

# CARBON DIOXIDE (CO<sub>2</sub>)

Carbon dioxide (CO<sub>2</sub>) is colorless. At low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor. It is slightly toxic and has a threshold limit value of 5,000 ppm. At [standard temperature and pressure](#), the density of carbon dioxide is around 1.98 kg/m<sup>3</sup>, about 1.5 times that of [air](#). At atmospheric pressure and a temperature of -78.51 °C (-109.32 °F), carbon dioxide changes directly from a solid phase to a gaseous phase through [sublimation](#), or from gaseous to solid through [deposition](#). Liquid carbon dioxide forms only at [pressures](#) above 5.1 atm; the [triple point](#) of carbon dioxide is about 518 [kPa](#) at -56.6 °C. The boiling point of the liquid is -70°F to +88°F, depending on pressure. When vaporized at 60°F, the expansion ratio is 535:1. CO<sub>2</sub> exists as a gas or solid below 60 psig.

In liquid form, carbon dioxide weighs 4.9 pounds per gallon. In gaseous form it is slightly heavier than air.

CO<sub>2</sub> is mainly produced as an unrecovered side product of four technologies: combustion of fossil fuels, production of hydrogen by steam reforming, ammonia synthesis, and fermentation. It can be obtained by or from air [distillation](#), however, this method is inefficient.

Acute carbon dioxide physiological effect is [hypercapnia](#) or [asphyxiation](#). Inhalation of CO<sub>2</sub> can be tolerated at three percent inspired concentrations for at least one month and four percent inspired concentrations for over a week. Increased concentrations increase the breathing rate – e.g., 5% CO<sub>2</sub> in air increases breathing rate by 300%. Approximately 12% or more CO<sub>2</sub> in air soon causes unconsciousness.

#### **(D-4) Unloading Instructions for Carbon Dioxide**

##### **Preparation:**

1. Spot your equipment at the customer location in a safe manner and out of the way of customer traffic.
2. Put on your personal protective equipment.
3. Check your bill to ensure you are at the right location and the right tank and that the tank is properly marked and all unloading equipment is correct. If not, do not attempt to unload. Call in for further instructions.
4. Read and record on the trip data sheet both customer and trailer liquid level and pressure gauge readings. Pay particular attention to full marks, pressure instructions, and any other instructions at the customer tank prior to unloading.



**WARNING!** NEVER STAND DIRECTLY IN FRONT OF OPEN LINES OR HOSES while operating this equipment. Open all valves slowly. Never allow a trailer containing CO<sub>2</sub> to de-pressurize below 150 psig as solidifying of the product inside the tanker could occur. Carbon dioxide may exist simultaneously as a gas, liquid, and/or solid when the temperature is – 69.9 degrees Fahrenheit and the pressure is 60.4 psig. This condition of temperature and pressure is known as the **triple point**. At temperatures and pressures above the triple point and below 87.8 degrees Fahrenheit, liquid CO<sub>2</sub> and gaseous carbon dioxide may exist in equilibrium in a closed container.

##### **Cool Down & Purge:**

5. Open and secure pump bucket box doors.
6. Open pump inlet valve slowly.
7. Start pump engine and allow to warm up at idle.
8. Remove dust caps from both trailer and storage tank liquid and vapor line connections. Clean and inspect for damage. If fittings are unsafe, do not unload.
9. Pull one end of the vapor hose from the hose tube, remove dust plug and connect to the trailer vapor line. Attach safety cable.
10. Pull the remaining portion of the vapor hose from the hose tube, remove the dust plug and connect to the storage tank vapor line. Attach safety cable.
11. Slowly open the trailer vapor valve.
12. Slowly open the storage tank bleed valve. Purge hose for a minimum of thirty seconds (30) seconds. Close storage tank bleed valve and slowly open storage tank vapor valve. This will allow the pressure between the trailer and storage tank to equalize.
13. Pull one end of the liquid hose from the hose tube, remove dust plug and connect to trailer liquid line. Attach safety cable.
14. Pull the remaining portion of the liquid hose from the hose tube, remove dust plug and connect to the storage tank liquid line. Attach safety cable.

##### **Prime & Unload:**

15. Slowly open trailer liquid discharge valve.
16. Slowly open storage tank liquid bleed valve. When a steady flow of liquid is observed coming from the bleed valve, close the bleed valve and slowly open the storage tank liquid valve. This will have purged the liquid unloading hose and drawn liquid through the system to properly cool down pump and lines.
17. Engage clutch on pump engine, pull throttle open to increase engine rpm's.

### **Monitoring:**

18. Both the trailer and storage tank pressures should remain equal during the unload process.
19. Periodically monitor both the trailer liquid level gauge and storage tank liquid level gauge to ensure transfer of product is taking place.
20. When the storage tank liquid level gauge indicates the tank is almost full, open the storage tank vapor line bleed valve. When liquid comes out of the bleed valve, the tank is full. If the trailer empties out first, the pump will change to a higher pitch. Open the trailer liquid line bleed valve to see if liquid is still being pumped. If not, proceed with the shut down procedure.

### **Shut Down Procedure:**

21. Release unload engine throttle and disengage clutch.
22. Close pump inlet valve.
23. Close trailer liquid and vapor valves.
24. Close storage tank liquid and vapor valves.
25. Open both trailer and storage tank liquid bleed valves slowly to blow out pressure in hose.
26. Open both trailer and storage tank vapor bleed valves slowly to blow out pressure in hose.
27. Disconnect liquid hose from storage tank, replace dust plug and place this end into hose tube.
28. Disconnect other end of liquid hose from trailer, replace dust plug and finish putting into hose tube.
29. Disconnect vapor hose from storage tank, replace dust plug, and place this end into hose tube.
30. Disconnect other end of vapor hose from trailer, replace dust plug and finish putting into hose tube.
31. Close remaining valves on trailer and storage tank. Replace all dust caps.
32. Shut off unload engine.
33. Record tank readings, complete paperwork, obtain delivery signatures and leave customer paperwork in designated place.
34. Before leaving, make sure all storage tank valves are closed, dust caps/plugs replaced and return any thing you moved, unlocked, etc., to its original position when you first arrived. Walk around units to ensure everything is disconnected and secure.

Note: Contractors must remain at the rear of the trailer during the unload process to monitor gauges and valves. Do not leave the area or sit in the cab of the tractor until the unload process is complete.

### **Reminders:**

- A. When positioning your unit to unload, try to avoid sharp angles for transfer hose connections. The straighter the better.
- B. Remember all valves and hoses are under pressure. Open all valves slowly.
- C. When removing dust caps/plugs, never stand in front of the fittings. Always stand to the side to avoid being struck by flying debris that may come out of the line under pressure.
- D. When disconnecting hoses, always stand to the inside of the loop. That way, if the hose was not completely relieved of pressure and pops off the fitting, the hose will jump away from your body.
- E. Before disconnecting hoses, shake the hose at the connection. If all pressure is relieved, the hose should be loose. If not, re-pressurize the hose, close valve and bleed down again.
- F. Before leaving, federal highway regulations prohibit product being transported in external piping. Be sure to bleed out all external piping.