TOOL BOX 069- Complacency and Pressure

How many of registered 1475 technicians and Gas suppression technicians check all the markings on a high pressure cylinder while servicing hand portable and fixed installations.

While attending the 2019 SAQCC Roadshow about Fire Cylinder Evaluation concerning BS5045, and the unfortunate incident of these units reaching the market place. (How it happened is negligible as I am not covering the root cause of the incident)

Before I presented the subject. It made think on my own complacency concerning the cylinder markings. One never thinks that a cylinder carrying the SANS1567 mark could be non-compliant

What does the normal technician look at when inspecting the markings?

a. Markings in correct place
b. Last pressure test manufacturer or approved test station
c. Tare weight for tolerance calculations
d. WC water capacity if you want to calculate liquid gas capacity

Very rarely do they check all markings correspond to the requirements, and complacency sets totally in when you see BS and the number 5045 – One never thinks the prefix number is so important.

The results from this incident, and the testing of one of these cylinders is extremely disturbing

Fail: Tensile test, bend test, and hardness test = very hard brittle material. So it can hardly expand or contract (temperature changes). Cannot take the stress from inside the cylinder where the molecule of gas vapour is trying to escape to atmosphere. This cylinder has no elasticity.

So this cylinder is a bomb waiting for the right moment or slight knock to explode

A. When using (exhausting the gas) temperature drop to +/-78 Degree Celsius (white snowy stuff, and frosting on outside of cylinder). Cylinder Contracting
B. When recharging, again very cold. Cylinder first expands little until the liquid gas enters. The contracts as it gets colder.
C. The hotter it gets the more it expands.

These particular units should have all been removed from service by now. But I doubt that has actually happened. So you technicians be warned if something drastic happens from your last service 2018 to your next service. You could be held responsible for the incident if a cylinder is not compliant.

This article is going to concentrate on CO2 gas mainly. But it is good to compare the gases used mainly in SANS1475 – The expellant for extinguishers that allowed and normally used is Argon, Helium, and Nitrogen. All these gases are Noble Gases – “Lazy” “The in active one” , and are definitely not temperature sensitive (Reason why Nitrogen is used in high performance racing car tyres)

Working With CO2 Carbon Dioxide

CO2 Gas is very volatile and dislikes changes in temperature

Working safely with carbon dioxide means understanding the characteristics of this gas and taking suitable safety precautions
The physical states of carbon dioxide, which depend on pressure and temperature, deserve

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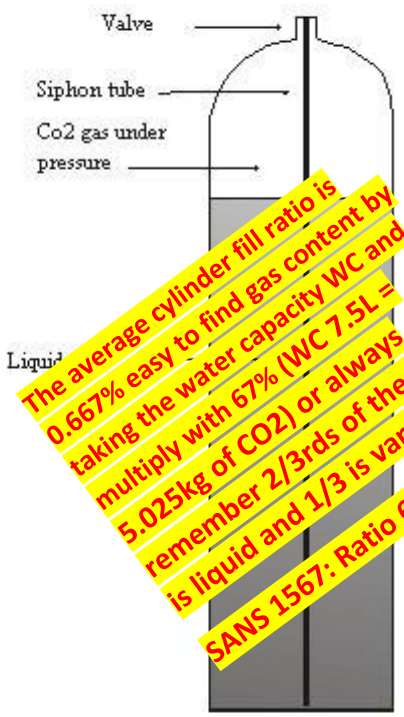


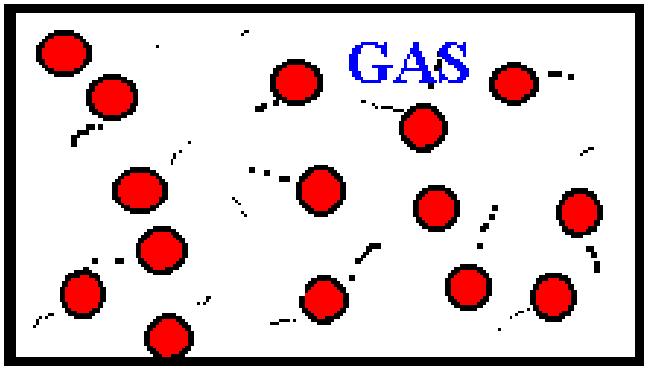
SANS 1567: Ratio 68% +/_2%

particular attention: Dry ice consists of compressed CO_2 snow that has been produced by depressurising, and the temperature is –79°C. Depending on how much it is compressed, 1 kg of dry ice produce 300 – 400 litres of CO_2 gas. A considerable pressure build-up can therefore occur if dry ice evaporates in a gas-tight vessel.

Filling Ratio

If the filling factor is exceeded, the pressure inside the cylinder increases substantially with even a slight rise in temperature. An overfilled CO_2 cylinder can burst if it is merely exposed to sunlight.

Note: The filling factor can be as high as 75% depending on the standard manufactured by and manufacturers recommended filling ratio.



Gases are composed of minute discrete particles (usually molecules).

- A mole can be defined as "the molecular mass, atomic mass and formula mass of a substance expressed in grams
- Carbon dioxide contain one carbon and two oxygen atoms and
- Mass of one Carbon mole = 12 g
- Mass of one Oxygen mole = 16 g
- Mass of two Oxygen mole = 2 x 16 = 32 g
- 12 + 32 = 44

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1. The particles are in continuous chaotic motion moving in straight lines between very frequent collisions with each other and the sides of the container.
2. The bombardment of the container walls by the particles causes the phenomenon we call pressure (i.e. force of impacts/unit area). The greater
3. The force of collision and the more frequent the collisions the greater the gas pressure exerted on the container surface.
4. The collisions are perfectly elastic i.e. no energy loss on collision due to friction.
5. At relatively low pressures the average distance between particles is large compared to the diameter of the particles and therefore the inter–molecular forces between the particles is negligible.
6. The average kinetic energy of the particles is directly proportional to their absolute temperature on the Kelvin scale.
    - This means if you heat up a gas the average kinetic energy of the particles increases, therefore the average speed increases too.

Pressure

The pressure in a CO_2 cylinder depends solely on temperature. At 20°C, for example, it is 5776kpa Even an almost empty CO_2 cylinder remains at 5776kpa at 20°C, as long as it contains the liquid phase. This means that the contents of a CO_2 cylinder cannot be determined by measuring its pressure, but only by weighing.

Compatibility

Carbon dioxide dissolves in water to produce carbonic acid, which reacts as a weak acid and has a corrosive effect on carbon steel and a few non-ferrous metals.

Temperature C	Pressure KPA	Remarks
-78.5	ZERO	Snowy particles and Frosting on Cylinder
-50	683	
-40	1006	
-30	1429	
-5.56	2999	
-0.56	3526	
+5	3953	
+9.44	4420	
+10.56	4544	
+15	5063	
+19.44	5628	
+20.57	5776	
+25	6401	

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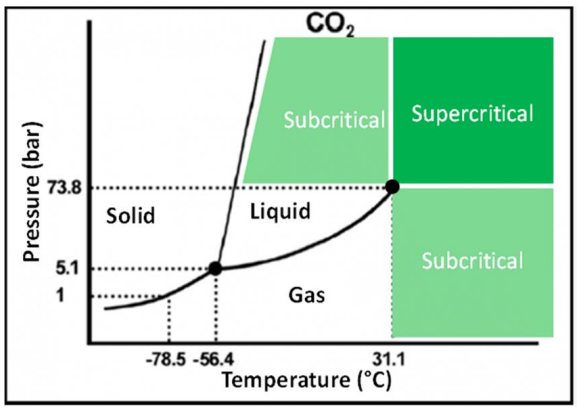
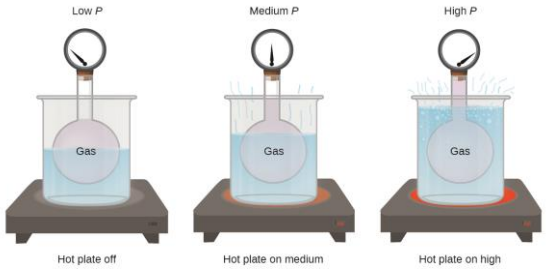
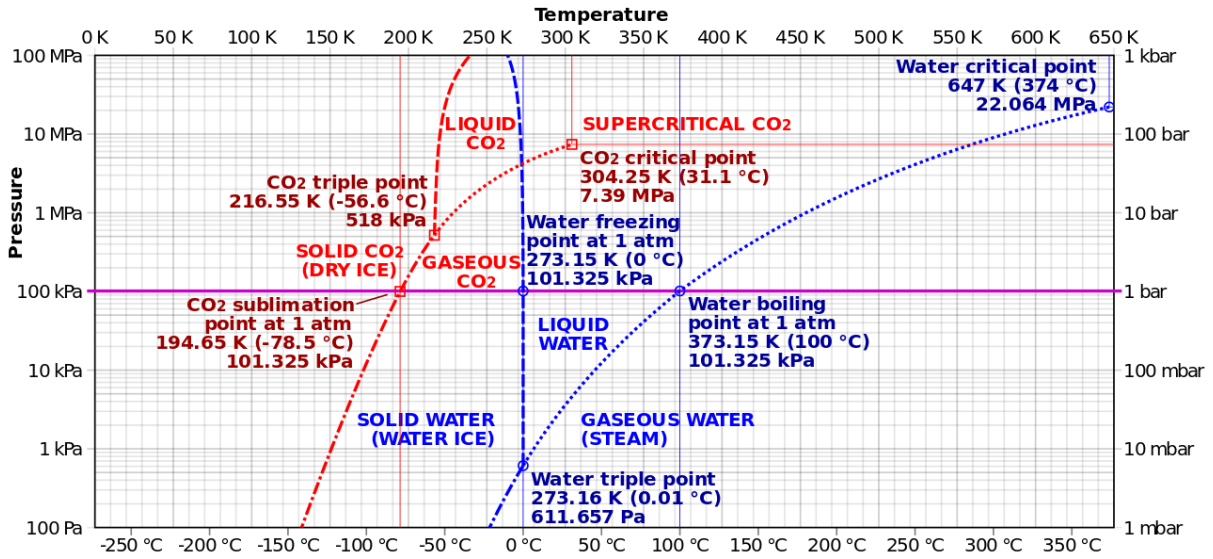




+30	7164	
+31	7391	Vapour stage totally critical
+65		The Extinguisher Developed Pressure SANS1567 up to as much as 20000kpa (20MPa). Not exceeding
Safety Valve / Rupture disk +/- 19000kpa		



Carbon Dioxide is not an **ideal gas** because it has attractive and repulsive forces between particles, **gas** particles have a volume, and the collisions are not elastic. ... Real **gases deviate from ideal behavior** at high pressures and low temperatures

Supercritical CO2

What's happening once **Supercritical** is reached, and the temperature is still rising?

1. The Molecules are speeding up and continually crashing into each other and the walls of the cylinder trying to escape.
2. These collisions are happening at a high speed and the molecules are trying to cluster together, and turn back into a liquid.
3. Obviously this will not happen, and there for the pressure will build up until the material containing the pressure ruptures.
4. The question is "What is going to give first"?
   Look at SANS1567 – Develop pressure not more than 20000Kpa at 65*C
   Manufacturers test pressure at least 1, 25 times Developed pressure (25000kpa)
   Rupture Disc (bursting) – 80% to 100% of test pressure
5. The question is "What is going to give first if the temperature climbs very fast"?
   Rupture Disc or Cylinder?

Super Heated Water

You can get superheated water and it doesn't bubble at all. This superheated water will bubble up out of the cup when it is moved or when something like a spoon or tea bag is put into it.

When Microwaved water heats faster than the vapour bubbles can form. If the container is very new or very smooth (no Defects or scratches) there is no place for the bubbles to form. As the bubbles cannot form and release some of the heat has built up, the liquid does not boil, and the liquid continues to heat up well past its boiling point.

Simple way to stop Superheating is place something in the vessel to defuse the super heating process such as a wooden spoon.

Another Example of Molecular release is your carbonated drinks such as Coke, Cream Soda etc. when you pour them into a glass. The bubble that form on the side of the glass is attached to faults, small deformities, and scratches in the glass (cannot be seen visually, or even identified by touch). The remainder of the bubbles are escaping to atmosphere, and eventually the bubble on the glass will pop releasing its energy.

What the Bottom Line:
The particular cylinder that was tested has no elasticity, and there for cannot accept expansion or contraction at all – Even a knock could cause it to explode. The safety valve will not even come into play. I am sure that there is still plenty out in the field.

What should a technician keep in mind when servicing CO2 extinguishers?
"If there is an incident – You can be traced via your Service Label"

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Do not be Complacent: *Complacency definition*, a feeling of quiet pleasure or security, often while unaware of some potential danger, defect, or the like; self-satisfaction or smug .

Presented By:	**Date**	**Signature**
Name:_____	**_____**	**_____**

NAME	**SIGNATURE**	**NAME**	**SIGNATURE**