The Downtown Review

Volume 3 | Issue 1 Article 2

October 2016

The Chemistry of the Flint Water Crisis

Ernest M. Oleksy
Cleveland State University

Dogo News author Meera Dolasia recently wrote about the water crisis in Flint, Michigan. The Flint water crisis is an unfortunate example of science and politics mixing poorly. The crisis began when city officials in Flint wanted to find a way to stop purchasing water from Detroit. The alternative they proposed was to use the nearby Flint River, which connects to Lake Huron, as the city's new primary water supply. City officials insisted that citizens should stop wasting money on bottled water and simply drink tap water, which would originate from the river.[1] As a water supply, however, the Flint River turned out to be remarkably poor. The lead content was found to be 900 times above the legal EPA standard.[4]

It is clear that Dolasia is writing in support of the citizens of Flint, rather than trying to justify the actions of the local government. When she discusses how the city officials erroneously insisted that the water quality of the Flint River was fine, she uses a noticeably contemptuous tone that becomes most evident when she repeats the officials' assertions with a frustrated exclamation point at the end of the sentence. She continues with commiseration for the children of Flint, whose cognitive development has been deleteriously and irrevocably affected by the crisis: she also mentions responses and reactions, for example discussing how healthcare workers are advising parents to give their children diets that are high in vitamin C, iron, and calcium.[1] Such advice is given in response to reported consequences of drinking Flint's water, which include convulsions, anxiety, memory loss, and sustained nausea.[5]

Although Dolasia displays a hint of favoritism in her writing, she is for the most part very professional. She presents a clear and objective rundown of events in a straightforward manner that is easy to follow. Politics and chemistry are both adequately represented and Dolasia is never unfair in her criticism of Flint's city officials. The only aspect of her writing that can be interpreted as directly critical of local government is her emphatic reminder that city officials insisted that the dangerous water was safe for consumption. All things considered, it is difficult to blame Dolasia for becoming noticeably aggravated at Flint officials' lethargic treatment of a growing crisis.

One of the most troubling aspects of the Flint water crisis is the fact that the water of the Flint River has reached a new equilibrium.[4] Equilibrium is essentially a state of balance in which the forward and reverse processes of a chemical reaction are at equal rates. It is these equal rates that bring balance to the system. Equal rates, however, does not mean equal net totals in products and reactants, as those can fluctuate and vary depending on different chemical reactions and different catalysts involved in those reactions.[2] Silberg and Amateis write that a system in a state of equilibrium will result in static values for both products and reactants, known as the equilibrium constant. Equilibrium can be represented by the following equation:[2]

$$\text{Rate}_{\text{fwd}} = \text{Rate}_{\text{rev}}$$

Equilibrium is a valuable concept in chemistry because all systems tend towards equilibrium, a process that can require either the forward or reverse reaction to occur at a higher rate than its counterpart in order to achieve said balance. Equilibrium can be disturbed by a number of factors, including but not limited to temperature and pressure. The effects of these alterations to a system in equilibrium can be predicted by what chemists refer to as Le Chatelier's Principles. These principles explain that an increase in pressure on a system will lead to reactions that decrease the overall volume of the system in order to return to equilibrium.[2] This is why the introduction of an alien substance, or simply the increase of any substance within a system, can lead to dramatic changes. If an increase dramatically increases the pressure of a system, then the system will be forced to undergo a reaction that will bring the pressure back down to equilibrium, which can lead to unintended consequences.

The lead levels within the Flint water systems grew to dangerous levels due to local government not anticipating the extent of the corrosion that would occur between the water and the lead pipes that transferred that water to civilians.[4] Corrosion is affected by the equilibrium of electrons between cathodes and anodes.[3] In the case of Flint, as electrons were being balanced in the system of the water pipes, lead was being corroded off into the water itself. This resulted in exorbitant concentrations of lead within the water system, which can also lead to the growth of pathogenic microbes within the water, making that water dangerous to consume.[4]

In order to combat this increase in lead content, precautions must be taken to minimize the exchange of electrons between the metal and electrolytes: this would effectively minimize the corrosion that is leading to the increased lead concentrations in Flint's drinking water.[3] In the case of Flint, healthcare officials came up with the idea to use inhibitors to slow the rate of chemical reactions: in this case, corrosion. The use of the inhibitors maintained an important mineral layer on top of the water pipes: this layer actually protects the water pipes from corrosion, keeping them from being deleteriously affected by the re-establishment of equilibrium.[4]

This step is very important, writes Torrice, because of chlorine.[4] Chlorine acts as a disinfectant within water, making it safe to drink. However, when lead-sourced corrosion takes place, the resulting increase in pressure forces a change in reaction rates and a changed concentration of chlorine. In Flint, the levels of chlorine were decreased by the free iron in the water, and became insufficient to keep the water clean, causing several negative effects on children's cognitive development among other side effects.[4]

The water crisis in Flint, Michigan thus demonstrates an example of the importance of equilibrium. Here, equilibrium shifts led to corrosion, and corrosion led to increases in lead and iron concentrations, which decreased chlorine concentrations, which led to dangerous drinking water for innocent civilians in Flint. Although this is a single example, equilibrium remains an unpredictable yet impactful shift that affects every process. The Flint water crisis, therefore, establishes the necessity for balance in even the most basic systems: this crisis also shows how the disturbance of such systems can lead to major problems for humanity.

Works Referenced

1. Dolasia, M. The Water Crisis in Flint, Michigan. Dogo News [Online] Jan 20, 2016. http://www.dogonews.com/2016/1/20/the-water-crisis-in-flint-michigan (accessed March 18, 2016).

2. Silberg, M.S.; Amateis, P.G. Chemistry 2, Vol. 2; McGraw-Hill: Boston, 2015; pp 731-763.

3. Thompson, N.G. Getting Started with Electrochemical Corrosion Measurement. Gamry Instruments. [Online] 2016. http://www.gamry.com/application-notes/corrosion-coatings/basics-of-electrochemical-corrosion-measurements/ (accessed March 18, 2016)

4. Torrice, M. How Lead Ended Up In Flint's Tap Water. C&EN [Online] Feb 19, 2016 http://cen.acs.org/articles/94/i7/Lead-Ended-Flints-Tap-Water.html (accessed March 18, 2016).

5. Nolen, L. (2016). Health Consequences of Flint's Water Crisis. Retrieved December 09, 2016, from http://nursing.advanceweb.com/Web-Extras/Online-Extras/Health-Consequences-of-Flints-Water-Crisis.aspx