Malt Maniacs E-pistle #2011-03

By Nabil Mailloux

This article is brought to you by 'Malt Maniacs'; an international collective of more than two dozen fiercely independent malt whisky aficionados. Since 1997 we have been enjoying and discussing the pleasures of single malt whisky with like-minded whisky lovers from all over the world. In 2010 our community had members from 15 countries; The United Kingdom, Sweden, Germany, Holland, Belgium, France, Switzerland, Italy, Greece, The U.S.A., Canada, India, Taiwan, Australia and South Africa. You can find more details on: www.maltmaniacs.org.

Wierd Whisky Science

Do the laws of physics change in the US?

"Know thyself" – Socrates

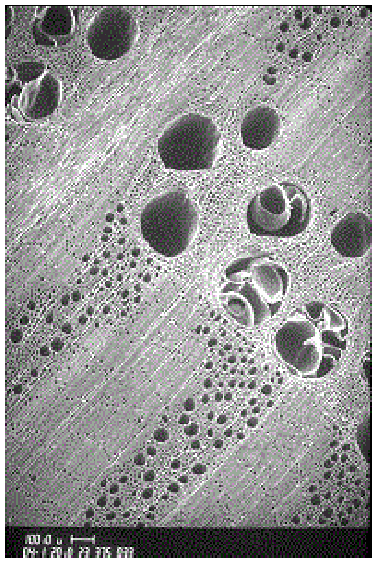
Here is what I know about myself: when it comes to making sense of the scientific world around me, I am often possessed with a curiosity that often borders on the obsessive-compulsive. If a statement, or an observation, does not fit within an accepted scientific theory, my mind will not rest until I have found a place in my scientific world within which it might rest soundly and logically. You can then imagine what my reaction upon hearing from Serge Valentin that *"it is well known that some bourbons actually go up in strength with age."* Oh, there would be no stopping me now.

The question that simply would not go away was: *"how is it that proof will go down in one country while going up in another?"* Initially, there were no easy answers proffered by my colleagues. However, Mark Gillespie did throw in *"Don't worry about how, Nabil, just enjoy!"*, which had the effect of throwing the proverbial gas onto the fire. How could I possibly get a good night's sleep now? So, with questions in hand, a few email addresses, and armed with about 50K$ of university degrees, I was off to discover why the apparent laws of science are different in the US.

Before we launch into this expedition, it is essential to have some background on the fundamental principles governing the evaporation of any liquid, be it in a barrel or a beaker. To start off, the law that governs how things evaporate is known as Raoult's Law. It states that if you have a mixture of liquids that is then heated, you will observe that the gas above the liquid is enriched in the component that has the lower boiling point. This makes sense because the liquid with the lower boiling point takes less energy to move it from the lazy

liquid phase to the more manic gas phase. So, to summarize, heavy, high boiling liquids like to stay a liquid; lighter, lower boiling liquids like to become gasses more easily!

Now, as always there are exceptions, such as water. Water is actually lighter than ethanol, but it has the strange property of acting like a mini-magnet with itself, and so even though it is lighter, it has a much higher boiling point than ethanol (alcohol). This is the property that actually allows liquid water to exist on our planet and form the basis for all life-forms.



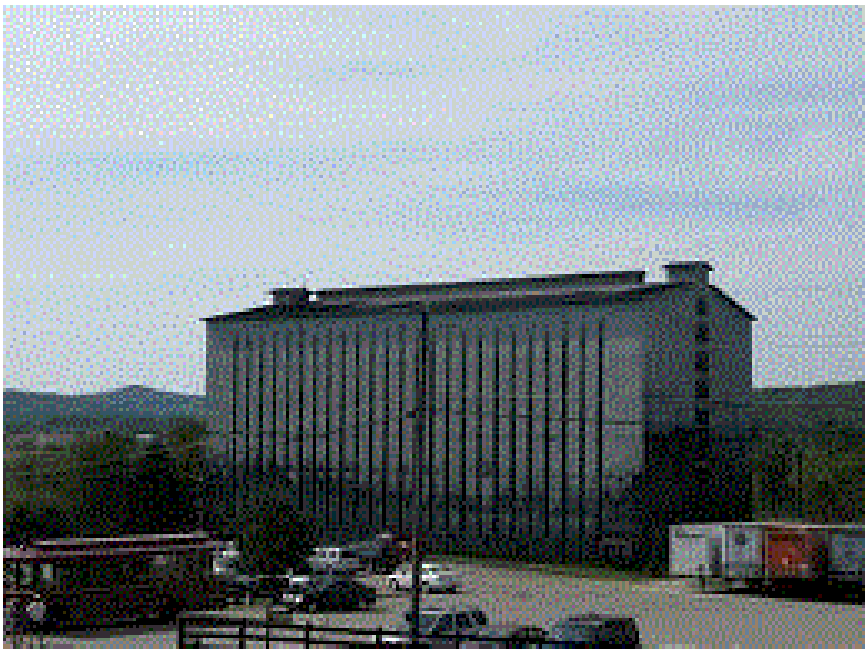
Consequently, in the world of scotch-chemistry, we are dealing with a mixture of water and ethanol, boiling at 100 C and 78 C, respectively. In a traditional still, we are adding oodles heat to this mixture. Every time the temperature of the mixture increases, some of the liquid will decide to jump up into the gas phase. Necessarily, a higher percentage of the molecules that jump up will be ethanol rather than water molecules, hence our ability to distil new make from the low wines.

But what about the liquid that is maturing in the cask, you might ask? Well, Raoult's Law applies everywhere in the known universe, so it applies in our casks, even the ones in the US! As the casks take up any heat that surrounds them, the gas leaving the casks is ALWAYS richer in alcohol relative to water. Naturally, this would lead you to the conclusion that more of the gas escaping the cask should also be alcohol, hence the reference to thirsty angels taking their share of the alcohol. So then how is it even possible that proof might go up?!

When I put this question to the people on Straightbourbon.com, it was suggested that the cask might act as a filter. An interesting notion except that the pore sizes in a wooden stave are to a molecule what my front door is to different sized ants. Both molecules are on the order of 0.0000000001 m long, or roughly 1000 times smaller than the larger pores in the electron micrograph to the above. Might there be a greater affinity for the cellulose in the wood towards one of the molecules? It is possible, but both molecules have somewhat similar structures to the cellulose, thus similar affinities. Also, if either water or alcohol had a greater affinity for the wood, then this effect should not change with location, but it does. This leaves but one possibility, an external factor influencing the movement of water or alcohol from the cask to the outside world.

Time for more chemistry (is that even possible?!). Equilibrium. Everything seeks out equilibrium (and not the cult classic sci-fi film!). Water drains from a bathtub because there is open space beneath it waiting to be filled. A balloon will expel the air to equalize the pressure with the outside world (or explode catastrophically!). Within the wood of a cask lies a mixture of alcohol and water vapour. From without, you will find an atmosphere that is virtually barren of any alcohol vapour, so what should be the result? Well naturally, the alcohol will want to leave the cask in an attempt (a futile one at that) to fill the outside world, until the exterior and interior of the cask contain the same amount of alcohol.

Therein lies the problem: the outside world is also much poorer in water vapour than the inside of the cask, so why does the alcohol escape faster in Scotland? Well, the easy, non-mathematical answer is that the exterior is MORE poor in alcohol, so the alcohol escapes FASTER to equalize MORE. Aye, but here's the rub...why is this sometimes NOT true in the US?

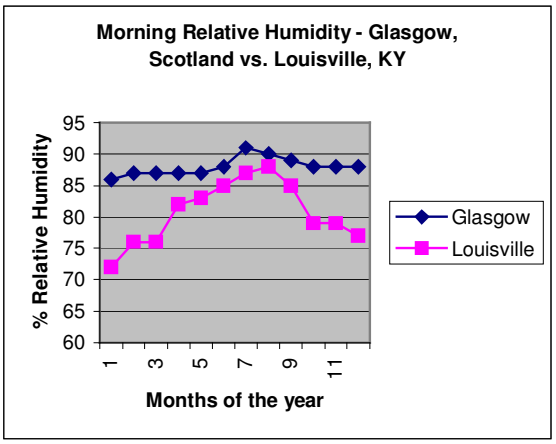


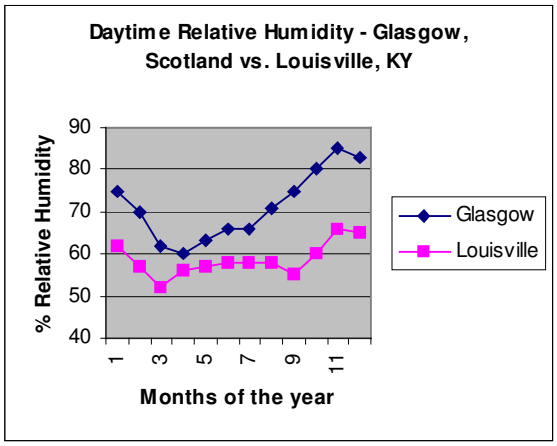
I also put this question to two people in the North American whisky business. Dan Tullio of Beam Global at the Hiram Walker distillery, and Bernie Lubbers, one of Beam's "whisky professors". Mr. Tullio indicated *that "at our warehouses the alcohol strength goes DOWN. The reason our strength goes down is because we heat our warehouses during the long cold months…enhancing the evaporating of large alcohol molecules vs the smaller water molecule."* Well, this seems to fit in with my theory thus far, except that usually smaller molecules (water) evaporate faster! He went on to say *that "in the US they have really tall, thin, TIN warehouse and the temperature at the top may be as much as 50 degrees Fahrenheit hotter than at floor level!"* All is still well with Raoult's Law thus far.

It is once Bernie lets me in on what they observe in their tall "rickhouses", that I ran into the crux of the problem. Bernie says *that for "the barrels from 4th floor on down, it is moist and cool, and the proofs will actually drop from 125 all the way down to around 115 proof on the bottom floors. Those barrels on the top floor can rise because it's hot and dry up there, and proof can rise to 140+ proof."* But what could be behind this? More heat, or energy, should simply speed up alcohol loss. What is changing here? The answer again, must lie in external factors, but what could be changing on the outside? Then answer, I thought, lay in his comment about *hot and dry*!

While I am simply a humble public educator, I can only make an educated guess (no pun intended). My initial explanation was that there must be a difference in the external relative humidity between Scotland and the US. In Windsor, Ontario, Canada, our winters and summers are characterized by high relative humidity in low lying warehouses, as they most likely are in Scotland. This would explain the traditional flow to the angels.

To try and substantiate this notion, I managed to find some interesting climate data for Kentucky and Glasgow. This data showed conclusively that, most of the time, Scotland had a much higher relative humidity throughout the year relative to Kentucky. However, this did not





stop the angels from taking their share of alcohol in the lower sections of Beam's rickhouses. So, it would seem that the relative humidity in the exterior of the rickhouses does not entirely explain the angels' odd behaviour in Kentucky. So, why do we see both a loss and a gain in alcohol content occurring in Beam's rickhouses?

My proposed answer to this question takes into account Bernie Lubbers' comments about humidity and temperature differences on the upper floors of Beam's rickhouses. It would seem that the type of warehousing, and location therein, has a direct effect on whether the angels give or take. When casks are closer to the damp earth, local humidity is higher; whereas when casks are further removed from the moist soil, on the hotter upper floors, the relative humidity decreases dramatically. Thus on the lower floors, the higher relative humidity is responsible for the traditional loss to the angel's share. However, on the upper floors, the equilibrium is shifted such that, in those drier conditions, water escapes faster than the alcohol, causing the alcohol content to actually increase. Both of these observations are also consistent with Raoult's Law and the law of equilibrium.

I was feeling like my proposed model was consistent with existing science and has paved the way to a good night's sleep. The only thing that might ensure my sweet somnolescence would be a reference *somewhere* that might confirm my suspicions. Now this is when being a part of an international mind-trust of whisky nuts comes in handy! I went back into my earlier Gmail discussion thread and voila, fellow Maniac Lawrence Graham had dug up the following reference:

A rise in temperatures increases the evaporation losses of both ethanol and water, while humidity influences the relative rate at which ethanol and water are lost. At high humidity more ethanol than water is lost and the strength is decreased; at low humidity more water than ethanol is lost and the strength increases (Philip 1989,Whisky Technology, Production and Marketing by Inge Russell)

I also searched for *"angel's share"* on Wikipedia and found a reference which confirmed again that lower humidity actually forces the angels to take water rather than alcohol! Looks like Wiki-Leaks (or Whisky-Leaks) strikes again.

Could scotch producers use dehumidified Kentucky-style rickhouses to discourage the angel's from visiting? Should they? If I were to hazard a guess, I would say that it is probably not hot enough during the summers in Scotland to drive off enough humidity for the water to escape the casks faster than the alcohol. Furthermore, the energy costs associated with heating or dehumidifying the warehouses would render the exercise economically unfeasible.

Science is a tiring exercise sometimes, more so for the obsessive-compulsive scientist. Nonetheless, in the end, it turns out that the laws of chemistry and physics do apply to all the nations on earth, which gives me great comfort as I sit down to contemplate a few whiskies that have spent some time in those famous Kentucky rickhouses.

C = Colour, N = Nose, P = Palate, F = Finish

Buffalo Trace (45%, OB, 2009, 750 ml)
C: Amber N: emphatic marachino cherry fruitiness complements the usual vanilla notes. Just a bit of charcoal, but on the whole very fruity. P: definite marachino cherry along with sweet vanilla, brown sugar, a malt-nuttiness alongside the sweet corn. F: long, fruity and minty. Comment: This 9 yo (not on label) is a standard bottling costing only 25$ USD. It has converted many a single malt fan into a bourbon lover. Their casks are sought after commodities by the likes of Bruichladdich and Kilchoman. **84 points**

George Dickel No.12 (45%, OB, 2010, 750 ml)
C: Amber N:sweet, vanilla as usual, somewhat nutty, yeasty, sour, and even yoghurty notes keep coming through. Hints of green apple. P: big peppermint, grapefruit, vanilla, BBQ briquets, and anise. F: medium on sour vanilla and charcoal. Comments: Not a bourbon at all but a Tennessee whisky because it is filtered through charcoal. I really gave this one a chance, but I'm really not fond of it. The sourness is too much, not enough fruit to balance that and the charcoal. **72 points.**

Jim Beam Black (43%, OB, 2010, 375 ml)
C: Amber N: starts on charcoal, then vanilla, peppermint, musty, brown sugar. P: sweet start on vanilla, with some licorice, and quite a bit of mint. F: coal smoke, mint, and anise. Comments: this is an 8yo, the equivalent of a 12 yo malt. A versatile whisky that could be sipped or mixed. **77 points**.

Knob Creek (50%, OB, 2010, 50 ml)
C: light amber N: minty vanilla with some fruitiness in the form of marachino cherries! Freshly planed wood, and some charred wood. Developps into toffee. P: thick, oily, nicely balanced spice, malty, developping into banana skins, and nutmeg. Great balance between sweet and dry. F: long spicy on mint, nutmeg, and cherries. Comment: this is another bourbon that any malt whisky fan would really enjoy. **85 points**

Evan Williams Single Barrel (45%, OB, 1997/2007, 750 ml)
C: golden amber. N: loads of banana, vanilla, and even a nice touch of mint. A little toffee makes an appearance to add to the sweetness. P: Nice minty pop balances the sweetnes. A little baked apple and spice as well as the ripe banana skin. F: long on mint and bananas. Comments: one of my first experiences with premium bourbon, and a lovely one at that. **83 points.**

Maker's Mark (45%, OB, 2009, 375 ml)
C: toffee N: All sorts of mint, peppermint, spearmint. One might say is it overly minted, to the point of being far too spirity. P: Again, the mint overwhelms any vanilla or fruity components. It is VERY drying, tannic really. F: medium on, yes, mint and vanilla. Comment: I found this rather unidemensional and unbalanced. **74 points.**

Eagle Rare Single Barrel 10 yo (45%, OB, 2007, 750 ml)
C: Golden amber, light maple syrup. N: a little charred oak, then a big vanilla hit. Rubbed on the hand yields distinct orange and cocoa notes. Later develops into toffee, creme brulee, and some maple syrup. Also some spicy nutmeg enters into the mix. P: Light and oily. Candied orange, sweet vanilla, planed oak. Nutmeg hits at the back of the palate. Nice balance on the palate with the sweetness yeilding to the drying wood influence. Slight charcoal with brown

sugar/maple syrup/toffee. F: spicy heat of cinnamon and nutmeg. Medium long. Comment: Buffalo Trace's older more mature brother (by one year). **87 points.**

Gentleman Jack NAS (40%, OB, 2010, 50 ml)
C: Light gold. N: freshly sawn lumber, cedar, mint, spirity, some charcoal. Water brings out more musty coal notes, oxidized apple. P: Not very expressive. Light vanilla, maple sugar, minty, sweeter than expected. Faint spiciness, not so much charcoal. No water needed. F: on applesauce and nutmeg. Shortish. Comment: This was filltered through charcoal, not once, but TWICE. I get the impression the second time may have removed too much of the good with the bad. **74 points**

Eagle Rare Single Barrel 10 yo (45%, OB, 2010, 750 ml)
C: amber. N: rubbed on the hand, orange peels and vanilla. A little soapy, waxy, some anise. With water: a little more fruity than 2007, some white pepper. P: sweet, cinnamon, very malty, very honeyed, fruity, signature cherries this time. With water: minty, vanilla, more stewed apples and cherries. F: maple sugar and anise. Long. Comment: This one is much closer to a single malt, more malty than 2007, but not as muscular. **84 points**

Nabil Mailloux hails from Kingston, Ontario, Canada, a town that likes to celebrate *almost* becoming our nation's capital. He is originally from southwestern Ontario, a town that is also known as South Detroit (Windsor), the automotive manufacturing capital of Canada. He holds a Master's degree in organic chemistry from Queen's University, Canada. While in the Quiet Pub at Queen's University, he was introduced to the world of single malt whisky by his good friend John Morgan. That very same Morgan also convinced him to buy a hogshead of whisky with him, thus forever changing his life. As a result, he has become obsessed with nosing, tasting and evaluating whisky. He eagerly awaits 2014, the bottling date for his cask. He also wonders what he's going to do with his share of the whisky…