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COMPARISON OF DECHLORANE AND HEXACHLOROETHANE
IN SMOKESCREEN COMPOSITIONS

by

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Weapons Research Division
Directorate of Research
U. S. ARMY CHEMICAL RESEARCH AND DEVELOPMENT LABORATORIES
Army Chemical Center, Maryland

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FOREWORD

This work was authorized under Task 4C30-07-007-03, Counter-measures Research (U), Subtask III, Smoke Research (U). The work was started in May 1956 and completed in September 1960. The experimental data are recorded in notebook 4938.

Acknowledgments

The authors are indebted to Mr Edmund J. Owens and Mr Charles Punte of the Toxicology Division, Directorate of Medical Research, for the toxicity data presented in this report.

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Chemical Research and Development Laboratories Special Publication 1-27

COMPARISON OF DECHLORANE AND HEXACHLOROETHANE
IN SMOKESCREEN COMPOSITIONS

Task No.: 4C30-07-007-03

Notebook No.: 4938

Date Started: May 1956

Date Completed: September 1960

APPROVED:


CARL M. HERGET, Ph. D.
Director of Research

DIGEST

A comparison of two smokescreen compositions, Dechlorane and hexachloroethane, was made with respect to smoke volume, burning time, storage stability, and toxicity.

The smoke volume and burning time of the Dechlorane composition are comparable to HC compositions. Its storage stability is superior to standard HC compositions. No significant difference in relative toxicity between the smoke clouds from the two compositions was found; both smokes produce chronic pathological degeneration of tissues of the respiratory system.

COMPARISON OF DECHLORANE AND HEXACHLOROETHANE IN SMOKESCREEN COMPOSITIONS

I. INTRODUCTION.

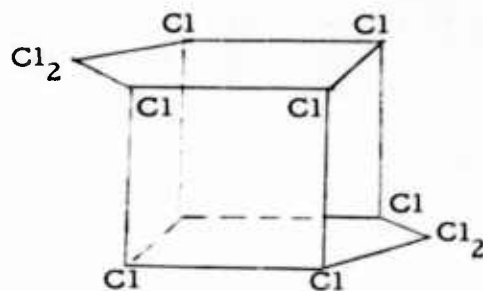
The object of this study was to evaluate perchloropentacyclo (5.2 1.0^{2.6}.0^{3.9}.0^{5.8}) decane (Dechlorane) in comparison with hexachloroethane in smokescreen compositions.

II. INVESTIGATIONAL PROCEDURES AND RESULTS.

Perchloropentacyclo (5.2 1.0^{2.6}.0^{3.9}.0^{5.8}) decane was investigated under the continuing research program on smokescreen compositions. Commercially, the compound is known as Dechlorane and is manufactured by the Hooker Chemical Company, Niagara Falls, New York.

The following chemical and physical properties are known for this compound:

A. Structure:



B. Melting point: 485°C

C. Density: 2.020 gm/cc at 24.3°C

D. Heat of combustion: 1,261 kcal/gm mole (calculated)
1,173 kcal/gm mole (experimental)

The oral toxicity in mice (as reported by Hooker Chemical Company) is 6 gm/kg (LD50).

Differential thermal-analysis data indicate that vaporization and decomposition become appreciable at 230° and 300°C, respectively.

The Dechlorane was tested by blending the material with zinc oxide and aluminum according to the standard procedures for preparing HC smokescreen compositions. The compositions were consolidated at a 5,000-pound dead load into the M8 grenade body, topped with first fire (MS511), and ignited. A composition of the following parts by weight produced the most satisfactory screening smoke:

Dechlorane -----	31.0
(Hooker Chemical Company)	
Zinc oxide-----	62.0
(MIL-Z-291b, Grade I or II)	
Aluminum, grained -----	7.0
(JAN-A-512, Grade I)	

The burning time for this composition varied from 105 to 150 seconds, which is within the specified burning range for smokescreen grenades. The screening effect and smoke volume produced by the composition were similar, by visual observation, to those produced by the standard hexachloroethane composition (figures 1 and 2, appendix).

M8-type grenades containing this composition were superior in storage characteristics to standard M8-HC grenades after 90-day climatic storage in hermetically sealed containers at 160°F. All units functioned satisfactorily and exhibited little if any corrosion.

The toxicity of the combustion products of the Dechlorane composition was determined by a series of chamber tests conducted by the Toxicology Division, Directorate of Medical Research, using dogs, rabbits, and rats as test animals. The results of these tests are given in tables 1, 2, and 3, appendix. The combustion products were found to be toxic because of the zinc chloride, which is used in both this composition and in the HC composition. For this reason, the toxic effects are not significantly different from those produced by the combustion of HC smoke containing hexachloroethane.

An interesting development during these toxicity studies was the appearance of chronic pathological findings in the test animals. Microscopic examination of tissues from the respiratory system indicated progressive development of pulmonary inflammation found in the bronchial tree and the supporting connective tissue of the lung. This condition appeared in both HC and Dechlorane smoke exposures. An exhaustive study to determine the cause of these lesions is currently under way using monkeys as test animals. It is estimated that this study will be completed within the next 12 months.

III. CONCLUSIONS.

The smoke volume and burning time of the Dechlorane composition are comparable to HC compositions. Its storage stability is superior to standard HC compositions. No significant difference in relative toxicity between the smoke clouds from the two compositions was found; both smokes produce chronic pathological degeneration of tissues of the respiratory system.

APPENDIX
FIGURES AND TABLES

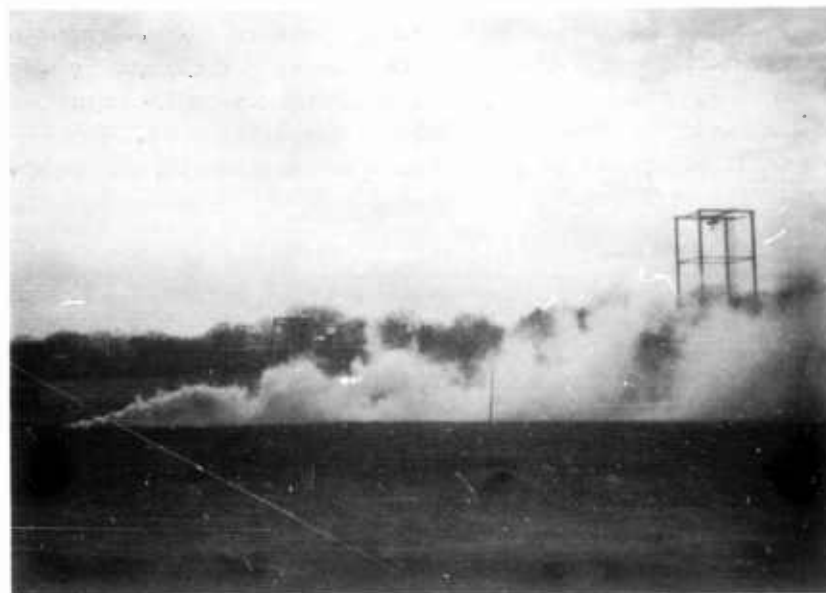


FIGURE 1
SMOKE PRODUCED FROM GRENADE CONTAINING HC COMPOSITION
(Burning time, 2 min 40 sec; Windspeed, 4 to 8 mph;
Distance from item, 60 yards)



FIGURE 2

SMOKE PRODUCED FROM GRENADE CONTAINING
DECHLORANE COMPOSITION

(Burning time, 2 min 20 sec; Windspeed, 4 to 8 mph;
Distance from item, 60 yards)

TABLE 1
COMPARATIVE RESPONSE OF DOGS, RABBITS, AND RATS EXPOSED
TO THERMALLY GENERATED HC OR DECHLORANE

Smoke	Particle mmd	C _t		Exposure time	Mortality fraction		
		Zn	Cl ₂		Dogs	Rabbits	Rats
	μ	mg min/cu m		min			
HC	2.0	36,420	45,000	30	3/4	3/4	2/10
HC	2.0	24,120	28,500	15	2/4	3/4	2/10
HC	2.0	4,750	8,200	5	1/4	2/4	1/10
Dechlorane	2.1	12,120	19,800	30	2/4	4/4	5/10
Dechlorane	2.1	900	10,500	15	0/4	2/4	5/10
Dechlorane	2.1	3,200	5,800	5	0/4	0/4	1/10

Note: One munition was used for each exposure.

TABLE 2
PARTICLE-SIZE DISTRIBUTION OF HC AND C₁₀C₁₂

Cascade-impactor stage	Particle-size distribution		Micron size
	HC (mmd = 2.0 μ)	C ₁₀ C ₁₂ (mmd = 2.1 μ)	
		%	
1	7.9	10.3	10.9
2	9.8	17.2	4.5
3	15.2	13.3	2.3
4	33.4	26.0	1.4
5	25.1	13.1	0.74
6	8.6	20.1	0.41

TABLE 3
PATHOLOGIC EFFECTS

Animals	Exposure time	Smoke	
		HC	Dechlorane
Dogs	min		
	30	None evaluated.	Severe, chronic, interstitial, bronchial pneumonia caused by an inflammatory process.
	15	—	Same as above; not as severe or extensive. Inflammation of fibrotic plugs or sears in the lumen of the bronchial tree.
Rats	30	Severe, chronic, interstitial, bronchial pneumonia caused by an inflammatory process.	Severe, chronic, interstitial, bronchial pneumonia caused by an inflammatory process.
	15	Same as above; not as extensive.	Same as above.
Rabbits	15	Abscess surrounded by fibrotic tissues; scattered areas of interstitial fibrosis.	Accumulation of pigment-bearing macrophages in the alveolar spaces.

Note: In this study, main emphasis was placed on the respiratory tract. In the rat, the heart, spleen, liver, and kidney were also studied and found to be free of lesions.

Interstitial pneumonia refers to pulmonary inflammation in which the bronchial tree and the supporting connective tissues of the lung are chiefly affected.

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