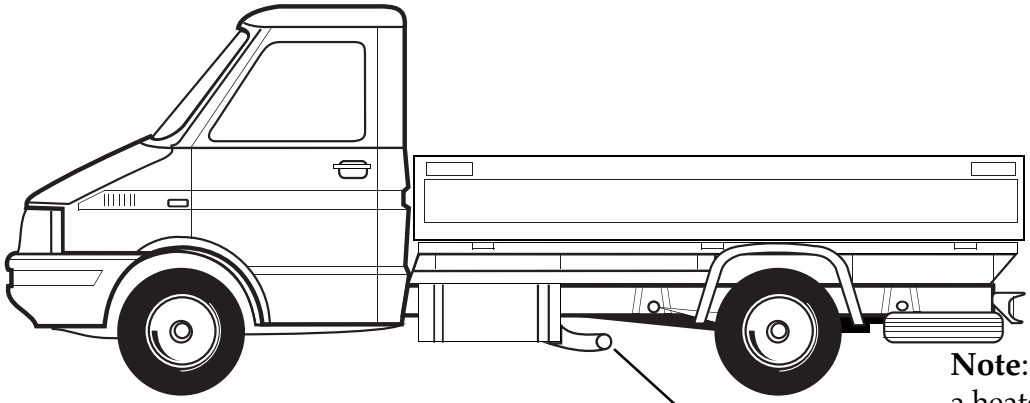
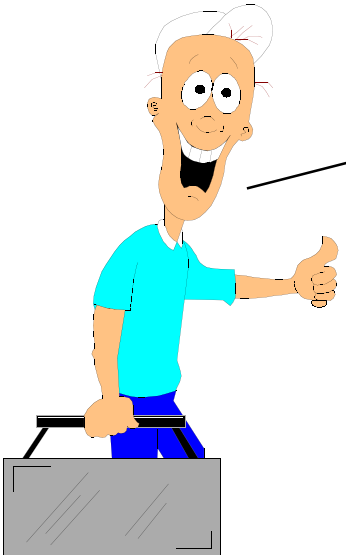
Propane powered **fork lifts** or **gasoline** powered **trucks** & **autos** with or without catalytic converters produce large amounts of **carbon dioxide** (CO_2). Catalytic converters create even more **CO_2** by oxidizing the carbon monoxide (**CO**) and unburnt hydrocarbon fuel.



Exhaust Gases

Note: Flu gas from a heater contains large amounts of CO_2 & smaller amounts of the gases shown below.



Do you **smell carbon monoxide** or is that something else coming out of the exhaust pipe?

Neither **CO** or **CO_2** have any odor.

The **Threshold Limit Value** (**TLV**) is the lower **toxic limit** for human exposure
See ***VALTRONICS*** **Application Note A11**

Typical quantities of **exhaust gas components** for an internal gasoline combustion engine at idle are:
Note: **about 100 times more CO_2 produced than CO**, **Propane powered engines produce very little CO**

CO_2	**11**%	(**110,000** ppm)	**Carbon Dioxide** - **No odor**
CO	0.12%	(1200 ppm)	**Carbon Monoxide** (converted to CO_2 in catalytic converter) - **No odor**
C_6H_{14}	0.08%	(800 ppm)	**Hexane** (hydrocarbon that is converted to CO_2 and H_2O in catalytic converter)
NO	0.06%	(600 ppm)	**Nitric Oxide** - **Extremely Toxic**
NO_2	0.007%	(70 ppm)	**Nitrogen Dioxide** - **Extremely Toxic**

The **Threshold Limit Values** (TLV) for the following gases are:(TLV is the maximum recommended exposure for an 8 hr period)

TLV for **CO_2** = 5000 ppm (0.5%)
TLV for **Hexane** = 500 ppm (Hexane is one of the hydrocarbon components of fuel)
TLV for **CO** = **50 ppm**
TLV for **NO** = 25 ppm Converted to **NO_2** by oxygen in air
TLV for **NO_2** = **5** ppm **Extremely TOXIC** gas - exposure to concentrations of 60 to 150 ppm causes immediate irritation of the nose & throat, coughing, nausea, choking, headache, shortness of breath, and restlessness. Edema may develop within 6 to 24 hours after such exposure. Concentrations of 100 to 150 ppm are dangerous for an exposure of 30 to 60 minutes and concentrations of 200 to 700 ppm may be fatal after a very short exposure.

Carbon dioxide (CO_2) monitoring in parking garages, near loading docks, near propane (C_3H_8) burners, forklifts or for **flu gas leaks**. CO_2 is more effective than **carbon monoxide** (**CO**) monitoring because **CO** is much more difficult to detect[1] at the level required for safety (below **CO**'s 50 ppm TLV). See ***VALTRONICS*** Model **2166 0.2**% (2000 ppm), or **0.5**% or **1.0**% full scale CO_2 monitors for remote sample draw monitoring.

All internal combustion engines consume fuel in proportion to the amount of work done. Over 99% of the carbon in the fuel is emitted as **Carbon Dioxide** (CO_2) in the exhaust. Other components of the exhaust gas include: **Carbon monoxide** (**CO**), unburned hydrocarbons (HC), nitric oxide (NO), and nitrogen dioxide (NO_2). With diesel engines, there can be a substantial amount of particulate matter (smoke) and considerably higher concentrations of NO_2.

Typical quantities of exhaust gas components for an internal combustion engine at idle are:
Note: **about 100 times more CO_2 produced than CO**

CO_2	11% (110,000 ppm)	**Carbon Dioxide**
CO	0.12% (1200 ppm)	**Carbon Monoxide** (converted to CO_2 in catalytic converter)
C_6H_{14}	0.08% (800 ppm)	Hexane (a hydrocarbon that is converted to CO_2 and H_2O in catalytic converter)
NO	0.06% (600 ppm)	Nitric Oxide
NO_2	0.007% (70 ppm)	Nitrogen Dioxide

The **Threshold Limit Values** (TLV) for the following gases are: (TLV is the maximum recommended exposure for an 8 hour period)

TLV for **CO_2**	= **0.5**% (5000 ppm)
TLV for Hexane	= 500 ppm (Hexane is one of the hydrocarbon components of fuel)
TLV for **CO**	= **50 ppm**
TLV for **NO**	= 25 ppm
TLV for **NO_2**	= 5 ppm

Carbon dioxide for all practical purposes is stable in air and its concentration in the atmosphere near an exhaust source depends on the ventilation rate. For underground parking facilities this will require some form of mechanical ventilation system[2]. The 1995 ASHRAE Applications Handbook states, "Control by instrumentation can be simplified by monitoring CO_2 levels, as studies have shown a relationship between the levels of various diesel engine pollutants and CO_2." With a dead end loading dock, natural convection of the fresh outside air may be sufficient but measurements will test and confirm that theory to some degree.

Re-breathing of oxygen-deficient air with high amounts of CO_2 by an engine will result in ever increasing carbon dioxide. Eventually, incomplete combustion of a significant portion of the fuel results in much higher levels of carbon monoxide rather than carbon dioxide. This situation is not likely to occur in a well-ventilated area, but is nevertheless possible.

The use of carbon dioxide detection as a means to insure safe air quality in underground areas has been studied by a number of companies and adopted by the U.S. Bureau of Mines[3].

The rationale behind this method is based on the fact that **diluting the 11 to 12% CO_2 with ventilation of fresh air to a level of less than 0.5% (TLV) will result in the dilution of all the toxic gases by the same ratio**, which brings all the gases below their TLV.

A number of companies have decided to use CO_2 detectors on outside air inlets to buildings that could be exposed to high concentrations of exhaust gases emanating from either a loading dock location or heavy commute traffic.

If you need help understanding this or any other application related opportunity, please call (209)754-0707 & ask for application assistance. We appreciate hearing about any constructive critique or new solutions that you may discover.

1. **CO False Alarms and Public Safety**, Western HVACR News, April 1996
2. Refer to the 1995 **ASHRAE Applications Handbook**, section 12, page 12.15, Control by Contaminant Level Monitoring
3. **NTIS. PB80-207541**

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