THE COMPOSITION OF DIESEL EXHAUST EMISSIONS

Diesel exhaust contains thousands of gaseous and particulate substances, but the presence of nitrogen dioxide, nitric oxide, carbon monoxide, carbon dioxide, sulfur dioxide, hydrocarbons and aldehydes are of concern for the purposes of air quality monitoring.

As a diesel engine runs, the complex make-up of diesel exhaust is constantly changing because of various load conditions. These conditions are met by changes in injected fuel quantities, which are then ignited with air in the combustion chamber. The composition of exhaust gas from a diesel engine changes constantly as the fuel/air ratio is altered to meet variable demands for power.

Particulate matter is also found in the exhaust of diesel engines. This is generally what is considered to be the “smoke” of diesel emissions and is not to be confused with the other exhaust components. Diesel particulate is a complex mixture of compounds composed of non-volatile carbon, large numbers of different absorbed or condensed hydrocarbons, sulphates and trace quantities of metallic compounds.

Over recent years attention has focused on diesel particulate matter for a number of reasons. About 90 percent of these particulates have a diameter of less than 1.0 µm. This means particles can penetrate to the deep regions of the lungs, where there is a possibility that they may participate in some form of biological activity. The role of elemental carbon in diesel particulate has gained significant prominence in relation to possible adverse health effects and is the focus of regulatory attention in Europe and North America.

Emissions are influenced by factors as engine type, duty cycle, fuel quality, engine maintenance, intake ambient conditions, operator work practices and emission controls. Because of this variability it is difficult to define a typical diesel exhaust; however, it is clear they do contain some compounds which require appropriate control procedures to minimize worker exposures.

Nitrogen Dioxide (NO2)

Inhalation of higher concentrations of NO2 can induce pulmonary edema, which may be fatal. The incidence of chronic effects from long exposure at lower concentrations can result in cases of emphysema and chronic bronchitis.

Nitric Oxide (NO)

Nitric oxide is less toxic than nitrogen dioxide, but changes into nitrogen dioxide in air.

Carbon Monoxide (CO)

Exposure to carbon monoxide decreases the ability of the blood to carry oxygen to the tissues. Inhalation of carbon monoxide may cause headache, nausea, dizziness, weakness, rapid breathing, unconsciousness and death.

Carbon Dioxide (CO2)

Carbon dioxide in itself is not toxic, but as any other gas contributes to the depletion of oxygen in a nonventilated or confined space. Carbon dioxide is commonly used as a surrogate gas for monitoring the toxic components of diesel emissions.

Sulfur Dioxide (SO2)

Sulphur dioxide causes irritation of the mucous membranes, which results from the action of sulfurous acid formed when the highly soluble gas dissolves in the body fluids. Short term exposure causes bronchoconstriction which results in an increase in flow resistance or difficulty of breathing.

Volatile Organic Compounds (VOC's)

(Also known as hydrocarbons). Volatile organic compounds result for the presence of unburnt fuel and thus, their composition is continuously varying, depending on load. While it is true that some hydrocarbons can have more severe health effects at high levels, concentrations usually present in diesel emissions are regarded as a respiratory irritant. Volatile organic compounds are detectable as a surrogate means for air quality monitoring.

Aldehydes

Small amounts of aldehydes occur in diesel exhaust, some of which are known to produce irritant effects especially regarding the eyes. Some aldehydes have been implicated in more serious health issues; however, the low concentrations normally found in diesel emissions significantly reduce the likelihood of any such occurrences.

Diesel Particulate (DP)

Diesel particulate (DP) is generally regarded as a respiratory irritant, although there is a potential for DP to play a role in the development of lung cancer in heavily exposed workers.