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INTERIM REPORT
ON
FUNCTIONAL FLUIDS; APPLICATION RESEARCH INDUSTRIAL HYDRAULICS
OCTOBER 1966 - FEBRUARY 1968

DATE - February 12, 1968

WRITTEN BY - J. H. Davidson

Monsanto

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St. Louis Research Report No. 3483

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February 12, 1968

Written by: J. H. Davidson

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INTRODUCTION

This report covers certain phases of applications research work performed in the area of industrial hydraulic fluids in the past one and one-half years. This work involved a continuance of effort to define low cost industrial fluids to meet particular market needs and evaluation of these fluids to determine their functionality in the applications for which they were designed.

SUMMARY

This report covers research work performed in the following areas:

1. Formulation of new fluids and reformulation of existing fluids to meet a particular market need.
2. Determination of the physical and functional properties of new and existing fluids.
3. Determination of the fire resistance characteristics of these fluids.
4. Evaluation of new and existing raw materials to up-grade quality and performance as well as to extend patent claims.
5. Monitoring of field tests on new fluids to determine the need for reformulation and evaluation if necessary.
6. Evaluation of competitive fluids to determine our position in the marketplace.

CONCLUSIONS

Five new fluids were defined for particular industrial and coal mine applications.

1. PYDRAUL 230 - a 230 SSU low cost FR fluid based on the Pydraul 312 concept and designed to operate in pumps requiring a 200-250 SSU fluid.
2. SANTOSAFE 100 - a low low viscosity version of Santosafe 500 defined to meet the need for an FR brake fluid in coal mining equipment.
3. SANTOSAFE 150 - a low viscosity version of Santosafe 500 defined for use as a low temp FR hydraulic fluid and/or brake fluid in coal mine applications.

4. SANTOSAFE 700 - a high viscosity version of Santosafe 300 defined to meet the need for a high density FR gear oil in coal mine applications.

5. MCS 648 - a fluid defined to meet the expressed desire of Alcoa for a 300 SSU fluid with fire resistance intermediate to Pydraul 312 and straight phosphate esters.

RECOMMENDATIONS

1. Continue evaluation of MCS 648, reformulating and retesting if necessary to gain at least part of very large potential business at Alcoa.

2. Continue work with Factory Mutual to gain approval for Pydraul 312-type fluids. Evaluate a propagation-type test suggested by FM and any further modifications of the Hot Channel Iron Test suggested by FM or joint FM-Monsanto efforts.

3. Complete evaluation of Pennzoil 650 S.R. and 600 Flash cylinder stocks as possible substitutes (or alternate sources) for Kerr-McGee 'G' Bright Stock in Santosafe fluids.

PATENT STATUS

Patent application Case 0-2219 covering bright stock/Aroclor/phosphate ester compositions has been filed (Sept., 1965). All Pydraul 312-type fluids (Pydraul 90,135,230,312,540) and Santosafe fluids (Santosafe 100,150,300,700) are covered in this case.

A refile of patent application Case 0-2219 is planned for early 1968. This refile will extend the viscosity range of bright stock claimed and will also cover trichlorobenzene and tri-tetrachlorobenzene as fire resistance diluents up to 100% substitution for Aroclor. Details of this work are given in the body of the report.

EXPERIMENTAL WORK AND DISCUSSION

I. Definition of Low Cost Industrial and Coal Mine Fluids

A. Pydraul 230

Due to the commercial success of Pydraul 312 and a desire to expand markets commanded by Pydraul 312-type fluids, Marketing and Development requested definition of a 200-250 SSU low cost FR fluid based on the Pydraul 312 concept. Reasons for developing such a fluid were obvious: (1) all oil companies offer 200-250 SSU oils; (2) our primary competition

in the FR fluid business, Houghton and Stauffer, both offer 200-250 SSU fluids; (3) a fluid of 225 SSU (approx.) would fit three of the four types of pumps now marketed by Vickers Inc.

A fluid of 230 SSU with the following composition was defined:

Gulf Mid-Continent 200 Bright Stock	28.0%
Aroclor 1242	51.7%
Aroclor 1232	6.0%
Tricresyl Phosphate	14.0%
Santolube 70	0.3%
Dow Corning 200 Fluid-350 cs	0.002%
Dupont Blue A Dye	0.003%

The composition of this fluid enables it to have the best combination of low cost, fire resistance, thermal stability and low volatility of all members of the Pydraul 312 line of products. This is due to relatively low bright stock content (<30%), use of triaryl phosphate rather than alkyl aryl type and the absence of TCB and TTCB which are very volatile. All physical property and test data for Pydraul 230 are given in Appendix I, Pages A-7 to A-9.

B. Santosafe Fluids

Santosafe 100 - This fluid was defined to meet the need for a low low viscosity fire resistant brake fluid for coal mine applications. The need for a 100 SSU fluid arose during an evaluation of Santosafe 150 by Jeffrey Manufacturing Co., a coal mine OEM. Jeffrey had some reservations about the low temperature properties of Santosafe 150 and inquired as to the possibility of formulation of a lower viscosity fluid of similar composition. Santosafe 100 was formulated and was found to have excellent low temperature properties (Pour Point=-35°F) without extremely high vapor pressure (TTCB-20%). The relative volatility of Santosafe 100 vs. typical brake fluids (presently used in mining equipment) is shown graphically in Appendix I, Pages A-12,13. Composition of Santosafe 100 is given below. Physical properties and test data are given in the tables of Appendix I, Pages A-1 to A-6.

Kerr-McGee 'G' Bright Stock	24.0%
Aroclor 1242	36.7%
Tri-tetrachlorobenzene (49% tetra)	20.0%
Tricresyl Phosphate	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid-350 cs.	0.002%
A20 Oil Black Dye	0.003%

Santosafe 150 - This fluid is a low viscosity version of Santosafe 300 and was defined to meet the requirements of low temperature coal mine applications. A 150 SSU fluid is needed primarily in Australia and the U.K. where low temperatures at mine entrances and in deep mines preclude the use of a medium or high viscosity fluid. Santosafe 150 is also suitable for use as a brake fluid in some applications although, as explained above, the superior low temperature properties of Santosafe 100 make it more desirable for most applications. Composition of Santosafe 150 is given below. Physical properties and test data are given in the tables of Appendix I, Pages A-1 to A-6.

Kerr-McGee 'G' Bright Stock	30.0%
Aroclor 1242	41.7%
Aroclor 1232	6.0%
Tri-tetrachlorobenzene (49% tetra)	15.0%
Tricresyl Phosphate	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid - 350 cs.	0.002%
A20 Oil Black Dye	0.003%

Santosafe 700 - Based on Santosafe 300 technology, this high viscosity FR fluid was defined for use as a high density gear oil in coal mine applications. Desire for a fluid of this type was expressed in the U.K. where requirement of the use of fire resistant fluids in mines is imminent. Santosafe 700 meets the basic requirements outlined by interested parties in the U.K., namely 3000 SSU @70°F and Timken OK Load minimum of 45 lbs. Physical properties and test data on Santosafe 700 are given in Appendix I, Pages A-1 to A-6. Composition is given below.

Kerr-McGee 'G' Bright Stock	30.0%
Aroclor 1254	22.7%
Aroclor 1248	40.0%
Tricresyl Phosphate	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid - 350 cs.	0.002%
A20 Oil Black Dye	0.003%

C. Manufacturing Processes For New Fluids

Since all of the raw materials which make up the new blends mentioned above are readily available, manufacture of the fluids is a relatively simple blending operation. In Appendix II, Pages A-14 to A-25 are given blend sheets for Pydraul 230, MCS 545 and Santosafe 100 as well as tentative processes for Santosafe fluids 150,300 and 700. Included in the

blend sheets are tentative specifications, while the tentative processes include viscosity and specific gravity correction sheets (for correction of errors in blending or variability in raw materials) as well as tentative specifications for the products.

II. Fluids Defined For Special Industrial Applications

A. MCS 648

This fluid was defined to meet the need expressed by Alcoa for a more fire resistant Pydraul 312-type fluid. Composition of this fluid is given below.

Gulf Mid-Continent 200 Bright Stock	15.0%
Aroclor 1248	72.7%
Aroclor 1254	5.0%
Tricresyl Phosphate	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid-350 cs.	0.002%

Since Alcoa had expressed a desire for a fluid with fire resistance between Pydraul 312 and straight phosphate esters, MCS 648 was formulated to provide more FR but with a minimal increase in cost. This goal was achieved by reducing phosphate ester content to 7% (14% in Pydraul 312) to offset the increase in Aroclor concentration. Estimated manufacturing cost of this fluid is $.88/gal. compared to ~$.75/gal. for Pydraul 312. Physical properties and test data on MCS 648 are given in Appendix III, Page A-26.

Performance of MCS 648 in fire tests shows it to be superior to Pydraul 312 and nearly equivalent to straight phosphate esters. Below is given data for Pydraul 312, MCS 648 and Cellulube 300 showing test results in the "Airless Paint Spray Gun Test" and the molten aluminum test (1200°F).

	Pydraul 312	MCS 648	Cellulube 300
Airless Paint Spray-Gun Test	(4)*	(3)*	(3)*
Molten Metal Test (1200°F)			
Pouring of Fluid - (Fluid at Room Temp.)	Ignites after short delay and burns to completion.	Ignites after long delay and burns to completion.	No ignition without spark. Ignites with spark and burns to completion.

Molten Metal Test (1200°F) Cont'd.

	Pydraul 312	MCS 648	Cellulube 300
Spray - AMS 3150 nozzle - (Fluid @140°F)	Ignites after short delay and burns with flames 2-3' high.	Delayed ignition. Burns with flames 18"-2' high. Spray extinguishes fire on occasion.	Ignites with spark and burns with flames ~2' high.
Spray - Bur. of Mines nozzle - (Fluid @140°F)	Ignites after short delay and burns with flames 2-3' high. No back-propagation to nozzle.	Delayed ignition. Burns with flames 18"-2' high. No back-propagation to nozzle.	Ignites with spark and burns with flames ~2' high. No back-propagation to nozzle.

* Rating System - (1) No fire; (2) Fire at Torch; (3) Spasmodic Fire; (4) Violent Fire

B. MCS 650, MCS 651

A request was received from Pratt and Whitney via Marketing for a 450 SSU hydraulic fluid. No details were forwarded as to application, degree of FR desired, cost, lubrication, etc., so two candidate fluids were defined and submitted to P & W for evaluation. These fluids were MCS 650, based on the "old" more FR Pydraul line and MCS 651, a blend Pydraul 312-type fluids. These fluids were submitted to P & W in January, 1968 and work on these fluids will be inactive until some feedback is received. Composition and physical properties of these two fluids are given in Appendix III, Page A-27.

C. Santosafe 300 With Non-Toxic PE

Due to toxicity considerations in the approval of Santosafe fluids for use in coal mines in the U.K., a sample of Walkers Century Oils (U.K.) so-called non-toxic phosphate ester (NTPE) was ordered by Development. A Santosafe 300 formulation containing NTPE was defined and routine physical properties and test data obtained so that the Santosafe fluids (containing NTPE) will be ready for submittal to the National Coal Board (NCB) if Santosafe (containing TCP) is rejected on the basis of toxicity by the Medical Department of the NCB.

III. Pydraul 312 Patent Work

A. Coverage of 150-190 SSU(@210°F) Bright Stocks

Based on fire test work carried out on Pydraul 312 formulations containing various viscosity grades of bright stock, it was recommended to the Patent Department that the scope of bright stocks covered in the Pydraul 312 patent (Case 0-2219) be extended to include those whose viscosity is in the 150-190 SSU (@210°F) range in addition to the 190-250 SSU bright stocks which are presently claimed. Blends containing bright stocks from 120-160 SSU were formulated and tested in both the high pressure spray and molten metal tests and compared to Pydraul 312 (contains 210 SSU B.S.). Results showed that blends containing bright stock > 150 SSU were completely equivalent to Pydraul 312 from a commercial standpoint. That is, the differences were so small that to eliminate oils of > 150 SSU (@210°F) would be to invite our competitors to make a "me-too" Pydraul 312 product using <190 SSU bright stock.

Compositions of blends tested and detailed results of high pressure spray and molten metal tests are given in Appendix IV, Pages A-29,30.

B. Coverage of TCB and TTCB

In Patent Case 0-2219 covering bright stock/Aroclor/phosphate ester systems, trichlorobenzene and a special tri-tetrachlorobenzene blend (49% tetra) were claimed as fire resistant diluents up to 30% substitution for Aroclor. Rather extensive evaluation of the lubrication properties of blends containing the chlorobenzenes showed that these FR diluents should be claimed up to 100% substitution for Aroclor. The Pydraul 312 Patent Case (0-2219) is based on the synergistic lubricity of selected blends in the Timken Load Test. The Timken passing loads of blends containing from 0 to 100% TTCB show that these blends have nearly the same synergistic characteristics as blends containing Aroclors. A refils of the Pydraul 312 patent in early 1968 will include these claims involving TCB and TTCB. Details of formulations tested and values obtained in relation to the original three component (bright stock, Aroclor, PE) system are given in Appendix IV, Pages A-31 to A-33.

IV. Factory Mutual - Pydraul 312 Approval

When Pydraul 312 was first developed as a new low cost FR hydraulic fluid, the approvals of Underwriters Laboratories and Factory Mutual Insurance Corp. were sought for 312 as a less hazardous fluid. Underwriters approved the fluid but Factory Mutual did not because of the failure of Pydraul 312 to pass the FM "Hot Channel Test". This test involves the spraying of fluid at 140°F and 1000 psi on an inclined iron plate which is heated to 1300°F. Numerous attempts to formulate fluids which would pass this test were unsuccessful, with blends containing as little as 10% bright stock failing the test because of burning on the channel.

In late 1967, Factory Mutual was again approached concerning the approval of Pydraul 312. With over two years industrial experience with no loss of property or life and over 150 users of Pydraul 312-type fluids, Monsanto believed that 312-type fluids had a proven record and might possibly convince FM that the Hot Channel Test was too severe. Through correspondence, the Marketing Department documented all line breaks, etc. with 312-type fluids and forwarded this information to Factory Mutual for their consideration. At the same time a research program was undertaken to study the variables of the Hot Channel Test and report as to the possibility of modifying the test to make it somewhat less severe. A summary of this study and the conclusions reached are given in Appendix V, Pages A-34 to A-37. Essentially the conclusion of the test work performed was that changing the variables of the test (temp., pressure, type of nozzle, etc.) does not change the outcome (i.e. a fluid ignites under any set of conditions or doesn't ignite at all). Also concluded was that the only worthwhile test showing realistic differences in fire resistance between petroleum oil, Pydraul 312 and phosphate esters was a "back-propagation" test in which the ignition source is removed and it is observed whether or not burning of the fluid continues.

Following documentation of field experience with Pydraul 312 and completion of research work, a trip was made to FM to determine their position as to possible approval of 312. They were rather receptive to possible modification of the Hot Channel Test and agreed that 312 was worthy of consideration for approval due to satisfactory field experience over an extended period. Our research work was explained to FM personnel and it was emphasized that, based on field and laboratory experience, propagation as well as ease of ignition of a fluid was important in determining fire resistance characteristics. After a lengthy discussion on various modifications which might be tried, FM suggested that perhaps a second spray of fluid

could be employed to measure the propagation characteristics of a fluid. This second spray would be a stream (of type used in AMS 3150 Spray Test) and would project through the flames (if any) caused by the incidence of the first spray on the hot channel. Work on this modification suggested by FM is active and it is planned to hold further discussions with FM as soon as test work is completed.

V. Miscellaneous

A. Evaluation of Bright Stocks For Pydraul and Santosafe

Esso Oil C220 Bright Stock -

A sample of the bright stock was received from the U.K. via Marketing for evaluation and possible use as the oil component in the blending of Pydraul 312 in the U.K. Several of the Pydraul 312-type fluids were formulated using this oil and physical properties plus lubricity, stability and flammability data were obtained on these blends. There were essentially no differences in performance between 312-type fluids using Esso bright stock and those using Gulf MC 200 or Mobil SR 225 bright stocks. However, the appearance of fluids formulated with the Esso oil was far inferior to standard 312-type fluids. Formulations took on a black, non-transparent appearance which is certainly unacceptable.

Research work was completed on this candidate bright stock and all information was forwarded to Marketing in January, 1967 (see Appendix VI, Pages A-38 to A-40). It was recommended that Marketing investigate possible clean-up of the Esso oil and also attempt to locate other sources of bright stock on the continent. The economics of blending the Pydraul fluids in Europe are under investigation but, as yet, no details have been received as to possible clean-up of the Esso oil or the availability of other bright stocks.

Candidate Bright Stocks For Santosafe Fluids - Due to expanded field test programs and further moves toward commercialization of the Santosafe fluids, several bright stocks were investigated for possible replacement of, or alternate sources for, Kerr-McGee 'G' Bright Stock. These included a further refined version of Kerr-McGee 'G' Stock and two cylinder stocks from Pennsylvania Oil Co. who indicated they could meet our price requirements of $.16-.18/gal. bulk. In oxidation-corrosion tests conducted on Santosafe 300 containing these various

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oils, it was found that both the Penn 650 SR and Penn 600 Flash stocks exhibited superior stability and caused significantly (100-3000%) less corrosion of copper and cadmium than either of the Kerr-McGee stocks. Further evaluation of the Penn oils should include fire resistance and lubricity tests as well as a full-scale pump test (V105C). Should a decision be made not to replace the Kerr-McGee '0' Stock presently used in Santosafe fluids, we may at least have an alternate source of bright stock, which we do not have at present. Details of oxidation-corrosion tests are given in Appendix VI, Pages A-41, 42.

B. Field Test Data

Numerous field trials on various fluids were started in the past year and a half and fluid condition monitored with respect to viscosity, acid number, moisture, etc. Among these trials are included tests on Pydraul 135 and MCS 545 as steam turbine control and steam turbine lube fluids (Richborough Power Station, SEAS, Denmark, British Petroleum, BBC Turbine in Mannheim, Holland), Pydraul 540 in an extrusion application (Dow Metal Products) and Santosafe 300 in a coal mine application (car spotter, U.S. Steel). Details of sample dates and times, operating conditions and fluid analyses are given in Appendix VII, Pages A-43 to A-51.

C. Information on Competitive Fluids and Conversion (To Pydraul) Data

Detailed in Appendix VIII, Pages A-52 to A-66 is information on various competitive fluids and directions concerning conversion to Pydraul fluids. Physical properties on numerous fluids including Cellulube (phosphate ester), Cellugard (water/glycol), Houghto-Safe (phosphate ester, water/glycol), Ucon (water/glycol), Pyrogard (phosphate ester base) and several water/oil emulsions are included.

Also included in Appendix VIII is data developed by R. W. Street concerning conversion from straight phosphate ester systems to Pydraul 312 via Pydraul A-200 or Aroclor 1248. Similar information developed by the author is included on conversion from Energol SHF (Europe) to Pydraul 312 and Pydraul 135.

NOTE: Information on compatibility of Pydraul 312-type and Santosafe fluids with other Pydraul fluids and with competitive fluids is given in Appendix I, Pages A-1 to A-6.

D. Installation of Large Scale Molten Aluminum Bath

In the latter part of 1967, a large Warwick furnace was purchased and installed at the Monsanto Fire Test Lab in St. Charles, Missouri. This furnace contains a large (12" diameter) metal pot filled with aluminum and is designed to simulate the exposed molten metal of a diecasting operation. This set-up will give a much more realistic picture of the fire resistance of various fluids than the laboratory-scale molten metal test which has been used previously. Work thus far with this new apparatus has shown that a series of three tests will give a good evaluation of the fire resistance of a fluid. These tests include pouring of the fluid on the metal surface (1200°F), spraying of the fluid with a stream-type nozzle (AMS 3150) and spraying of the fluid with an atomizing-type nozzle (Bureau of Mines). In each part of the test, observations are made as to fluid FR with and without a spark as a possible ignition source. Addition of this apparatus to the fire test facility should add much to customer visits and to the credibility of Monsanto's fire testing expertise.

E. Acryloid 710-Separation of V.I. Improver From Pydraul F-9,150

From time to time over the past several years, we have incurred customer problems with the Pydraul 150 and Pydraul F-9 blends due to a separation of Acryloid 710 (V.I. Improver) from the base stock. In mid-1967, this problem was incurred with 60 drums of Pydraul 150 shipped to R.W.E. Weiswiler in Germany. At that time, it was decided that a method of screening all incoming Acryloid 710 (Rohm and Haas) should be developed to detect lots of material that would not go completely into solution with the 150 and F-9 base stocks. Such a test was developed based on the appearance (clarity) of the finished blend before Dow-Corning fluid (antifoam additive) and dye are added. Details of the test and correspondence with Manufacturing concerning implementation of the test are given in Appendix IX, Pages A-69 to A-71.

J. H. Davidson

ms

Approved by:

MONS 038212

W. R. Richard (Date)

Monsanto

FROM (NAME & LOCATION): St. Louis Research

DATE: January 31, 1968 cc: C. E. Anagnostopoulos

SUBJECT: COMPOSITION, PROPERTIES AND TEST DATA ON PYDRAUL 312-TYPE AND SANTOSAFE FLUIDS

REFERENCES:

TO:

W. R. Richard
L. R. Stark
J. F. Herber
J. D. Sullivan
H. S. Bergen
R. Davis
D. F. Smith
D. E. Roush
R. A. Garcia
C. L. Early
M. McEwen

Attached are tables for Pydraul 312-type and Santosafe fluids which give up-to-date figures on composition, physical properties, lubricity tests, performance tests, electrical properties, flammability tests, stability tests and heat transfer properties. These tables should be of considerable value in that they provide nearly all property measurements and test data under one cover.

The present tables are the first revision of those published in December, 1966 and include data on four new fluids; Pydraul 230 and Santosafe fluids 100, 150 and 700. Needless to say, there is a continual need for updating and expanding of test data and hopefully, this will be done on a somewhat routine (semiannual) basis in the future.

All comments and suggestions concerning future publication of information on Pydraul and Santosafe will be welcomed.

J. H. Davidson

LLB

Attn.

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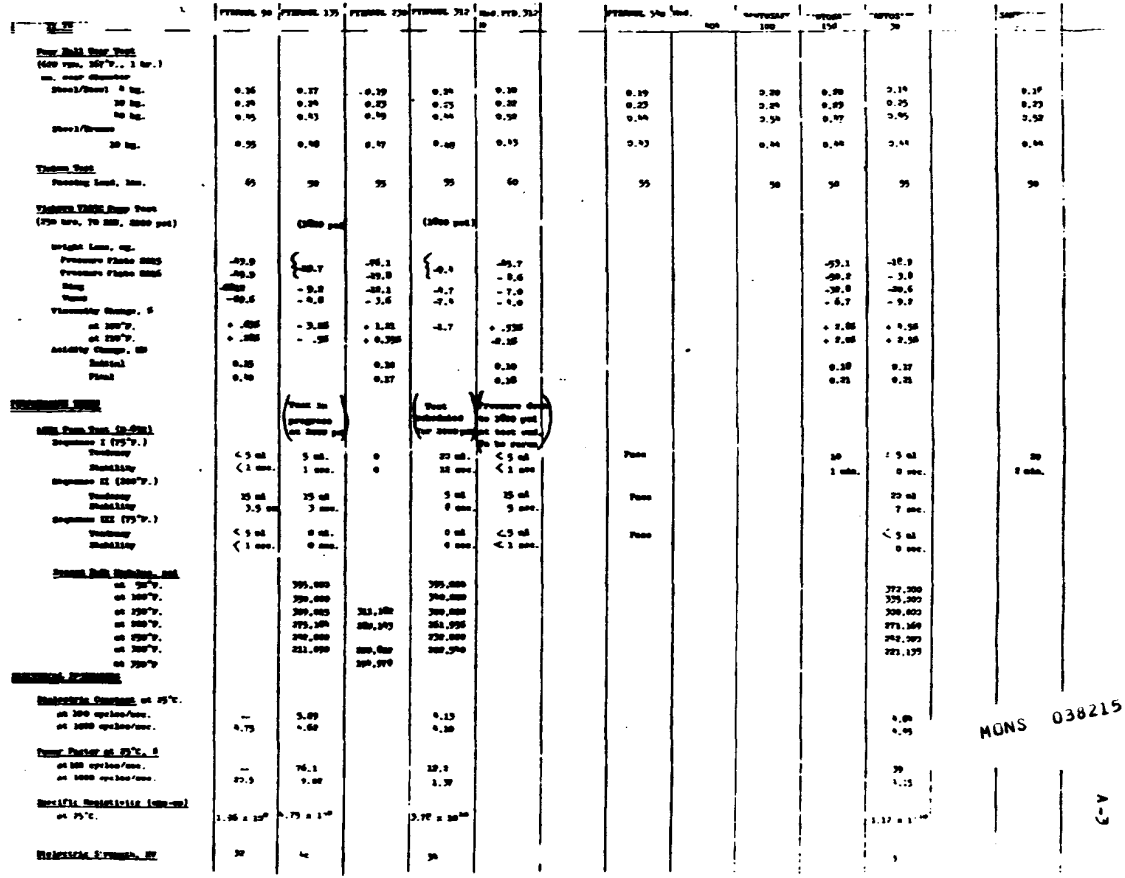

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MONS 038216

FL LIFT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flash Point		330	380	385°F	395°F	395°F	415°F				[illegible]	
Fire Point		>600°F	>600°F	605°F	595°F	>600°F	740°F				[illegible]	
A.I.T.		840°F	760°F		780°F	805°F	815°F	800°F		840°F	825°F	835°F
Fire Clamper Test (Number of Cycles/Fresh Sample)				36	28					37	40	44
Aged 2 hrs. at 150°F.		29.8	27.4	36	28					36	40	44
Aged 4 hrs. at 150°F.			27.4	36	28					34	40	44
Temperature/Pressure Spray Ignition Test												
Propane Torch Ignition			Pass		Pass		Pass				Pass	
Electric Arc Ignition			"		"		"				"	
Kerosene-Sucked Cotton			"		"		"				"	
High Pressure Spray (See Appendix) (150°F. at 1000 psi)			G.	G.	G.	G.	G.				G.	
U. S. Bureau of Mines Approval										Yes	Yes	Yes
Underwriter's Approval			Yes		Yes							
CONSISTENCY TESTS[7]												
Kinematics (168 hrs. at 150°F.)												
Nasal	% v Increase	93.5	85		57.4	63.5	43				77.5	
	% v Increase	90.6	98		64.0	69.3	42.3				73.5	
	Hardness - Before	70	65		67	70	66				67	
	- After	46	41		46	49	52				47	
Silicone	% v Increase	5.90			3.70	3.34	3.76				6.1	
	% v Increase	5.09			1.93	5.61	1.92				3.1	
	Hardness - Before	74			72	74	70				72	
	- After	72			70	73	68				72	
Vitam	% v Increase	1.06	-0.1		0.2	0.37	5.27				0.94	
	% v Increase	0.87	3.4		[illegible]	2.91	3.54				1.7	
	Hardness - Before	72	68		68	72	66				72	
	- After	67	65		67	69	[illegible]				72	
SPR	% v Increase	65	73		58.9	59.6	57.3				[illegible]	
	% v Increase	65	90		60.7	63.2	59.4				[illegible]	
	Hardness - Before	73	69		71	73	69				[illegible]	
	- After	57	53		54	57	53				[illegible]	
Brazer	% v Increase	74.8				65.4					[illegible]	
	% v Increase	77.6				71.7					57.3	
	Hardness - Before	76				76					[illegible]	
	- After	63				65					[illegible]	
Polyurethane	% v Increase	94.5	88.6		61.2	67.2	76.3				[illegible]	
	% v Increase	98.4	80.4		59.9	59.3	66.7				[illegible]	
	Hardness - Before	52	46		47	52	47				[illegible]	
	- After	33	35		36	35	36				[illegible]	
Neoprene	% v Increase	[illegible]				96.4					[illegible]	
	% v Increase	113.0				111.3					[illegible]	
	Hardness - Before	73				73					[illegible]	
	- After	51				53					[illegible]	
Solubility With Other Fluids												
Hydraul Fluids		a.	a.	a.	a.	a.	a.	a.	a.	a.		
Phosphate Esters		d.	d.	d.	c.	d.	d.	d.	d.	d.		
Water Glycol		a.	a.	a.	a.	a.	a.	a.	a.	a.		
Petroleum Oils		f.	f.	f.	f.	f.	f.	f.	f.	f.		

MONS 038217

APPENDIX

Solubility With Other Fluids

a.(1) Soluble in all proportions with other fluids of "Pydraul 312 series" fluids, ie. Pydraul 90, 135,230,312,540 and MCS 545 and Pydraul fluids A-200 and 280.

(2) Pydraul 135 completely compatible with Pydraul 150.

(3) 30% Pydraul F-9, Pydraul 625 is soluble in "312 series" fluids or use Pydraul A-200 as an intermediate fluid until concentration of A-200 reaches 50%, then add "312 series" fluids as make-up.

b. Pydraul fluids not used in coal mine machinery.

c. Approximately 10% ester is soluble at room temperature; 15% is insoluble.

d. Approximately 20% ester is soluble at room temperature; 25% is insoluble.

e. Essentially insoluble.

f. Soluble in all proportions but petroleum oil contamination can reduce the fluid's fire resistance.

High Pressure Spray Test

g. Localized burning in contact with flame but propagation <12 inches.

h. At 2 feet from orifice flames carried one foot.
At 3 feet from orifice flames carried 18 inches.
At 4 feet from orifice intermittent flashes carried to hood.

PYDRAUL 230

Viscosities 40°F - 885 cs

100°F - 49.5 cs (230 SUS)

210°F - 5.42 cs (44.0 SUS)

Specific Gravity at 25/25°C - 1.1680

Acid No. - 0.15

Moisture - 0.02%

Pour Point - 0°F

ASTM Foam Test -

Tendency (ml) - 0
Stability (min)- 0

ASTM Emulsion Test -

ml oil - 40

ml H_2O - 40

ml emulsion - 0

time (min)- 20

ASTM Rust Test (Sea Water) - 10 (No rust)

Hydrolytic Stability Test (48 hrs.)

% change in 100°F visc. - -1.4%

% change in 210°F visc. - - .85%

Initial Acid No. - 0.12

Final Acid No. - 0.27

Copper Strip Wt. Loss - -0.0009 g.

Insolubles - None

Acidity of Water - 0.04

Bulk Modulus (lb/in^2)

150°F - 311,182

200°F - 280,143

300°F - 220,802

350°F - 194,978

PYDRAUL 230

Compressibility (in^2/lb)

150°F - 3.21×10^{-6}

200°F - 3.57×10^{-6}

300°F - 4.53×10^{-6}

350°F - 5.13×10^{-6}

Coefficient of Thermal Expansion - 0.00040/°F

Specific Heat BTU/lb °F at 77°F - 0.330.37

Thermal Conductivity BTU/hr°F ft. - 0.068 (at 80°F)

Vapor Pressure - Equipment problems will delay determination indefinitely.

Shell Four Ball Test (167°F, 620 rpm, 1 hr.)

Steel/Steel	4 Kg.	- 0.19 mm
	10 Kg.	- 0.23
	40 Kg.	- 0.49
Steel/Bronze	10 Kg.	- 0.47

Timken Passing Load (lbs) - 55

Falex E.P. Test (Chrysler Procedure)

Wear Test: Loss of V Blocks - 0.6 mg.

Loss of Test Pin - 2.6 mg.

Load Test: Max. Passing Load - 1250 lbs.

Flash Pt. - 385°F

Fire Pt. - 625°F

Auto-Ignition Temp. - 900°F

Low Pressure Spray Test - Slight increase in flame intensity.

High Pressure Spray Test - No flashing or burning up to 6' from the orifice. From 6'-10' from the orifice, localized burning up to 6-8" from tip of torch.

MONS 038220

PYDRAUL 230

Molten Metal Test (1250°F) - Flashes without spark after 90-95% of fluid is vaporized. Flashes with spark but is self-extinguishing until 50% of fluid is vaporized, then flashes and burns to completion.

Bureau of Mines Wick Test - 36 cycles

Compatibility with Phosphate Esters (Houghtosafe, Cellulube)

20% is soluble at room temperature; 25% is not soluble.

Toxicity - See Attachment

TOXICITY OF VARIOUS PYDRAULS AND MCS COMPOUNDS
(All samples administered or applied in undiluted form)

COMPOUND	Acute Oral LD_{50} Rat mg/kg	Acute Skin MLD Rabbit mg/kg	Classification of Toxicity Oral	Skin
Pydraul 625	20,700 (17,390-24,630)	>2000 <3160	Practically non-toxic	Slight
Pydraul A C	18,920 (16,270-21,950)	>794 <1260	Practically non-toxic	Mild to moderate
Pydraul F-9	11,200 (9,855-12,770)	>501 <794	Practically non-toxic	Moderate
Pydraul 280	8,440 (6835-10,380)	>2000 <3160	Practically non-toxic	Slight
Pydraul 135	4,200 (3025-5840)	>1260 <2000	Slight	Mild
MCS 404	15,000 (10,875-20,700)	>1260 < 2000	Practically non-toxic	Mild
MCS 528	8,400 (6,885-10,250)	> 794 < 1260	Practically non-toxic	Mild to moderate
MCS 153	7,850 (6,085-10,130)	>1260 <2000	Practically non-toxic	Mild

MONS 038222

A-13

COMPARISON TABLE ON PYDRAUL 230, 312, and 135

Test Compound	Acute Oral Rat LD_{50} mg/kg	Acute Skin Rabbit MLD mg/kg	Skin Irritation Rabbit	Eye Irritation Rabbit	Vapor Inhalation -- Rat 6 hr. Exposure
Pydraul 230	10,500	>1260 <2000	Slight	Mild	Practically non-Toxic
Pydraul 312	6500	>2000 <3160	Slight	Slight	Practically non-Toxic
Pydraul 135	4615	>1580 <2510	Non-irritating	Slight	Practically non-Toxic

October 16, 1967
WJH/-ah

MONS 038223

J. H. Davidson - Research Center

January 9, 1958

W. R. Richard
L. R. Stark

WRICH
LSTAR

VAPOR PRESSURE OF SANTOSAFE 100, 150 AND GLYCOL BRAKE FLUIDS

C. L. Early - CE...L

Attached are vapor pressure curves requested by you on Santosafe fluids 100 and 150 and glycol brake fluids "Dolco Supreme" 11-S (from Jeffrey Mfg. Co.) and Shell "Super Safety" (typical automotive brake fluid).

As I mentioned to you earlier, data was obtained by the isoteniscope method since the regular vapor pressure apparatus in our analytical section is being repaired and will not be in working order for some time. It is important to note that the lowest temperature at which data could be obtained is 150-160°C since the nitrite salt bath used to heat the samples begins to crystallize at 150-155°C. I extrapolated the curves below 150°C as best I could; however, pressures corresponding to temperatures below 150°C should be taken only as approximations.

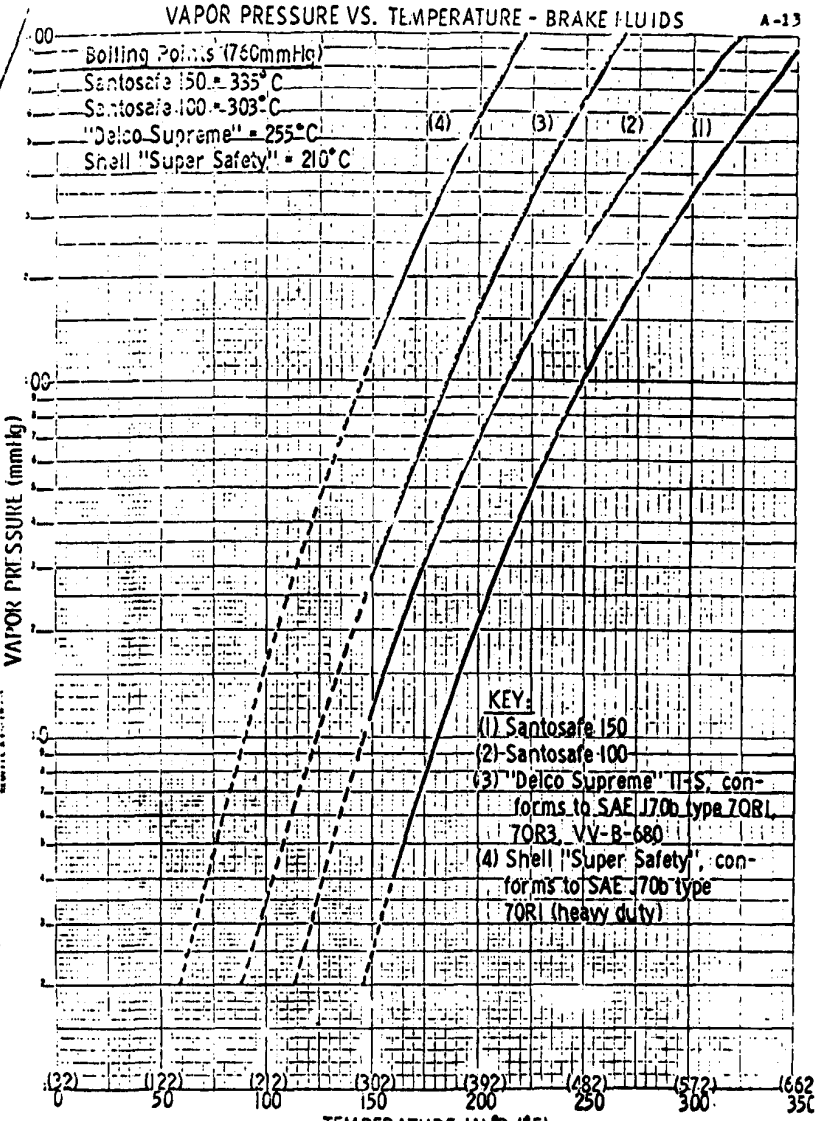
As soon as the vapor pressure apparatus is repaired, I will request our analytical people to obtain accurate low temperature data.

J. H. Davidson

ms

Att.

MONS 038224


VAPOR PRESSURE VS. TEMPERATURE - BRAKE FLUIDS
Boiling Points (760mmHg)
Santosafe 150 = 335°C
Santosafe 100 = 303°C
"Delco Supreme" = 255°C
Shell "Super Safety" = 210°C
(4)
(3)
(2)
(1)
VAPOR PRESSURE (mmHg)
KEY:
(1) Santosafe 150
(2) Santosafe 100
(3) "Delco Supreme" 11-S, conforms to SAE J70b type 70R1, 70R3, VV-B-680
(4) Shell "Super Safety", conforms to SAE J70b type 70R1 (heavy duty)
(32) (122) (212) (302) (392) (482) (572) (662
0 50 100 150 200 250 300 350
TEMPERATURE IN °C (°F)

PYDRAUL 230

Established: September 21, 1967

Composition:	Original lbs.	Alternate lbs.
44785 - Oil, Gulf M.C. 200 Bright Stock	28.0	
44786 - Oil, Mobil SR 225 Bright Stock		27.5
81101 - Aroclor 1242	51.7	52.2
82611 ~~82113~~ - Aroclor 1232	6.0	6.0
80071 - Tricresyl Phosphate	14.0	14.0
82113 - Santolube 70	0.3	0.3
31100 - Dow Corning 200 Fluid - 350 cs.	0.002	0.002
20640 - Dye, Dupont Oil Blue A	0.003	0.003

Tentative Specifications

Test	Control Limits	Method
Appearance	Blue-Green Liquid	16-B
Moisture (KF in Methanol)	0.10% max.	78-B
Neutralization No.	0.30 max.(Acid)	80-B
Flash Point	375°F min.	52-A
Sp.Gr. 25/25°C	1.150-1.180	116-A
Viscosities:		126-A
at 100°F	47.0-53.0 cs.	
at 210°F	5.25-5.85 cs.	

Blending Conditions

Standard - See Process - Section III

Toxicity and Hazards

Normal Precautions

Tentative Issue No. 1

September 21, 1967

Developed by: J. H. Davidson

MONS 038226

Modified Pydraul 312 (MCS 545)

Established: January 27, 1967

Composition:

		Original lbs.	Alternate lbs.
44785	- Oil, Gulf 200 N.C. Bright Stock	30.5	
44785	- Oil, Mobil SR 225 Bright Stock		30.0
61101	- Aroclor 1242	47.2	47.7
61102	- Aroclor 1248	8.0	8.0
60071	- Tricresyl Phosphate	14.0	14.0
62113	- Santolube 70	0.3	0.3
31100	- Dow Corning 200 Fluid, 350 cs.	0.002	0.002
20540	- Dye, Dupont Oil Blue A	0.003	0.003

Tentative Specifications:

Test	Control Limits	Method
Appearance	Blue-Green Liquid	16-B
Moisture	0.10 max.	78-B
Neutralization No.	0.30 max.	80-B
Flash Point	350°F min.	52-A
Specific Gravity 25/25°C	1.08-1.14	116-A
Viscosities:		126-A
at 100°F	63-72 cs.	
at 210°F	6.2-7.1 cs.	

Blending Conditions:

Standard - See Process - Section III

Toxicity and Hazards:

Normal Precautions

Tentative Issue No. 1

January 27, 1967

Developed by: J. H. Davidson

SANTOSAFE 100

[illegible] November 1, 1967
[illegible]
Composition

[illegible]	-	Oil, Kerr McGee 'G' Bright Stock	2[illegible].0 lbs
[illegible]	-	Aroclor 1242	36.7 lbs
32611 [illegible]	-	Aroclor 1232	12.0 lbs
[illegible]	-	Tri-[illegible]trachlorobenzene(49% tetra)	20.0 lbs
[illegible]071	-	Tric[illegible] Phosphate	7.0 lbs
[illegible]	-	Santolube 70	0.3 lbs
31100	-	Dow Corning 200 Fluid - 350 cs	0.002 lbs
20317	-	A20 Oil Black Dye	0.003 lbs

Tentative Specifications

Test	Control Limits	Method
Appearance	Green Black Liquid	16-B
Moisture (KF in methanol)	0.10 max.	78-B
[illegible] No. (Acid)	0.30 max.	80-B
Flash Pt.	325°F min.	50-A
Specific Gravity 25/25°C	1.22-1.24	116-A
Viscosities:		126-A
at 100°F	20.0-22.0 cs	
at 210°F	3.10 - 3.50 cs	

Blending Conditions

Standard - See Process - Section III

Toxicity and Hazards

Normal Precautions

Tentative Issue No. 1

November 1, 1967

Developed By: J. H. Davidson

MONS 038228

INTRODUCTION

SANTOSAFE 150 is a low viscosity version of SANTOSAFE 300. It is to be used as a hydraulic fluid in low temperature coal mine applications.

SYNOPSIS OF PROCESS

SANTOSAFE 150 is prepared by blending bright stock oil, Aroclors, tri-tetrachlorobenzene, tricresyl phosphate and various additives.

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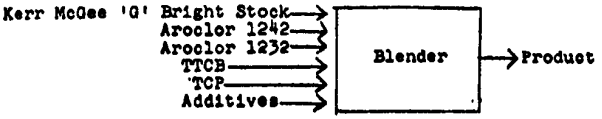

BILL OF MATERIALS

Basis: 100 lbs. of product

Raw Material	Weight (lbs)
Kerr McGee 'G' Bright Stock Oil	30.0
Aroclor 1242	41.7
Aroclor 1232	6.0
Tri-tetrachlorobenzene (49% tetra)	15.0
Tricresyl Phosphate	7.0
Santolube 70	0.3
Dow Corning 200 Fluid - 350 cs.	0.002
A 20 Oil Black Dye	0.003

PROCESS IN DETAIL

The blending operation may be carried out in any suitable steel or glass-lined equipment.

The raw materials are charged to the blend tank and are agitated for about one hour at 80-130°F.

After specification tests have been completed, the batch is circulated through a filter to remove suspended matter and transferred to storage or shipping containers.

DISCUSSION

If Kerr-McGee Bright Stock, tri-tetrachlorobenzene or Santolube 70 have been stored outdoors in temperatures below 50°F, heating to 80-100°F is recommended before removing from shipping containers.

MATERIAL SPECIFICATIONS

A. Raw Materials

		Raw Material Code No.
1.	Oil, rr McGee 'G' Bright Stock	44787
2.	Aro. 1242	81101
3.	Aroclor 1232	81115
4.	Tri-tetrachlorobenzene (49% tetra)	60820
5.	Tricresyl Phosphate	80071
6.	Santolube 70	82113
7.	Dow Corning 200 Fluid - 350 cs.	31100
8.	A 20 Oil Black Dye	20317

B. Final Product

Following are tentative specifications. They are based on a minimum amount of laboratory data, and should be reviewed after several plant batches are made.

TENTATIVE SPECIFICATIONS
SANTOSAFE 150

Test	Control Limits	Method
Appearance	Green Black Liquid	16-B
Moisture	0.10% max.	78-B
Neutralization No. (Acid)	0.30 max.	80-B
Specific Gravity 25/25°C	1.189-1.203	116-B
Viscosities:		126-A
100°F -	30.5-34.0 cs.	
210°F -	4.20-4.55 cs.	

If the batch is out of specification, use the following guide to make viscosity or specific gravity corrections.

1. If both specific gravity and viscosity are out of specification, adjust to correct viscosity first. By correcting the viscosity, the specific gravity should fall into place at the same time. If the specific gravity is still off-spec. after viscosity adjustment, proceed to Paragraph 2 below.

   If the viscosity of the batch is:

High at 100°F	Low at 100°F
Add tri-tetrachlorobenzene; 1.0 lbs/100 lbs/each 1.0 cs. over 34.0 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 1.0 cs. less than 30.5 cs.

High at 210°F	Low at 210°F
Add tri-tetrachlorobenzene 1.0 lbs/100 lbs/each 0.1 cs. over 4.55 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 0.1 cs. less than 4.20 cs.

2. If the specific gravity is out of specification low:

   Add a mixture of 35% Aroclor 1242, 65% Aroclor 1248; 1.0 lbs/100 lbs/0.002 units low.

   If the specific gravity is out of specification high:

   Add a mixture of 70% TCP, 30% Bright Stock; 1.0 lbs/100 lbs/0.005 units high.

TOXICITY AND HAZARDS

Normal precautions with all materials. Aroclor and tri-tetrachlorobenzene are irritating to the eyes and nasal passages.

STREAM AND ATMOSPHERIC POLLUTION

No waste is involved in the process.

J. H. Davidson

ms
3/15/67

File Copy Approved By
Manager of Research
W. R. Richard

Date of Approval

INTRODUCTION

SANTOSAFE 300 is a low-cost synthetic hydraulic fluid to be used in coal mine applications.

SYNOPSIS OF PROCESS

SANTOSAFE 300 is prepared by blending bright stock oil, Aroclors, tricresyl phosphate and various additives.

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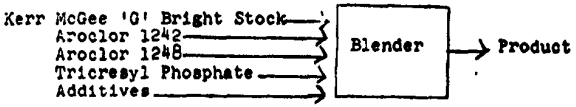


BILL OF MATERIALS

Basis: 100 lbs. of Product

Raw Material	Weight (lbs)
Kerr-McGee 'G' Bright Stock Oil	30.0
Aroclor 1242	55.7
Aroclor 1248	7.0
Tricresyl Phosphate	7.0
Santolube 70	0.3
Dow Corning 200 Fluid - 350 cs.	0.002
A 20 Oil Black Dye	0.003

PROCESS IN DETAIL

The blending operation may be carried out in any suitable steel or glass-lined equipment.

The raw materials are charged to the blend tank and are agitated for about one hour at 80-130°F.

After specification tests have been completed, the batch is circulated through a filter to remove suspended matter and transferred to storage or shipping containers.

DISCUSSION

If Kerr McGee Bright Stock or Santolube 70 have been stored outdoors in temperatures below 50°F, heating to 80-100°F is recommended before removing from shipping containers.

MONS 038232

MATERIAL SPECIFICATIONS

A. Raw Materials

		Raw Material Code No.
1.	Oil, Kerr McGee 'G' Bright Stock	44787
2.	Aroclor 1242	81101
3.	Aroclor 1248	81102
4.	Tricresyl Phosphate	80071
5.	Santolube 70	82113
6.	Dow Corning 200 Fluid - 350 cs.	31100
7.	A 20 Oil Black Dye	20317

B. Final Product

Following are tentative specifications. They are based on a minimum amount of laboratory data, and should be reviewed after several plant batches are made.

TENTATIVE SPECIFICATIONS
SANTOSAFE 300

Test	Control Limits	Method
Appearance	Green Black Liquid	16-B
Moisture	0.10% max.	78-B
Neutralization No. (Acid)	0.25 max.	80-B
Flash Point	375°F min.	50-A
Specific Gravity 25/25°C	1.185-1.195	116-B
Viscosities:		126-A
100°F -	59.0-67.0 cs.	
210°F -	5.7-6.3 cs.	

If the batch is out of specification, use the following guide to make viscosity or specific gravity corrections.

1. If both specific gravity and viscosity are out of specification, adjust to correct viscosity first. By correcting the viscosity, the specific gravity should fall into place at the same time. If the specific gravity is still off-spec. after viscosity adjustment, proceed to Paragraph 2 below.

   If the viscosity of the batch is:

High at 100°F	Low at 100°F
Add Aroclor 1242; 1.0 lbs/100 lbs/each 1.0 cs over 67.0 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 1.0 cs less than 59.0 cs.

High at 210°F	Low at 210°F
Add Aroclor 1242; 1.0 lbs/100 lbs/each 0.1 cs over 6.3 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 0.1 cs less than 5.70 cs.

2. If the specific gravity is out of specification low:

   Add Aroclor 1248; 1.0 lbs/100 lbs/0.002 units low.

   If the specific gravity is out of specification high:

   Add a mixture of 50% Aroclor 1242, 35% Bright Stock Oil, 15% TCP; 1.0 lbs/100 lbs/0.001 units high.

TOXICITY AND HAZARDS

Normal precautions with all materials. Aroclor is irritating to the eyes and nasal passages.

STREAM AND ATMOSPHERIC POLLUTION

No waste is involved in the process.

J. H. Davidson

ms
3/15/67

File Copy Approved By
Manager of Research
W. R. Richard

Date of Approval

MONS 038234

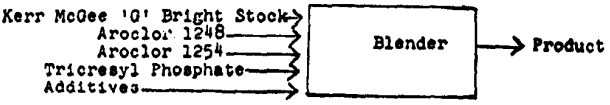
INTRODUCTION

SANTOSAFE 700 is a high viscosity gear lubricant to be used in coal mine applications.

SYNOPSIS OF PROCESS

SANTOSAFE 700 is prepared by blending bright stock oil, Aroclors, tricresyl phosphate and various additives.

FLOW SHEET



BILL OF MATERIALS

Basis: 100 lbs of Product

Raw Material	Weight (lbs.)
Kerr McGee 'G' Bright Stock Oil	30.0
Aroclor 1248	40.0
Aroclor 1254	22.7
Tricresyl Phosphate	7.0
Santolube 70	0.3
Dow Corning 200 Fluid - 350 cs.	0.002
A 20 Oil Black Dye	0.003

PROCESS IN DETAIL

The blending operation may be carried out in any suitable steel or glass-lined equipment.

The raw materials are charged to the blend tank and are agitated for about one hour at 100-140°F.

After specification tests have been completed, the batch is circulated through a filter to remove suspended matter and transferred to storage or shipping containers.

DISCUSSION

If Kerr McGee Bright Stock, Aroclor 1254 or Santolube 70 have been stored outdoors in temperatures below 50°F, heating to 80-100°F is recommended before removing from shipping containers.

MATERIAL SPECIFICATIONS

A. Raw Materials

	Raw Material Code No.
1. Oil, Kerr McGee 'G' Bright Stock	44787
2. Aroclor 1248	81102
3. Aroclor 1254	81103
4. Tricresyl Phosphate	80071
5. Santolube 70	82113
6. Dow Corning 200 Fluid - 350 cs.	31100
7. A 20 Oil Black Dye	20317

B. Final Product

Following are tentative specifications. They are based on a minimum amount of laboratory data and should be reviewed after several plant batches are made.

TENTATIVE SPECIFICATIONS
SANTOSAFE 700

Test	Control Limits	Method
Appearance	Dark Green Liquid	16-B
Moisture	0.10% max.	78-B
Neutralization No. (Acid)	0.30 max.	80-B
Specific Gravity 25/25°C	1.220-1.240	116-B
Viscosities:		126-A
100°F -	143.0-153.0 cs.	
210°F -	7.80-8.80 cs.	

If the batch is out of specification, use the following guide to make viscosity or specific gravity corrections.

1. If both specific gravity and viscosity are out of specification, adjust to correct viscosity first. By correcting the viscosity, the specific gravity should fall into place at the same time. If the specific gravity is still off-spec. after viscosity adjustment, proceed to Paragraph 2 below.

   If the viscosity of the batch is:

High at 100°F	Low at 100°F
Add Aroclor 1248; 1.0 lbs/100 lbs/each 1.0 cs over 153.0 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 1.0 cs less than 143.0 cs.

High at 210°F	Low at 210°F
Add Aroclor 1248; 1.0 lbs/100 lbs/each 0.1 cs over 8.8 cs.	Add Bright Stock Oil; 1.0 lbs/100 lbs/each 0.1 cs less than 7.8 cs.

2. If the specific gravity is out of specification low:

   Add Aroclor 1248; 1.0 lbs/100 lbs/0.002 units low.

   If the specific gravity is out of specification high:

   Add a mixture of 50% Aroclor 1248, 35% Bright Stock Oil, 15% TCP; 1.0 lbs/100 lbs/0.001 units high.

TOXICITY AND HAZARDS

Normal precautions with all materials. Aroclor is irritating to the eyes and nasal passages.

STREAM AND ATMOSPHERIC POLLUTION

No waste is involved in the process.

J. H. Davidson

ms
3/15/67

File Copy Approved By
Manager of Research
W. R. Richard

Date of Approval

APPENDIX III

COMPOSITION, PROPERTIES, TESTS-MCS 648

Composition:

Gulf MC 200 Bright Stock	15.0%
Aroclor 1248	72.7%
Aroclor 1254	5.0%
TCP	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid	0.002%

Properties:

Viscosities:

40°F -	3,288 cs.
100°F -	66.9 cs (310 SSU)
210°F -	4.94 cs

Specific Gravity 25/25°C -	1.3074
Acid No. -	0.20
Moisture -	0.05%

Tests:

Timken OK Load -	45 lbs.

Four Ball Wear Test
(620 rpm, 167°F, 1 hr)

Steel/Steel	4 Kg. - 0.20
	10 Kg. - 0.25
	40 Kg. - 0.52

ASTM Rust Test (Sea Water) - 10 (no rust)

MONS 038238

FROM : J. H. Davidson - Research Center

January 19, 1968

SUBJECT: 450 SSU FLUIDS FOR PRATT AND WHITNEY

TO : D. F. Smith - DSMIT

cc: W. R. Richard WRIC
L. R. Stark LSTA
J. F. Herber/J.D. Sullivan JHER
H. S. Bergen/N.T. Johnson HBER
R. Davis/D.E. Roush/ RDAV
R. A. Garcia
W. G. Martin - NEW YORK SALES
C. L. Early CEAR

Per Bill Martin's request for a 450 SSU (industrial) hydraulic fluid for evaluation by Pratt and Whitney, two fluids of this viscosity have been formulated and a gallon of each has been forwarded directly to Bill. One of the fluids, MCS 650, is a blend of our "old" Pydraul fluids while MCS 651 is made from our low-cost Pydraul 312 line. Although I received no information as to application, desired degree of FR etc., and no request for physical properties or application test data, I have developed a few routine properties which should be of interest to you. Composition and properties are as follows:

	MCS 650	MCS 651
Composition:	Pydraul 625-79.0% Pydraul A-200-21.0%	Pydraul 540-70.5% Pydraul 312-29.5%
Viscosities:		
100°F	97.9 cs (454 SSU)	97.6 cs (452 SSU)
210°F	5.19 cs (43.3 SSU)	8.53 cs (54.5 SSU)
Acid No.	0.32	0.21
Moisture	0.04	0.06
Sp. Gr. 25/25°C	1.375	1.158
Flash Point	440°F	430°F
Fire Point	>600°F	575°F

If you have questions concerning these fluids or need additional data in the near future, please call.

J. H. Davidson

ms

MONS 038239

COMPOSITION, PROPERTIES, TESTS-SANTOSAFE 300 WITH NTPE

Composition:

Kerr McGee 'G' Bright Stock	30.0%
Aroclor 1242	55.7%
Aroclor 1248	7.0%
Walkers non-toxic phosphate ester	7.0%
Santolube 70	0.3%
Dow Corning 200 Fluid	0.002%
A20 Black Dye	0.003%

Properties:

Viscosities:

100°F	-	65.6 cs
210°F	-	6.17 cs

Specific Gravity 25/25°C	-	1.187
Acid No.	-	0.27
Moisture	-	0.06%

Tests:

Timken OK Load	-	40 lbs.

Four Ball Wear Test
(620 rpm, 167°F, 1 hr)

Steel/Steel	4 Kg. -	0.20
	10 Kg. -	0.22
	40 Kg. -	0.45
Steel/Bronze	10 Kg. -	0.39

ASTM Rust Test (Sea Water)	-	10 (no rust)

J. H. Davidson - Research Center

September 14, 1967

cc W. R. Richard WRICH
L. R. Stark/ LSTAR
W. H. Calloway
R. Davis/D.F. Smith RDAVI
C. L. Early CEARL
J. E. Maurer JMAUR

PYDRAUL 312 PATENT - VISCOSITY OF BRIGHT STOCKS TO BE COVERED

O : R. C. Loyer - RLOYE

Per my memo of 8/28/67 and subsequent discussions with you, fire tests have been completed on Pydraul 312-type blends containing various viscosity grades of bright stocks. Specifically, the following blends were prepared in the laboratory and tested in the high pressure spray and molten metal tests.

A.	Sunray DX 120 B.S.	40%	D.	Gulf 150 B.S.	40%
	Aroclor 1242	46%		Aroclor 1242	46%
	TCP	14%		TCP	14%
B.	132 SSU(@210°F) B.S.	40%	E.	Shell 150 B.S.(162 SSU)	40%
	Aroclor 1242	46%		Aroclor 1242	46%
	TCP	14%		TCP	14%
C.	141 SSU(@210°F)B.S.	40%	F.	Pydraul 312	
	Aroclor 1242	46%		Gulf 200 B.S.	38%
	TCP	14%		Aroclor 1242	48%
				TCP	14%

NOTE: Blends B and C contain bright stocks which were blended from Shell 150 B.S.(162 SSU) and Sunray DX 120 B.S. This was done due to the unavailability of commercial bright stocks between 120 and 150 SSU.

HIGH PRESSURE SPRAY TEST RESULTS (Temp. of fluid=150°F)

Blend A - Intermittent flashing 6-8" from the orifice with flames carrying 8-10' downstream. Flames are self-extinguishing.

B - Occasional flashing 6-8" from the orifice with flames carrying 8-10' downstream. Flames are self-extinguishing.

C - Flashes with difficulty 8-10" from the orifice with flames carrying 6-8' downstream. Flames are self-extinguishing.

D - Flashes with great difficulty 8-10" from the orifice with flames carrying 6-8' downstream. Flames are self-extinguishing.

MONS 038241

E - Flashes with great difficulty 8-10" from the orifice with flames carrying 6-8' downstream. Flames are self-extinguishing.

F - Flashes with great difficulty 8-10" from the orifice with flames carrying 6-8' downstream. Flames are self-extinguishing.

MOLTEN METAL TEST RESULTS (Molten Aluminum at 1250°F)

Blend A - Flashes without spark and burns to completion after 60% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/3 of fluid is vaporized, then flashes and burns to completion.

Blend B - Flashes without spark and burns to completion after 60% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/3 of fluid is vaporized, then flashes and burns to completion.

C - Flashes without spark and burns to completion after 75% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/2 of fluid is vaporized, then flashes and burns to completion.

D - Flashes without spark and burns to completion after 90-95% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/2 of fluid is vaporized, then flashes and burns to completion.

E - Flashes without spark and burns to completion after 90-95% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/2 of fluid is vaporized, then flashes and burns to completion.

F - Flashes without spark and burns to completion after 90-95% of fluid is vaporized. Flashes with spark but is self-extinguishing until 1/2 of fluid is vaporized, then flashes and burns to completion.

Based on these test results, I recommend that the scope of the bright stocks claimed in the Pydraul 312 patent be extended to include those from 150 SSU (@210°F) to 190 SSU in addition to those from 190 SSU to 250 SSU which are now claimed. This extension is very necessary, Ray, to give us maximum protection against a "me-too" Pydraul 312 product being developed by our competitors.

Please call me if you have questions.

J. H. Davidson

NOTE: Timken Load Tests on blends containing TTCB (substituted for Aroclor) will be started next week. I anticipate that this work will be completed by 10/6/67, although timing will depend on the number of tests required to establish limits on the TTCB substitution.

J. H. Davidson - Research Center

November 17, 1967

COVERAGE OF TCB AND TTCB IN PYDRAUL 312 PATENT

TO : R. C. Loyer - RLOYE

cc W. R. Richard
L. R. Stark
J. F. Herber/
J. D. Sullivan
M. McEwen/C.L. Early
G. R. Buchanan/R. Davis
J. E. Maurer

As you know, Ray, I have been working on Pydraul 312-type blends using TTCB as a replacement for Aroclor. At the present time, TTCB and TCB are claimed as a substitute for Aroclor up to 30% by weight. Rather extensive evaluation of numerous blends in the Timken Load Test now shows that we should claim TTCB and TCB up to 100% substitution for Aroclor.

Attached is a table showing the blends evaluated, as well as a plot showing the area claimed in the Pydraul 312 patent for Bright Stock/Aroclor/Phosphate Ester systems. The letters and Timken values on the triangular coordinate plot correspond to those given in the table.

Blends corresponding to the three "corners" (B,C,D) and the center (E) of the area presently claimed were tested in the Timken Load Machine and were found to exhibit synergistic lubricity (Note that the passing load of TTCB itself is 45 lbs).

Blends J through O were tested to determine the limits of synergism and, as seen from the plot, points below the line BKJD do not exhibit the synergistic lubricity concept of the 312 invention.

I have yet to determine the solubility limits of the Bright Stock, TTCB (TCB), Phosphate Ester systems but it is only a formality. I thought you should have this information as soon as possible in lieu of your plan to refile the case sometime in the near future.

J. H. Davidson

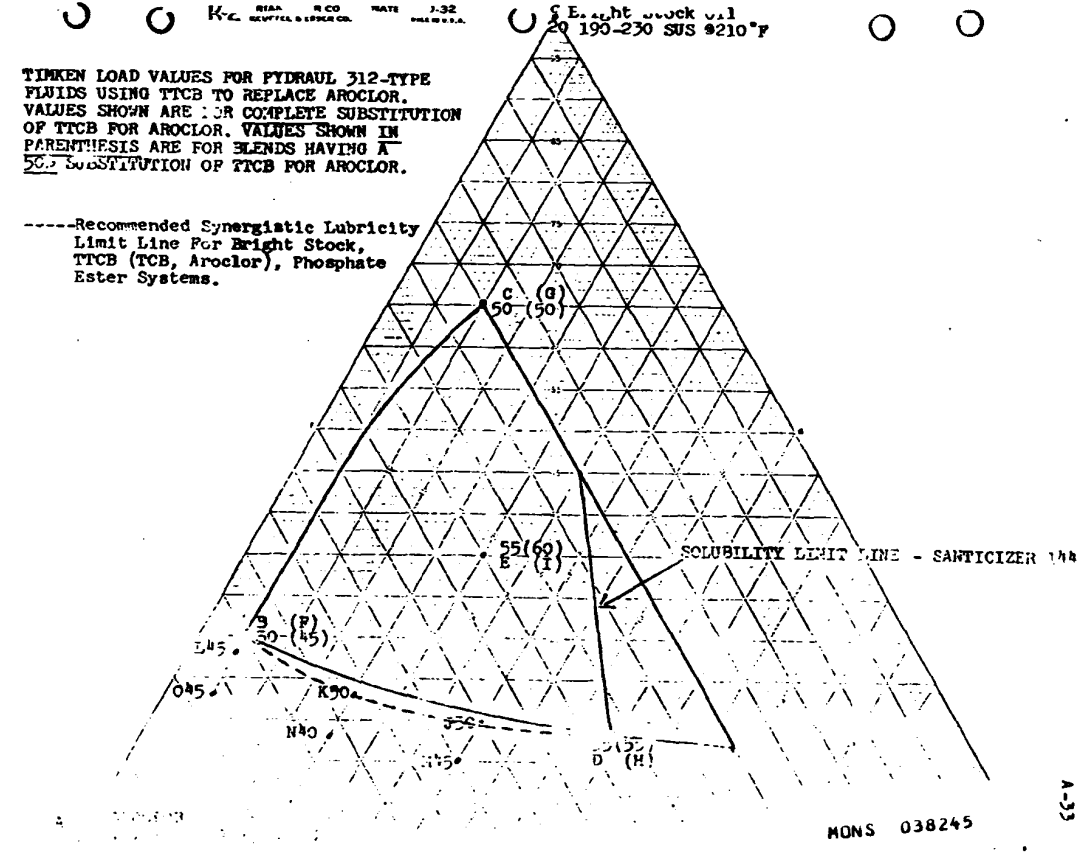
ms

Att (2)

MONS 038243

COMPOSITION AND TIMKEN LOAD VALUES FOR BRIGHT STOCK, TTCB, PE SYSTEMS

	Bright Stock	Aroclor	TTCB	Phosphate Ecter (TCP or Sant.144)	Timken Passing Load (lbs)
A.			100%		45
B.	25%		70%	5%	50
C.	65%		25%	10%	50
D.	14%		38%	48%	55
E.	35%		40%	25%	55
F.	25%	35%	35%	5%	45
G.	65%	12.5%	12.5%	10%	50
H.	14%	19%	19%	48%	55
I.	35%	20%	0%	25%	60
J.	15%		50%	35%	50
K.	18%		62%	20%	50
L.	23%		72%	5%	45
M.	10%		55%	35%	45
N.	13%		67%	20%	40
O.	18%		77%	5%	45


TIMKEN LOAD VALUES FOR HYDRAUL 312-TYPE FLUIDS USING TTCB TO REPLACE AROCLOR. VALUES SHOWN ARE FOR COMPLETE SUBSTITUTION OF TTCB FOR AROCLOR. VALUES SHOWN IN PARENTHESIS ARE FOR BLENDS HAVING A 50% SUBSTITUTION OF TTCB FOR AROCLOR.
-----Recommended Synergistic Lubricity Limit Line For Bright Stock, TTCB (TCB, Aroclor), Phosphate Ester Systems.
C (G) 50 (50)
55(60) E (I)
SOLUBILITY LIMIT LINE - SANTICIZER 148
B (F) 50-(45)
D (H)
MONS 038245
A-33

SCREENING TESTS WITH PYDRAUL 312

1.	1000 psi, FM nozzle	- Spray for 10 sec. No ignition until spray turned off. Flames reached about 1-1/2 ft. above channel.
2.	100 psi, FM nozzle	- Ignition on channel after 2 sec. of spraying. Spraying continued for 8 sec. Flames about 1 ft above channel after spray turned off.
3.	200psi, FM nozzle	- Ignition on channel after 2 sec. of spraying. Spray continued for 5 sec. Flames 1 ft. above channel after spray turned off.
4.	500 psi, FM nozzle	- Ignition on channel after 2 sec. of spraying. Spray continued for 10 sec. Flames 1-1/2 ft. above channel after spray turned off.
5.	800 psi, FM nozzle	- Ignition on channel after 3-4 sec. of spraying. Spray continued for 6 sec. Vigorous burning on channel.
6.	1000 psi, AMS 3150 nozzle	- Spray for 10 sec. No ignition until spray stopped, then vigorous burning on channel.
7.	500 psi, AMS 3150 nozzle	- Spray for 10 sec. No ignition until spray stopped, then vigorous burning on channel.
8.	200 psi, AMS 3150 nozzle	- Spray for 10 sec. No ignition until spray stopped, then vigorous burning on channel.
9.	1000 psi, AMS 3150 nozzle nozzle normal to channel, and 12" away	- Spray for 10 sec. No ignition until spray stopped, then vigorous burning on channel.
10.	1000 psi, 3.5 gph nozzle nozzle normal to channel and 12" away	- Spray for 5 sec. No ignition until spray stopped, then vigorous burning on channel.
11.	Same as 10. but at 200 psi	- Spray for 10 sec. No ignition until 5 sec. after spray turned off, then vigorous burning on channel.
12.	200 psi, FM nozzle nozzle normal to channel and 12" away	- Spray for 10 sec. No ignition until spray stopped, then vigorous burning on channel.

NOTE: During tests 9 through 12, there was no dripping of fluid from channel into pan placed below front of channel.

TEST	OIL	PYDRAUL 312	PHOSPHATE ESTER	WATER-GLYCOL	WATER-OIL EMULSION
1. Pouring of 100 cc and 200 cc aliquots of fluid on channel-have catch pan below channel.	Immediate ignition with flames 3-5' high. Flames carried down from channel into pan below. Some burning in pan.	Ignition after 7-8 sec delay. No burning as fluid runs off end of channel and no burning in pan.	No ignition of fluid, only cloud of white fumes.		
2. Pouring of 100 cc aliquots of fluid on channel-have 2' unheated extension of channel.	Almost immediate ignition with flames 4-6' high above channel. Small amount of oil runs down runway and burns, but goes out after about 1'.	Ignition after short delay with flames 3' high. Small amount of fluid runs down runway and burns, but goes out after about 6".			
3. 1000 psi, 3.5 gph nozzle in vertical position 6" above channel.	Immediate ignition but fluid did not run off front of channel.	Ignition after spray turned off but fluid did not run off front of channel even when pressure dropped to 500 psi and 200 psi.			
4. 1000 psi, Bur.of Mines nozzle, move nozzle back from channel, measure propagation of flame back to nozzle.		Ignition on channel after short delay. Nozzle moved back 18", 24" and 36" from channel. In all cases fire extended back to 6-8" from nozzle.			

MONS 038247

Cont'd. Next Page.....

CONT'D.

TEST	OIL	HYDRAUL 312	PHOSPHATE ESTER	WATER-GLYCOL	WATER-OIL EMULSION
4. 1000 psi, British nozzle, move nozzle back from channel, measure propagation of flame back to nozzle.	Immediate ignition on channel. Nozzle moved back to positions up to 4' from channel. In all cases fire continuously comes back to 4" from the nozzle.	Ignition on channel after short delay. Nozzle moved back to several positions up to 3' from channel. In all cases fire spasmodically comes back to 6" to 1' from nozzle.	No ignition of fluid. Oil poured on channel to get fire started. PE sprayed into fire and burns continuously on channel. When nozzle moved back from channel fire comes back reluctantly to 6-8" from the nozzle.	Ignition on channel after short delay. Nozzle moved back to several positions up to 3' from channel. Fire comes back reluctantly to 6-8" from the nozzle.	
5. 1000 psi, FM nozzle, move nozzle back from channel, cut off ignition source (channel) once flame carries back to spray nozzle.	Immediate ignition on channel. Nozzle moved back to 3' from channel with fire coming back to 4" from orifice and burning violently. When ignition source cut off, burning continues up to 1 min. when spray was turned off.	Ignition on channel after short delay. Nozzle moved back to 3' from channel with fire coming back to 6-8" from nozzle. When ignition source cut off, fire goes out immediately.	No ignition on channel. Oil poured on channel to get fire started. Nozzle moved back to 3' from channel. Fire comes back reluctantly to about 1' from orifice. When ignition source cut off, fire goes out immediately.	Same as Phosphate Ester.	Almost immediate ignition on channel. Nozzle moved back to 3' from channel with fire coming back to 4-5" from nozzle. When ignition source cut off, fire continues to burn for 45 sec. On repeat test fire continues for 1 min. when spray was turned off.

MONS 038248

CONCLUSIONS

1. Water-glycol fluids will ignite in the FM test.

2. Using the present FM apparatus, there is no way to change the variables of the test (angle of channel, direction of spray, distance of nozzle to channel, etc.) so that Pydraul 312 will pass.

3. There is no way to have a "fluid running" type of propagation test without pouring of the fluid. Even this is not very definitive and FM would probably have serious reservations about using a test which does not involve spraying the fluid at a realistic working pressure.

4. A test utilizing an extension of the channel is not definitive enough when the fluid is poured and is of no use at all when the fluid is sprayed.

5. The only test with promise is a "back propagation" test in which the nozzle is moved back from the channel, the ignition source cut off and it is determined whether burning of the fluid continues or ceases after the ignition source is removed.

6. One of the major deficiencies of the test is that the duration of the test is too short. This is due to the fact that the channel is not continuously heated and cools down immediately upon spraying of the fluid. A test of this short duration does not allow a realistic evaluation of the fluid.

Spray Nozzles Used

1. Factory Mutual - 1.5 gph, 80°
2. British SMRE - 2.5 gph, 80°
3. Bur. of Mines - 1.25 gph
4. AMS 3150 - .0145 in. dia.
5. 3.5 gph, 80°

Monsanto

FROM (NAME & LOCATION): St. Louis Research Department

DATE: January 23, 1967

SUBJECT: EVALUATION OF EUROPEAN ESSO BRIGHT STOCK IN PYDRAUL 312-TYPE FLUIDS

REFERENCE:

cc: W. R. Richard Res. 1
L. R. Stark LSTAR
G. R. Buchanan GBUCH
D. F. Smith DSMIT
C. L. Early CEARL

TO : Richard Davis RDAVI

The preliminary evaluation of Esso Bright Stock Oil C220 by Research is now complete and fluids of the PYDRAUL 312 series blended using this oil show essentially no significant changes with respect to physical properties, lubricity, stability and flammability. I have attached the results of all tests and property measurements performed.

Our main problem, at the moment, is the appearance of the fluids blended using this oil. The black, non-transparent appearance which the PYDRAUL 312-series fluids take on when the Esso oil is used, is simply not acceptable. As you mentioned, I think the two paths that are open to us are:

1) Investigate possible clean-up of this oil with Esso.

2) Try to locate other European bright stock oils which meet our specifications.

The desirability of cleaning up the oil certainly appears to be questionable, since it is already twice the cost of the Gulf MC 200 and Mobil SR 225 Bright Stocks which we use at present. However, we really won't know until we have the complete story on the economics of making the PYDRAULS in Europe.

Should the appearance problem be resolved, Research will (at a minimum) want to conduct further flammability tests as well as a pump test before we can think about approval for this oil.

As soon as the necessary economic data is gathered, I suggest we have a meeting with all parties concerned. Please call me if you have questions on the attached data.

Jerry

J. H. Davidson

ms

Attachment

MONS 038250

	PYDRAUL 135	PYDRAUL 312	Modified PYDRAUL 312	MCS 404
Fluid Properties				
Viscosity				
100°F	29.2	66.6	65.7	120.8
210°F	4.57	7.73	6.65	9.01
Viscosity Index	+60	+85	+36	+25
Specific Gravity 25/25°C	1.1950	1.1100	1.1663	1.1857
Quality Tests				
Acidity	0.22	0.10	0.20	0.20
Moisture	0.02%	0.02%	0.02%	0.02%
Lubricity Tests				
Four Ball Wear				
mm scar diameter				
Steel/Steel 4 Kg.	0.20		0.20	0.20
10 Kg.	0.27		0.23	0.27
40 Kg.	0.56		0.54	0.56
Steel/Bronze 10 Kg.	0.44		0.53	0.44
Stability Tests				
Hydrolytic Stability (48 hrs, 200°F, copper strip)				
Acidity				
Initial		0.10	0.20	0.20
Final		0.20	0.36	0.47
Acidity of Water (mgNaOH/g fluid		0.06	0.068	0.064
Insolubles		None	None	None
Copper Strip				
Initial Weight		4.1395 g	4.3973 g	4.7831 g
Final Weight		4.1368 g	4.3945 g	4.7807 g
Weight Loss		0.0027 g	0.0028 g	0.0024 g
Viscosity				
Initial @ 100°F		66.6	65.7	120.8
Final @ 100°F		71.5	70.3	130.4
% change@ 100°F		+ 7.35%	+ 7.0%	+ 7.95%
Initial @ 210°F		7.73	6.65	9.01
Final @ 210°F		7.65	6.49	8.54
% change@ 210°F		- 1.04%	-2.41%	- 5.21%

	PYDRAUL 135	PYDRAUL 312	Modified PYDRAUL 312	MCS 404
Oxidation - Corrosion				
(168 hrs, 250°F, air)				
Metal Attack (mg/cm²)				
Al	NC	- 0.01		
Mg	NC	- 0.01		
Cu	- 0.78	- 1.89		
Fe	- 0.01	NC		
Cd/Fe	- 0.04	- 0.05		
Viscosity				
Initial @ 100°F	29.2	66.6		
Final @ 100°F	76.9	90.3		
% change @ 100°F	+163%	+ 35.6%		
Initial @ 210°F	4.57	7.73		
Final @ 210°F	9.23	9.25		
% change @ 210°F	+102%	+ 19.7%		
Acidity, TAN				
Initial	0.22	0.10		
Final	0.79	1.18		
Flammability Tests				
Flash Point (°F)	370	400	445	460
Fire Point (°F)	725	700	720	740
AIT (°F)	850	830	795	825
Molten Metal Test * (1350°F)	a.	b.	a.	a.
Hot Manifold Test* (1500°F)	c.	c.	c.	c.

* See Descriptions Below:

a. Delayed ignition, burns to completion. Ignites by spark with difficulty, burns to completion.

b. Delayed ignition, burns to completion. Ignites by spark, burns to completion.

c. Flashing and burning on the bead. Does not carry to the pan or burn in the pan.

J. H. Davidson - Research Center

December 22, 1967

W. R. Richard WRICH
L. R. Stark LSTAR

[illegible] OF BRIGHT STOCKS
[illegible]

C. D. [illegible] - CEARL

From time to time we have discussed the stability of Kerr McGee 'G' Bright Stock presently used in the Santosafe fluids and the need to evaluate a further refined version of 'G' stock as well as alternate sources of bright stock. Since obtaining a further refined version of 'G' stock and two Pennzoil cylinder stocks from you, oxidation and corrosion tests have been run on Santosafe 300 containing these oils, the results of which are attached.

As you will note, not only is there a significant reduction in viscosity with the Pennzoil oils but a significant reduction in Cd and Cu attack, particularly with the Pennzoil 600 Flash on Cadmium. Observe that test conditions (300°F) were more severe than normal (250°F) so that any differences in the fluids would be magnified.

I feel that these test results certainly justify further evaluation of the Pennzoil stocks, particularly the 600 Flash material, and plan to conduct fire resistance and thermal stability tests as soon as possible.

If you have questions or ideas on future work, please call me.

J. H. Davidson

ms

Att.

MONS 038253

OXIDATION-CORROSION TEST RESULTS

Conditions: 300°F, 168 hrs., 5ℓ air/hr.

Fluid	% Viscosity Change @210°F	Mg	Al	Cd	Fe	Cu
Santosafe 300 with Kerr-McGee 'G' Stock	57.9%	+.03	-.01	-29.25	+.03	-9.87
Santosafe 300 with Further Refined Kerr-McGee 'G' Stock	45.1%	+.04	NC	-28.09	+.07	-9.35
Santosafe 300 with Pennzoil 650 S.R. Stock	28.4%	+.09	+.05	-16.60	+.13	-7.09
Santosafe 300 with Pennzoil 600 Flash Stock	18.1%	+.07	NC	-.24	+.07	-4.54

APPENDIX VII

MONSANTO COMPANY
ORGANIC CHEMICALS division
ST. LOUIS, MISSOURI

FIELD TEST ON PYDRAUL 135

COMPANY CONDUCTING TEST: C.E.G.B. - ENGLAND (RICHBOROUGH POWER STATION)

MACHINE NO.: #3 TURBINE

SEALS:

PRESSURE:

FLUID IN MACHINE PREVIOUS TO THIS TEST: PYDRAUL A-200

PROPERTIES ON SAMPLES

Sampling Date	Approximate Operating Hours	Viscosity, SUS 100°F	210°F	Neut. No.	Remarks Remarks
8/19/66	Flushing Fluid				
8/23/66	New Fluid Charge				
8/30/66		137.8	41.0	.24	
8/31/66	8 hrs. after loading of unit	140.4	41.0	.19	
9/2/66	30	140.4	41.0	.27	
9/3/66	54	140.4	41.0	.21	
9/4/66	78	141.3	41.2	.29	
9/8/66	168	140.0	41.0	.23	
9/19/66	Sample from coolers 377	140.9	41.5	0.21	
9/26/66	From cooler 545	139.6	41.3	0.23	No problems.
10/6/66	785	141.8	41.1	0.20	"
10/13/66		140.9	41.2	0.28	Looks good.
11/17/66	2,185	143.1	41.3	0.28	
12/5/66	2,617	142.7	41.0	0.29	
12/19/66	2,953	143.5	41.1	0.23	
1/2/67	3,289	144.0	40.1	0.24	

MONS 038255

MONSANTO COMPANY
ORGANIC CHEMICALS division
ST. LOUIS, MISSOURI

FIELD TEST ON
PYDRAUL 135

COMPANY CONDUCTING TEST: C.E.G.B. - ENGLAND (RICHBOROUGH POWER STATION)

MACHINE NO.: #3 TURBINE

SEALS:

PRESSURE:

FLUID IN MACHINE PREVIOUS TO THIS TEST: PYDRAUL A-200

PROPERTIES ON SAMPLES

Sampling Date	Approximate Operating Hours	Viscosity, SUS 100°F	210°F	Neut. No.	Remarks Remarks
1/2/67	3,289	144.0	40.1	0.26	
2/13/67	4,300	143.1	41.1	0.33	
2/27/67	4,633	142.7	41.2	0.35	
3/28/67	5,329	144.9	41.4	0.30	
No date	5,977	142.7	41.3	0.28	
5/1/67	6,145	142.2	41.4	0.34	
6/23/67	7,457	141.8	41.1	0.33	
Fluid clay treated during annual shutdown, July 1967					
9/67	392 on treated fluid	125 Red.#1 (~142 SSU)	--	0.18	Richborough date
10/30/67	769 Running Hours	141.8	41.1	0.27	
1/[illegible]/68	1[illegible] Running Hours	142.2	41.3	0.28	Rec'd 1/17

MONS 038256

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON PYDRAUL 135

COMPANY CONDUCTING TEST: SEAS, Denmark

MACHINE NO.: New Steam Turbine Power Plant

PRESSURE: 1,000 psi

SEALS: Viton (mainly)

FLUID IN MACHINE PREVIOUS TO THIS TEST: None
(Clay Filters Used)

PROPERTIES ON SAMPLES:

		MONSANTO			SEAS
Sampling Date	Weeks in Service	Viscosity, SUS 100°F	210°F	Neut. No.	Neut. No.
10/12/66	6	145.2	41.97	0.24	0.22
11/3/66	8	147.1	41.71	0.20	
11/18/66	10	149.7	41.45	0.23	
11/29/66	12				0.36
12/9/66	13	151.5	41.90	0.35	
1/6/67					0.56
1/7/67	Clay Filters Changed				
1/9/67	17	150.6	41.90	0.23	
1/14/67					0.17*
1/14/67					0.34**
3/17/67	23	152.9	42.10	0.32	
6/6/67	40	158.7	42.03	0.38	
9/27/67	51	160.8	42.23	0.45	

* Downstream ex filter
** Bulk fluid - not yet completely neutralized

MONS 038257

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON PYDRAUL 135

COMPANY CONDUCTING TEST. Mannheim, Holland

MACHINE NO.: New BBC 125 mw Turbine

PRESSURE: 1,000 psi

SEALS: Viton

FLUID IN MACHINE PREVIOUS TO THIS TEST: None
(Clay Filters Used)

PROPERTIES ON SAMPLES:

		MONSANTO			MOBILE		
Sampling Date	Time in Service	Viscosity, SUS 100°F	210°F	Neut. No.	Viscosity, SUS 100°F	210°F	Neut. No.
-	None (typical new fluid properties)	141	40.9	0.20			
?	~1000 hrs	152	42.0	0.13			

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON PYDRAUL 135 AS STEAM TURBINE LUBRICANT

COMPANY CONDUCTING TEST: British Petroleum Oil Refinery, Dunkerque, France

TEST MACHINE: Alsthom Steam Turbine, 250 h.p.

OIL PUMP: Gear-type, Cast Iron Housing

FILTRATION: Coarse screen on pump inlet only; No paper or clay filters used.

FLUID OPERATING TEMP: Front and Rear Bearings, 57°C
Cooler Out, 37°C

PROPERTIES ON SAMPLES:

Sample Date	Approx. Oper. Hours	BP TEST RESULTS Viscosity @ 122F, cs	Neut. No. mg KOH/g	% Water	MONSANTO TEST RESULTS Viscosity @ 100F, cs	Neut. No.	% Water	Syn. Sea Water Rust
7/67	41	17.42	0.50	1.2	28.3	0.63	7%	Not enough sample
/67	309	17.64	0.28	3.0	28.7	0.55	15%	"
/25/67	374	17.79	0.43	2.0				
/31/67	542		0.56		30.1	0.49	3%	
/67	715	17.91	0.39	2.5	30.6	0.45	2.7%	
12/67	1046	18.77	0.45	3.0	30.5	0.51	3%	
/67	1358	18.96	0.46	2.5	32.3	0.39	-	
	1718	18.96	0.20	1.6	32.3	0.39	-	
/67					32.5	0.34	3.6%	
21/67	2510	19.59	0.33	3.0	No sample received			
/67	2534	19.57	0.36	0.5	32.5	0.34	3.6%	No sludge or debris in sample.
Test stopped temporarily on 6/26/67 for regular summer shutdown.								
/67	3038	19.35	0.17	20.0	33.4 cs	0.31	1.7%	
/67	3686	19.65	0.69	2.0	33.6 cs	1.22	4.0%	
/67	5006	19.66	1.76	4.5	33.8 cs	0.96	2.0%	Rec'd. 11/8

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON MCS 545 AS STEAM TURBINE LUBRICANT

COMPANY CONDUCTING TEST: British Petroleum Oil Refinery, Dunkirk, France

TEST MACHINE: Worthington 500 H.P. Turbine, Serial No. 15554-5-6, with Reduction Gears

OIL PUMP:

FILTRATION: Cuno Micro Klean 25 μ Cotton Filter

FLUID OPERATING TEMP.: Approximate turbine bearing temperature, 60°C
Approximate gear reduction bearing temp., 50°C
Approximate fluid temperature range, 48°C to 85°C

PROPERTIES ON SAMPLES:

Sample Date	Approx. Oper. Hours	BP TEST RESULTS Viscosity @ 122F,cs	Neut.No. mg KOH/g	% Water	MONSANTO TEST RESULTS Viscosity @ 100F,cs	Neut. No.	% Water	Rema.
[illegible] BP turbine oil TH100 HB					62.49	.08		
[illegible] BP turbine oil TH100 HB					63.59	.21		
-	-	34.32	0.30	0.05	65.3	0.20	0.05	Fluid [illegible]
10/6	24	34.17	0.81	Traces	66.29	0.45	0.05	Rec'd I
3./67	72	34.13	0.77	0.05	66.57	0.48	0.06	" 11/
1./67	216	34.52	0.82	Traces				
7/67	432	34.80	0.47	Traces	65.02	0.64	0.18	" 12/
Above flushing replaced with test fluid, 11/9/67								
/67	24	33.75	0.58	-	65.30	0.43	0.03	" 12/
/67	120	33.90	0.47	-	65.06	0.44	0.04	" 12/
/67	216	NA	NA	NA	66.42	0.47	0.04	" 12/
/67	336	33.91	0.58	None	65.6	0.45	0.06	" 12/
/67	516	33.96	0.80	Traces	69.6	0.72	0.05	" 12/

MONS 038260

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON MCS-404

COMPANY CONDUCTING TEST: Dow Chemical Company, Madison, Illinois

MACHINE NO.: New 1800-Ton Farrell Extrusion Press

SEALS: Primarily Viton A?

PRESSURE: 3000 psi from Two Oilgear DVH 15025, 108-gpm Piston Pumps

FLUID IN MACHINE PREVIOUS TO THIS TEST: None - New Machine

PROPERTIES ON SAMPLES:

Sampling Date	Approximate Operating Hours	Viscosity, 100°F, SSU	Neut. No. - mg KOH/g	Oilgear Filter Test, Particle Count	Remarks
6/16/66	None-New Fluid	546	0.16	Small amount of bronze-like mat'l	Green-New cond.
6/23/66	1 week(8 hr/day)	549	0.14	More bronze-like mat'l+rod fibers	Temp. 114°F
7/1/66	2 weeks "	546	0.22	Same as 6/23 sample	Temp. 106°F
7/7/66	3 weeks "	544	0.17	" "	Temp. 96°F
7/13/66	~4½ weeks	537	0.15	Test in progress	Temp. 110-120°F
9/12/66	~12 weeks	548	0.21	" " "	Temp. 104°F
10/20/66	~18 weeks	562	0.22		
11/16/66	Not listed	552	0.20	Test in progress	Temp. 100-120°F
12/20/66	" "	550	0.26	" " "	Temp. 92°F
1/25/67	" "	556	0.23	" " "	"
3/31/67	~9 mo. @ 16 hrs./day	563	0.39		
5/11/67	~11 mo. @ 16 hrs./day	554	0.30		
7/5/37	~13 months	559	0.37		
10/9/67	16 months	549	0.49		

MONS 038261

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON MCS-404

COMPANY CONDUCTING TEST: Dow Chemical Company, Madison, Illinois

MACHINE NO.: New 1800-Ton Farrell Extrusion Press

SEALS: Primarily Viton A?

PRESSURE: 3000 psi from Two Oilgear DVH 15025,

FLUID IN MACHINE PREVIOUS TO THIS TEST: None - New Machine

PROPERTIES ON SAMPLES:

Sampling Date	Approximate Operating Hours	Viscosity, 100°F, SSU	Neut. No.-mg KOH/g	Oilgear Filter Test, Particle Count	Remarks
1/5/68	19 Months	565	0.44		Rec'd 1/6 Sample take prior to in
1/25/68	19 Months				Rec'd 1/25 stallation o new earth filter

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS, MISSOURI

FIELD TEST ON SANTOSAFE 300

COMPANY CONDUCTING TEST: U. S. Steel Corporation
Frick District
Robena #3 Mine
Uniontown, Pennsylvania
Mr. Jack Marsh

TEST MACHINE: Stamler Car Spotter

PUMPS & MOTORS: 2-Section CS&S Gear

PREVIOUS FLUID USED: U. S. Steel Phosphate Ester

APPROXIMATE OPERATING (FLUID) TEMPERATURE, °F: 85 Typical

APPROXIMATE OPERATING PRESSURE, PSI: From 0 to 1500

PROPERTIES ON SAMPLES

Sample Date	Approx. No. of Operating Days	Viscosity, SSU 100°F	210°F	Neut. No., mg KOH/g	% Water	Remarks
1/10/67	None	290	46	0.2 to 0.3	0.05	Typical New Fluid Properti
	4 weeks	268	45.0	0.39	0.02	
/9/67	-	269	45.1	0.46	0.04	
/29/67	-	275	45.2	0.40	0.03	
6/16/67	-	270	45.3	0.34	0.02	
1/24/67		273	45.1	0.40	0.05	
					MONS	038263

Monsanto

FROM (NAME & LOCATION): J. H. Davidson - Research Center

DATE: April 17, 1967

SUBJECT: HOUGHTO-SAFE 1480

REFERENCE:

TO: R. Davis - RDAVI

cc: W. R. Richard WRICH
L. R. Stark LSTAR
C. L. Early CEARL
G. R. Buchanan/ GBUCH
D. F. Smith
R. A. Steenrod RSTEE

Analyses have been completed on the sample of Houghto-Safe 1480 recently submitted by you. Results are as follows:

Viscosities:

100°F - 81.3 cs.
210°F - 4.83 cs

Acid No. - 0.61

Specific Gravity - 1.3529

% Cl - 31.1 %

% P - 3.25%

GLC analysis showed approximately 50% Aroclor and 50% phosphate ester. Considering the viscosity of the fluid and the % chlorine, it appears that the biphenyl is 54% chlorinated (Aroclor 1254).

I will retain the unused portion of the sample so that further work may be carried out if necessary.

J. H. Davidson

ms

FROM (LOCATION) St. Louis Research Department cc: L.R.Stark
C.L.Early
R.Davis
D.F.Smith

DATE January 5, 1966

SUBJECT Composition of Mobil Pyrogard 210

TO W. R. Richard
G. R. Buchanan
M. McEwen

For some time we have been trying to obtain samples of Mobil's new line of Pyrogards. Mobil has refused to sell them to us. Recently, Dale Smith obtained a pint sample of Pyrogard 210 at Singer Mfg. Co. in Elizabeth, New Jersey. The analysis on this sample indicates a composition of roughly 60% triaryl phosphate and 40% Aroclor 1248. Unless the structure of triaryl phosphate is indeed peculiar, Pyrogard 210 infringes on U. S. Patent 3,136,726 to Douglas Aircraft. This patent covers Pydraulis 29, AC, 280 and 150.

Property data on Pyrogard 210 is given in the attached table. Properties of a similar mixture of 60% TCP and 40% Aroclor 1248 are also presented.

Elemental analysis on Pyrogard 210 gave 19.8% chlorine and 4.59% phosphorus. These figures correspond to 41.3% Aroclor 1248 and 54.5% TCP (or 56.6% xylyl di-cresyl phosphate or 55.7% dixylyl cresyl phosphate, or 60.8% trixylyl phosphate). All of these phosphates are covered by U.S. Patent 3,136,726 (claim number one). From G.P.C., NMR and IR, no other components appear.

It is felt that Pyrogard 210 falls within the scope of this patent.

R. W. Street

MONS 038265

TABLE I

Pyrogard 210 - Composition/Properties

	Pyrogard 210	60% TCP/40% Aroclor 1248
Viscosity		
100	32.07	33.3
210	3.61	3.70
G.L.C. Analysis	40% Aroclor 1242-1248 60% Triaryl phosphate	- -
Elemental Analysis	19.8% Cl 4.59% P	19.2% Cl * 5.05% P*
Density 23°C	1.259	1.263

* Calculated

IR Spectra: Pyrogard 210 and 60% TCP/40% Aroclor 1248 are nearly identical. Differences believed due to variation in isomeric content.

FIRE-RESISTANT HYDRAULIC FLUIDS

Pydraul AC	Cellulube 90 Shell S. F. R. Fluid A	Cellulube 150 Shell S. F. R. Fluid B	Cellulube 220 Shell S. F. R. Fluid C	Cellulube 300 Shell S. F. R. Fluid D	Cellulube 550
Clear Blue Liquid	Clear Oily Liquid	Clear Oily Liquid	Clear Oily Liquid	Clear Transp. Liquid	Clear Transp. Liquid
Mild Ester Type	Slight Mild	Slight Mild	Slight Mild	None	None
1.36 (60°F)	1.20-1.21 (20°C)	1.155-1.175 (20°C)	1.145-1.165 (20°C)	1.135-1.175 (20°C)	1.15-1.19 (20°C)
410	90 18.3	150 32.2	220 47.5	306 66.0	621 134
43	37 5.25	40 4.18	42 4.80	45.5 5.84	52 7.87
+20°F	−30°F	−10°F	0°F	+5°F	+20°F
470°F	455°F	455°F	455°F	455°F	455°F
> 725°F	665°F	665°F	665°F	665°F	665°F
1080°F	1150°F	1150°F	1150°F	1150°F	1150°F
350°F (Air Temp)	·	·	·	·	·
0.15 (Max)	0.1 (Max)	0.1	0.1	0.1	0.1
Phosphate Ester Base	Phosphate Ester	Phosphate Ester	Phosphate Ester	Phosphate Ester	Phosphate Ester

Celluguard 150	Celluguard† 200	Ucent 150 CP	Ucon 275 CP	Houghto-Safe 620	
Red Liquid	Red Liquid	Cloudy Amber Liquid	Cloudy Amber Liquid	Cloudy Amber Liquid	
Characteristic	Characteristic	Characteristic	Characteristic	Characteristic	
1.055	1.060 (60°F)	1.079 (20°F)	1.08 (20°F)	1.055	
150 (76 at 150°F)	205 (102 at 150° F)	158	276	200	
·	·	·	·	·	
−25°F	−20°F	−40°F	−25°F	−20°F	
·	None	·	·	·	
·	None	·	·	·	
·	·	·	·	·	
150°F	150°F	150°F	150°F	150°F	
·	·	·	·	·	
Water/Glycol	Water/Glycol	Water/Glycol	Water/Glycol	Water/Glycol	

†These terms are registered trademarks: Celluguard & Cellulube (Celanese), Houghto-Safe (E F Houghton), Ins (Shell Oil), Minnesota & Sunsafe (Sun Oil), Pyroguard (Socony-Mobil Oil), and Ucon (Union Carbide)

PHYSICAL PROPERTIES OF

Physical Property	PYDRAUL® 60	PYDRAUL 150 Socony-Mobil Pyrogard† 42	PYDRAUL F-9	PYDRAUL A-200	PYDRAUL 626
Appearance	Clear Blue Liquid	Cloudy Blue Liquid	Cloudy Blue Liquid	Cloudy Blue Liquid	Cloudy Blue Liquid
Odor	Mild Ester Type	Mild Ester Type	Mild Ester Type	Mild Charac-teristic	Mild Ester Type
Specific Gravity	1.090 (75°F)	1.125 (75°F)	1.285 (75°F)	1.42 (60°F)	1.35
Viscosit (SUS) @100°F	62.5	143.3	235	230	628
210°F	35.1	51.6	44.7	42	45.9
Pour Point	−70°F	−55°F	−5°F	+10°F	+20°F
Flash Point	435°F	425°F	430°F	390°F	465°F
Fire Point	460°F	465°F	675°F	> 725°F	> 725°F
Autogeneous Ign. Temp.	895°F	970°F	1110°F	1220°F	1080°F
Max. Temp. Tolerated For Continuous Use	200°F	200°F	300°F	300°F	300°F
Acidity	*0.15 (Max)	0.17 (Max)	0.30 (Max)	0.8 to 1.10	0.30 (Max)
Type of Fluid	Phosphate Ester	Phosphate Ester Base	Phosphate Ester Base	Chlorinated Hydrocarbon Base	Phosphate Ester Base

Physical Property	Houghto-Safe† 1010	Houghto-Safe 1055	Houghto-Safe 1120	Inust 902	Minnesafe† Sunsafe†
Appearance	Light Green Liquid	Light Green Liquid	Light Green Liquid	Yellow Liquid	Liquids Sunsafe-cream Minesafe-white
Odor	None	None	Mild Ester Type	Mild Pleasant	None
Specific Gravity	1.17 (25°C)		1.16 (60°F)	0.93 (60°F)	0.92-0.93 (60°F)
Viscosity (SUS) @100°F	123	560	230	450 Rest	375-500
@210°F	39	52	43.4	263 Motion	-
Pour Point	−25°F	+25°F	0°F	-	0°F
Flash Point	480°F	505°F	485°F	-	-
Fire Point	-	675°F	670°F	-	-
Autogeneous Ign. Temp.	1200°F	1200°F	1200°F	-	-
Max. Temp. Tolerated For Continuous Use	-	-	-	150°F	150°F
Acidity	0.14	-	0.3	2.6	-
Type of Fluid	Phosphate Ester	Phosphate Ester	Phosphate Ester	Water-Oil Emulsion	Water-Oil Emulsion

*PYDRAUL is a Monsanto Chemical Company trademark. Registered in U.S. Patent Office.

R. M. Stark

St. Louis Research Department

April 27, 1966

Cellulube 220 Conversion to Pydraul 312

R.P. to L.R.S. dated 3/23/66

Richard Davis RDAVI

D—

L.R.Stark
R.C.Cox
W.R.Richard
C.L.Early

The requested laboratory data for converting Cellulube 220 accounts to Pydraul 312 has been obtained.

Two graphs are attached which will give the specific gravity, 25/25°C., and viscosity - 210°F, of mixtures of Cellulube 220 and Aroclor 1248, the transition fluid. These graphs may be used to determine the composition of the customer's fluid during the period in which he adds Aroclor 1248. When the composition of the system reaches 65% Aroclor 1248 and 35% Cellulube 220, Pydraul 312 may be added without oil phase separation. This corresponds to a fluid having a 210°F. viscosity of 39.64 SUS and a specific gravity of 1.3239. At higher concentrations of 220, about 40% and greater, separation may occur.

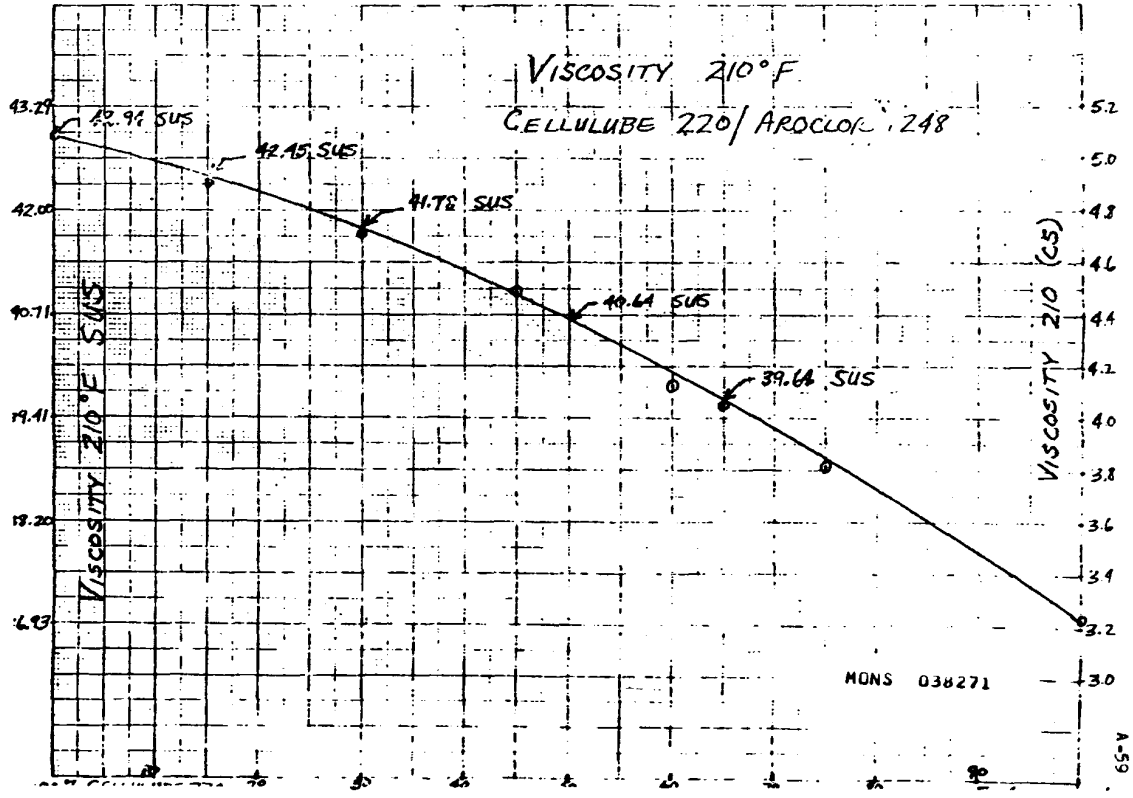
Lubricity, foam and elastomer swell tests were run on two formulations. F2859 consists of 65% Aroclor 1248 and 35% Cellulube 220. F2860 consists of 50% F2859 and 50% Pydraul 312. The data is given below:

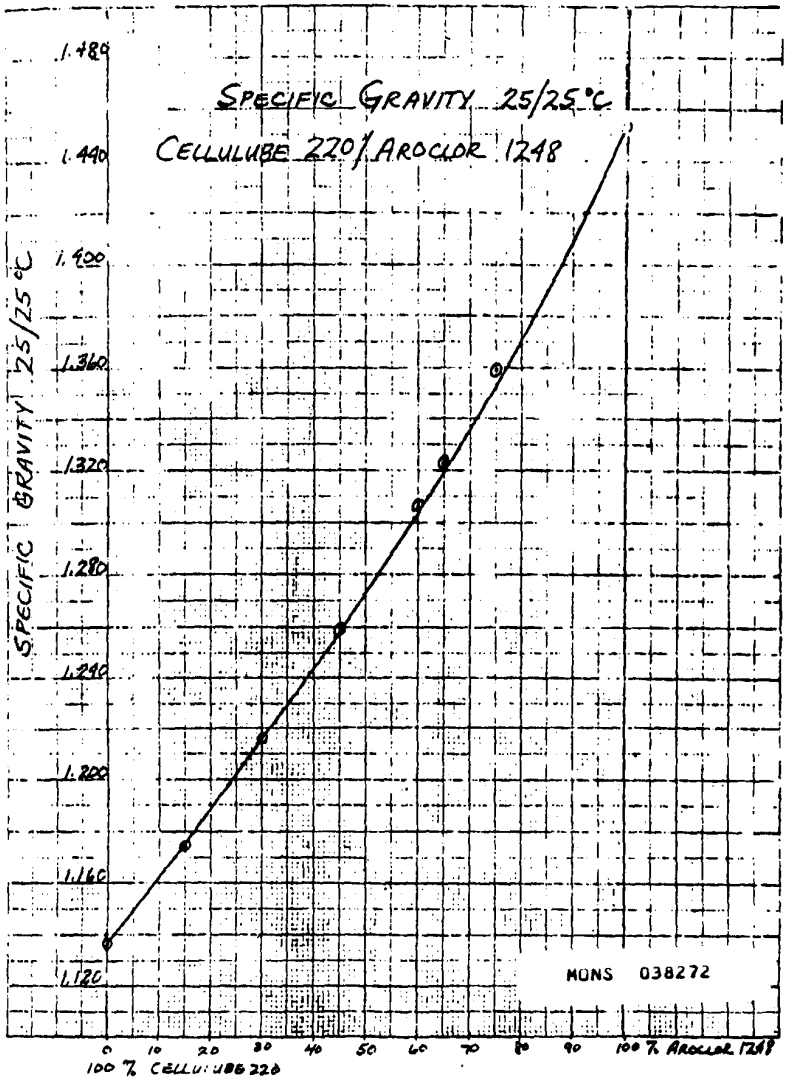
	F2859	F2860
Viscosity - -		
100°F	51.20	55.2
210°F	4.05	5.60
Pour Point	+5°F	0°F
Lubricity - Shell 4 Ball Wear Wear Scar dia. (mm.)		
40 Kg.	0.59	0.54
10 Kg.	0.25	0.22

	[illegible]	[illegible]
Foam Test (ASTM D892) -		
75°F Tendency	60 ml.	0 ml.
75°F Stability	0 ml.	-
200°F Tendency	15 ml.	15 ml.
200°F Stability	0 ml.	0 ml.
75°F Tendency	35 ml.	0 ml.
75°F Stability	0 ml.	-
Elastomer Compatibility (168 Hrs., 158°F Immersion Test)		
Viton		
Durometer "A" Hardness -		
Initial	68	65
Final	64	60
% Volume Increase	0.23	-0.58
% Weight Increase	1.60	1.62
Butyl		
Durometer "A" Hardness -		
Initial	70	70
Final	58	54
% Volume Increase	17.6	50.5
% Weight Increase	29.7	50.5

R. W. Street

mw


VISCOSITY 210°F
CELLULUBE 220/ AROCLOR 1248
42.91 SUS
42.45 SUS
41.78 SUS
40.64 SUS
39.64 SUS
43.29
42.00
40.71
39.41
38.20
VISCOSITY 210°F SUS
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
VISCOSITY 210 (CS)
MONS 038271
A-59


SPECIFIC GRAVITY 25/25°C
CELLULUBE 220/AROCLOR 1248
SPECIFIC GRAVITY 25/25°C
1.480
1.440
1.400
1.360
1.320
1.280
1.240
1.200
1.160
1.120
MONS 038272
0
10
20
30
40
50
60
70
80
90
100 % AROCLOR 1248
100 % CELLULUBE 220

[redacted]

St. Louis Research Department

May 16, 1966

Cellulube 220 Conversion
to Pydraul 312

R.D. to R.W.S. - 5/3/66

Richard Davis RDAVI
B-2-S

L.R.Stark
R.C.Cox
W.R.Richard
C.L.Early

Here is some additional data which can be used to promote conversion using Pydraul A200 as the intermediate fluid.

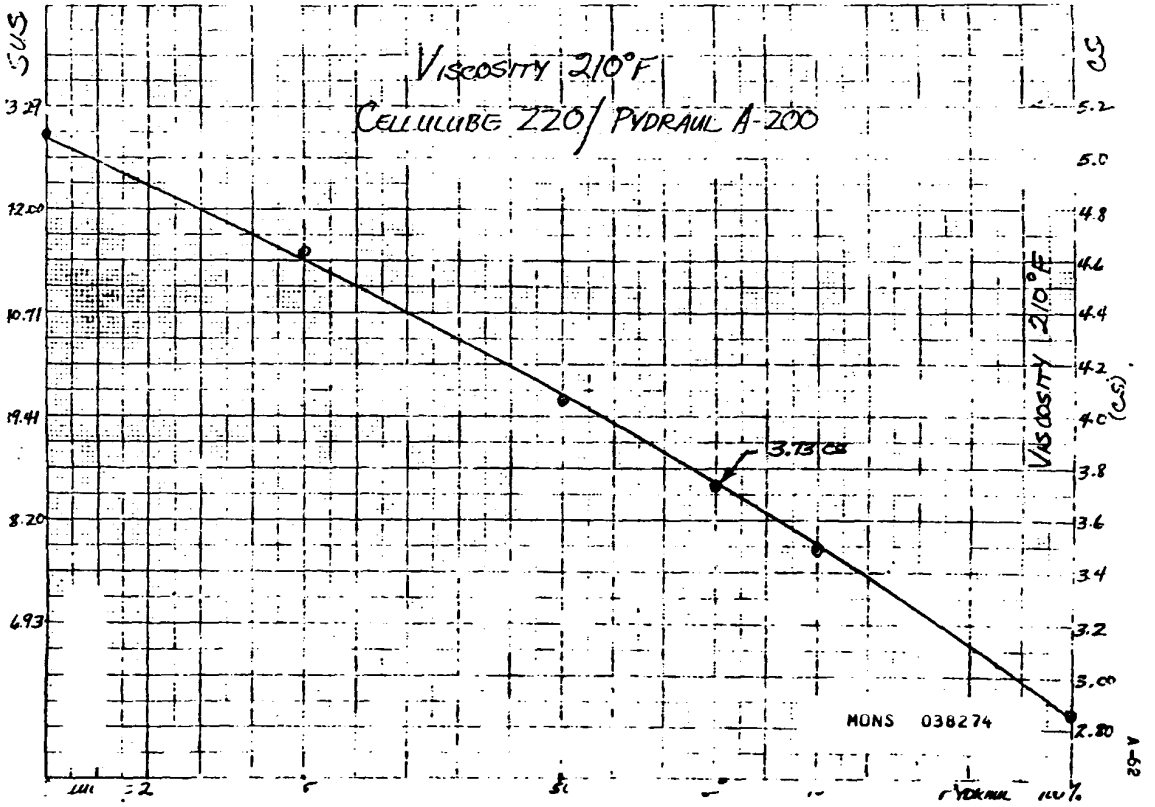
Once again, to avoid oil separation the Pydraul A200 content should be 65% or greater before starting to add Pydraul 312. At this level - 65% Pydraul A200, 35% Cellulube 220, F2861, the specific gravity at 25/25°C. is 1.306 and the 210°F. viscosity is 3.73 cs. or 38.60 SUS.

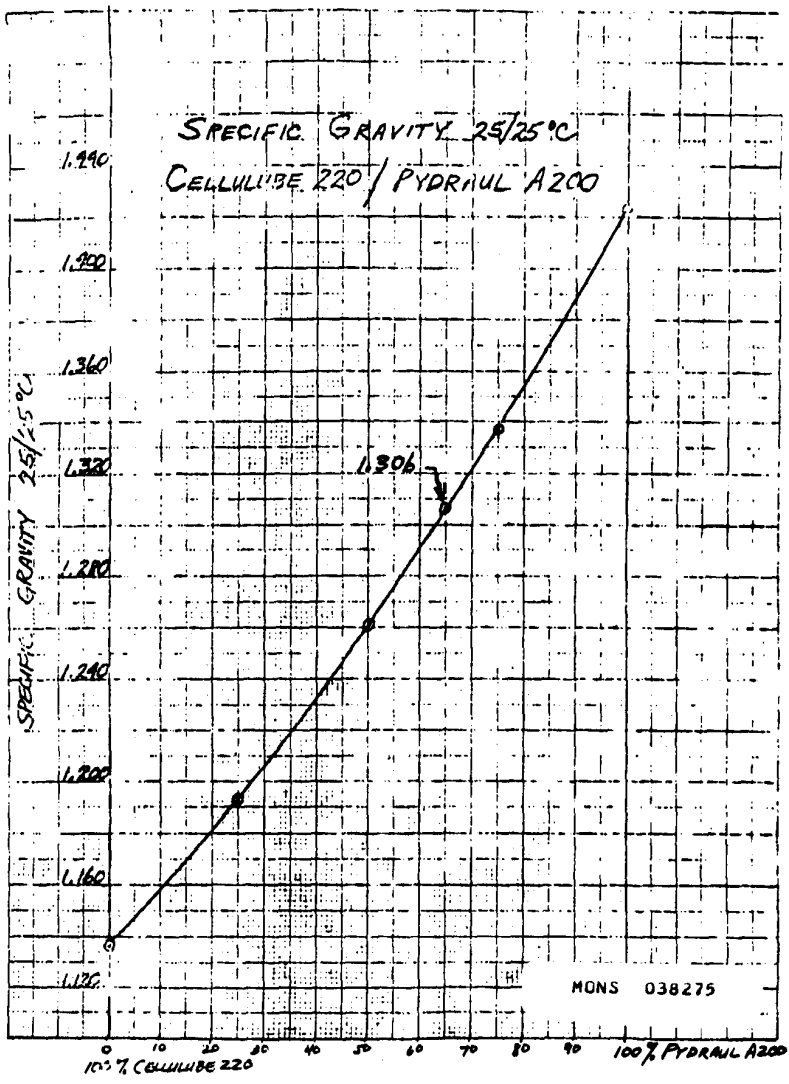
Since the fluid added already contains a defoamer, we would expect no foam problems. The elastomer compatibility is expected to be about the same as F2859 and F2860.

Properties	F2861
Viscosity	
100	40.44
210	3.73
Lubricity Shell 4 Ball	
Wear Scar dia. (mm)	
40 Kg.	.59
10 Kg.	.25

R. W. Street

mw


VISCOSITY 210°F
CELLULUBE 220 / PYDRAUL A-200
SUS
CS
3.27
12.00
10.71
19.41
8.20
4.93
5.2
5.0
4.8
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.00
2.80
VISCOSITY 210°F (c.s.)
3.73 cs
MONS 038274
A-62


SPECIFIC GRAVITY 25/25°C
CELLULOBE 220 / PYDRAUL A200
1.400
1.380
1.360
1.340
1.320
1.300
1.280
1.260
1.240
1.220
1.200
1.180
1.160
1.140
SPECIFIC GRAVITY 25/25°C
1.306
MONS 038275
0
10
20
30
40
50
60
70
80
90
100 % CELLULOBE 220
100 % PYDRAUL A200

53

J. H. Davidson - Research Center

June 21, 1967

CONVERTING ENERGOL SHF0303 SYSTEMS TO PYDRAUL 312 (PYDRAUL 135) VIA PYDRAUL A-200

R. Davis - RDAVI

W. R. Richard WRICH
L. R. Stark LSTAR
J. F. Horber/J.D. Sullivan JHERB
G. R. Buchanan/ D. F. Smith/ R. Garcia GBUCH
C. L. Early CEARL

Per your request, I have developed the specific gravity and viscosity curves necessary for conversion of Energol SHF0303 systems to Pydraul 312 or Pydraul 135 using Pydraul A-200 as an intermediate fluid.

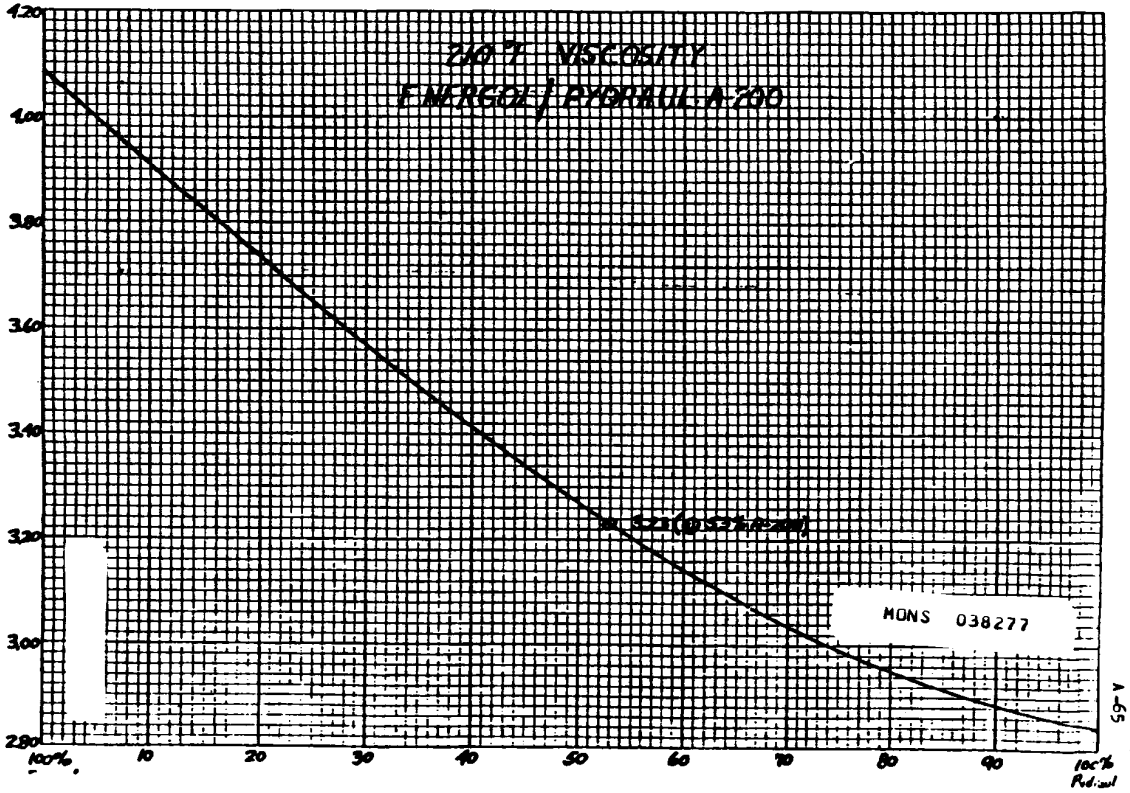
You will note that the A-200 content must reach 53% before 312 or 135 can be added. Addition of any of the 312-type fluids before the composition reaches 53% A-200 will result in separation into an oil-rich top phase and a PE/Aroclor-rich bottom phase.

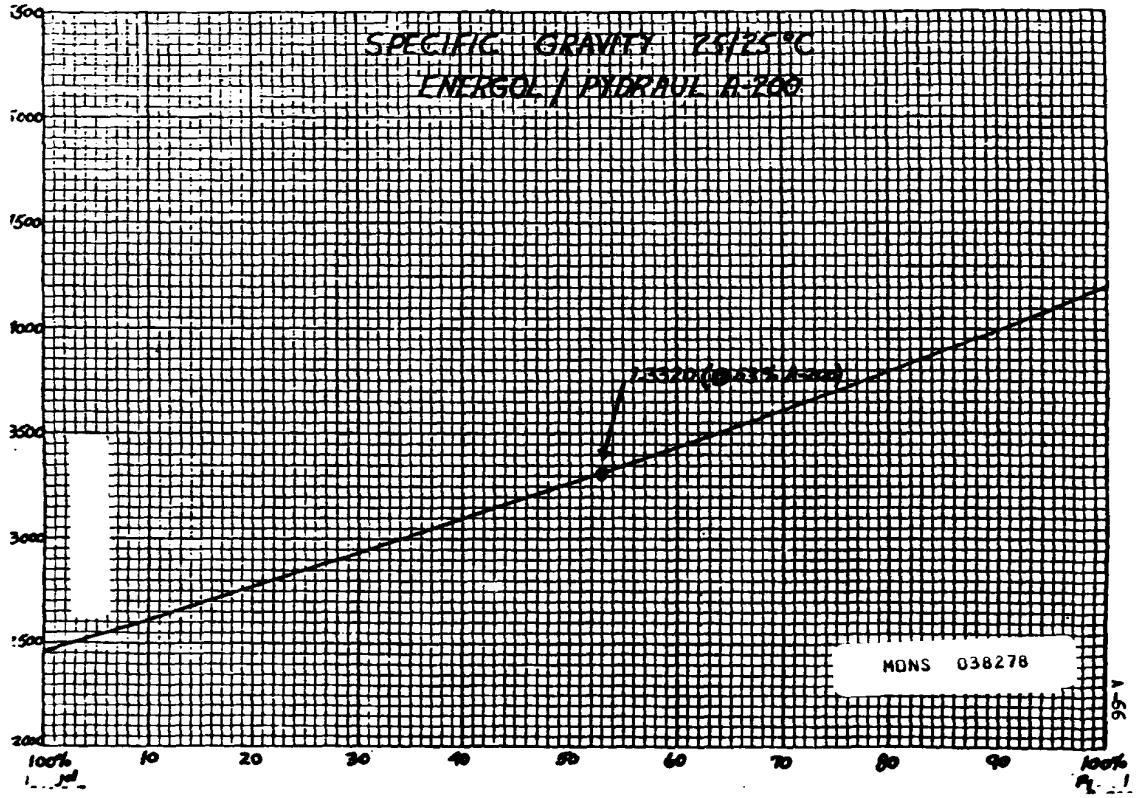
If you have questions or need additional data, let me know.

J. H. Davidson

JHD:ms

MONS 038276


210 °F VISCOSITY
ENERGOL / PYDRAUL A-200
4.20
4.00
3.80
3.60
3.40
3.20
3.00
2.80
100%
10
20
30
40
50
60
70
80
90
100%
Pedisul
MONS 038277


K+E 10 X 10 TO THE INCH 46 0703
SPECIFIC GRAVITY 25/25°C
ENERGOL / PYDRAUL A-200
1.3320 (@ 63% A-200)
MONS 038278
1500
1000
3500
3000
2500
2000
100%
10
20
30
40
50
60
70
80
90
100%

A-66

Established August 18, 1955 as OS-67
by Tentative Process P-628, Job 2615

Composition

80071	Tricresyl Phosphate	43.0 lbs.
81103	Aroclor 1254	57.0 lbs.
20640	Blue A Dye	0.0007 lb.

Specifications	Sales	Internal	Procedures
On each lot			
Appearance	Clear, blue liquid, free of sediment		16-B
Moisture (By KF in methanol)	0.15% max	0.02 to 0.10%	78-B
Neutralization number	0.15 max	0.02 to 0.10	80-B
Specific gravity @ 25/25°C	1.345 to 1.385*	1.355 to 1.375*	116-A
Viscosity: At 100°F	82 to 92 cs	84 to 91 cs	126-A
At 210°F	4.6 to 5.0 cs	4.70 to 4.95 cs	
On each 10th lot			
Pour point	+20°F max	+10 to +20°F	100-A

*Tentative limits

Specification Correction Guide

If both specific gravity and viscosity are out of specification, adjust to correct viscosity first. By correcting the viscosity, the specific gravity should fall into place at the same time. If the specific gravity is still out of specification after viscosity adjustment, Proceed by Step 2 below.

1. If viscosity of the batch is:
   a. HIGH at 100 to 210° F - Contact Research.
   b. LOW at 100° F - Add aroclor 1254 at 0.5 lb/100 lbs/each centistoke less than 82.0 cs
      LOW at 210°F - Add Aroclor 1254 at 1.5 lbs/100lbs/each 0.1 cs. less than 4.60 cs.

2. If specific gravity is:
   a. LOW - Contact Research.
   b. HIGH - Add TCP at 1.0 lb/100 lbs/each 0.002 units specific gravity is high.

Blending

Standard. See Process - Section III

Toxicity & Hazards

Normal Precautions

First Data Page Issued July, 1961
Issue #2 - April, 1962 to show blending operation changes,
Issue #3 TENTATIVE - July 12, 1967 - To widen sales specific gravity range from 1.340 - 1.360 to 1.345-1.385

Revised by: J. H. Davidson
Approved by: J. F. Herber

Review date: July 15, 1968

MONS 038279

Established: January 8, 1957 as OS-82
By Tentative Process P-740, Job 3132

Composition

S1105	Aroclor 1260	49.85 lbs.
S0071	Tricresyl Phosphate (High Viscosity)	49.85 lbs.
S2113	Santilube 70	0.30 lb.
S1100	DC-200 Fluid, 350 cs.	0.002 lb.
20640	Blue A Dye	0.0007 lb.

Specifications	Sales	Internal	Procedure
On each lot			
Appearance	Cloudy, blue liquid free of sediment		16-A
Moisture (by KF in methanol-pyridine)	0.15% max	0.08% max	78-B
Neutralization No. (acid)	0.30 max	0.25 max	80-B
Foam test	250 ml max	0 to 150 ml	54-A
Specific gravity @ 25/25°C	1.360 to 1.400*	1.370 to 1.390*	116-A
Viscosities: At 100°F	125 to 145 cs.	130 to 140 cs	
At 210°F	5.7 to 6.2 cs.	5.84 to 6.04 cs.	
On each 10th lot			
Pour point	+30°F max	+25°F max	100-A

*Tentative limits

Specification Correction Guide

If both specific gravity and viscosity are out of specification, adjust to correct viscosity first. By correcting the viscosity, the specific gravity should fall into place at the same time. If the specific gravity is still out of specification, after viscosity adjustment, proceed to Step 2 below.

1. If viscosity of the batch is:
   a. HIGH at 100 or 210°F - Contact Research
   b. LOW at 100°F - Add Aroclor 1260 at 1 lb/100 lbs. each 6.0 cs. less than 125.0cs
      LOW at 210°F - Add aroclor 1260 at 1.5 lbs/100 lbs/each 0.1 cs less than 5.70 cs.

2. If specific gravity is:
   a. LOW - Contact Research
   b. HIGH - add TCP at 1.0 lb/100 lbs/each 0.002 units specific gravity is high.

Blending

Standard. See Process - Section III

Toxicity & Hazards

Normal precautions.

First Data Page Issued April, 1962: Showed blending operation changes.
Issue #2 - March, 1964 - DC-200 Fluid concentration reduced from 50 ppm to 20 ppm.
Issue #3 - March 17, 1964
Issue #4 - September 2, 1965 - To show revised specifications.
Issue #5 - TENTATIVE - July 12, 1967 - To raise sales specific gravity range from 1.340-1.380 to 1.360-1.400

Review date: July 15, 1968

Revised by: J. H. Davidson
Approved by: J. F. Herber

J. H. Davidson - Research Center

November 28, 1967

ACRYLOID 710 IN PYDRAUL F-9
AND PYDRAUL 150 BLENDS
JHD Memo to W.E. Ault, 11/3/67

R. A. Geisman - JFQ

W. R. Richard
L. K. Stark
R. E. Hatton
J. W. Baker
P. F. Gatens
D. E. Munie
Q. M. Capocefalo
G. R. Buchanan
R. Davis/D. F. Smith/
D. E. Roush
W. E. Ault

In reference to the Acryloid 710 separation problem in Pydraul 150 and F-9 fluids in general and to the recent customer complaint on Pydraul 150, I believe we have found a relatively simple solution to the problem. It involves visual examination of the fluids at room temperature before Dow Corning 200 fluid (anti-foamant) and Blue A Dye are added. In all cases when these fluids were prepared in the laboratory, blends made with "bad" Acryloid were very cloudy and opaque while blends prepared from "good" Acryloid were water clear.

I have attached a procedure for the "appearance" test for both Pydraul 150 and Pydraul F-9. Obviously, the best time to run the test is before the batch is blended since we want to identify any bad Acryloid before it is used in a final blend. I strongly recommend that the test be run both before and after the batch is blended since it is such a simple test.

I am forwarding samples of "good" and "bad" Pydraul F-9 and Pydraul 150 so that you may see the difference in the appearance of the fluids.

The attached procedure supersedes the "centrifuge test" given in my memo of 4/14/67 since I believe this test is more definitive. Please call if you have questions.

J. H. Davidson

ms

NOTE: I will notify Paul Biven to include this test in the specifications as a tentative procedure.

Att.(1)

APPEARANCE TEST ON PYDRAUL 150 AND PYDRAUL F-9

PYDRAUL 150

Prepare the following blend in at least a 100 gram amount:

Santicizer 141	69.0%
Aroclor 1242	25.0%
Acryloid 710	6.0%

Stir the blend for 20-30 minutes at any convenient temperature up to 60°C. Allow the fluid to cool to room temperature (65-75°F). The fluid should be very light yellow and water clear. If a cloudy or opaque appearance is observed, the blend is unacceptable and the lot of Acryloid 710 used should be rejected.

PYDRAUL F-9

Prepare the following blend in at least a 100 gram amount:

Aroclor 1248	52.5%
Tricresyl Phosphate	45.0%
Acryloid 710	2.5%

Stir the blend for 20-30 minutes at any convenient temperature up to 60°C. Allow the fluid to cool to room temperature (65-75°F). The fluid should be very light yellow and water clear. If a cloudy or opaque appearance is observed, the blend is unacceptable and the lot of Acryloid 710 used should be rejected.

IT IS IMPERATIVE FOR BOTH FLUIDS THAT THE TEST BE RUN BEFORE THE DOW CORNING 200 FLUID AND BLUE A DYE ARE ADDED AND THAT THE APPEARANCE OF THE FLUID IS OBSERVED WHEN THE FLUID IS AT ROOM TEMPERATURE. IF DOW CORNING 200 IS ADDED TO THE BLEND THE FLUID WILL BE CLOUDY IN ALL CASES. IF THE FLUID IS ABOVE ROOM TEMPERATURE, THE SOLUBILITY OF THE ACRYLOID 710 IS IMPROVED, THE CLOUDINESS DECREASES AND THE TEST IS NOT AS DEFINITIVE.

J. H. Davidson - Research Center

December 21, 1967

W. R. Richard WRICH
L. R. Stark LSTAR

ADDITION OF TENTATIVE APPEARANCE SPECIFICATION TO PYDRAUL 150 AND PYDRAUL F-9 FINISHED PRODUCT SPECIFICATIONS

P. M. Diven - JFQ

From time to time we have incurred customer problems with the Pydraul 150 and Pydraul F-9 blends due to a separation of Acryloid 710 (V.I. improver) from the base stock. In order to rectify this situation, Research has developed a screening test to insure the quality of incoming Acryloid 710.

Attached is a procedure outlining this screening test which we have requested the A-Lab to perform on all finished product Pydraul 150 and Pydraul F-9. By this memo, I am requesting that the F-9 and 150 blend sheets be reissued to include this test as a tentative test. I have forwarded the procedure and samples of material to Ray Goisman, so he is aware that this test is to be performed.

J. H. Davidson

mb

Att. (1)

Monsanto

FROM (NAME & LOCATION): St. Louis

DATE: June 29, 1967

SUBJECT: TOXICITY OF HEXACHLOROBUTADIENE

REFERENCE:

cc: W. R. Richard - WRICH
L. R. Stark - LSTAR
J. F. Herber - JHERB
J. D. Sullivan - JSULL
C. L. Early - CEARL
R. Davis - RDAVI

TO : J. M. Davidson - JDAVI

Attached is a copy of the report from Younger Laboratories indicating his results with the animal studies on hexachlorobutadiene. The table below shows comparison with Aroclor 1242.

	Aroclor 1242	Hexachlorobutadiene
Oral LD_{50} (rats)	8650 mg/kg	175 mg/kg
Skin MLD (rabbits)	794 - 1260 mg/kg	501 - 794 mg/kg

It would appear that this is not a likely substitute for Aroclor in our Pydraul fluids.

The range finding inhalation study tells us little except that inhalation at ambient temperature does not appear to be an acute hazard. Whether or not chronic exposures would indicate that the butadiene compound is more or less toxic would require about a $10,000 study and six months of animal research.

Elmer P. Wheeler

EPW:ejs