MISTING OF LOW VAPOR PRESSURE HALOCARBONS

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ABSTRACT

Several candidate Halon 1301 (bromotrifluoromethane) replacements having a low ozonedepletion potential (ODP) have higher boiling points (usually corresponding to higher molecular weights) and lower vapor pressures than Halon 1301. This laboratory-scale study investigates the **use** of misting systems to provide total-flood fire protection with these lower vapor pressure halocarbons.

Five chemicals were investigated: 2,2-dichloro-1,1,1-trifluoroethane, $CHCl_2CF_3$ (HCFC-123); pefluorohexane. C_6F_{14}; perfluoromethylcyclohexane, $C_6F_{11}CF_3$; pemuorodimethylcyclohexane. $C_6F_{10}(CF_3)_2$; and perfluoromethyldecalin, $C_{10}F_{17}CF_3$. These materials have boiling points ranging from 24 °C to 155 °C and molecular weights between 153 and 512 (compared with Halon 1301, which has a boiling point of -57.8 "C and a molecular weight of 149). Testing was conducted using the 175-liter enclosed NMERI Laboratory Extinguishment and Emissions Test Chamber (LEETC). This chamber has been used in the past to test Halon 1301 replacement candidates; however, it has not been used before the present investigation to examine misting systems.

Two types of misting nozzles were used: hollow-cone spray pattern ("atomizing") and full-cone (**"SpiralJet®"**) spray pattern. The hollow-cone spray nozzles consisted of a nozzle body, orifice insert in a cap, and a core. Five sizes **of** the hollow-cone nozzles were used in this testing. The full-cone nozzles were one piece with a spiral design and with larger flow rates and drop sizes. Qualitative tests were run on three sizes of the full-cone nozzles using water; however. only the lowest flow rate full-cone nozzle was used in any fire extinguishment testing reponed in this paper. At this time, no droplet size information has been collected.

The studies showed the following:

1. In comparison with halocarbons. water exhibited relatively poor extinguishment of hydrocarbon fuel fircs when misted into an enclosed 175-liter space.

2. Four halocarbon chemicals — HCFC-123, pefluorohexane, perfluoromethylcyclohexane, and pemuorodimethylcyclohexane, having boiling points between 24 °C and 102 °C — showed highly effective fire extinguishment. Note that several of these agents have boiling points significantly above room temperature. Only one halocarbon agent. pefluoromethyldecalin, with a boiling point of 155 °C, **was** found to have poor fire extinguishment abilities in this study.

3. These observations indicate that agent misting can extinguish hydrocarbon liquid fuel fires in enclosed volumes using amounts as low as 25 percent of the theoretical amount predicted from cup burners for halocarbons with boiling points of 102 °C and below. The very limited testing indicates that extinguishment ability falls off significantly at a boiling point between 102 and 155 °C.

4. Halocarbon chemicals having boiling points significantly higher than that of Halon 1301 appear highly promising as Halon 1301 replacements **for** area protection against fires when discharged through misting systems. Additional studies are needed to determine the hold time, inertion characteristics. and optimum droplet size distribution. Studies are also needed to determine the ability of such systems to protect against explosions.

5. Significant corrosion (pits and white corrosion deposits) of the LEETC was observed following these tests. despite the fact that the chamber walls were nickel-plated. It was impossible to determine whether the corrosion was worse with any particular agent, since the corrosion appeared to increase as the testing program progressed. The corrosion appeared to be **due** to combustion products rather than to the neat agent.

INTRODUCTION

Since many of the chemicals proposed as Halon 1301 replacements have boiling points significantly higher than the currently used agent, an alternative means of dispensing the chemicals may be required in order to provide three-dimensional fire and explosion protection. A number of low volatility halocarbons (high molecular weight perfluorocarbons, hydrofluorocarbons, hydrochlorofluorocarbons, unsaturated bromocarbons, geminal bromochlorocarbons, geminal dibromocarbons, and fluoroiodocarbons) could provide prolonged fire protection as stratospheric ozone-protective extinguishants for an enclosed area if they were dispersed as aerosols. Though this concept had never been subjected to testing, it could provide an acceptable approach to total-flood fire protection.

This paper presents some initial, preliminary work on fire suppression testing with misted perfluorocarbons and one hydrochlorofluorocarbon. At this time, drop size information is qualitative only; however, future quantitative drop sizing work is planned.

TEST SETUP AND PROCEDURES

Test Apparatus

Testing was conducted using the Laboratory Extinguishment and Emissions Test Chamber (LEETC). This chamber has been used in the past to test Halon 1301 replacement candidates (Ref. 1); however, it has not been used before the present investigation to examine spray systems.

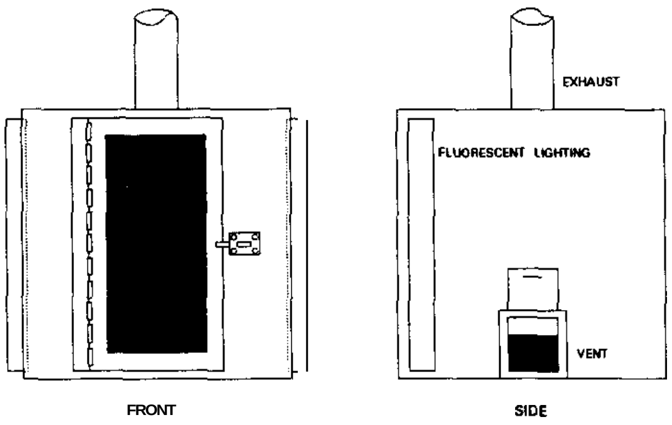

Figure 1. NMERI **LEETC.**

The NMERI LEETC is a 175-liter enclosed metal test chamber (Figure 1) which can be placed in a standard-sized fume hood. The apparatus is used (1) to determine extinguishment characteristics of total-flood agents and (2) to characterize and quantify emission products from extinguished fires. No emission product characterization studies were performed during the present study.

The walls and bottom of the chamber are 0.476-cm (3/16-inch) thick nickel-plated aluminum mounted on a steel frame. To avoid possible warping with large fires, the top is constructed of 0.476-cm (3/16-inch) nickel-plated steel. Nickel plating is used to reduce the interaction of the emission products and chamber materials. A hinged door at the front provides access, and a window, 20.96 by 40.6 cm (8.25 by 16.0 inches) , allows a 852-cm^2 (132 in^2) viewing area for visual observation and video documentation. Two 10.16-cm (4-inch) square vents, which can be opened to varying degrees, are placed on the centerline toward the bottom of each side. The opening in the 10.16-cm (4-inch) inside diameter chimney on the center of the top plate can be adjusted with a damper. This chimney can also be entirely blocked by a plate laid across the top. Fluorescent lights running from top to bottom toward the front of each side panel provide interior lighting. Four threaded posts are suspended from the top of the LEETC to suspend baffles, as needed. For the testing reported here, a 10.8-cm (4.25-inch) square, 0.32-cm (1/8-inch) thick aluminum deflection plate was suspended from the top of the chamber using a clamp to one of the posts.

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1. Kibert, C. J., and D. S. Dierdorf, "Encapsulated Micron Aerosol Agents," ***Proceedings, Halon Alternatives Technical Working Conference***, Albuquerque, New Mexico. May 1993, pp. 421-435

Nozzles

Two types of misting nozzles, both manufactured by Spraying Systems Co., Wheaton, Illinois, were used: Type N Hydraulic Atomizing Nozzles, with a hollow-cone spray pattern, and SpiralJet® Spray Nozzles, with a full-cone spray. In the following discussion. drop size information is qualitative only.

The Atomizing Nozzles consist of a nozzle body. orifice insert in a cap. and a core. Five sizes of the Atomizing Nozzles were used in this testing (Table 1). As the nozzle number increases from ".60" to "26," the discharge rate and drop size increase. The SpiralJet® spray nozzles are one piece with larger flow rates and drop sizes. Qualitative tests were run on three sizes (Table 2) using water; however, only the 12007 nozzle, which had the lowest flow rate among the SpiralJet® nozzles, was used in the fire extinguishment testing in this project. This decision was made after the preliminary qualitative tests with water showed sprays resembling standard water sprinkler discharges with the other two SpiralJet® nozzles. The nozzle flow rates are shown in Tables 3 and 4 and are taken from the manufacturer's literature.

Table 1. Type N Hydraulic Atomizing Nozzles'

Nozzle No.	Core No.	Spray Angle (deg)			Nominal Orifice Diameter	
		40 psig‡	80 psig‡	300 psig‡	(in)	(mm)
.60	206	†	35	65	0.016	0.406
2	216	70	75	77	0.028	0.711
6	225	73	79	81	0.042	1.067
14	421	85	88	90	0.076	1.930
26	625	73	74	77	0.086	2.184

'From manufacturer's literature.

‡Pressures are gauge at nozzle inlet; 1 psig = 6.89kPa.

†Not given.

Table 2. SpiralJet® Spray Nozzles'

Nozzle No.	Pipe Size	Spray Angle‡	Nominal Orifice Diameter		Free Passage Diameter		Nozzle Length	
	(in)	(deg)	(in)	(mm)	(in)	(mm)	(in)	(mm)
12007	0.250	120	0.09375	2.38	0.09373	2.38	1.875	47.62
17030	0.375	170	0.1875	4.76	0.125	3.18	1.875	47.62
17082	0.375	170	0.3125	7.94	0.125	3.18	1.875	47.62

'From manufacturer's literature.

*Spray angle for water at 10 psig (68.9kPa).

Table 3. Flow Rates for Atomizing Nozzles (Gal/Hr)*

Nozzle No.	Pressure (psi)‡								
	30	40	60	100	200	300	500	700	1000
.60	t	t	t	0.95	1.3	1.6	2.1	2.5	3
2	1.7	2	2.5	3.2	4.5	5.5	7.1	8.4	10
6	5.2	6	7.3	9.5	13.4	16.5	21	25	30
14	12.1	14	17.1	22	31	38	50	59	70
26	23	26	32	41	58	71	92	109	130

'From manufacturer's literature; 1 gal/hr = 4.4546 Uhr.

‡Pressures are gauge at nozzle inlet: 1 psi = 6.89 kPa.

†Not given.

Table 4. Flow Rates For SpiralJet® Nozzles (Gal/Min)*

Nozzle No.	Pressure (psi)				
	10	20	40	100	400
12007	0.7	0.99	1.4	2.2	4.4
17030	3	4.2	6	9.5	19
17082	0.2	11.6	16.4	26	52

*From manufacturer's literature; 1 gal/min = 4.4546 Umin.

‡Pressures are gauge at nozzle inlet; 1 psig = 6.89 kPa.

Chemicals

The chemicals used in this testing are listed in Tat' : 5.

Table 5. Halocarbons U. d in Misting Tests

International Union of Pure and Applied Chemistry (IUPAC) Name	Common Name	Formula
2,2-Dichloro-1,1,1-trifluoroethane	HCFC-123	$CHCl_2CF_3$
Tetradecafluorohexane	Perfluorohexane	
Monokis(trifluoromethyl)undecafluorocyclohexane	Pefluoromethylcyclohexane	$C_6F_{11}CF_3$
Bis(trifluoromethyl)decafluorocyclohexane	Perfluorodimethylcyclohexane	$C_6F_{10}(CF_3)_2$
Monokis(trifluoromethyl)heptadecafluorobicyclo[4,4,0]decane	Perfluoromethyldecalin	$C_{10}F_{17}CF_3$

Cup-burner extinguishment concentrations for these chemicals and the extinguishing concentrations as determined by the NMERI/CGET 5/8-scale cup burners are shown in Table 6 (Ref. 2). The agent quantities required to achieve these concentrations in the 75-liter LEETC were calculated from the cup-burner values and the liquid agent densities and are also shown in this table. The quantity given for perfluoromethyldecalin is estimated since cup-burner data are not available for this compound. Water was also used in this testing as a baseline agent and to test nozzle flow. The properties of the chemicals used are shown in Tables 7 and 8.

Table 6. Cup-Burner Extinguishment Concentrations

Common name	Formula	Extinguishment Concentration (% by volume)	Amount Required for LEETC (mL)
HCFC-123	$CHCl_2CF_3$	7.1	84
Pemuorohexane	C_6F_{14}	4.4	201
Perfluoromethylcyclohexane	$C_6F_{11}CF_3$	3.5	96
Perfluorodimethylcyclohexane	$C_6F_{10}(CF_3)_2$	3.2	100
Perfluoromethyldecalin	$C_{10}F_{17}CF_3$	(3.6)’	73

‘Cup-burner tests were not determined for this agent. The extinguishment concentration given is that of perfluorodecalin, $C_{10}F_{18}$

Table 7. Properties. Higher Molecular Weight Agents’

Empirical formula. primary component	$C_6F_{11}CF_3$	$C_6F_{10}(CF_3)_2$	$C_{10}F_{17}CF_3$
Boiling point (“C)	76	102	155
Pour point (“C)	-30	-70	-70
Molecular weight	350	400	512
Density (kg/L)	1.788	1.828	1.972
Viscosity (kinematic) (mm^2/sec)	0.873	1.06	3.25
Viscosity (dynamic) (mPa-sec)	1.561	1.919	6.41
Surface tension (mN/m)	15.4	16.6	18.5
Vapor pressure (kPa)	14.1	4.8	0.290
Heat of vaporization at boiling point (kJ/kg)	85.9	82.9	75.5
Specific heat (kJ/kg °C)	0.963	0.963	1.09

*Temperature-dependent properties are given at 25 °C unless otherwise noted,

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[2] “Cup-Burner Test Results,” ***Technical Update Series,*** CGET 1, Center for Global Environmental Technologies, University of New Mexico, Albuquerque, New Mexico. 1993, 8 pp.

Table **8.** Properties, Lower Molecular Weight Agents'

	Water	Perfluorohexane	**HCFC-123**
Empirical formula	H_2O	C_6F_{14}	$C_2HCl_2F_3$
Boiling point (°C)	100	56	24
Pour point (°C)	0	-90	Unknown
Molecular weight	18.01	338.03	152.93
Density (kg/L)	1.00	1.68	1.462
Viscosity (kinematic) (mm^2/sec)	0.8904	Unknown	0.307
Surface tension (mN/m)	71.97	12	Unknown
Vapor pressure (kPa)	3.167.	30.9	*96.5*
Heat of vaporization at boiling pt (kJ/kg)	2,257	88	172
Specific heat of liquid (kJ/kg °C)	4.1796	1.05	0.689

*Temperature-dependent properties are given at 25 °C.

Procedure

The discharge nozzles were placed at the lop center of the LEETC. Testing was conducted with the aluminum deflector plate suspended at distances of 1.5, 4.5, and 10 inches (3.8, 11.4. and 25.4 cm) below the nozzle tip (corresponding to positions noted as "high," "medium," and "low." Most tests were performed with the deflector plate in the medium position. The fire pans were placed on the floor of the LEETC, on the center line with the nozzle and the deflector plate. Five pans were available for use (Table 9), and some preliminary testing was performed for each using water. Except where noted (one series of tests with perfluorohexane), all tests reported here used the No. 2 fire pan. Approximately 0.635 cm (1/4 inch) ofn-heptane fuel was floated on water for all tests. Many investigators use the aspect ratio of the fire pan area to the total chamber volume in square feet per 1000 cubic feet as a measure of fire size. Fires rated as "small," "medium," and "large" have aspect ratios of 0.06, 0.6, and 6 1.149 ft^2/1000 ft^3 respectively. Note, however, that no technical justification has been given for using the aspect ratio as a measure of fire size. The No. *2* pan used for most tests has an aspect ratio of 1.149 ft^2/1000 ft^3, corresponding to a fire size between "medium" and "large."

Table **9.** Fire Pans

Pan No.	Depth		Diameter		Area		Aspect Ratio'
	(in)	(cm)	(in)	(cm)	(in^2)	(cm^2)	(ft^2/1000 n3)
1	0.750	1.905	0.875	2.222	0.601	3.877	0.674
2	1.625	4.128	1.562	3.967	1.918	12.37	1.149
3	2.000	5.080	3.000	7.620	7.069	45.61	7.923
4	2.250	5.715	4.000	10.160	12.566	81.07	14.09
5	2.000	5.080	8.000	20.320	50.266	324.3	56.34

'Ratio *of* fire pan area *to* **LEETC** interna.

For each test, the appropriate volume of water or halocarbon agent was added to the discharge cylinder using a syringe, and the cylinder was pressurized with nitrogen. The vents on the LEETC were then closed, and the fuel in the fire pan was ignited and allowed to bum for approximately 30 seconds with the LEETC door open. The door was then closed, and the solenoid was activated to allow discharge. The fire was observed to determine whether extinguishment occurred. For many, but not all, tests the discharge time and the time to extinguishment, if any, were recorded. If extinguishment did not occur. the fire was extinguished with a plate inserted through a vent, and the chamber was allowed to air out through the stack in preparation for the next test. The stack was kept open during all tests.

TEST RESULTS

Nitrogen Discharge

To determine the effect of nitrogen-only discharges on fires, the discharge cylinder was filled with nitrogen to five different pressures, and extinguishments were attempted using nitrogen discharge only. This was done to determine whether the discharge force could extinguish the test fires. It must be recognized that nitrogen gas discharge does not resemble the discharge of more liquid fluids, and comparisons using nitrogen may be questionable. Qualitative observations in our laboratory, however, indicate that fire disruption by liquids is significantly less than that by gases, other things being equal. Thus. testing with nitrogen appears to provide a more conservative estimate of the possibility for extinguishment by the discharge force only.

Application of nitrogen gas by itself caused no extinguishments at any of the tested pressures using the atomizing nozzles. This observation indicates that any extinguishments observed with these nozzles are due to the agent rather than disruption of the fire by the discharge. In a number of cases. extinguishment was obtained using nitrogen alone with the SpiralJet® 12007 nozzle. Thus. extinguishments using this nozzle should be interpreted with caution.

Water

Preliminary extinguishment tests were run using 50 and 100 milliliters of water with all five sizes of the atomizing nozzles and the smallest SpiralJet® nozzle. In these tests, water performed exceedingly poorly. Extinguishments were obtained only in some of the tests using the largest flow rates (SpiralJet® 12007 nozzle). The performance was significantly different than observed with the chemical agents, which performed at least as well with the smallest drop size as with the largest.

Perfluoromethyldecalin

Perfluoromethyldecalin was chosen for the initial tests with halocarbon agents. The results are shown in Table 10. Only one extinguishment was obtained. Unlike the case for water. this highly viscous, low vapor pressure agent performed best as a fine spray. Even in this case, however, the results were poor, though near-extinguishments were obtained in several cases with the No. 2 nozzle The largest nozzle used. 12007, produced large droplets, which showed little effect on the fire. The No. 2 nozzle, on the other hand, produced a fine, highly visible mist.

Table 10. Perfluoromethyldecalin Tests*

Nozzle No.	Deflector Position	Pressure (psig)‡	Discharge (sec)	Ext. Time (sec)
2	Medium	600	27.78	31.07
2	Medium	600	26.50	§
2	Medium	300	†	§
2	Medium	400	43	§
2	Low	300	†	§
2	Low	400	43	§
6	Medium	400	13.4	§
6	Low	400	13.4	§
12007	Medium	400	4.22	§

*100 mL of agent used. Where determined, the discharge times are given. The time to extinguishment is given for the only successful extinguishment.

‡Pressures are gauge at nozzle inlet (1 psig = 6.89 bar).

§No extinguishment.

†Not recorded.

Table 11. HCFC-123 Tests*

Liquid Volume (mL)	Discharge Time (sec)	Extinguishment Time (sec)
100	‡	7.52
50	14.1	7.48
50	14.42	10.29
40	10.85	7.39
25	7.18	†

*All HCFC-123 tests were run with a No. 2 nozzle and a nozzle inlet pressure of 400 psig (2756 kPa). The deflector plate was set at medium position.

‡Discharge stopped before completion.

†No extinguishment.

HCFC-123

HCFC-123 performed exceedingly well compared with perfluoromethyldecalin or water. Extinguishments were obtained with as little as 50 percent of the minimum amount needed as predicted from cup-burner testing (Table 11). The appearance of the flame and of the agent was significantly different from that observed with either perfluoromethyldecalin or water. The agent rapidly formed a highly visible white cloud, and the flame developed a green tinge with sputtering immediately prior to extinguishment.

Perfluorohexane

The results of testing with perfluorohexane are shown in Table 12. Extinguishments were obtained with all nozzles using only *25* percent of the minimum amount predicted from cup-burner testing. Use caution in interpreting the results with the 12007 nozzle since some extinguishments were obtained with this nozzle using nitrogen gas alone. The vapor was significantly less visible than was observed for **HCFC-123,** and no green tinge was observed during flame extinguishment. The absence of a green tinge is not unexpected since this coloration is almost certainly due to the presence of chlorine in the **HCFC-123.** The relationship between extinguishment and discharge times is shown in Figure 2. The straight line in this figure is not a fit to the data, but merely allows *easy* visualization of whether the extinguishment time was longer or shorter than the discharge time. The effect of nozzle number on extinguishment time is shown in Figure 3. As the discharge time decreased and as the discharge rate increased, the extinguishment time decreased however, the ability to extinguish the tire eventually appeared to be relatively independent of either nozzle or discharge time. In all tests, the extinguishment time was very close to the discharge time.

Table **12.** Perfluorohexane Tests[1]

Nozzle	Discharge Time (sec)	Extinguishment Time (sec)
2	15.94	12.18
2	15.69	16.03
2	17.34	12.13
6	6.39	12.12
6	5.81	7.06
6	5.82	7.37
14	3.56	2.84
14	3.80	2.57
14	4.22	5.44
26	2.47	1.50
26	2.75	4.19
26	3.08	1.34
12007	1.46	1.50
12007	1.43	1.12
12007	0.96	0.84

[1] **All** tests were run using 50 mL (liquid volume) of agent, **400** psig **(2756 kPa)** nozzle inlet pressure, and a deflector plate set at medium position.

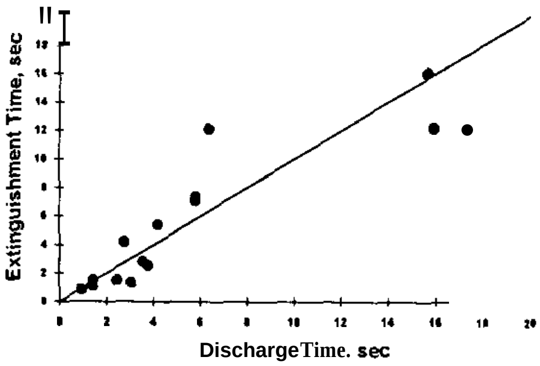

Figure **2.** Extinguishment Time Versus Discharge Time for Perfluorohexane.

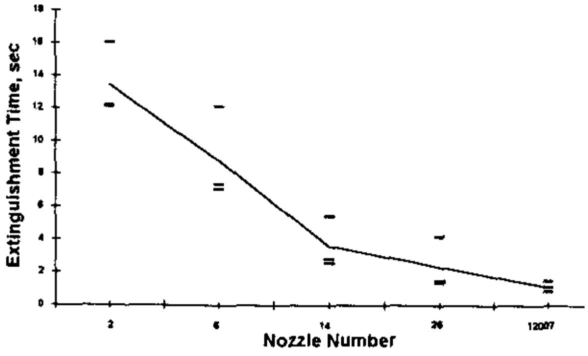

Figure **3.** Extinguishment Time Versus Nozzle Number for Perfluorohexane. (Note that nozzle size increases with increasing Nozzle Number.)

Table 13. Extinguishment Tests With Perfluorohexane, No. 3 Fire Pan'

Nozzle No.	Discharge Time (sec)	Extinguishment Time (sec)
2	13.80	16.03
2	13.58	11.97
2	14.42	17.38
6	5.25	5.59
6	5.53	5.47
6	5.62	11.13
12007	0.90	1.16
12007	1.03	0.75
12007	1.01	0.87

'All tests were run using 50 mL (liquid volume) of agent, 400 psig (2756 kPa) nozzle inlet pressure, and a deflector plate set at medium position.

Since pertluorohexane performed so well, extinguishment testing was also performed using the No. 3 fire pan, which has an aspect ratio of 7.923, corresponding to a slightly larger than "medium" fire. The results are shown in Table 13. Unlike the situation with the No. 2 fire pan, the average extinguishment time was somewhat longer than the discharge time (Figure 4), though this was not true in a few individual tests (particularly with the 12007 nozzle). In all cases, however, the fire was extinguished. This is an interesting observation since the fire was qualitatively observed to have a significant size relative to the internal volume of the LEETC.

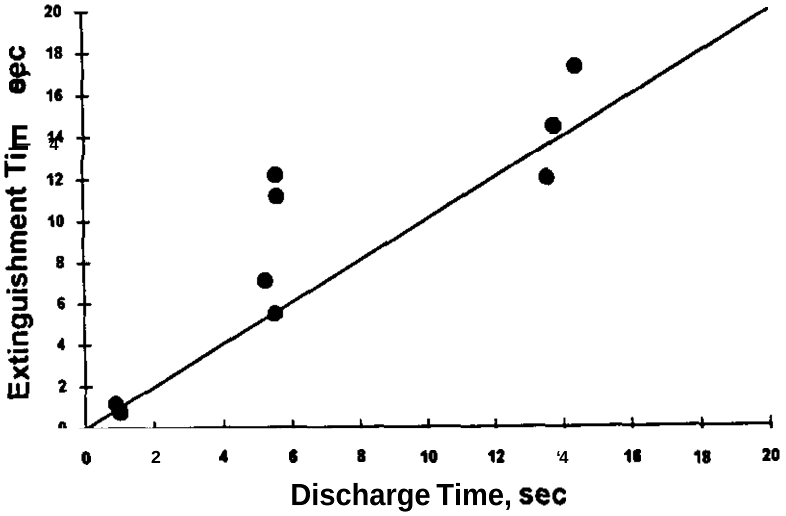

Figure 4. Extinguishment Time Using Perlluorohexane With No. 3 Fire Pan.

Perfluoromethylcyclohexane

Table 14 presents the results for the extinguishment tests with perfluoromethylcyclohexane. Limited testing indicates that the minimum amount of perfluoromethylcyclohexane necessary for extinguishment was about 40 percent of the amount estimated, Note, however, that cup-burner data are not available for this compound, and the estimated minimum concentration must be treated with caution.

Table 14. Extinguishment Tests With Perfluoromethylcyclohexane*

Liquid Volume (mL)	Pressure (psi)‡	Discharge Time (sec)	Extinguishment (sec)
50	200	18.55	20.98
50	200	17.81	10.89
50	400	13.63	8.58
50	400	14.41	16.10
25	400	8.12	†
50	600	11.21	11.21
40	600	9.42	17.56

*All tests were run with the deflector plate set at medium position and with Nozzle No. 2.

‡Pressures are gauge at nozzle inlet (1 psi = 6.89 kPa).

†No extinguishment.

Table 15. Extinguishment Tests With Perfluorodimethylcyclohexane*

Pressure (psi)‡	Discharge Time (sec)	Extinguishment Time (sec)
200	20.59	18.00
200	17.98	16.50
400	11.47	20.39
400	12.03	24.57
600	11.65	11.94
600	11.56	11.00

*All tests were run with the deflector plate set at medium position, a No. 2 Nozzle, and 50 mL (liquid volume) of agent.

‡Pressures are gauge at nozzle inlet (1 psi = 6.89 kPa).

Perfluorodimethylcyclohexane

All perfluorodimethylcyclohexane tests (Table 15) were run with approximately 50 percent of the amount predicted from the cup-burner extinguishment concentration. All tests gave a successful extinguishment. Although the amount of agent was not varied, the fact that two extinguishment times were considerably longer than the discharge time indicates that the amount used was very close to the minimum effective amount.

CONCLUSIONS

The following conclusions can be drawn:

1. In comparison with halocarbons. water exhibited relatively poor extinguishment of hydrocarbon fuel fires when misted into an enclosed 175-liter space.

2. Four halocarbon chemicals — HCFC-123, perfluorohexane, perfluoromethylcyclohexane. and perfluorodimethylcyclohexane, having boiling points between 24 °C and 102 °C — showed highly effective fire extinguishment. Note that several of these agents have boiling points significantly above room temperature. Only

one halocarbon agent, perfluoromethyldecalin, with a boiling point of 155 °C, was found to have poor fire extinguishment abilities in this study.

3. These observations indicate that agent misting can extinguish hydrocarbon liquid fuel tires in enclosed volumes using amounts as low as 25 percent of the theoretical amount predicted from cup burners for halocarbons with boiling points of 102°C and below. The very limited testing indicates that extinguishment ability falls off significantly at a boiling point between 102 and 155 °C.

4. Halocarbon chemicals having boiling points significantly higher than that of Halon 1301 appear highly promising as halon replacements for area protection against tires when discharged through misting systems. Additional studies are needed to determine the hold time, inertion characteristics, and optimum droplet size distribution. Studies are also needed to determine the ability of such systems to protect against explosions.

5. Significant corrosion of the LEETC was observed following these tests, despite the fact that the chamber walls were nickel-plated. It was impossible to determine whether the corrosion was worse with any particular agent, since the corrosion appeared to increase as the testing program progressed. The corrosion appeared to consist of pits with white deposits, and appeared to be due to combustion products rather than to the neat agent. Consequently, an investigation of materials compatibility with combustion products must be performed before the suitability of halocarbon misting can be determined.

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