

Transportation with Dry Ice

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States of matter:

Solid: water, that is stored below a temperature of 0°C turns into its solid phase: ice.

Liquid: water, coming out of a tap is in liquid phase (temperatures between 0 and 100°C).

Gas: water being boiled above temperatures of 100°C will let off water in gas form: steam.

Dry ice in general

What is dry ice? In physics, the term “state of matter” refers to the different forms that a certain material can be in: solid, liquid and gas (more exist, but won't be viewed in this case). The best example is the different states of water (listed on the left).

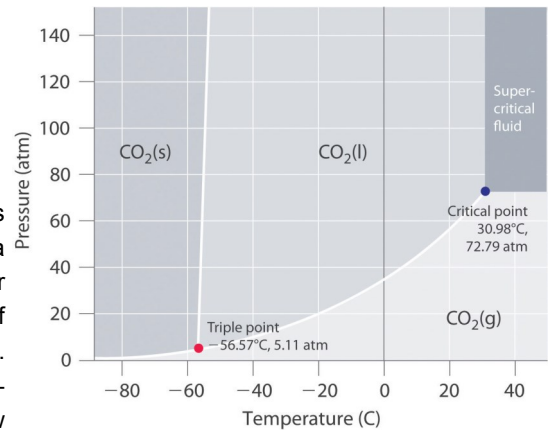
In all of the above mentioned matters, the pressure also has an important role to play, thus the temperature values given here are only valid at a pressure of 1013.25 hPa (1atm)

A point exists, where at a certain temperature and pressure, all 3 states coexist. For water

this point is 0.01°C and a partial vapour pressure of 0.006 atm. The phenomenon is known as the triple point of water.

Dry ice, is a CO₂ in its solid phase. Carbon Dioxide turns into dry ice at -78.5°C (at 1 atm). The triple point of CO₂ is -56.60°C and 5.11 atm.

When a matter changes from solid to liquid or liquid to gas, it is called sublimation. When the matter changes from gas to liquid or liquid to solid it is



Triple point of CO₂

called deposition: this is known as phase transitions. During the sublimation transition, dry ice melts and is directly vaporised into its gas phase. The liquid phase is only achievable when the temperature and pressure allow it, please see the triple point of CO₂ diagram.

Why the need to use dry ice during transportation?

Dry ice is often used as a coolant due to the fact that it is colder than water ice and, that CO₂ has no liquid phase in standard atmospheric conditions. When dry ice melts, there is only an increase of CO₂ levels but no other residues.

Today, dry ice is used widely in the transportation business for both frozen and non frozen goods. If the product is directly in contact with the dry ice, it

will freeze. Depending on the insulation used, the temperature of the product can vary.

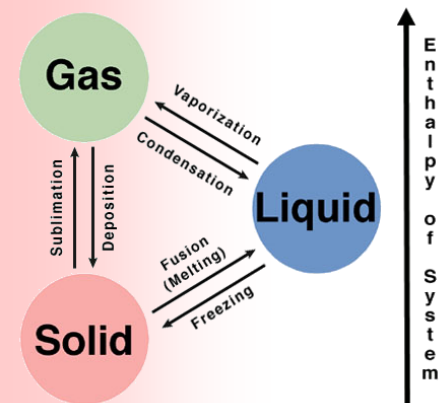
The main advantage of dry ice is that it has twice the cooling energy of water ice and that dry ice will sublimate at a rate of 1% of its total mass per hour in an insulated container (14% at room temperature).

Precautions need to be taken when handling dry ice: the use of cryogenic gloves for example! As dry ice sublimates into gas, it is important not to pack it in a gas tight container otherwise an explosion could occur.

1kg of dry ice will produce 0.45m³ of CO₂ gas. Therefore it is very important to monitor the rooms where the packages are stored or loaded/unloaded.

As CO₂ is a odourless and colourless gas, it is very important for life safety to always monitor the CO₂ level when using dry ice. CO₂ is capable of causing asphyxiation at high concentrations!

In the workplace exposure limitations exist: short term, 15 minutes, 15'000 ppm and long term (8 hours) 5'000 ppm.



Phase transition diagram

What solutions can Rotronic offer?

Rotronic offers a range of products for CO₂ monitoring, from a handheld to a transmitter via a data logger (all equipped with alarms).

With the NDIR measurement

principle, Rotronic offers a very accurate way of measuring the CO₂ levels in the atmosphere.

A range of both Indoor Air Quality and Life Safety prod-

ucts are available, so choosing the correct device for the STEL (Short Term Exposure Limit) or the LTEL (Long Term Exposure Limit) is made easier.



CF8 transmitter

350 - 450 ppm	400 - 1,200 ppm	> 1,000 ppm	5,000 ppm (0.5%vol)	38,000 ppm (3.8%vol)	> 100,000 ppm (10%vol)
Fresh air outdoors	Room air	Fatigue and loss of concentration become apparent	Maximum permissible value at the workplace during an 8-hour workday	Breathing air (direct exhalation)	Nausea, vomiting, loss of consciousness and death

Rotronic products:

Handhelds:

- **CP11**
0...5'000 ppm,
0...50°C,
0...95%rh (non condensing),
±30 ppm, ±2.5%rh and ±0.3K...

Dataloggers:

- **CL11**
0...5'000 ppm,
0...50°C,
0...95%rh (non condensing),
±30 ppm, ±2.5%rh and ±0.3K,
40'000 data point memory,
Min, Max and average values...

Transmitters:

- **CF3 series**
0...2000 or 0...5000 ppm
Display,
Audible and light alarms
Wall and duct mount
- **CF8 series**
0...2'000, 0...5'000, 0...30'000,
0...40'000 ppm
Relay,
Display,
Wall and duct mount
Temperature measurement

Display:

- **CO2-Display**
0...5'000 ppm,
CO₂ level,
0...50°C,
0...95%rh (non condensing),
±30 ppm, ±2.5%rh and ±0.3K,
Time, date...



CL11 Handheld

Customer benefits:

Accuracy:

Choosing Rotronic gives you the best accuracy on the market.

The precise CO₂ measurement comes from the NDIR measurement principle, where the light is carried over a path of 15cm for IAQ (Indoor Air Quality) applications for a more accurate measurement. For life safety

measurements, the path is 4cm.

Multipurpose:

Most instruments also offer the possibility to measure CO₂ along with other parameters such as relative humidity and temperature. This offers a general overview of the atmosphere where the measurements take place.

A complete portfolio:

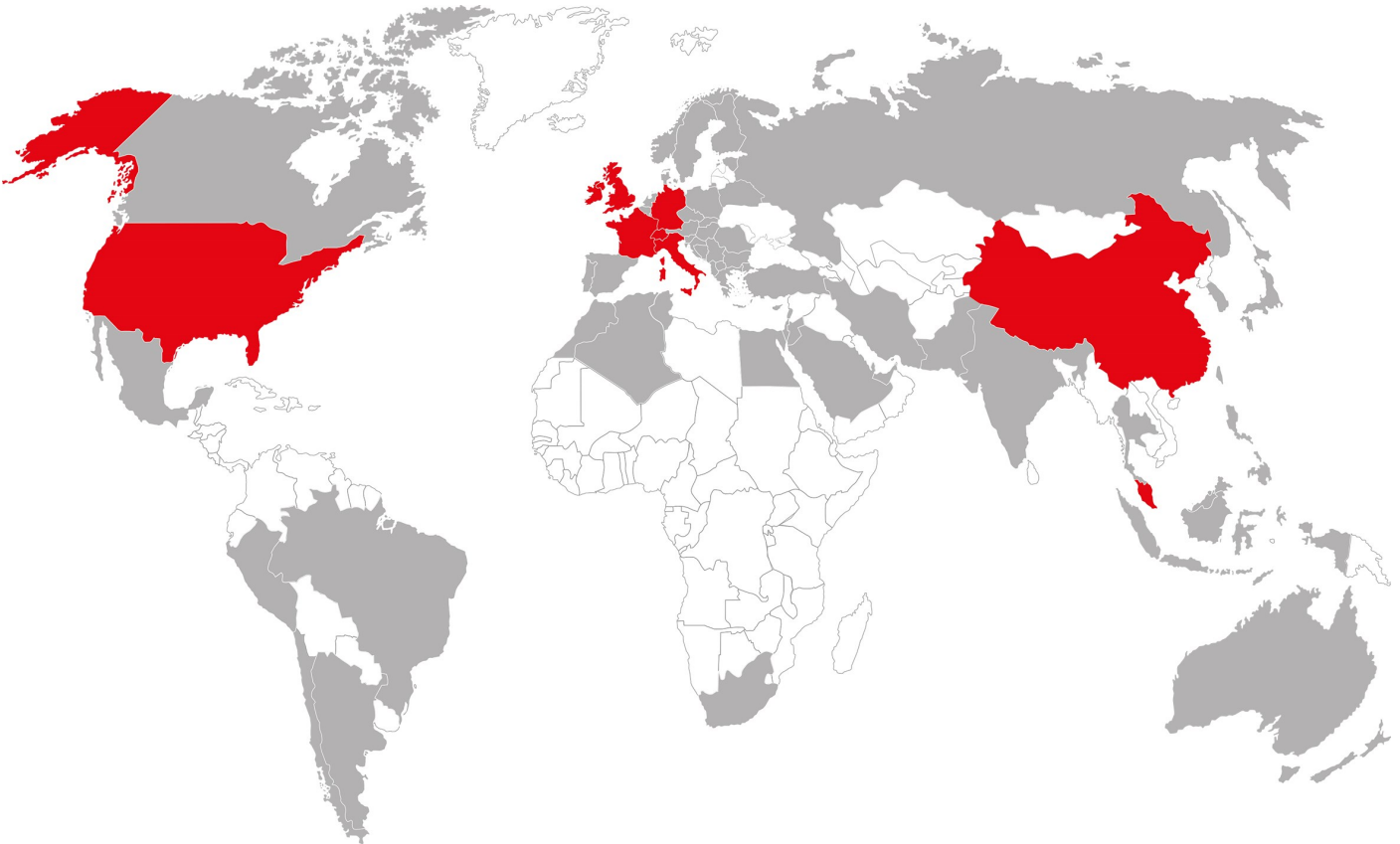
No matter what the application is, Rotronic has a product that will suit your application! The CO₂ setup is based on customer feedback, so if you think that Rotronic can help you, please don't hesitate to contact us for your OEM applications.



CO2-Display

Contact us:

Rotronic is represented in more than 40 countries around the world. An up to date list of all our partners is available at www.rotronic.com/international



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