



DIESEL ENGINE EMISSIONS

BACKGROUND

Over the last 25 years or so there has been increasing public concern over the nature and composition of the combustion by-products that are emitted from engine exhaust pipes. Initially the greatest attention was given to petrol engines because in their original form, these engines, excluding smoke or particulates, produced significantly higher emissions than diesel engines. Extensive development of emission controls on petrol engines has reduced the undesirable exhaust gases to levels below that of typical diesel engines.

The main concern with diesel engine emissions has always been smoke because it is clearly visible, particularly at high engine loads. In the past this smoke was considered to be undesirable because of aesthetics and odour but now there is growing concern about the health effects of this particulate matter when it is breathed into the lungs. The term particulates is used to describe the collection of small particles that make up smoke.

THE SOURCE OF EMISSIONS

Exhaust emissions as they are known are just the by-products of combustion of a fuel. For every 1kg of fuel burnt, there is about 1.1kg of water (as vapour/steam) and 3.2kg of carbon dioxide produced. Unfortunately we don't have 100% combustion and so there is also a small amount of products of incomplete combustion and these are carbon monoxide (denoted CO), hydrocarbons (vaporised fuel) and soot or smoke (actually hydrocarbons in a different form). In addition, the high temperatures that occur in the combustion chamber promote an unwanted reaction between nitrogen and oxygen from the air. This results in various oxides of nitrogen, commonly called NOx.

There are also several minor contributors to exhaust emissions which are burnt crankcase oil and sulphur from the fuel. Both of these components will show up mostly as particulates. Oil consumption is obviously a function of engine design and amount of wear but sulphur dioxide is formed from the sulphur in the fuel.

MEASUREMENT OF EXHAUST EMISSIONS

The gaseous emissions are generally measured using electronic instruments but for field use Drager tubes are used. These contain a chemical which changes

colour by varying degrees when a particular gas is present. This is most commonly used in underground mines to ensure that engine emissions meet the Mines Department regulations.

Any of the non gaseous emissions from a diesel exhaust are measured as smoke or particulates. This includes smoke, soot and sulphur dioxide. Smoke may be filtered out of the exhaust and weighed or the exhaust passed through an instrument such as a Bosch Smoke Meter that measures opacity ie the percentage of light transmittence.

The units of measurement of emissions vary with the application and test procedure. Typical units are ppm, % volume, gm/kw hr, gm/km or gm/test.

Currently on road diesel emissions are not measured in Australia but in the future we may adopt regulations from overseas.

While it is difficult to quantify the typical emissions from a diesel engine, using the current USA regulations for an approximation, 1kg of fuel would produce around 30gm of carbon monoxide, 3.5gm of hydrocarbons, 1.7gm of particulates and 8gm of NOx.

Total unwanted emissions which could be attributed to 'inefficient' combustion accounts for something less than 4% of fuel used. Note that this does not necessarily relate to wasted fuel because these components are the product of incomplete combustion and so have still released much of their energy content. As an aside, this shows that there is not much scope to improve fuel consumption through improved combustion alone.

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