TerranearPMC Safety Share

Week of October 12, 2015 – Vehicle Emissions (NO_x and So_x)

A few weeks ago the car manufacturer, Volkswagen, was the recipient of a legal action, administered by the EPA that resulted in a massive, 500,000 car recall. The reason for this recall was that the manufacturer had designed its vehicles to deliberately conceal diesel pollutants during emissions testing. Through investigations it was determined that the cars-in-question can exhaust up to 40 times more emissions (into the atmosphere) than legally allowed.

US regulations for vehicle emissions are more stringent than European laws. Nevertheless, VW claimed it could bring emissions down to California's "Tier 2 / Bin 5″ emission standard of 70 mg/mile. (New York, Massachusetts, Vermont, and Maine also use this standard).

According to recent investigations, VW had installed electronic devices that allowed their vehicles to sense when an emissions test was being performed, and, as such, would enable the vehicle to initiate its full suite of pollution-scrubbing mechanisms to bring the car into full legal compliance. Once it was no longer undergoing testing, the car would shut these mechanisms off, allowing greater concentrations of pollutants to exhaust into the atmosphere. Specific vehicles that have been recalled are the VW Golf, Jetta, Beetle, and Passat TDI models, as well as the Audi A3 and A4 diesel models.

In the United States, emissions testing is established through the jurisdiction of local air quality regulators, such as the California Air Quality Resources Board (CARB) as well as other state regulatory agencies. However, local air emissions testing still needs to meet the requirements established by the EPA through 40 CFR, Part 85 86: *Control of Air Pollution from Mobile Sources*.

The most recent EPA regulation for emissions (''Tier 2 standards'') establishes more stringent standards for passenger cars, light trucks, and larger passenger vehicles then previous regulations. The program is designed to focus on reducing the emissions of those pollutants most responsible for the ozone and particulate matter (PM) impact (while ozone is important to protect us from UV radiation 10-30 miles above the earth, it is very harmful within our immediate atmosphere). These materials are: nitrogen oxides (NO_X) and various types of volatile organic compounds (VOC), which, in the presence of sunlight are considered to be ozone precursors. Thus reducing these substances, we are controlling our health from potential ozone exposure.

Ambient ozone is formed in the lower atmosphere through a complex interaction of VOC and NO_X emissions. Cars and light trucks emit a substantial fraction of these substances. Ambient PM is emitted directly from cars and light trucks; it also forms in the atmosphere from NO_X, sulfur oxides (SO_X), and VOCs, all of which are emitted by motor vehicles.

The terms, NO_x and SO_x, refer to those chemical compounds known as oxides of nitrogen and oxides of sulfur. The most common NO_x are nitrogen oxide, NO and nitrogen dioxide, NO_2, while the common SO_x materials are sulfur dioxide SO_2, and sulfur trioxide, SO_3.

SO_2 is a colorless gas with a pungent odor that dissolves in water very easily (forming a weak acidic solution – *sulfurous acid* – not to be confused with sulfuric acid). When sulfur dioxide combines

with the oxygen in the air SO_3 is slowly formed. SO_3 then rapidly combines with water to produce sulfuric acid. The lifespan of SO_x in the atmosphere is from 4 to 10 days.

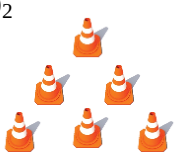
Sulfur dioxide (SO_2) can harm crops and trees, textiles, building materials, animals, and people; either as a result of exposure to long-term low concentrations or short-term high concentrations. It turns leaves yellow and decreases the growth rate of crops. Sulfur dioxide corrodes metal, and causes building materials and textiles to deteriorate and weaken.

Even at low concentrations (approximately 5 parts per million – ppm) SO_2 can severely irritate the throat and lungs and, when SO_2 attaches to fine dust particles in the air, the results can be respiratory system damage as such particles can reach the deepest regions of the lung. The current occupational exposure limits for SO_2 is 5 parts per million (ppm) as the OSHA PEL and 0.25 ppm as the ACGIH TLV. Short-term exposures to high levels of sulfur dioxide can be life-threatening while the NIOSH immediately dangerous to life and health (IDLH) airborne concentration is 100 ppm.

Because SO_2 is readily soluble in water, it is a major contributor to acid deposition. While acid deposition is a broader term than acid rain, the two are often used interchangeably. Most acid rain is caused by emissions of SO_x and NO_x which converts to sulfuric acid and nitric acid (among other products). Diluted forms of these acids, and other substances, can fall to earth as rain, snow, sleet, hail, or fog. When it is not raining, the oxides interact directly with soil, vegetation and water in a variety of ways referred to as dry deposition.

The term "acid rain" (pH of less than 5.6) was coined by Robert Angus Smith in 1872 who referred to sooty skies over Manchester, England in his publication *Air and Rain: The Beginnings of Chemical Climatology*. In recent years, a great deal of attention has been given to acid deposition as many countries around the world reported lifeless lakes, damaged forest and property damage. A concern is that pollutants discharged in one country drift across borders to settle as acid deposition and affect the ecosystems in other countries

Both NO and NO_2 are nonflammable and colorless to brown at room temperature. Nitric oxide (NO) is a sharp sweet-smelling gas at room temperature, whereas nitrogen dioxide (NO_2) has a strong, harsh odor. NO has an OSHA PEL and ACGIH TLV of 25 ppm and an IDLH of 100 ppm. Meanwhile, NO_2 does not have a typical OSHA PEL, but rather a ceiling limit (a concentration that workers should never be exposed for any amount of time – even mere seconds) of 5 ppm. The NO_2 ACGIH TLV is 0.2 ppm, while the NIOSH IDLH is 20 ppm! Another NO_x, is nitrous oxide (N_2O aka “laughing gas”); however this is not a vehicular emissions pollutant (otherwise, it would be typical to see drivers during rush hour stuck in traffic with smiles on their face!).



While EPA’s Tier 2 Program has been in effect for 15 years, in two years, the Tier3 program goes into effect. Tier 3 is designed to further reduce the sulfur content of gasoline while being more restrictive for both tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles, and some heavy-duty vehicles. Will more stringent regulations help to improve the overall health of our environment? And at what cost will see such regulations circumvented?

A wise man can learn more from his enemies than a fool from his friends

(From the movie, “Rush” Niki Lauda)