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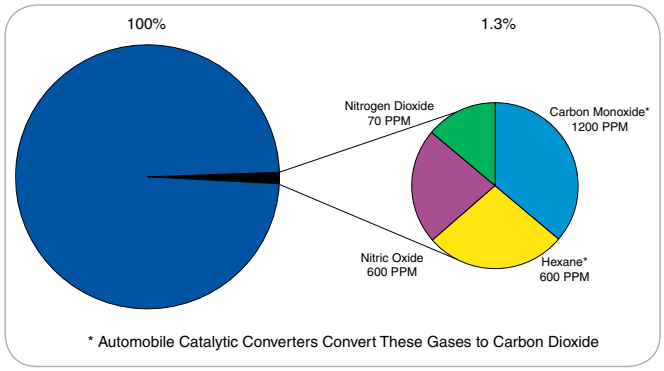
Application Note

Carbon Dioxide (CO_2) and Combustion Sensing

Carbon dioxide is one of the most plentiful by products of the combustion process used by automobiles, trucks and fuel-fired appliances. For properly operated and maintained equipment CO_2 will be produced in quantities 100 times or greater any other combustion byproduct considered harmful, including carbon monoxide, hexane, nitric oxide or nitrogen dioxide. It is also important to note that the catalytic converters used in all vehicles produced in North America will convert almost 100% of carbon monoxide and hexane to CO_2. The figure below shows a breakdown of the byproducts of combustion by volume (in ppm) for a automobile at idle. Note that nitrogen and oxygen are also given off in combustion fumes, but are not considered harmful byproducts.

Because CO_2 is the overwhelming byproduct of combustion, it can be used to indicate the presence of combustion byproducts. For example, the US Bureau of Mines has recommended that carbon dioxide can be used as an index for measuring and controlling diesel pollutants[1].



Also, the 1995 ASHRAE Applications Handbook states: "Control (of combustion fumes) by instrumentation can be simplified by monitoring CO_2 levels, as studies have shown the relationship between various engine pollutants and CO_2."[2] The chart below provides the 8 hour Threshold Limit Value established for the most common combustion byproducts. Assuming the proportion of CO_2 production to other byproduct production are similar to the above breakdown, the chart below shows the level of CO_2 that would have to be reached for the TLV of other contaminants to be achieved.

In actual applications where CO_2 is used to control for combustion byproducts, the CO_2 threshold should be considerably lower than indicated above in order to provide a significant safety margin and to consider the wide range of vehicles that might be operating in a facility such as a parking garage. The US Bureau of Mines has suggested that 1,300 ppm of CO_2 is a good control level for diesel equipment in mines. In parking garages, maximum levels of 700-800 ppm ensure that ventilation systems are responsive to combustion fumes and that the possibility of buildup of other contaminants is negligible.

Gas By-Product	TLV Concentration	CO_2 Level Equivalent
Carbon Dioxide	5,000 ppm	5,000 ppm
Hexane	500 ppm	91,700 ppm
Carbon Monoxide	50 ppm	4,580 ppm
Nitric Oxide	25 ppm	4,580 ppm
Nitrogen Dioxide	5 ppm	7,860 ppm

References

1. H.D. Daniel Jr, "Carbon Dioxide As An Index Of Diesel Pollutants", US Bureau Of Mines, U.S. Department Of The Interior, IC-9324, 1992
2. ASHRAE 1995, ASHRAE Applications Handbook 1995, American Society Of Heating & Refrigeration Engineers, page 12.15, Control by Contaminant Level Monitorings.

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