Airbags: Chemical Reactions Saves Lives

The article about airbags starts off by telling the story of the first time airbags saved lives in 1990. Thanks to the life saving technology, both drivers walked away from the crash. The article goes on to tell about how when John Hetrick first invented the airbag in 1953, but were not required in all automobiles until 1998, 45 years later. Next, the article talks about how the airbag works. When the car impacts an object sensors in the front of the car send an electrical signal to a cylinder containing a mixture of chemicals that are ignited by the spark and react rapidly to form a large amount of nitrogen gas. This gas fills the nylon bag making it burst out of the steering wheel, where the driver impacts the soft “balloon” as the harmless nitrogen gas drains out holes in the side of the bag allowing the driver to come to a sudden, but gentler stop.

The chemicals involved in creating the nitrogen gas are sodium azide (NaN₃), potassium nitrate (KNO₃), and silicon dioxide (SiO₂). The spark causes the sodium azide to decompose rapidly creating solid sodium metal and nitrogen gas. 2NaN₃(s) → 2Na(s) + 3N₂(g) The created sodium then reacts with the potassium nitrate to create more nitrogen gas. 10Na(s) + 2KNO₃(s) → K₂O(s) + 5Na₂O(s) + N₂(g) The remaining substances finally react with the silicon dioxide to form harmless glass. K₂O + Na₂O + SiO₂ → glass

The article then tells about some problems that had to be figured out before the airbag could start saving lives. These problems include how to make it deploy only on a hard impact
and how to make it deploy in under a second. These problems were solved with the introduction of a acceleration sensor sealed in a non-corrosive housing. Also mentioned is the use of boron and potassium nitrate to help ignite the sodium azide to begin the chain of reactions. The last parts of the article tell about the unintentional dangers of airbags including the toxicity of the un-reacted chemicals and the immense force of the expanding bag.

Even though I was assigned to read this article I did in fact find it very interesting. One of the things that I thought was interesting was how long it took for airbags to be required in vehicles after their invention. Today, airbags seem like a common sense safety feature, so to think that they were simply being ignored for so many years, and to think about all of the lives they could have saved is kind of appalling. Another thing that made this article interesting to read is that the generation of the nitrogen gas in the airbag is in fact the product of multiple chemical reactions rather than a single reaction. It is amazing to think that a single reaction can occur in less than a second, let alone almost five separate reactions. One more thing that I thought was interesting was the fact that the purpose of one of those reactions was just to change the harmful byproducts of the nitrogen gas producing reactions to harmless glass. For me, that last reaction is just the icing on the cake that makes the airbag such an ingenious invention.

The first reaction in the process is when the spark from the sensor ignites the sodium azide which produces solid sodium and nitrogen gas. $2\text{NaN}_3(s) \rightarrow 2\text{Na}(s) + 3\text{N}_2(g)$. This is a decomposition reaction because a single compound is broken down to create two separate elements and it required energy to begin the reaction. The next reaction is the one where the
newly created sodium reacts with the potassium nitrate to create more nitrogen gas, potassium oxide, and sodium oxide. $10\text{Na}_\text{(s)} + 2\text{KNO}_3\text{(s)} \rightarrow \text{K}_2\text{O}_\text{(s)} + 5\text{Na}_2\text{O}_\text{(s)} + \text{N}_2\text{(g)}$. This is a single replacement reaction because a solitary element reacts with a compound to create a new compound(s) and a left over element. The final reaction in the process is where potassium oxide, sodium oxide, and silicon dioxide react to form glass. $\text{K}_2\text{O} + \text{Na}_2\text{O} + \text{SiO}_2 \rightarrow \text{glass}$. This is a combination (synthesis) reaction because multiple reactants are combining to form a single product.

After reading the article I continued my learning about airbags through some internet research. In my research I learned that side airbags in fact differ from frontal airbags. In operation they are for the most part the same, except that side airbags may stay inflated for up to five seconds to keep the passenger safe in the event of a rollover, where a frontal airbag inflates and deflates in about one second. Most airbags inflate in $1/30$th of a second and travel at around 200 mph. This shows just how fast the chemical reactions occur inside an airbag. Something that I noticed in my research about airbags is that they are structured much like a shotgun shell. When an airbag goes of an impact makes an accelerometer create a spark the causes the explosive reaction that generates the gas that fills the airbag and pushes it out of the steering wheel. In a shot gun shell the primer is hit by the impact of the firing pin and creates a spark, the spark then begins a rapid combustion reaction with the gunpowder which generates a lot of gas pushing the projectiles out of the barrel of the gun.
SOURCES:

http://www.accidentreconstruction.com/newsletter/oct04/air-bag-types.asp