Myths and Science of Mendeleev’s Vodka
by Vladimir Shilsev

Lord Halifax, Agnes Perkins and Albert Einstein are often credited with saying kinds of variations of “Culture is what is left after you have forgotten all you have learned.” From that perspective science contribution to culture could be the names and faces of recognition and sometime the myth associated with the greatest scientists. Take Isaac Newton – hard to estimate how few people after 200 can remember his gravitation formula or explain his three laws of dynamics but majority remember that it was him who was hit by an apple and invented the gravitation. Galileo is credited with saying Eppur si muove (“... and yet it moves!”) at deathbed, symbolizing unbroken free spirit of those convinced that the Earth rotates around the Sun. Ben Franklin is known for his kite experiment in which he extracted electricity from the skies and sometimes recognized as the face on the hundred dollar bill. Needless to say that all these myths are debunked by scholars but are alive because they are natural to us – they glue the corresponding names to our culture texture.

Mendeleev belongs to the same rare flock of geniuses. The periodic table he invented in 1869 occupies arguably the largest space on the walls in every classroom around the globe, and UNESCO celebrates its 150th anniversary this year. As with others, the table is generally known and but details happily forgotten by the gross majority of public, his name is more or less recognized (though it’s longer than usual, and his first and middle ones Dmitri Ivanovich are unmemorably long too), his portrait (Fig.1) can be identified as “some classics” as he is equally if not more hairily as Einstein, Galileo, Newton and Franklin, though it is doubtful that more than 5% can say who is who looking at him and, say, his contemporary evolutionist Charles Darwin. His main myth is that his creative breakthrough was an unconscious product of “idea-incubation” — one February evening, after a wearying day of work, Mendeleev envisioned in a dream how chemical elements should lined up to form groups with similar properties his periodic table if arranged by atomic weight. Surely a myth, the whole idea that there is a chance for a breakthrough in a dream is cherished by generations of young students and young researchers, despite very little evidence of its effectiveness.

What makes Mendeleev somewhat out of row and calls his name in everyday’s life is another, very popular myth that credits him with the invention of vodka, a mix of 40 parts of alcohol and 60 parts of water. In Russia the claim was rooted in the early part of 20th century, easily satisfied the general desire to add legitimacy to any possible piece of national culture, and percolated in numerous anecdotes, movies, literature and even scholarly books. It easily spread overseas with the product, and every time I visit even local liquor store in the US, I can find on one of colorfully labeled bottles that “...In 1894, Dmitri Mendeleev, the greatest scientist in all Russia, received the decree to set the Imperial quality standard for Russian vodka and the ‘Russian Standard’ was born” (of course, “Russian Standard” is brand name, but is called as something of a scientific standard).

This myth, similarly to vodka itself, has two parts of truth and 3 parts of “water”. Truth is that indeed Mendeleev’s 1865 doctoral dissertation [Fig.2] was indeed “A discourse on the compound of alcohol and water”. That was a masterpiece of experimental physicist who tried to find out what the we can learn about interaction of molecules from precise measurements of the density and thermal expansion of the mix to the level of 0.01%, studied some 1/20 contraction of the mix volume which peaks at 52% of the alcohol by volume or 46% by weight [Fig.2], came out with an idea of associations of H2O and C2H5OH molecules - due to which we now know as hydrogen bonds — particularly stable at certain concentrations, and as a byproduct invented the most efficient method to obtain the purest 100% alcohol of the time via chemical purification from relatively easily produced 96% mix. Also true is that as an expert in chemical technology in general and alcohol rectification in particular, and as strong proponent of state-supported industrial development of the country, Mendeleev was part of the Government commission on introduction of an efficient excise tax, which eventually was introduced in early 20th century and comprised up to a quarter of the state budget. But of course, neither the work in commission nor the personal opinion on the best way to mix vodka, nor the dissertation was about the proof that 40% (by volume) vodka is optimal in any aspect.

Still, the 40% vodka has several remarkable properties. At room temperature, the mixture is three times more viscous than either of primary liquids because, and vodka out of the freezer is 2,5 times more syrupy — that’s why it is strongly advised to drink it very cold to fully enjoy its smoothness. One should not afraid to leave vodka in a freezer - the bottle won’t burst as it would happen to any water dominated beverage: alcohol acts as an antifreeze, allowing the mixture to stay liquid below zero, and vodka freezes only at -25°C. If one forgets to put it in the freezer and leaves it in an open glass at room temperature, the alcohol and water will evaporate equally, leaving the relative concentrations unchanged. So, you’ll still have vodka — just less. At 40 percent or more alcohol, you can set fire to the fumes at room temperature — and that was used for simple check of the alcohol content since the times of the state monopoly on vodka production and distribution (introduced in 1474 by Tsar Ivan III) to prevent barkeeps from watering vodka down. The method was not accurate enough, and the next state monopoly reform by Peter the Great in 1698 demanded more sophisticated standard, called predel (or half) — the mix to be heated to boiling, fumes ignited and after the burning is completed, the remaining volume has to be one half of initial volume. That gave 38% alcohol mix plus minus few per cent.

What makes vodka different from all other hard liquors - whiskey, rum, tequila, schnapps, etc - is its taste, or to be precise, it’s formal absence. Until mid-19th century, vodka was clear and relatively pure mix with smooth panary taste, inherited from the distillation stage. While other hard liquors cherished their own specific aromas using various methods, only vodka went through chemical technology revolution and is now produced differently. It proceeds through four main stages: few times distillation, rectification which results in about 90% or more alcohol free of any other impurities, mix with water to get to 40% and extended additional filtering through activated charcoal or other types of absorbents. As the result, concentration of ethers, aldehydes, methyl alcohol, furfural and complex oils — i.e. all the components that bring up taste and aroma and make e.g. cognac different from whiskey — is about 0.01%, or factor of a hundred to a thousand less than in any spirit. Though one would expect no taste at all, but in fact there is a slight after-taste and various vodka taste competitions indicate that there are actual differences for various
brands, reflecting mostly the quality of initial rectificated alcohol, type and quality of the water and details of the final filtering. So, what is called “bad vodka” can be discovered on the spot if it has taste, but all good vodkas are nice and smooth and the only actual indicator of superb quality is “the next morning”. Vodka, being the purest of all alcoholic beverages, results in the least hangover which is usually caused by consumption of 150 to 500 ml of it (about 50 to 200 grams of pure alcohol). The biological effects are, of course, individual and vary widely depending on body weight, gender, age and previous experience. Surely, most the effects are negative – alcohol is unhealthy – but that is not why people drink. In any case, vodka seems to have the least negative effect on thinking abilities, as attested by, e.g., many great Russian mathematicians of the past and present.

Over at least six centuries of vodka in Russia, Poland and Nordic countries, the beverage has deeply ingrained in the culture. For example, in Russia, a good party calls for at least for must have’s: good reason, good company, good food and good vodka. All four are believed to counteract alcoholism. Hard to tell how effective they are, but for example, toasting is almost obligatory, with three most common are for the occasion of the gathering, za zdorovia! (for your health!) and za dam! (for women!). Optimal size of the party, capable of keeping over-the-table discussion is believed to be “between the number of graces and number of muses” (three to nine, correspondingly, in Greek mythology). Russian national diet and vodka are strongly interconnected, if not to say they ideally fit each other. Over centuries of side-by-side development, The proper food includes caviar, salted (not marinated) cucumbers, mushrooms and tomatoes, salko (green bacon), mustard, pierogi, salted and smoked fish, e.g. sturgeon, salmon and, especially, herring, hot soups, pelmeni (beef dumplings), beef or pork roast, thin round pancakes, plain or stuffed, etc, etc, etc. To learn more one can just re-read Russian classic literature, like Tolstoy’s Anna Karenina (Part One, where her brother Steve goes for lunch) or Chekhov’s short story Hors d’Oeuvre, Vodka needs to be drunk cold and at once, in one gulp. Given high concentration of alcohol, the typical shot volume varies from 50 to 100 grams. Corresponding traditional shapes of the vodka shot glasses are such that they allow the “at once” drinking, with larger opening and either broad or heavy bottom for stability [Fig.4].

As with fire, vodka has to be treated properly to be enjoyable. One has to remember that yes, it has long history and great cultural background, but quite predictable pleasant and unpleasant effects. Mendeleev himself, for example, did not drink vodka out of fear of becoming an alcoholic as one of his elder brothers – so, he preferred red wine.

Fig. 1: Dmitrii Ivanovich Mendeleev (1834-1907)
Разсуждение
О соединении спирта съ водою,

Для получения степени доктора химии.

Санкт-Петербург.
Типография С.-Петербургского Императорского Университета.
1865.

Fig. 2: Cover page of Mendeleev's PhD thesis "A discourse on the compound of alcohol and water" (St.Petersburg, 1865)

Fig. 3: Density of the alcohol mix with water vs concentration.
Fig. 4: Traditional vodka shot-glasses (left to right): 80 ml bottom-heaved Faberge, 65 ml crystal lafitinik, 50 ml Beluga brand. Wine tasting glass in the background is given for comparison.