Laurence Yeung documents how paying attention pays off

One of my favorite things about lab work is the opportunity to be creative in tiny ways. These "lab tricks" often go undocumented, though, so they are often lost to the ether when lab members move on to bigger and better things. The Yeung Lab's attempt to alleviate this problem will be occasional posts about challenges we've encountered and how we addressed them, which we hope will also help and amuse our fellow intrepid lab rats elsewhere. Today, I'll tell you how we slow down the leak rate on our vacuum sampling vessels so we can store them for up to six months—by filling up the valve stem with water.

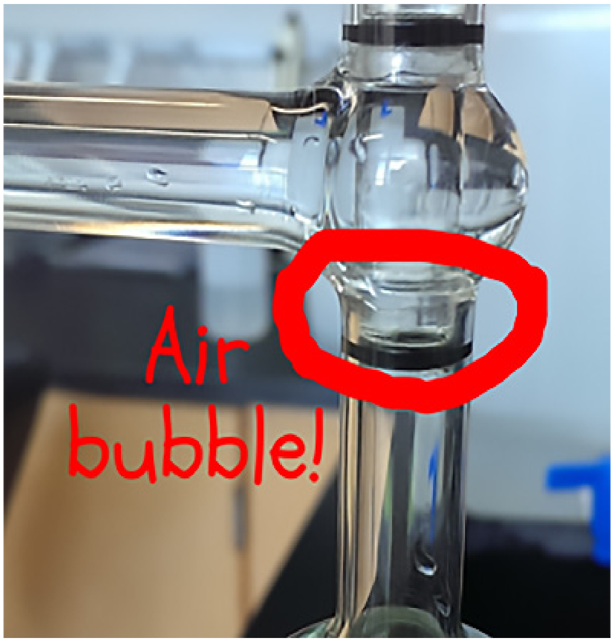

Figure 1: The enemy

It’s not as simple as you think. Because of the tight tolerances in high-vacuum valves and the presence of waxy vacuum grease, water does not like to wet the part of the valve right next to the o-ring seal. Unfortunately, it is also the most important area to get wet: A bubble there is as bad as having the valve exposed to the atmosphere.

The challenge, then, is to get rid of all the air bubbles in the valve, and to do it efficiently. We had about 32 vessels to prepare for this round, and many more in the future, so it was an important problem to solve.

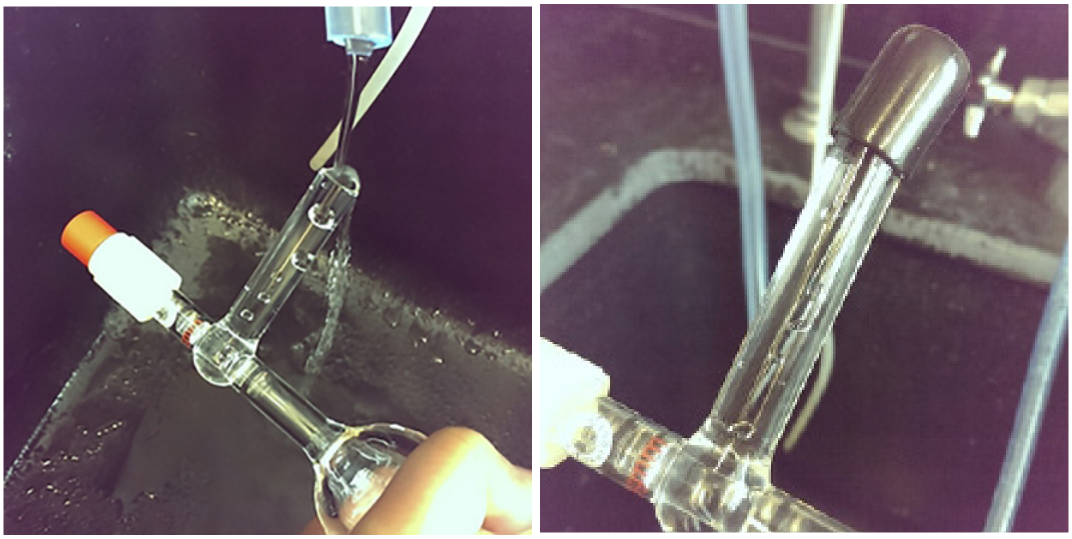

Figure 2: Filling and capping the stem

I was originally taught to tap the neck of the bottle on the table until the bubbles came out. While it is a reasonable technique, its ineffectiveness became quite apparent as I was teaching my grad students how to do it. We were all having a lot of trouble tapping with enough force to dislodge the bubble without risking breaking the glass. So I found another solution.

We use a PVC endcap, which is usually only added when we're done to keep the water in the stem, to our advantage. After filling up the stem to the brim, we push the endcap on. The close fit between the endcap and the stem results in some resistance when pushing the cap on. This is a good thing.

That resistance indicates that you're making a weak seal with the valve stem, which can be used to pull the bubbles out.

We pull the cap off quickly (see Figure 3). It makes a satisfying "pop" sound. That's the sound of the suction generated, which dislodges the bubble and may even degas the water a little (like when you open a bottle of soda). A bit of water often comes out of the stem but that's okay—it's just the cost of doing business, and a small price to pay for efficiency.

We found that the stem needs to be filled to the brim. The technique relies on the fact that air is compressible and water is not; if there is an air bubble at the tip of the stem, all you'll end up doing is compressing and decompressing that top bubble, and not any of the bubbles inside the stem.

Even with this technique, we found that we have to refill the stem and go about 5 or 6 cycles per bottle before all the bubbles are out. Yet, it is still much faster than the tapping method; I'd say maybe by 3 times or more. And that really pays off when you've got many bottles to pack and take to the field.

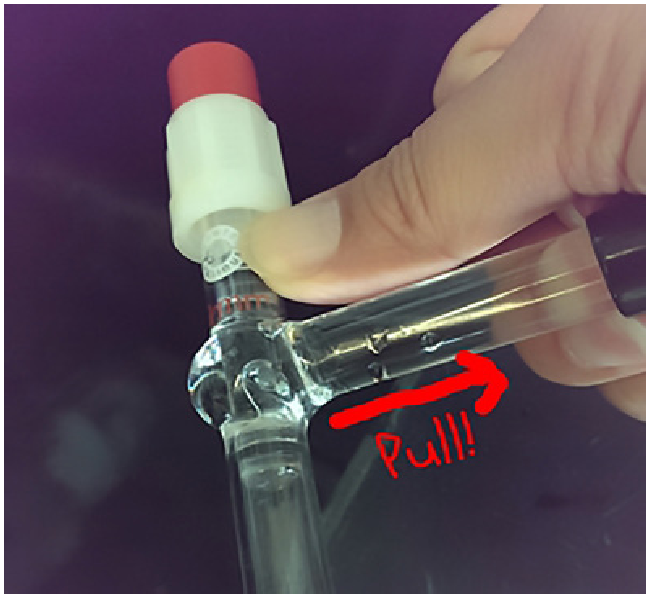

Figure 3: Pulling out air bubbles.

Figure 4: Stem filled with water and no bubbles. Success.

Figure 5: Bottles galore

Laurence Yeung is an assistant professor in the Earth Science department, an expert on clumped isotope geochemistry and mass spectrometry, who has a passion for precisely conducting laboratory and field studies and collecting data on atmospheric and ocean chemical processes.