Chemiluminescence

Chemiluminescence Professor Stewart CHM 151L-003 Group Members: Melissa Spegal Jessica Buddi March 19, 2013 Megan Cochran Professor Stewart Chemiluminescence March 19, 2013 Introduction: The objective of this lab was to carry out a systematic set of experiments in order to determine which combination of chemicals produce the brightest and longest lasting light, through chemiluminescence. Chemiluminescence can be defined as the emission of light by a chemical reaction that does not produce heat.

Chemiluminescence can also be found in nature, where it is referred to as bioluminescence. This can often be found in many deep sea fish, algae, and fireflies. Luminol is one of many chemicals that can be used to create chemiluminescence outside of nature. Scientists are very interested chemiluminescence because it could be very helpful in many real life situations such as in glowsticks. The military uses high-grade glowsticks to have light in field situations where electricity is not an option.

Marine biologists and deep sea divers also use those glow sticks to provide light and make new discoveries in the deeps of the ocean or underwater caves. During the chemiluminescence experiment the goal was to produce light during a series of trials in order to create light or a glow. In order to do this systematically, all chemicals were used to start and as it became apparent that some chemicals did not effect the outcome of certain trials they were eliminated one at a time.

Because the trials were done systematically from one to the next, only one element of each trial was changed at a time, making it easy to single out the defining factors. There were many chemicals used during this experiment

including Luminol, bleach, DMSO, NaOH, HCl, and H2O2. On the second day of trials, the Luminol was chilled to test the effects this would have on the glow we obtained through chemical reactions. Results of Day 1: Table 1:

Trial | Luminol (D) | Bleach (D) | DMSO (D) | 1M NaOH (D) | 1M HCl | H2O2 (D) | Results | A1 | TAD | 5* 1 | 5 2 | 5 3 | 5 4 | 5 5 | Orange color | A2 | TAD | 10 2 | 5 1 | 10 4 | 10 3 | 10 5 | Brown | A3 | TAD | 5 2 | | | | 5 1 | FLASH yellow | A4 | TAD | 3 1 | | | | 2 2 | Slight flash | A5 | TAD | 5 3 | | 5 2 | | 5 1 | * Flash | A6 | TAD | 5 3 | | 5 2 | | 10 1 | Less flash | B1 | TAD | 5 4 | 5 3 | 5 2 | | 5 1 | Flash | B2 | TAD | 5 4 | | 5 2 | 5 3 | 5 1 | Flash | B3 | TAD | 5 4 | 5 3 | | 5 2 | 5 1 | | B4 | TAD | 5 4 | | 5 3 | 10 2 | 5 1 | Small flash | B5 | TAD | 5 4 | 10 3 | 5 2 | | 5 1 | Blue flash | B6 | TAD | 5 4 | 10 2 | 5 1 | | 5 3 | 2. 7 sec flash | C1 | TAD | 5 3 | 11 2 | 5 1 | | 5 4 | Small blue flash after bleach | C2 | TAD | 3 4 | 10 1 | 5 2 | | 5 3 | 3. 2 sec flash | C3 | TAD | 5 4 | 10 1 | 5 2 | | 5 3 | Small blue flash | C4 | TAD | 3 4 | 5 1 | 10 2 | | 5 3 | 4 seconds flash/glow | C5 | TAD | 10 4 | 2 1 | 10 2 | | 5 3 | 6 sec glow | C6 | TAD | 10 4 | 10 1 | 10 2 | | 10 3 | 24. sec glow | D1 | TAD | 10 4 | 10 2 | 10 1 | | 10 3 | | D2 | TAD | 10 4 | 3 1 | 10 2 | | 5 3 | Small flash | D3 | TAD | 5 3 | | 5 2 | | 5 1 | Small flash | D4 | TAD | 1 4 | 10 1 | 5 2 | | 1 3 | Flash | D5 | TAD | 2 1 | 10 2 | | | 10 3 | | D6 | TAD | 4 1 | 10 2 | | | 10 3 | | , Asterick (*) - stirred Highlighted – Order of placement into the cell wells. The tad of Luminol was the first in every trial. (D) – Drops Pink Highlighted Row: Best Trial of the Day Results of Day 2: Table 2:

Trial | Luminol (mL) | Bleach (D) | DMSO (D) | H2O2 (D) | NaOH | Results | A1 | TAD | 10 4 | 10 1 | 10 3 | 10 2 | Quick glow - odor | A2 | 1 1 | 5 2 | | 5 3 | 5 2 | glow | A3 | 1 1 | 5 4 | 5 2 | 5 3 | | glow | A4 | 1 1 | 5 3 | | 10 2 | | glow | A5 | 1 3 | 5 4 | 5 2 | | 10 1 | glow | A6 | 1 1 | 5 3 | | | 5 2 | glow | B1 | 1 1 | 5 3 | | 5 2 | |

* ! long glow | B2 | 1 1 | 5 4 | 5 2 | 5 3 | | * | B3 | 1 1 | 5 3 | 5 2 | | | *! 36 sec glow | B4 | 1 1 | 10 3 | 10 2 | | | *! 23 seconds | B5 | 1 1 | 5 3 | | 10 2 | | * Bright but shorter | B6 | 1 1 | 5 3 | 5 2 | | | *! | C1 | 1 1 | 5 4 | 10 2 | 2 3 | | *! | C2 | 1 1 | 5 3 | 20 2 | | | *! 29 Secs | C3 | 1 3 | 1 2 | 1 1 | | | *! | Chilled - *

Stirred - ! Highlighted – Order of placement into the cell wells. The tad of Luminol was the first in every trial. – Drops Pink Highlighted Row: Best Trial of the Day Table 3: MSDS Chemical Name | Ingestion | Skin Contact | Disposal | Inhalation | Luminol | Loosen clothing, if not breathing perform mouth to mouth recessitation. Do not induce vomit. | Wash with lots of water. Cover skin with emollient. | Not Available | Rest. Ventilate Area, seek medical attention. | Bleach | Drink Water. Do not induce vomiting. | Wash skin with water for 15-20 minutes. | Containerize and use absorbants on liquid. | Remove, fresh air. DMSO | Loosen clothing, if not breathing perform mouth to mouth recessitation. Do not induce vomit. | Wash with soap and water. | Waste container. | Fresh air | Discussion: The best trial of the experiement was on day two, trial B3. During that trial 1 mL cold Luminol was used and added to the cell well first, followed by five drops of DMSO, and five drops of bleach in that order. This was the best trial because it yielded the brightest and longest lasting glow compared to all of the others. On the trial before the same exact method was carried out except there was hydrogen peroxide in the mix also. In order to change things up, the peroxide was eliminated and that proved to be an effective tactic.

It became blatently apparent that some of the chemicals were not needed entirely including the NaOH, and HCL. By the trial B6, on the second da, y the HCL had been eliminated. Hydrogen peroxide was never eliminated but it

was noted as in trial B3 on the second day that the longest trial was performed without it. Many factors affected the results of each trial, some definitely more than others. For instance, for the entire first day, all trials were performed with the solid form of Luminol, and on the second day, starting with trial A2, the Luminol stock solution was used. As reflected in the table above, the stock solution created a much longer glow on average.

To furthur amplify the Luminol's effect from trial B1 on day two, the Luminol stock solution was used in a chilled form which created the best results of both days as seen in trial B3. It also became apparent that stirring the chemicals helped maintain the glow longer per trial C2 on day two. Luminol was the only chemical that was chilled, all other chemicals remained room temperature. The order of chemicals was an important factor in creating chemiluminescence as well. During the beginning trials of the first day the best order to add the chemicals was not apparent, but by trial C4 one thing was certain, the luminol needed to be the first chemical placed in the well. In trial C3, when Luminol was added last, there was only a small blue flash with no lingering glow at all.

Also, by the second day, it was realized that the bleach was reacting with the Luminol and if the bleach was added last, the glow did not fizzle out as quickly such as in trial B4 on the second day, which had a 23 second glow, subsequently improving results on day two as opposed to the first day. After completeing much more in-depth research on the topic of chemiluminescence other checmicals had been foun, that if the experiment was done over would have been requested, such as copper nitrate, which would have significantly extended the length of the glow. Conclusion: Using

1mL of chilled Luminol stock solution, five drops of DMSO, and five drops of bleach, in that order and stirring at the end, the longest glow of 36 seconds was created as per trial B3 on day two. The bleach reacting with the Luminol gave a bright glow, and the DMSO aided in the length of time the trial glowed.