The Denton Flyer

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Next Meeting:

The next meeting of your EAA Chapter 661 is going to happen as scheduled this Saturday, 1 July at 1200 CDT at our usual meeting place at US Aviation, 4850 Spartan Drive, on the field at KDTO, on the second floor in Classroom Bravo. Please note that the Aviation Tacos and Beverage Service (ATBS) has been suspended for the summer. Expect the ATBS to make a triumphant return in September.

This meeting will be a lively discussion of the arrival procedures for AirVenture at KOSH. Our guest speaker will be Brian Kelly. Brian will talk about the arrival process from the controller's perspective.

Brian was commissioned a second lieutenant through Air Force ROTC. After completing Undergraduate Navigator Training, he served as a navigator aboard the HC-130P, the search and rescue variant of the C-130 Hercules, or "the Herk." In the aftermath of Hurricane Katrina, Brian was a member of the crew who flew the first active-duty mission to extend the flying time of Air Force rescue helicopters via aerial refueling. He coordinated Temporary Flight Restrictions (TFRs) that ensured the integrity of the airspace above the disaster area. For this, he was awarded the Air Force Achievement Medal. With this experience, he was key in planning the response to Hurricane Rita, which struck the already devastated Gulf Coast only one month later. While in the Air Force, Brian was deployed twice in support of Operation Enduring Freedom.

Brian continues to be actively involved in aviation and flight safety in several capacities. He is a private pilot and a member of the Love Field Pilots Association. He works as an air traffic controller, joining the FAA in 2008. Notably, he was selected to serve as a controller at EAA AirVenture in Oshkosh in 2014. Brian has worked ATC at every AirVenture since then, becoming ATC team lead in 2018.

Brian says his most important roles are in service with his church and as a devoted husband and father.

Poker Run:

After Brian's talk, we will be completing the final phase of the **Poker Run.** If you have purchased one or more hands, bring your incriminating selfies from the designated locations. We will deal the hands and determine the winners. There will be prizes awarded for the best hands. See the flyer below. Recall the designated locations are as follows: ACT, ADM, GPM, MWL, and SLR.

If you have not been to all the locations, you still have a few days to get those selfies. If you don't get to all of the airports before the meeting, please plan to participate anyway. Many a poker hand has been won with only three cards. Fly safe.

If you have not registered, time is running out! Point your phone at the magic square on the attached flyer and follow the instructions.

Supplemental Oxygen:

By Russell Erb

Editor's note: This is the third and final installment of a three-part treatise on supplemental oxygen and why you may want to use it at lower altitudes than required by regulation. It is reprinted here from The Trailing Edge with the author's permission. For more, go to "The Trailing Edge" (http://erbman.org/trailingedge).

Filling the Oxygen Bottle

Filling your oxygen bottle would seem to be a simple process: go to the FBO, they fill it (assuming they even offer this service), and you hand them a wad of cash. Done.

Yes, that works, but it doesn't have to be like that. The first thing you may notice is that the price for an oxygen fill is a flat rate, regardless of the size of your bottle. That is because the actual cost of the oxygen that goes in your bottle is mere pennies. The high price you are paying is essentially the hourly wage of the person who filled your bottle, since he or she can't be doing any other billable activity while filling your bottle. Add in a little bit for the insurance premiums for pumping high pressure gas into a cylinder that the FBO has no idea of its integrity.

There is no "certification" requirement to refill oxygen bottles, so if you are willing to spend money, you can do it yourself. Typically, your small bottle that goes in the airplane is filled from a large bottle that stays in your shop. Of course, filling your small bottle will remove oxygen from the large bottle, causing its pressure to drop. The two bottles will stabilize at some pressure below where the large bottle started. Keep doing this, and the pressure that you can fill your small bottle to decreases with each fill.

One way to stave off this loss of pressure is to use a series (or cascade) of large bottles to fill the small bottle. The large bottle with the lowest pressure is used first to do the grunt work of getting most of the oxygen into the small bottle. Then a large bottle with higher pressure is used to add a little more oxygen to raise the pressure further. A third large bottle can be used to further raise the pressure. This uses very little oxygen from the third bottle. More bottles could be used, but the benefit drops off rapidly after the third bottle.

When the third bottle gets to an unacceptably low final pressure, the first bottle is swapped out for a new, full large bottle which takes the place of the third bottle. The previous second bottle becomes the first bottle, and the previous third bottle becomes the second bottle.

So how well does that work? Let's do some recreational maths to find out. Starting with the Perfect Gas Law (Equation of State).

$$P = \rho RT$$

Let's break the density apart into mass and volume.

$$P = \frac{mRT}{V}$$

When we connect two bottles together, then the total mass of the gas must fill the total volume of the two bottles. Using a subscript "1" for the first large bottle and a subscript "T" for the target bottle, the equation becomes

$$P = \frac{(m_1 + m_T)RT}{(V_1 + V_T)}$$

ASSUMPTION ALERT: This very simplified equation has several assumptions that we should be aware of. Even with these assumptions, it still gives a good indication of how the pressures will drop.

1. The equation assumes all of the gas in both bottles is at the same temperature. As the gas moves into the low pressure bottle it will be compressed, which will raise its temperature (just like that bicycle pump you dropped because it got hot). This temperature rise requires energy. This is known as pressure-volume

work (Pv work) in the trade. The faster the compression, the more energy is lost to heat from the rising temperature. In practice, the target bottle is typically submerged in water to absorb this heat. For purposes of this discussion, we will assume that the transfer of gases happens very slowly so there is no significant Pv work and hence no rise in temperature.

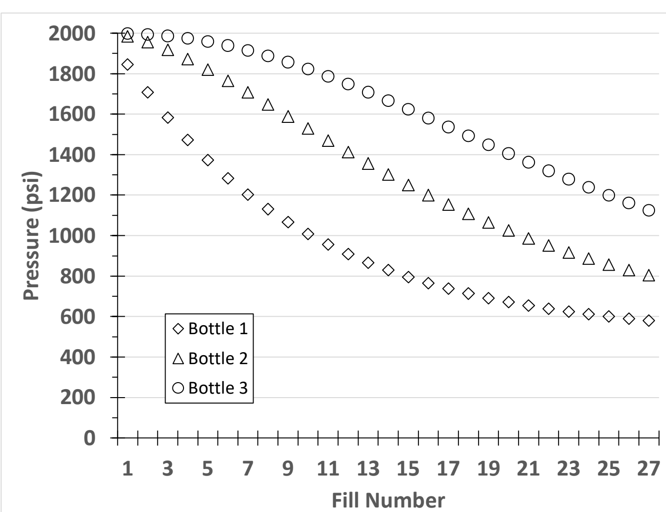
2. The gas constant to be used is not the familiar gas constant for air, but rather the gas constant for pure oxygen.

$$R_{O_2} = 2797.2\ \frac{ft^2}{sec^2\,K}$$

Now let us assume we have three source bottles, each at 2000 psi pressure and a labeled volume of 200 cubic feet. That means that the gas inside the cylinder would have a volume of 200 cubic feet at standard temperature and pressure (STP), which would be 59° F and 14.7 psi (Sea Level Standard). Doing some maths, we find the actual volume of each of these three bottles is 1.47 cubic feet.

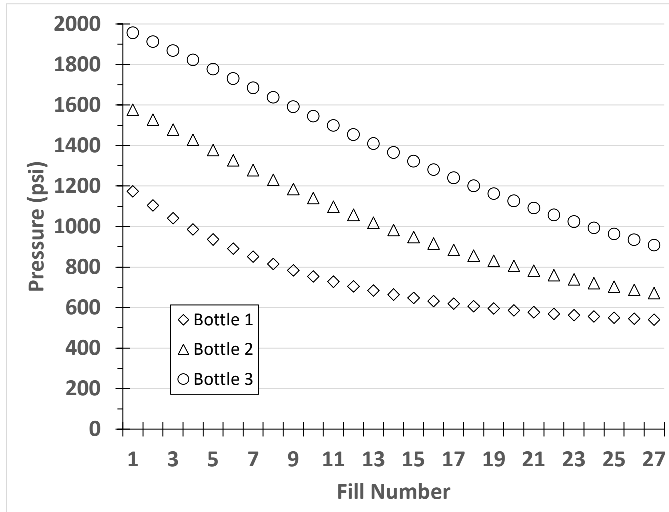
The target bottle has an advertised volume of 648 liters at 2000 psi pressure. This calculates to an actual volume of 0.168 cubic feet. The target bottle will be assumed to be at 500 psi at the beginning of each fill cycle.

We will do the analysis at a temperature of 59°F, although strangely the temperature doesn't affect the final pressure, just how much oxygen is in the cylinder at that pressure.



Cascade Pressure of Each Bottle. Target Bottle Pressure Equals Bottle 3

With this setup, we can accomplish 15 fills with the final pressure only getting down to 1623 psi. At this point, Bottle 1 is getting close to the starting pressure of the target bottle, and therefore not contributing much to the fill. If we then swapped out Bottle 1 for a new bottle at 2000 psi and moved it into the third position, then the graph would look like this:



Cascade Pressure of Each Bottle After Renewing Bottle 1 as Bottle 3

Now we can get eight fills before the target pressure falls below 1600 psi. Compare this to using only one bottle (see previous chart) where we would only get three fills with the pressure already slightly below 1600 psi.

Where Does the Oxygen Come From?

From the atmosphere, of course! The real question is how is it separated from all of the nitrogen, argon, and other stuff. The answer is surprisingly similar to the way gasoline or kerosene is separated from crude oil—by taking advantage of differing boiling points.

Per Reference 8, air is filtered, and then alternately compressed (which raises the temperature) and then cooled. This is done several times, until the air is at about 2000 psi and 70°F. High pressure air cannot hold as much water vapor as low pressure air, so water is drained out at each step as it condenses out, resulting in almost perfectly dried air. Then the pressurized air is cooled to -275°F and the pressure is dropped to about 90 psi. At this point, oxygen and nitrogen are liquid and everything else is frozen and filtered out. By playing with the temperatures, the oxygen vapor is boiled off. The oxygen vapor, still at about 90 psi, is re-cooled, liquified, and stored in double-walled containers. (Atmospheric air is about one per cent argon, so during this process the argon is separated out to be used for inert gas welding and other processes.)

To get the oxygen to the state that it comes to us, the liquid oxygen is boiled off and the gaseous oxygen is compressed to 2000 psi to go into the bottles you pick up at the distributor.

The Aviator's Breathing Oxygen (ABO) myth:

According to the FAA (Ref 7), "Aviator's oxygen must meet certain standards to ensure that it is safe to be taken to altitude. Only aviator's grade breathing oxygen meets this specification. Neither medical grade nor industrial grade oxygen is safe to substitute because they do not meet the same stringent standards as ABO." Strangely, this statement is not supported by any extant regulation. It lives on because it is "common knowledge" passed by oral tradition from pilot to pilot. Reference 8 tells that oxygen type is not mentioned in any regulation, only in Advisory Circulars (non-regulatory). Even those Advisory Circulars say the Aviators Breathing Oxygen or equivalent must be used. Reference 8 goes on to say "Some really heavy-duty experts have scoured government documents, and queried many government agencies, trying to find out just what the heck 'equivalent' means in this context. Its meaning appears to be nowhere specified, which leaves it up to the user." If anyone ever starts claiming it is against the regulations to use oxygen sold under different names, ask them to show you the regulation they are referring to. Nobody has found it yet.

Oxygen is typically sold (at differing prices) as Aviator's Breathing Oxygen, Medical Oxygen, or Industrial (or Welder's) Oxygen. Remember that part about boiling off the LOX and compressing the resulting oxygen gas? This differentiation comes about because long ago Aviator's Breathing Oxygen and Medical Oxygen were compressed with water-sealed compressors to reduce the impurities added, while Welder's Oxygen may have been compressed by machinery using oil for lubrication.

However, modern industrial processes demand pure gases, so the old ways of compressing died out. Now all oxygen is compressed in compressors using dry lubricants, leading to the same standards of purity and cleanliness for all oxygen. All three types come from the same source. The only difference is the label they put on it.

Medical oxygen is just as dry as the other types. The humidity is added by bubbling the gas through water after it comes out of the bottle and just before it gets to the patient. Any moisture in the bottle would threaten to freeze as the pressure drops and block the flow path.

Have you seen all of the oxygen equipment that says "Use No Oil"? Oil in the presence of high-pressure oxygen tends to explode, so why would anyone let oil get into the bottle?

What does this mean? If you are setting up your own oxygen fill station, it doesn't matter how the oxygen is labeled on the bottle, because it is all the same stuff.

References

1. "Time of Useful Consciousness, Wikipedia" https://en.wikipedia.org/wiki/Time_of_useful_consciousness
2. "Physiological hazards of flight at high altitude" https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(03)15059-3/fulltext
3. Discussions with Lt Col Matt "Spider" Taranto, USAF Test Pilot School Staff Aerospace Physiologist
4. "Partial Pressure" https://en.wikipedia.org/wiki/Partial_pressure , Wikipedia
5. Hemo The Magnificent https://youtu.be/08QDu2pGtkc?t=2240
6. "Pulse Oximeters; An Amazing Use of Light" https://youtu.be/4pZZ5AEEmek Technology Connections
7. FAA, Oxygen Equipment: Use in General Aviation Operations https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/oxygen_equipment.pdf
8. Pelican's Perch #13: Getting High on Welder's Oxygen https://www.avweb.com/features/pelicans-perch-13getting-high-on-welders-oxygen/


EAA Poker Run
WIN PRIZES
$20 PER HAND
*NO LIMIT
July 1st at Noon Denton Airport
US Aviation Bravo Room
Trade your selfies for poker hands.
Fly or drive to each location within the month of June.
*Selfie must show date
ACT - Black Hawk Building
ADM - The Line Shack
GPM - Statue or FBO Doors
MWL - Mineral Wells Terminal
SLR - Red Barn Cafe
Take a selfie with our chosen airport identifier at each of the five destinations listed.
REGISTER
chapters.eaa.org/eaa661