to operate in an environment-friendly way and will meet the planned emissions limits of the future as well.

3. VARIANTS OF BLUETEC

The BlueTec system has a number of components that "scrub" the exhaust before it is released into the atmosphere. Two variants of the BlueTec system exist: the DeNO_x system and the AdBlue system.

3.1 DeNO_x System

Exhaust leaves the engine and passes through a Diesel Oxidation Catalyst (DOC), which reduces carbon monoxide and unburned hydrocarbons in the exhaust. Next is the NO_x Absorber Catalyst, or NAC, which removes and traps oxides of nitrogen (NO_x is one of the chief elements in diesel pollution). During periods of lean operation (low fuel-to-air ratio) NO_x is stored; under richer operating

conditions (which can be created by manipulating the fuel injection) the NAC undergoes a regeneration process and releases ammonia into the exhaust. The ammonia is stored downstream in the Selective Catalytic Reduction (SCR) catalyst which uses it to further reduce NO_x.

In between the NAC and SCR catalysts is a particulate filter that traps particulate emissions (soot). As the particulate filter becomes full, the engine computer manipulates the fuel injection process to raise the exhaust gas temperature, which in turn burns off the particulates. In simple words NO_x gases produced under normal operation are trapped and temporarily held in the converter. At prescribed intervals, under direction of the on board computer, the fuel system delivers intermittent rich combustion phases. NAC undergoes a regeneration process and releases ammonia into the exhaust recombines with the trapped oxides of nitrogen inside the hot housing and break-up the NO_x molecules. The resulting clean nitrogen gases and water vapour are purged, leaving behind a clean converter with regenerated catalysts that are ready to accept the next wave of nitrogen oxides.

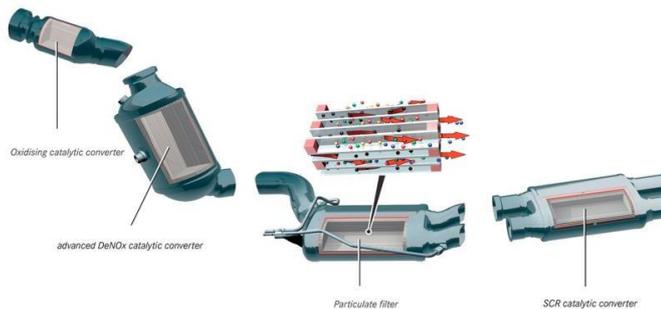


Fig -1: DeNO_x System

3.2 AdBlue System

The AdBlue system houses the DOC and particulate filter in a single housing. In addition to the NAC catalyst, ammonia is supplied by injecting a fluid called AdBlue into the exhaust upstream of the SCR catalyst. The addition of AdBlue fluid enables the SCR catalyst to reduce NO_x emissions to a level even lower than the NAC-SCR system. AdBlue is carried in an on-board tank which can be replenished when the car is serviced; a gallon of AdBlue fluid lasts approximately 2,400 miles.

Mercedes-Benz designed this process for their larger and heavier line of SUVs and their R-series crossover, following the logic that these vehicles already have a higher rate of fuel consumption and that they would be more economical using a system that does not rely on frequent fuel-consuming rich mixture events for NO_x abatement. This injection process relies on chemical conversion via a reaction between the AdBlue urea solution and the accumulated NO_x molecules within the SCR converter. When AdBlue is injected into the hot

exhaust steam, it is reduced to water and urea. At a temperature of about 400 degrees Fahrenheit (170 Celsius), the urea reforms into ammonia (NH₃) which then reacts with NO_x gases in the converter to produce benign nitrogen gas and water vapour.

Heavy, high fuel consumption SUVs that spend a good deal of time under load are best served by AdBlue injection. On the other hand, smaller fuel efficient passenger cars that are, by and large, passenger moving cruisers, make optimal use of the NO_x storage converter.

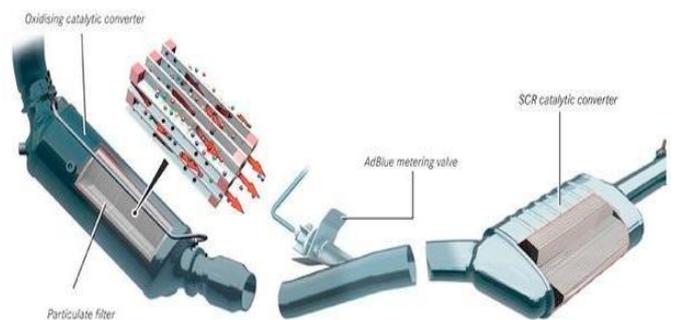


Fig -2: AdBlue System

4. TOTAL PROCESS

The BlueTec system will use two catalytic converters specifically targeting NO_x. The first converter traps the NO_x, and later releases it to the second converter which then converts it to nitrogen (N₂) and water (H₂O). But to make it pass the more stringent, AdBlue will have to be introduced into the system, making the conversion more complete.



Fig -3: Chemical Reaction

The whole exhaust system would work like so:

1. A Diesel oxidation catalyst reduces the amounts of carbon monoxide (CO) and hydrocarbons (HC) released from the exhaust.
2. A DeNO_x catalytic converter begins a preliminary removal of oxides of nitrogen.
3. A particulate filter traps and stores soot particles, burning them off when the filter gets full.
4. If the above are not sufficient to meet the exhaust specifications, a Selective Catalytic Reduction (SCR) catalytic converter will take the remaining nitrogen oxides and convert them to nitrogen and water. AdBlue will be injected into the exhaust gas stream to enable the conversion.

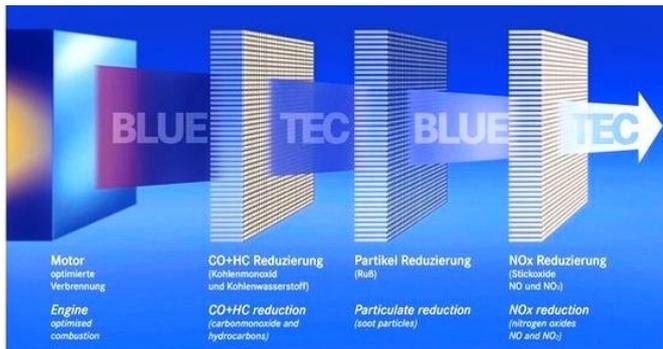


Fig -4: Total Process

5. ADVANTAGES & DISADVANTAGES

5.1 Advantages

- Reduction in NO_x emission
On average, NO_x emissions are reduced on the order of approximately 80 percent.
- Optimal and clean combustion
Combustion has been optimised to reduce fuel consumption and adapted to ensure low particulate emissions. Adding in AdBlue converts the resulting nitrogen oxides into nitrogen and water vapour.
- Reduction in fuel consumption of up to 5%
An optimized combustion process not only results in extremely low particulate emissions but also cuts fuel consumption by up to 5%.
- BlueTec works with all brands of oil and fuel grades
You can continue to fill up your BlueTec vehicle with your preferred diesel. And you can keep on using commercially available oils because BlueTec does not place any restrictions on the diesel and oil grades which may be used.
- AdBlue is widely available
AdBlue is widely available throughout Mercedes-Benz truck dealerships, spare parts and accessories centres. The network of AdBlue refilling stations is steadily expanding. AdBlue tanks are available in different sizes to cater for all operations and in order to minimize impact on payload and vehicle application. To increase convenience, the refilling of diesel and AdBlue can take place at the same time.
- Service intervals are the same for BlueTec vehicles
Long service intervals make financial sense and are also the clearest sign of up-to-date technology. BlueTec ensures that you can continue to enjoy the customary long service intervals and the associated reduced downtime.

5.2 Disadvantages

- Requirement to replenish the tank of AdBlue
The problem with these systems is the requirement to replenish the tank of the aqueous urea solution
- Corrosive effect
AdBlue is slightly corrosive to some metals.



Fig -5: AdBlue Tank

6. SCOPE

DaimlerChrysler is becoming increasingly bullish about the prospects for diesel in the US, given the rising concerns about fuel economy here combined with apparently ongoing customer demand for size and performance.

J.D. Power and Associates forecasts that the market share for diesel passenger cars in the US, which currently stands at around 3.4%, will quadruple by the year 2015. Mercedes-Benz is convinced that once BlueTec technology has established itself, this forecast will appear conservative rather than optimistic.

Accordingly, the Mercedes group will share the technology with the Chrysler group, as evidence by the Jeep prototype. The pace of that, and the pace of the overall BlueTec diesel rollout in the US, will depend to a great extent on the customer reaction to the E320s when they hit showrooms in the fall.

This may, over the next several years, contribute to altering the competitive landscape for improved fuel-efficiency, with clean diesel cars becoming poised to occupy the territory currently being scoped out by many hybrid implementations—fuel economy improvements of some 20–30% over comparable current gasoline platforms—with a lower-cost solution than hybrids.

Mercedes's GL BLUETEC full-size SUV, for example, is projected to offer fuel economy of 26 mpg US; the upcoming Chevy Tahoe Hybrid 25 mpg.

7. CONCLUSIONS

NO_x emissions can be reduced upto 80% with BlueTec. Fuel consumption can be reduced upto 5% with the use of BlueTec. Since it ensures optimal and clean combustion and can be used with all grades of oil and fuel, BlueTec can be introduced everywhere in the world to replace the conventional diesel engines. Over decades, the diesel increasingly has become a clean, powerful, high-speed drive unit, yet has retained its economical nature. Originally it was this economic efficiency and robustness which impressed contemporaries; today the diesel engine is an extremely low-emission power plant with sporty characteristics. Consequently, in the face of increasingly stringent emissions standards, the current BlueTec engines constitute an alternative to gasoline engines more than they ever did. The market reflects this development: in the meantime every second car sold in Western Europe is a diesel car. Mercedes-Benz even sells 54 percent of its cars with a compression-ignition engine under the hood. The diesel is coming on very strong.

REFERENCES

- [1] http://www.mercedes-benz.ie/content/ireland/mpc/mpc_ireland_website/enng/home_mpc/truck_home/home/trutru/axor/bluetec/reasons.
- [2] <http://www.greencarcongress.com/2006/01/daimlerchrysler>
- [3] <http://en.wikipedia.org/wiki/Bluetec>