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DEVELOPMENT OF SUPERIOR LIQUID COOLANTS CCF-1

Semi-Annual Technical Progress Report for September 1, 1978—February 28, 1979

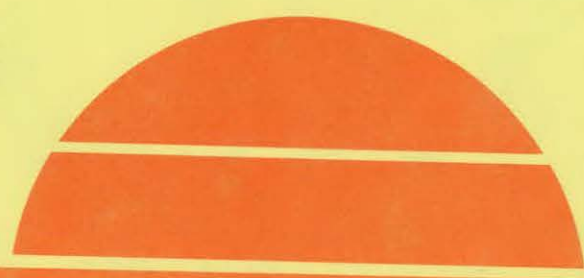
By
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MASTER

February 28, 1979

Work Performed Under Contract No. EM-78-C-04-4296

Dow Corning Corporation
Midland, Michigan



U.S. Department of Energy



Solar Energy

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SEMI-ANNUAL
TECHNICAL PROGRESS REPORT

DOE CONTRACT NUMBER EM-78-C-04-4296

DEVELOPMENT OF SUPERIOR LIQUID COOLANTS CCF-1

REPORT PERIOD

1 September 1978 - 28 February 1979

February 28, 1979

PREPARED BY:

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"This work has been supported by the Solar Heating and Cooling Research and Development Branch, Office of Conservation and Solar Application, U.S. Department of Energy".

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ABSTRACT

This semi-annual report summarizes the results of physical property testing, F.H.S.A. toxicity testing and Biological Oxygen Demand (BOD) testing on five solar heat transfer fluids. The status of solar collector stagnation testing at New Mexico State University on four solar heat transfer fluids is reviewed.

Cost effectiveness will be evaluated from the results of these and other tests yet to be undertaken, including stagnation performance in solar collectors. This economic evaluation will be presented in the final technical report at the conclusion of all contract tasks.

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DESCRIPTION OF PROJECT

The work to be performed under this contract is part of the national program for Research and Development in Solar Heating and Cooling.

The overall objective is to stimulate the advancement of an industrial, commercial and professional capability for producing and distributing various solar energy systems. It is contemplated that the demand on fossil fuel supplies will be reduced through widespread use of solar energy (a) in heating and cooling of residential and commercial buildings, (b) for service and process hot water, and (c) for the thermal needs of agricultural and industrial processes.

The specific objective of this work is to establish the most cost effective solar heat transfer fluid through a comprehensive one year study of the four most common fluids being used. Criteria for making the assessment will be the relative results of F.H.S.A. toxicological studies, fire hazards testing, thermal performances efficiency, corrosion studies, collector stagnation testing and physical property comparison data of various fluids. Contributing to cost effectiveness shall be the simplification of solar collector systems by the elimination of devices and premium metals used to protect against freezing, over-heating and corrosion.

PHYSICAL PROPERTY TESTING

All physical property testing was performed by the Analytical Services Department at Dow Corning Corporation with the exception of thermal conductivity analysis which was performed at the Thermal Research Laboratory at the Dow Chemical Company, Midland, Michigan.

Test methods identified by a CTM designation refer to Dow Corning corporate test methods. These methods are based, when appropriate, on standard methods in ASTM or other compendia, but may not be exactly equivalent. Vapor pressure measurements were obtained by ASTM D323 as modified for operation at 400 F (204.4 C). Liquid thermal conductivity measurements were obtained using a hot wire method similar to that described by O. B. Cecil, R. H. Munch, Ind. Eng. Chem. 48, 437 (1956).

Physical property data was obtained for each of the following heat transfer fluids:

<u>Fluid Sample</u>	<u>Fluid Description</u>
A	Uniroyal® PAO-LV Polyalphaolefin
B	Dow Corning® X2-1162 Heat Transfer Liquid
C	Syltherm™ 444 Heat Transfer Liquid
D	Prestone II® Ethylene Glycol/Water 50:50 Mixture by weight
E	Ambitrol® NTC Propylene Glycol/Water 50:50 Mixture by weight

Table I summarizes the results of physical property testing.

TABLE I

	TEST	UNIROYAL			ETHYLENE GLYCOL/	PROPYLENE GLYCOL/
	METHOD	PAO-LV	X2-1162	SYLTHERM TM 444	WATER	WATER
Flash Point	CTM0021A	266°+5°F (130°C)	320°+5°F (160°C)	465°+10°F (240.5°C)	No Flash	No Flash
Flash Point	CTM0052	350°+5°F (176.7°C)	413°+10°F (211.7°C)	622°+10°F (327.8°C)	No fire - Boils @ 220°F	No fire - Boils @ 220°F
Viscosity	CTM0004					
77°F (25°C)		19.00cs±.40	10.2cs±.20	19.7cs±.40	3.08cs±.06	4.92cs±.10
140°F (60°C)		6.63cs±.12	6.03cs±.12	11.2cs±.20	1.47cs±.05	1.89cs±.05
210°F (98.9°C)		2.95cs±.05	3.58cs±.05	6.61cs±.05	0.74cs±.05	1.24cs±.05
Thermal Conductivity	Hot Wire Method	K, cal cm ⁻¹ sec ⁻¹ °C ⁻¹ ±2%				
25°C		3.38x10 ⁻⁴	3.29x10 ⁻⁴	3.49x10 ⁻⁴	9.285x10 ⁻⁴	8.590x10 ⁻⁴
40°C		3.32x10 ⁻⁴	3.33x10 ⁻⁴	3.43x10 ⁻⁴	9.490x10 ⁻⁴	8.790x10 ⁻⁴
60°C		3.23x10 ⁻⁴	3.14x10 ⁻⁴	3.36x10 ⁻⁴	9.750x10 ⁻⁴	9.025x10 ⁻⁴
80°C		3.14x10 ⁻⁴	3.05x10 ⁻⁴	3.29x10 ⁻⁴	9.970x10 ⁻⁴	9.215x10 ⁻⁴
100°C		3.10x10 ⁻⁴	2.97x10 ⁻⁴	3.22x10 ⁻⁴	10.120x10 ⁻⁴	9.330x10 ⁻⁴
Specific Gravity	CTM0001A(±.005)					
77°F (25°C)		0.809	0.938	0.953	1.069	1.047
140°F (60°C)		0.786	0.906	0.921	1.050	1.024
210°F (98.9°C)		0.764	0.872	0.888	1.024	0.995
Pour Point	CTM0133	-112°F (-80°C)	<-148°F (<-100°C)	-94°F (-70°C)	-27.4°F (-33°C)	-58°F (-50°C)

TABLE I

TABLE I (con't)

TEST METHOD	UNIROYAL PAO-IV	X2-1162	SYLTHERM TM 444	ETHYLENE GLYCOL/ WATER	PROPYLENE GLYCOL/ WATER
Coefficient of Expansion	CTM0782X (Temp. Range = 25-98.9°C)				
	$6.31 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}$	$9.44 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}$	$9.28 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}$	$6.33 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}$	$7.35 \times 10^{-4} \text{ } ^\circ\text{C}^{-1}$
Vapor Pressure	ASTM D323				
psig@400°F (204.4°C)	< 0.4	< 0.4	< 0.4	205 _{±15}	205 _{±15}
mmHg@400°F (204.4°C)	< 20.69	< 20.69	< 20.69	10,600 _{±775}	10,600 _{±775}
Specific Heat	CTM544 C _p , BTU/pound-°F (Cal/gm-°C)				
77°F (25°C)	0.52 _{±0.01}	0.37 _{±0.01}	0.38 _{±0.01}	0.88 _{±0.02}	0.90 _{±0.02}
140°F (60°C)	0.55 _{±0.01}	0.39 _{±0.01}	0.40 _{±0.01}	0.90 _{±0.02}	0.92 _{±0.02}
210°F (98.9°C)	0.57 _{±0.01}	0.41 _{±0.01}	0.41 _{±0.01}	a	a

a Unable to determine Specific heat without either a mass change or pressure change.

TABLE I (con't)

F.H.S.A. TOXICOLOGICAL TESTING

This testing was performed by the Health and Environmental Services Department at Dow Corning Corporation, Midland, Michigan. Assessments were made of acute toxicologic properties and evaluation of household consumer hazards when tested according to methods promulgated by the Consumer Product Safety Commission in compliance with the Federal Hazardous Substances Act (F.H.S.A.) regulations.

The results of the acute toxicity studies conducted on a 50% mixture of propylene glycol (Ambitrol® NTC) in water in compliance with F.H.S.A. regulations and a 50% mixture of ethylene glycol/water in compliance with F.H.S.A. regulations are as follows: (Appendix A contains complete test reports)

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight
Eye Irritation	Not an eye irritant
Skin Irritation	Not a skin irritant

The results of the acute toxicity studies conducted with Uniroyal® PAO-LV in compliance with F.H.S.A. regulations, Dow Corning® X2-1162 Heat Transfer Liquid in compliance with F.H.S.A. regulations, and Dow Corning Syltherm™ 444 Solar Heat Transfer Liquid in compliance with F.H.S.A.

regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic, LD ₅₀ >15.4 gm/kg body weight
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight
Eye Irritation	Not an eye irritant
Skin Irritation	Not a skin irritant

BIOLOGICAL OXYGEN DEMAND TESTING

A HACH Manometric BOD apparatus, Model 2173 was used to determine the biochemical oxygen demand of each test fluid. Fresh secondary effluent from the City of Midland Waste Treatment Plant was used as seed in these tests. Test fluids were dispensed into the test vessels at a concentration of 1250 parts per million. Each concentration was run in triplicate for a total of 5 days. A five-day BOD on a glucose/glutamic acid standard was conducted concurrently. Results are reported as the ratio of parts of oxygen consumed per parts of test chemical. (Appendix A)

<u>Fluid Sample</u>	<u>Biological Oxygen Demand</u>
Uniroyal® PAO-LV Polyalphaolefin	0.19 ±0.09
Dow Corning® X2-1162	No measurable demand
Syltherm™ ₄₄₄	No measurable demand
Ethylene Glycol/ Water 50:50 Mixture by weight	0.55 ±0.01
Propylene Glycol/ Water 50:50 Mixture by weight	0.55 ±0.01

The five day BOD of the glucose/glutamic acid solution was within acceptable limits for this procedure.

SOLAR COLLECTOR STAGNATION TESTING

Solar collector stagnation testing is being performed by the Physical Science Laboratory at New Mexico State University, Las Cruces, New Mexico. The test facility is located in an area with one of the highest annual insolation exposures in the United States. Consequently, the time necessary to complete the testing at elevated temperatures is expected to be relatively short (7-10 months). PSL is performing collector efficiency testing in conformance with the National Bureau of Standards proposed procedure NBSIR 74-635.

The project objectives are to measure the performance and determine long term effects on these four heat transfer fluids in multi-metal collector loops at high temperatures. Fluid samples will be removed and analyzed periodically and sent to Dow Corning for analysis. Effects of fluids on collector metals will be determined at the end of stagnation testing by metallurgical analysis.

Four closed loops have been fabricated, each consisting basically of two solar collectors (one with a copper absorber and one with an aluminum absorber), pump, solenoid valve, expansion tank, pressure relief valve, sediment bowl and flowmeter, all interconnected with copper pipe. Ancillary items in each loop include a thermometer well, pressure taps and a sampling valve. Stagnation temperatures in the range of 300° to 375°F. are desired for these tests.

A 24-hour timer opens the solenoid valve and runs the pump once each morning for a 15-minute period. The solenoid valve provides positive shutoff to prevent thermosiphon flow which would lower stagnation temperatures. During this daily pumping period, flow rates and temperatures are monitored and recorded. The readings give an indication of any scale build-up or other restriction in the collector. The sediment bowl traps heavier precipitates or loose scale which is visually recorded at regular intervals. The expansion tanks are sized to accommodate fluid expansion without loss of liquid or vapor, and to limit pressure build-up to values well below the collector design value.

A data logger with digital cassette tape recorder monitors and records all data at pre-set intervals during the test periods (daylight hours). Data includes (a) thermocouple measurements on the collector absorber surfaces, (b) thermocouples in the inlet and outlet thermometer wells, (c) collector differential pressure, (d) flow as measured by a venturi flow meter with differential pressure transducer, (e) insolation, (f) ambient temperature, (g) wind velocity, (h) expansion tank temperature, and (i) system gauge pressure.

Data recorded on cassettes is dumped periodically through the existing collector test facility-computer interface and stored in a computer file for processing and print out of information such as accumulated time at various temperature levels and periodic collector efficiency tests. Existing programs compute collector efficiencies. New

programs will be developed for the stagnation time-temperature profiles and any other required presentations.

While most of the operation and data taking is automatic, a daily visual check is made on regular work days to check for leaks, proper operation of automatic systems and data logger and any sediment accumulation. After each 200 hours of operation above a preselected stagnation temperature, a fluid sample will be removed from each system and shipped to Dow Corning for analysis. After each 250 hours at temperature a collector efficiency test will be performed and reported to Dow Corning.

From previous experience, it is estimated that a stagnation temperature of 300°F can be achieved for approximately 4 to 5 hours on an average clear day.

Solar collector test loops and solar heat transfer fluids are identified as follows:

<u>Test Loop Number</u>	<u>Test Fluid Description</u>
1	Dow Corning Syltherm TM 444
2	Uniroyal PAO-LV Polyalphaolefin
3	Prestone II Ethylene Glycol/Water 50:50 Mixture by weight
4	Ambitrol NTC Propylene Glycol/Water 50:50 Mixture by weight

Detailed test data is not yet available for these experiments but will be presented in the final technical report.

APPENDIX A

DOW CORNING CORPORATION HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

ACUTE TOXICOLOGIC PROPERTIES AND 5-DAY BIOLOGICAL OXYGEN DEMAND OF UNIROYAL PAO-LV

A sample of Uniroyal PAO-LV was submitted to the Biological Services Department for an assessment of acute toxicologic properties and evaluation of household consumer hazards when tested according to the Consumer Product Safety Commission in compliance with the Federal Hazardous Substances Act (FHSA) regulations. This colorless liquid is commercially available as a lubricant base and may be used as hydraulic, electrical and solar heat transfer fluids.

Uniroyal PAO-LV is essentially non-toxic when ingested on an acute basis by laboratory rats ($LD_{50} > 15.4$ gm/kg body weight) and is not absorbed through the skin in acutely toxic amounts ($LD_{50} > 2.0$ gm/kg body weight).

Direct eye contact with Uniroyal PAO-LV should not result in irritation. According to FHSA guidelines, this material is not an eye irritant.

Application of this liquid to skin produced a very slight amount of redness. Under current FHSA regulations, Uniroyal PAO-LV is not a primary skin irritant.

Presentation of Data

A. Acute Oral Toxicity of Uniroyal PAO-LV in Rats

<u>Sex</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
M	15.4	0/5
F	15.4	0/5

B. Acute Dermal Toxicity of Uniroyal PAO-LV in Rabbits

<u>Condition of Skin</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
Abraded	2.0	0/3
Intact	2.0	0/3

C. Eye Irritation Potential of Uniroyal PAO-LV in Rabbits

	Period After Exposure	Animal No.					
		D-6	B-9	C-5	C-7	C-9	C-10
Cornea	24 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea	48 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	72 Hrs.	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	7 Days	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Comments

Not an eye irritant.

D. Skin Irritation Potential of Uniroyal PAO-LV in Rabbits

<u>Parameter</u>	<u>Reading Interval (Hours)</u>	<u>Mean Value</u>
Erythema & Eschar Formation:		
Intact skin	24	0.2
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	<u>0.0</u>
	Subtotal	0.2
Edema Formation		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	<u>0.0</u>
	Subtotal	0.0
	TOTAL	0.2

PRIMARY IRRITATION SCORE: 0.05

Comments:

Not a skin irritant.

SUMMARY

The results of the biological oxygen demand and acute toxicity tests conducted with Uniroyal PAO-LV in compliance with FHSA regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight.
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight.
Eye Irritation	Not an eye irritant.
Skin Irritation	Not a skin irritant.
Biological Oxygen Demand	0.19 ± 0.09

DOW CORNING CORPORATION
HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

ACUTE TOXICOLOGIC PROPERTIES AND 5-DAY BIOLOGICAL OXYGEN
DEMAND OF DOW CORNING® X2-1162 HEAT TRANSFER FLUID

I. PURPOSE

A sample of DOW CORNING® X2-1162 Heat Transfer Fluid was received by the Biological Services Department for determination of Biological Oxygen Demand, assessment of acute toxicologic properties, and evaluation of household consumer hazards when tested according to methods promulgated by the Consumer Product Safety Commission in compliance with the Federal Hazardous Substances Act (FHSA) regulations. This straw colored liquid is intended for use in industrial heat transfer systems.

II. RESULTS

Dow Corning X2-1162 heat transfer fluid is essentially non-toxic when ingested on an acute basis by laboratory rats. (LD₅₀ >15.4 gm/kg body weight) and is not absorbed through the skin in acutely toxic amounts (LD₅₀ >2.0 gm/kg body weight).

Direct eye contact with Dow Corning X2-1162 heat transfer fluid should not result in irritation. According to current FHSA guidelines, this liquid is not an eye irritant.

A single application of Dow Corning X2-1162 heat transfer fluid should not produce irritation. When tested according to current FHSA regulations, this liquid is not a primary skin irritant.

III. PRESENTATION OF DATA

A. Acute Oral Toxicity of Dow Corning X2-1162 Heat Transfer Fluid

<u>Sex</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
M	15.4	0/5
F	15.4	0/5

B. Acute Dermal Toxicity of Dow Corning X2-1162 Heat Transfer Fluid

<u>Condition of Skin</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
Abraded	2.0	0/3
Intact	2.0	0/3

C. Eye Irritation Potential of Dow Corning X2-1162 Heat Transfer Fluid in Rabbits

	<u>Period After Exposure</u>	<u>VALUES</u>					
		<u>Animal Numbers</u>					
		<u>C-11</u>	<u>E-6</u>	<u>E-7</u>	<u>E-9</u>	<u>E-10</u>	<u>E-11</u>
Cornea	24 Hours	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

	48 Hours						
Cornea		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

	72 Hours						
Cornea - before stain		0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

	7 Days						
Cornea - before stain		0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Comments

Not an eye irritant.

D. Skin Irritation Potential of Dow Corning X2-1162 Heat Transfer Fluid in Rabbits

<u>Parameter</u>	<u>Reading Interval (Hours)</u>	<u>Mean Score</u>
Erythema & Eschar Formation:		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	<u>0.0</u>
	Subtotal	0.0
Edema Formation:		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	<u>0.0</u>
	Subtotal	0.0
	TOTAL	0.0

PRIMARY IRRITATION SCORE: 0.0

Comments:

Not a skin irritant.

SUMMARY

The results of the Biological Oxygen Demand and acute toxicity tests conducted on Dow Corning X2-1162 heat transfer fluid in compliance with FHSA regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight.
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight.
Eye Irritation	Not an eye irritant.
Skin Irritation	Not a skin irritant.
Biological Oxygen Demand	No measurable Biological Oxygen Demand

DOW CORNING CORPORATION
HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

ACUTE TOXICOLOGIC PROPERTIES AND 5-DAY BIOLOGICAL OXYGEN DEMAND OF
SYLTHERM® 444 HEAT TRANSFER FLUID

A sample of Syltherm 444 heat transfer fluid was submitted to the Biological Services Department for determination of acute toxicologic properties and evaluation of household consumer hazards when tested according to procedures prescribed by the Consumer Product Safety Commission in compliance with Federal Hazardous Substances Act (FHSA) regulations. This water-clear liquid is intended for use as a solar collector fluid.

Syltherm 444 heat transfer fluid is essentially non-toxic when ingested on an acute basis by laboratory rats ($LD_{50} >15.4$ gm/kg body weight) and is not absorbed through the skin in acutely toxic amounts ($LD_{50} >2.0$ gm/kg body weight).

Direct eye contact with Syltherm 444 heat transfer fluid may result in, at most, a very slight amount of irritation which is similar to a "windburn" effect. According to current FHSA definition, Syltherm 444 heat transfer fluid is not an eye irritant.

Skin exposure to this liquid should not cause irritation. Under the condition of this test, Syltherm 444 heat transfer fluid is not a skin irritant.

Presentation of Data

A. Acute Oral Toxicity of Syltherm® 444 Heat Transfer Fluid

<u>Sex</u>	<u>Dose Level (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
M	15.4	0/5
F	15.4	0/5

B. Acute Dermal Toxicity of Sylthermtm 444 Heat Transfer Fluid

<u>Condition of Skin</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
Abraded	2.0	0/3
Intact	2.0	0/3

C. Eye Irritation Potential of Sylthermtm 444 Heat Transfer Fluid in Rabbits

	<u>Period After Exposure</u>	<u>VALUES</u>					
		<u>Animal Numbers</u>					
		<u>E-12</u>	<u>F-4</u>	<u>F-6</u>	<u>F-7</u>	<u>F-8</u>	<u>F-9</u>
Cornea	24 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea	48 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	1
- chemosis		0	0	0	0	0	0

Cornea - before stain	72 Hrs.	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	7 Days	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Comments

Not an eye irritant

D. Primary Skin Irritation Potential of Syltherm® 444 Heat Transfer Fluid in Rabbits

<u>Parameter</u>	<u>Reading Interval (Hours)</u>	<u>Mean Score</u>
Erythema & Eschar Formation:		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	0.0
	Subtotal	0.0
Edema Formation:		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	0.0
	Subtotal	0.0
	TOTAL	0.0

PRIMARY IRRITATION SCORE: 0.0

Comments

Not a skin irritant.

SUMMARY

The results of the biological oxygen demand and acute toxicity tests conducted on Syltherm 444 heat transfer fluid in compliance with FHSA regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight.
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight.
Eye Irritation	Not an eye irritant.
Skin Irritation	Not a skin irritant.
Biological Oxygen Demand	No measurable biological oxygen demand

DOW CORNING CORPORATION
HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

ACUTE TOXICOLOGIC PROPERTIES AND 5-DAY BIOLOGICAL OXYGEN
DEMAND OF ETHYLENE GLYCOL/WATER

A laboratory prepared sample of a 50:50 mixture (w/w) of ethylene glycol (Prestone II) and water was submitted to the Biological Services Department for determination of acute toxicologic properties and household consumer hazards when tested according to procedures prescribed by the Consumer Product Safety Commission in compliance with Federal Hazardous Substances Act (FHSA) regulations. This cloudy, "fluorescent" lime-yellow liquid is commercially available as a heat transfer fluid.

Ethylene glycol/water (50:50 by weight) is essentially non-toxic when ingested on an acute basis by laboratory rats ($LD_{50} > 15.4$ gm/kg body weight) and is not absorbed through the skin in acutely toxic amounts ($LD_{50} > 2.0$ gm/kg body weight).

Direct eye contact with this material should not cause irritation. According to current FHSA guidelines, this material is not an eye irritant.

A single application of ethylene glycol/water (50:50 by weight) to skin may cause, at most, a very slight amount of redness. In accordance with FHSA definition, this liquid is not a skin irritant.

Presentation of Data

A. Acute Oral Toxicity of Ethylene Glycol/Water in Rats

<u>Sex</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
M	15.4	1/5
F	15.4	3/5

Comments

Under the conditions of this test, ethylene glycol/water appears to be slightly higher in oral toxicity among female test subjects.

B. Acute Dermal Toxicity of Ethylene Glycol/Water in Rabbits

<u>Condition of Skin</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
Intact	2.0	0/3
Abraded	2.0	0/3

C. Eye Irritation Potential of Ethylene Glycol/Water in Rabbits

	<u>Period After Exposure</u>	<u>VALUES</u>					
		<u>Animal Numbers</u>					
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Cornea	24 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea	48 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	72 Hrs.	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	7 Days	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Comment

Not an eye irritant.

D. Skin Irritation Potential of Ethylene Glycol/Water in Rabbits

<u>Parameter</u>	<u>Reading Interval (Hours)</u>	<u>Mean Score</u>
Erythema & Eschar Formation:		
Intact skin	24	0.2
Intact skin	72	0.0
Abraded skin	24	0.2
Abraded skin	72	<u>0.0</u>
	Subtotal	0.4
Edema Formation:		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	<u>0.0</u>
	Subtotal	0.0
	TOTAL	0.4

PRIMARY IRRITATION SCORE: 0.1

SUMMARY

The results of the biological oxygen demand and acute toxicologic studies conducted with a 50:50 mixture of ethylene glycol/water in compliance with FHSA regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight.
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight.
Eye Irritation	Not an eye irritant.
Skin Irritation	Not a skin irritant.
Biological Oxygen Demand	0.55 ± 0.01

DOW CORNING CORPORATION
HEALTH & ENVIRONMENTAL SERVICES DEPARTMENT

ACUTE TOXICOLOGIC PROPERTIES AND 5-DAY BIOLOGICAL OXYGEN
DEMAND OF POLYPROPYLENE GLYCOL/WATER

A laboratory prepared sample of a 50:50 mixture by weight of polypropylene glycol (Ambitol NTC) and water was submitted to the Biological Services Department for determination of acute toxicologic properties and assessment of household consumer hazards when tested according to procedures prescribed by the Consumer Product Safety Commission in compliance with Federal Hazardous Substances Act (FHSA) regulations. This translucent, blue liquid is commercially available for use as a heat transfer fluid.

Polypropylene glycol/water (50:50 by weight) is essentially non-toxic when ingested on an acute basis by laboratory rats ($LD_{50} >15.4$ gm/kg body weight) and is not absorbed through the skin in acutely toxic amounts ($LD_{50} >2.0$ gm/kg body weight).

Direct eye contact with this liquid should not cause irritation, therefore, according to current FHSA definition, this material is not an eye irritant.

Application of polypropylene glycol/water (50:50 by weight) to skin may produce, at most, a very slight amount of redness. According to FHSA guidelines, this liquid is not a skin irritant.

Presentation of Data

A. Acute Oral Toxicity of Polypropylene glycol/water in Rats

<u>Sex</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
M	15.4	0/5
F	15.4	0/5

B. Acute Dermal Toxicity of Polypropylene Glycol/Water in Rabbits

<u>Condition of Skin</u>	<u>Dose (gm/kg)</u>	<u>No. Dead/No. Dosed</u>
Abraded	2.0	0/3
Intact	2.0	0/3

C. Eye Irritation Potential of Polypropylene Glycol/Water in Rabbits

	<u>Period After Exposure</u>	<u>VALUES</u>					
		<u>Animal Numbers</u>					
		<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Cornea	24 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea	48 Hrs.	0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	72 Hrs.	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Cornea - before stain	7 Days	0	0	0	0	0	0
- after stain		0	0	0	0	0	0
Iris		0	0	0	0	0	0
Conjunctiva - redness		0	0	0	0	0	0
- chemosis		0	0	0	0	0	0

Comments

Not an eye irritant

D. Skin Irritation Potential of Polypropylene Glycol/Water in Rabbits

<u>Parameter</u>	<u>Reading Interval (Hours)</u>	<u>Mean Score</u>
Erythema & Eschar Formation		
Intact skin	24	0.3
Intact skin	72	0.0
Abraded skin	24	0.3
Abraded skin	72	0.0
	Subtotal	0.6
Edema Formation		
Intact skin	24	0.0
Intact skin	72	0.0
Abraded skin	24	0.0
Abraded skin	72	0.0
	Subtotal	0.0
	TOTAL	0.6

PRIMARY IRRITATION SCORE: 0.2

SUMMARY

The results of the Biological Oxygen Demand and acute toxicity studies conducted on a 50% mixture of polypropylene/glycol (Ambitrol NTC) in water in compliance with FHSA regulations are as follows:

<u>Test Conducted</u>	<u>Classification</u>
Acute Oral Toxicity	Not toxic and not highly toxic; LD ₅₀ >15.4 gm/kg body weight.
Acute Dermal Toxicity	Not toxic and not highly toxic; LD ₅₀ >2.0 gm/kg body weight.
Eye Irritation	Not an eye irritant.
Skin Irritation	Not a skin irritant.
Biological Oxygen Demand	0.55 ± 0.01