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PELLETIZED CS-2 FOR TERRAIN DENIAL

A PRELIMINARY FEASIBILITY STUDY

by

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July 1972

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13 ABSTRACT

In order to disperse CS-2 more effectively for terrain denial, pellets containing 75% CS-2 mixed with 25% calcium carbide have been formed. These pellets do not aerosolize directly when dropped from a fifty foot height nor do they aerosolize on impact with the ground. After impact with the ground, the carbide reacts with atmospheric moisture and the pellet disintegrates leaving CS-2 deposited on the ground in a readily aerosolizable form.

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Project 1W062116A081

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FOREWORD

The work described in this report was conducted under Project 1W062116A081, Chemical Dissemination and Dispersion Technology (U). This work was started in June 1967 and completed in September 1968. The experimental data are recorded in notebook 7840.

The volunteers in these tests are enlisted US Army personnel. These tests are governed by the principles, policies and rules for medical volunteers as established in AR 70-25.

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DIGEST

In order to disperse CS-2 more effectively for terrain denial, pellets containing 75% CS-2 mixed with 25% calcium carbide have been formed. These pellets do not aerosolize directly when dropped from a fifty foot height nor do they aerosolize on impact with the ground. After impact with the ground, the carbide reacts with atmospheric moisture and the pellet disintegrates leaving CS-2 deposited on the ground in a readily aerosolizable form.

PELLETIZED CS-2 FOR TERRAIN DENIAL - A PRELIMINARY FEASIBILITY STUDY

I. INTRODUCTION.

The dissemination of CS-2 (o-chlorobenzylidenemalononitrile blended with 5% Cab-O-Sil[1] ST-1) for terrain denial presents difficultiies not found in the dissemination of other agents for direct effect. The powder must be spread on the ground uniformly but the dissemination technique must not cause the powder to aerosolize during emplacement. Currently, the Army uses the XM925 bomb, the XM28 dispenser, and the Air Force chemical bomb BLU-52A/B to disperse CS-2 for terrain denial.[1] In each of these air-dropped munitions, the CS-2 powder is carried to the ground and then released, either explosively or mechanically. This agent dissemination results in nonuniform ground deposition and considerable loss of agent through aerosolization. Reports from the field reveal that it is possible to find paths through the contaminated area where there is little or no agent.[2]

The effectiveness of CS-2 for terrain contamination can be improved by preagglomerating the agent into pellets of a size to produce ballistic aimability and to eliminate aerosolization during dispersal. If these pellets are dispersed from a continuous release hopper, uniform target coverage will be achieved. The pellets must revert to an aerosolizable powder after dispersal on the target.

The formation of agglomerates in CS-2 powder in an uncontrolled fashion is an undesirable process. In fact, the additive contained in the CS-2 is specifically an antiagglomerant. Controlled agglomeration as defined in this report is a desirable process. The method of agglomeration can be by means of a binder, by compaction, by fusion, or other similar process. Depending on the method chosen, the agglomerates may be either similar or variable in shape and size with a higher bulk density than the loose powder.

Several different approaches have been tested to prepare CS-2 in an agglomerated form for terrain denial.[3,4] In these preparations, the CS-2 has been agglomerated with a mixture of components chosen so that the combination will both hold the CS-2 together and then deagglomerate upon exposure to the atmosphere. The main deficiencies of these procedures are that the deagglomeration process does not revert all the material to a powder as reaerosolizable as CS-2 and the time needed for the deagglomeration is quite long. This report describes one approach that has shown promise to meet the objectives for denial of terrain using CS-2.

II. EXPERIMENTATION.

The method chosen to agglomerate the CS-2 powder was by pressing cylindrical pellets. A mold of 1 1/2-inch diameter was used. The pellets were formed using a Carver Laboratory press at loadings of 250 pounds (141 psi), 500 pounds (283 psi), and 2000 pounds (1131 psi). Ten grams of

[1] Department of the Army Field Manual 3-2, Tactical Employment of Riot Control Agent CS. April 1970.

[2] Personal communication with Chemical Staff Officers from SEA.

[3] Sweeney, F. J. and Tarpley, W. B. Contract DAAA15-70-C0051. The Franklin Institute Research Laboratories. Disintegrating Agent Pellets (U). Final Report. August 1970. UNCLASSIFIED REPORT.

[4] MacLean, R. L. Contract DAAA15-69-C-0450. Aerojet-General Corporation. The Study of Pelletized CS-2. (U). Final Report. December 1969. UNCLASSIFIED REPORT.

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powder were used in each pellet giving pellets approximately 1/2 inch in height. To assist in deagglomerating the pellet after its impact with the ground, calcium carbide powder was blended with the CS-2 in the ratio of three parts CS-2 by weight to one part calcium carbide. Preliminary tests had shown that this ratio of CS-2 to carbide gave excellent results in breaking up the pellets upon exposure to the atmosphere. The pellets were wrapped in aluminum foil and stored in a dessicator. Control pellets, consisting of CS-2 blended with 25% by weight talc powder were prepared.

The calcium carbide reacts with atmospheric moisture to produce acetylene gas and calcium oxide.

$$CaC_2 + H_2O_{(g)} \longrightarrow CaO + C_2H_{2(g)}$$

In order to determine if the strongly basic hydrated CaO was degrading the CS-2, powdered calcium carbide was mixed into CS-2, aerated to react the carbide, and allowed to stand for fourteen days. A sample of this material was mixed with absolute ethanol and the resulting solution was filtered to remove the silica and calcium oxide. The ultraviolet absorption spectrum of the solution was recorded with a Beckman (Model DB) Spectrophotometer using absolute alcohol as the reference liquid. The strong absorption peak at 295 mμ and the absence of a peak at 250 mμ confirmed that the CS was not degraded.[5]

A drop test of these pellets was conducted using the 50-foot high tower at Carroll Island. The foil-wrapped pellets were removed from the dessicator, unwrapped, and then dropped close to the base of the tower. The ground was hard-packed, dry, and bare of vegetation. Observers recorded the appearance of the pellet during flight and on impact. The disintegration of the pellet was observed and a photographic record of the results was made. The pellets containing CS-2 mixed with talc were also dropped as controls. In order to observe the reaerosolizability of the CS-2, a volunteer equipped with a protective mask stepped onto the disintegrated pellet and the results were photographed.

III. RESULTS AND DISCUSSION.

The most important property of these pellets to be studied is the pellet disintegration and the recovery of the CS-2 in readily reaerosolized form. The disintegration of CS-2 pellets containing carbide was first observed in the laboratory. Upon exposure to air, the pellet developes cracks all over the exposed surface. The pellet becomes somewhat crumbly when touched but it does not fall apart by itself. For the pellets containing 25% carbide, the above disintegration process was completed in under fifteen minutes.

The more meaningful test of the disintegration was the drop test from the top of the fifty-foot tower. Figures 1, 2, and 3 show in sequence: the pellet before the test, the pellet on the ground after drop, and finally the reaerosolization of the CS-2 when stepped on by a volunteer. The pellet containing carbide breaks up to a considerable extent upon impact. The further disintegration of the pellet by the carbide reaction results in a reversion of the material to aerosolizable CS-2.

[5] Sass, S. Personal communication.

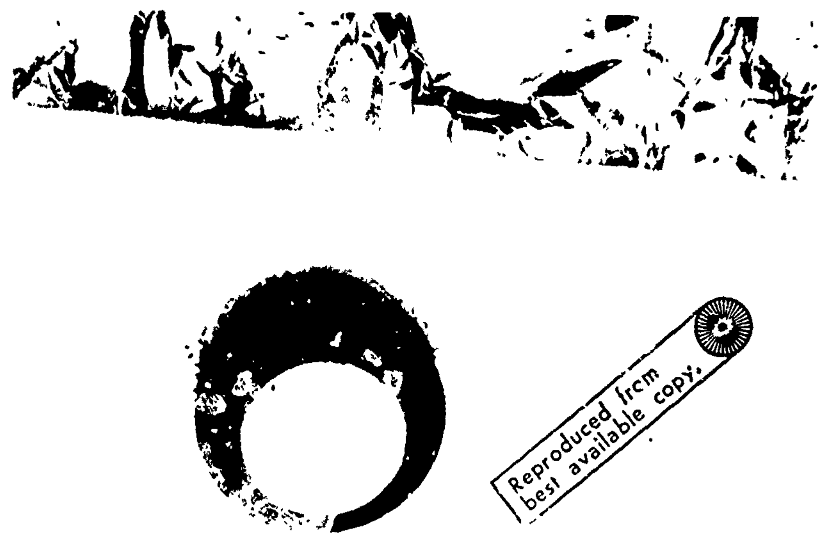

Figure 1. Pelletized CS-2 Before Drop Test

A summary of the drop tests is presented in the table. In this test, none of the pellets disintegrated in flight. By pelletizing the powder, it is possible to disperse CS-2 for terrain denial without significant downwind loss during dispersal. The pellets pressed at 250 and 500 pounds loading resulted in chunks of material with very little loose powder. The pellets containing talc in place of the carbide gave much poorer breakup than did the carbide containing pellets. Of the control pellets, only the pellet pressed at 250 pounds load resulted in any powder at all. The CS-2 did not reaerosolize from the talc-CS-2 chunks after impact.

Table. CS-2 Pellet Drop Test Results

All pellets contained 75% CS-2 and were dropped from a fifty foot high tower.

Pellet composition	Disintegration in flight	Disintegration in impact
25% talc pressed at 2000 lb	None	Large chunks, no loose powder
25% CaC_2 pressed at 2000 lb	None	Small chunks, some loose powder
25% talc pressed at 500 lb	None	Big chunks, no loose powder
25% CaC_2 pressed at 500 lb	None	Well dispersed powder, some small chunks
25% talc pressed at 250 lb	None	Chunks with some loose powder
25% CaC_2 pressed at 250 lb	None	Powder somewhat dispersed
25% CaC_2 pressed at 250 lb	None	Powder somewhat dispersed

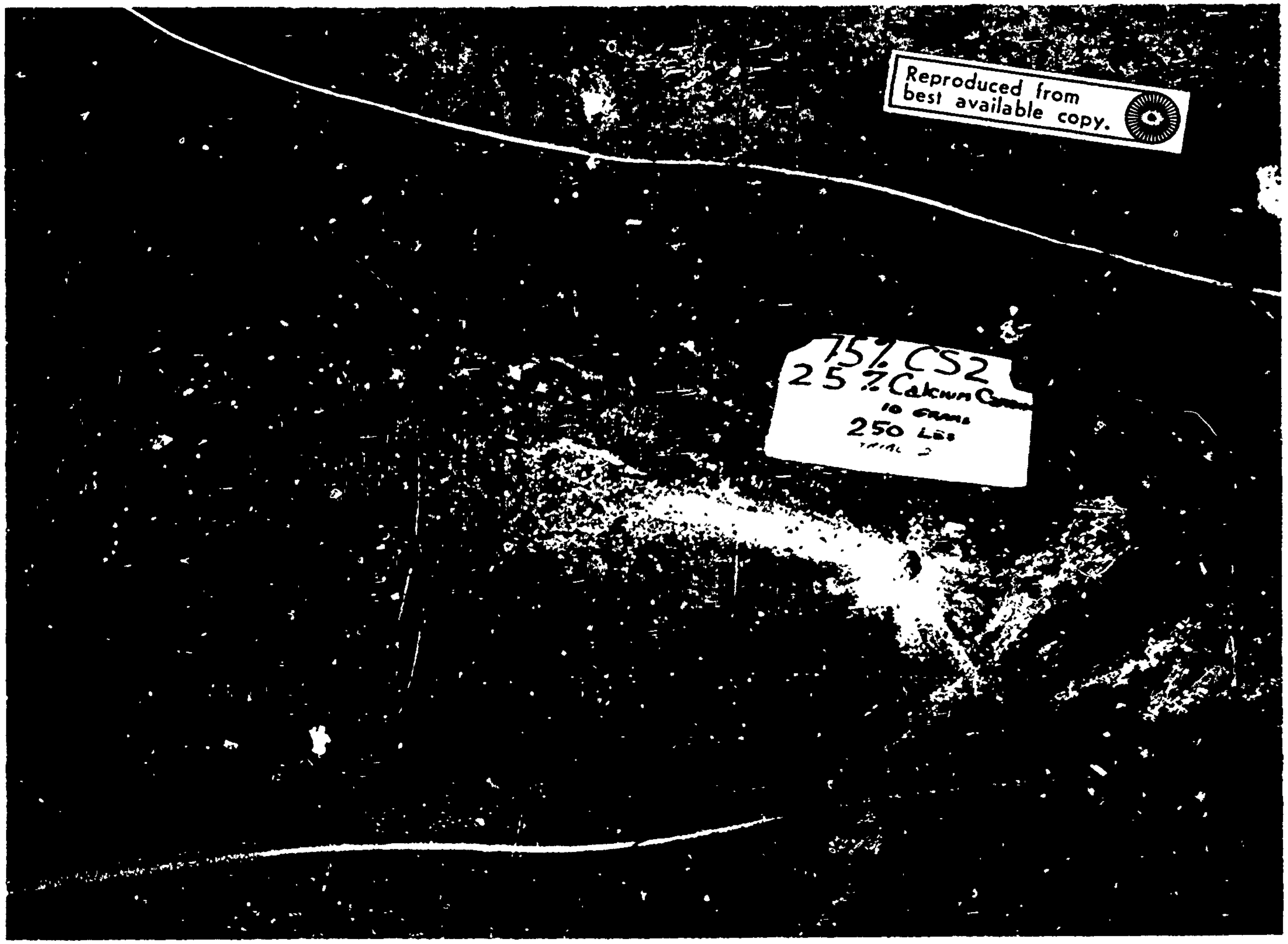

Figure 2. Pelletized CS-2 After Drop Test

Figure 3. Reaerosolization of Pelletized CS-2 After Drop

As stated earlier, reports from Chemical Officers in the field reveal that the ground deposition of CS-2 from air-dropped munitions leaves large uncontaminated areas. It is possible to pick a path through the area without encountering any agent. It is believed that the use of pellets such as described in this report will result in a more uniform distribution of the agent on the ground. This does not imply that all the area will be contaminated. There will be many small uncontaminated areas rather than a few large areas. Under normal conditions it will not be possible for an intruder to pick a path through the area without encountering the agent material.

The use of calcium carbide as the reactive additive presents the hazard of explosive acetylene gas being formed in a leaking munition. This may necessitate safety design features in addition to the requirement for leak-tight munitions.

Continued research on this program is needed to identify the optimum mixture of carbide, CS, and silica to accomplish long-term terrain denial. As a corollary, research is needed on the methods of dispersing pelletized CS-2 to achieve uniform ground deposition of the agent. Other related subjects that need to be studied are the optimum pressure that should be used to press the pellets, the most desirable pellet size and shape, and the effects of weathering on the powder after deposition on terrain.

IV. CONCLUSION.

The blending of CS-2 with calcium carbide and pelletizing the resulting powder can produce an effective CS-2 system for terrain denial use.