



## Empty Cylinder, Ngai Rule of Thumb for ER

Just because no gas vents from the cylinder when the valve is opened doesn't mean it is empty. A cylinder is never empty until it is physically cleaned of its contents. Even at 0 psig the cylinder will always contain 1 atm of the gas. There must be a positive indication that the valve is open and not plugged. The simple test to do this is to pressurize the valve outlet with an inert gas or air to see if it goes in and then vents out. Even if it does, the cylinder could still contain 1 atmosphere of the gas.

Many incidents have occurred because this has not been followed.

Even cylinders after their valves have been removed have proven to be a hazard. In a rare case the cylinder had been exposed to the environment for a long period of time. Air diffusion into the cylinder can be limited and the gas will remain in the cylinder.

For example:

1. In 1960 in France a hydrogen cylinder had the valve removed and was open to the atmosphere for a week. An operator lowered a light into the cylinder to inspect the interior. The bulb broke against the side and a fire came out of the cylinder top, singeing the operators face.
2. On September 7, 2004, an experienced cylinder hydrotest operator had verified that pressure had been removed from a steel oxygen cylinder prior to removing its valve. He utilized a devalving machine with a Lexan protective shield to safely remove the valve. He, then numbered the valve and cylinder so that the valve could be rematched to the cylinder after hydrotest. When he turned back to the cylinder to use a wire brush on a drill to remove the Teflon thread tape and paste, an explosion occurred burning him.
3. In 2013 a junk yard employee used a cutting wheel to cut a "empty" oxygen cylinder valve that was open. There was an immediate explosion injuring him.
4. In 2021, CNG cylinders that were left outside for over 10 years with the valve open still had a LEL gas reading of 40% when purged.

To effectively purge a cylinder in the field and render it safe, it must be:

1. Pressurized with inert gas and the vented (Huff and Puff)
2. Flow through purge if there are two valves (inert gas one end and vent from the other)
3. Evacuated and pressurized with inert gas and then vented

The effectiveness level of the methods is ranked from 1 to 3.

For ER the easiest option is Huff and Puff. For a toxic, flammable or corrosive gases, the Ngai HazMat Rule of Thumb is to do it 3 times at 100 psig purge gas and vent to 0 psig. Assuming ideal mixing, this will reduce a pure gas concentration in the cylinder to 2000 ppm. For highly toxic gases it is 5 times to reduce it to 30 ppm. These concentrations will make the cylinder no longer hazardous for transportation classification.

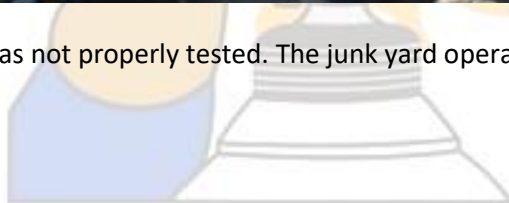


Evacuation with a mechanical vacuum pump and purging is much more effective. One cycle is as effective as 5 Huff and Puffs.

After they are “empty” and they are to be scrapped, cylinders must be physically rendered useless by drilling a hole in their side or cutting them open to prevent others from filling and using them. Stamp out cylinder number and DOT specifications as well. Some gas suppliers will stamp “sold” onto cylinder shoulder.



Chlorine ton cylinder that was not properly tested. The junk yard operator attempted to crush it. The release killed him.



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