Tips & Technology
For Bosch business partners

Current topics for successful workshops No. 02/2016

Gasoline / Diesel Injection

BOSCH
Invented for life

40 years of Bosch lambda sensors

Production anniversary in 2016: 1 billion Bosch lambda sensors

Catalytic converters and lambda sensors: integral parts of modern-day cars

No other vehicle component stands for “clean driving” as lambda sensors do. Unthinkable to build a modern motor vehicle without it. Lambda sensors first allowed the application of three-way catalytic converters – and thus the compliance with modern emission standards.

Exhaust emissions: three main problems

Name giver and centerpiece of the lambda-sensor technology is “lambda value 1”. This value is achieved at the complete combustion of a fuel mixture with a ratio of 14.66 to 1 – i.e. 14.66 kg of air in relation to 1 kg of fuel. However, hardly any engine achieves such a ratio without any corrective actions. During operation, combustion engines usually produce three types of pollutants: carbon monoxide and hydrocarbons in case of excessive fuel or nitrous gases in case of excessive oxygen within the fuel mixture. Even with a correct ratio, incomplete combustion is not uncommon. This results in emissions of all of the three pollutants as they are released into the environment by the exhaust system.

Paying attention: exhaust guards

Catalytic converters burn those exhaust gases which have not been burned during the combustion. For this purpose, the lambda sensor measures the oxygen level of the combustion products yet before they pass the catalytic converter on their way out. Only lambda sensors detecting variations of the oxygen concentration allow compliance with the stipulated 90-percent reduction of exhaust emissions. The information gathered by the sensor is forwarded to the ignition and injection engine management. The corrected fuel mixture ensures an optimum combustion within the catalytic converter.

Technical basis: thermodynamics

The origins of lambda technology can be traced back to 1889. At his “Nernst equation”, professor Walther Nernst, who was later on awarded the Nobel Prize in Chemistry, describes laws of thermodynamics. Knowing these laws allowed the development of lambda sensors in first place.

1920: Walther Nernst receives the Nobel Prize

Lambda technology: realized opportunity

In 1968, Bosch used a technology measuring the oxygen ratio of melted lead for its battery production – ideal for the development of lambda sensors. As the environmental authorities in the USA announced more stringent emission standards in 1970, Bosch started tests with lambda sensors for the fuel management. The production of heatresistant ceramics was already known from the spark-plug production – thus allowing Bosch to use suitable materials. After all, these sensors are exposed to exhaust gases featuring up to 1 000 °C.

Readiness for series production: a path of trial and tribulation

Predevelopment began with testing products of other manufacturers – revealing disastrous results: The tested sensors broke after just one hour. Accordingly there was still a lot to be done prior to the market launch. When the first sensors of own production were tested in autumn 1971, the results were not really convincing either. Due to thermal problems, the laboratory prototypes also broke after just two hours. Not even the electrodes used lasted long enough. The subsequent development was a path of trial and tribulation. But finally, in 1975, a service life of 250 hours had been reached – enough for a mileage of 20 000 kilometers.

1973: first Bosch lambda sensor

Series production: a huge success

The first manufacturer to equip his vehicles with Bosch lambda sensors as standard was Volvo. In 1976, Volvo launched its 240/260 series in the USA – with a huge impact both on the public and on the market. The emissions were that low, they did not only fall below the applicable emission regulations but would actually comply with even more stringent future regulations. The demand for lambda sensors was shooting up. In 1977, Ford USA and Bosch signed a supply agreement about three million pieces per year.

Clearly visible from the outside: Volvo with lambda sensor

2nd generation: preheated lasts longer

The next version, which was ready to be launched onto the market in 1982, featured a clear advantage: It was heatable. As early as 30 seconds after starting a cold engine, it would work reliably. Its service life was doubled now featuring some 160 000 kilometers. The simple reason for this improvement: The former sensor was cold at first and thus extremely sensitive to hot exhaust gases. With the new sensor heating up to 400 °C once the key is turned, this problem was solved.

Today: planar lambda sensors

At the mid-1990ies, the “finger-type sensor” used until then was further developed. A new plate-shaped sensor, also made from ceramics, was created: the planar lambda sensor – by

now, the most widely used one. Unlike stepchange sensors only determining a lack or excess of oxygen, the new planar wide-band sensors, which could now also be produced, were able to linearly measure the oxygen ratio over wide ranges. Diesel engines are also equipped with wide-band sensors and NO_x and particle sensors also based on ceramic technology.

Planar wide-band sensor

Latest type of sensor: LSF xfour

2016: one billion lambda sensors

By now, 50 million lambda sensors leave the German main plant in Rutesheim and the production facilities in the USA, Brazil, China and as of 2016 also Romania each year. For the anniversary in 2016 they will sum up to 1 billion sensors. The sensor elements for planar lambda sensors are produced in Bamberg (Germany) and Anderson (USA).

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