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TOXIC CLOUD DEFEAT

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14. ABSTRACT The threat of biological weapons developed a new requirement to defeat toxic clouds. Currently, there are no methods to deal with such a threat. The goal of moving, burning, or neutralizing a toxic cloud that is endangering troops is projected. The threat of various toxic agents leads to additional challenges in detection and defeat. A technique using explosive charges to burn the toxins in the air was developed for large outdoor areas. Basic engineering tests were performed. Test results and techniques are included in this report.					
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INTRODUCTION

With the existence and threat of biological weapons, a new requirement exists to defeat toxic clouds. Currently there are no methods to deal with such a threat. The goal of moving, burning, or neutralizing a toxic cloud endangering troops is projected.

Objectives for this program are:

- Research an effective toxic cloud defeat method
- Demonstrate burning techniques
- Develop a method to create a controlled cloud

BACKGROUND

The threat of toxic agents such as anthrax, botulinum, ricin, aflatoxin, plague, and smallpox has spurred research in both detecting and defeating such agents. Research has been focused on decontaminating an area and objects using non-toxic methods. Some such methods use spray liquid or foam on the contaminated area. A spraying technique requires a human to physically stand in the contaminated area to disperse the decontaminant. This technique is ideal for small areas or indoors such as subways. However, for large areas of cloud like toxins another approach is necessary. This research project uses explosives to burn the toxins in the air. Such a technique would be suitable for large outdoor areas. Also, exposure time to the toxins is limited.

The threat of toxic clouds has become more realistic in recent years, but research in this field is just starting to flourish.

RESULTS

Experimental Design

In the development of a toxic cloud defeat method, a burning technique was selected since it appears to be the most effective and safest mode for the troops. The initial experimental design concept was to test multiple explosives in a confined chamber. The concept was to suspend a toxic cloud simulant within an enclosed chamber, detonate the respective explosive, and video the results.

Simulant

A nontoxic simulant was researched to provide a safe yet reasonable alternative for testing purposes. Two such simulants that were studied include corn starch and glycerin. Both of which are biological matter that burn fairly easily. Corn starch was used over glycerin because of its availability and cost. For the test 4 tbsp of corn starch were used per balloon.

Balloon

One device used to represent the event of toxic cloud formation through biological weapons was a simple balloon. Since the testing needed to be performed on a large scale, balloons with a 4 ft diameter were purchased instead of normal party size balloons. One challenge with using a balloon as an instantaneous dispersion device was keeping the corn starch suspended inside the balloon without it sticking to the walls due to static. A small computer fan was attempted to disperse the simulant, but did not adequately suspend the material. Other techniques investigated included using an antistatic spray on the balloon to minimize corn starch clinging to the walls. Also, the antistatic spray was used directly on the corn starch and dried in the oven to minimize the clinging effect. Neither of which produced the desired results. When researching other methods to suspend the simulant inside the balloon, an alternative method was discovered. According to a website by Loren Winters, a teacher of high-speed imaging at the North Carolina School of Science and Mathematics, the corn starch will take the form of the filled balloon after the balloon is broken. This method uses the static cling of the corn starch to create a uniform surface of the material after the balloon is broken (fig. 1).

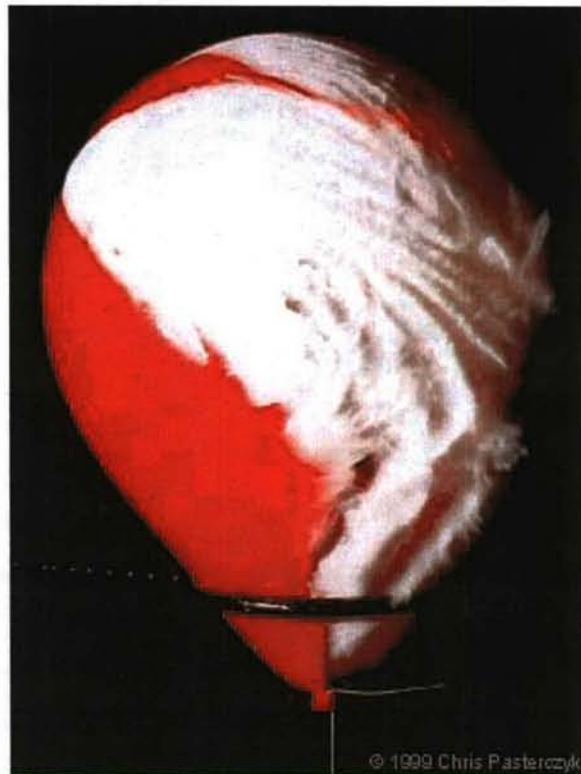


Figure 1
Corn starch in toy balloon
(Chris Pasterczyk and Steve Gardos, Noble and Greenough School)

Explosives

The explosives considered for this test were blast explosives that burn at a high temperature. Explosives with high aluminum content were considered. The explosives tested were YJ05 and Binex. Both of these explosives also exhibit a thermobaric effect. It was found that the fire ball produced by YJ05 was much smaller than Binex per unit mass of charge used. As a result of testing, the YJ05 pressed pellet produced a fireball approximately half the size of a 5-g Binex charge. In some instances of toxic cloud defeat, one explosive may be more appropriate than the other. When comparing videos of varying amounts of Binex, the size of the blast with respect to amount of explosive can be observed.

Test Setup

To test the effects of Binex and YJ05 on a cloud of biological matter (corn starch), the experiment was performed in a closed chamber (fig. 2). Four tablespoons of corn starch was added to an uninflated balloon 4 ft in diameter. Also, the container of YJ05 or Binex as well as a detonator was placed inside the balloon. The balloon was then inflated using compressed air to a diameter of approximately 2.5 ft to 3 ft, and the charge was centered in the balloon using the detonation cord attached to the detonator and then sealed using electrical tape. A string was attached to either side of the chamber to hang the balloon in the center of the chamber. Two detonators were placed on the outside of the balloon to break the balloon and distribute the corn starch into a cloud before the detonation of the main charge. Using a time delay generator, the main charge was detonated 20 ms after the two simultaneous detonators on the balloon. A Phantom 5 high speed digital camera was used to capture the event. To light the event, four dual shop lights were placed inside the chamber and two spotlights were placed in the camera ports to light the experiment. An exposure time of 500 μ s, a sample rate of 1000 pictures per second were used for the experiment, and the viewable area of the camera represented approximately a 4 ft by 4 ft area. Also, a post trigger setup was used where the camera continuously records until the trigger, and then 150 pictures are taken after the trigger.



Figure 2
Test setup including balloon and lights

Eight total shots were performed in this testing. Each of which will be explained in detail.

Shot 1 used a YJ05 pellet inside the balloon. The detonators on the balloon functioned properly; however, the detonator on the main charge did not function. Therefore, the results of the first shot included a cloud of corn starch surrounding the undetonated main charge (fig. 3).



Figure 3
Shot 1 - cloud photograph

Shot 2 used a YJ05 pellet inside the balloon. The results of this shot showed the cloud formed properly; however, when the YJ05 detonated, no visible burning of the corn starch occurred (fig. 4). Conclusion, either the amount of YJ05 was too small for the cloud or another explosive should be tested.



Figure 4
Shot 2 - YJ05 burn

Shot 3 used a Binex grenade inside the balloon. The results of this shot were not very clear. The cloud formed properly; however, when the Binex detonated, the light flooded the camera lens and a whiteout occurred. Conclusion, less Binex should be used for the next shot for observation purposes.

Shot 4 used approximately half the charge of a Binex grenade inside the balloon. The results of this shot were also somewhat unclear. As in shot 3, the cloud formed properly, but a whiteout occurred. However, once the area came into view again, there was no evidence of corn starch in the vicinity of the event (fig. 5). Conclusion, it appeared as though the corn starch was burned, but the results were not clear and need to be further verified.



Figure 5
Shot 4 - after whiteout $\frac{1}{2}$ grenade Binex

Shot 5 used 45.37 g in a small plastic film container, less than half of the charge of a Binex grenade inside the balloon. As in the previous shots, a cloud formed and a whiteout occurred and little data was obtained (fig. 6). Conclusion, less Binex should be used for the next shot.



Figure 6
Shot 5 - after whiteout 45.37 g Binex

Shot 6 used 5.54 g of Binex in a small container without a balloon. The results of this shot showed the entire event and no whiteout occurred. No balloon was used for this shot to establish a baseline for the amount of Binex that could be filmed and avoid a whiteout (fig. 7). The fire ball created by the 5.54 g of Binex did not fill the entire 4 ft by 4 ft viewable area by the camera; therefore, in shot 7, slightly more Binex was used.



Figure 7
Shot 6 - max fireball 5.54 g Binex

Shot 7 used 6.27 g of Binex in a small container inside the balloon. The cloud formed properly and the event detonated properly. The area of the fireball was much greater than in the previous shot and appeared to burn the corn starch (fig. 8). Conclusion, a baseline test should be performed to compare the size of the fireball with the added fuel (corn starch), to the size of the fireball without the balloon and corn starch.



Figure 8
Shot 7 - maximum fireball with corn starch 6.27 g Binex

Shot 8 used 6.27 g of Binex in a small container without a balloon and corn starch. The results of this shot verified the conclusions from shot 7. The fireball was not nearly as large as from shot 7 (fig. 9). Conclusion, the fire must be burning the corn starch as fuel; therefore, fulfilling the goal of burning a toxic cloud simulant.



Figure 9
Shot 8 - max fireball with no corn starch 6.27 g Binex

CONCLUSIONS

A successful project was carried out to show that explosives will burn biological matter. Due to the outcome of shots 7 and 8, there is evidence that Binex will burn a cloud of biological matter, in this case corn starch. The fact that the fire ball in shot 8 was much smaller than that of shot 7, where the only other fuel in the chamber was corn starch, shows that Binex was burning the corn starch. Because of these findings, future research may prove beneficial for integrating a system using explosives to control toxic clouds in the battlefield.

Summary of shots

Shots	Balloon	Explosive	Mass of explosive	Results
1	Yes	YJ05	1 pellet	Charge did not go
2	Yes	YJ05	1 pellet	Charge did not burn corn starch
3	Yes	Binex	1 grenade	Whiteout
4	Yes	Binex	1/2 grenade	Whiteout-evidence of burning
5	Yes	Binex	45.37 g	Whiteout-evidence of burning
6	No	Binex	5.54 g	Some burning occurred
7	Yes	Binex	6.27 g	Burning occurred
8	No	Binex	6.27 g	Less flame than shot 7

Using explosives, such as Binex, may be a viable approach for toxic cloud defeat. Based on this study more research, including possible delivery system, may be beneficial.

FUTURE PLANS

Some plans for expanding the toxic cloud research include collecting more quantitative data from the tests. Some desired information includes the concentration of the corn starch in the area after detonation, the density of the cloud, and the relationship of charge mass to blast radius. To gain some insight, modeling the reaction may be an effective tool in predicting the behavior of the system.

To experimentally determine corn starch concentrations, an air collection and analysis device would be necessary.

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