file Pydraul

A guide to fire-resistant hydraulic fluids.



TOWOLDMON0020927
WATER_PCB-00005396

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Bulletin number IC/FF-30

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Pydraul "E" series

STRAIGHT PHOSPHATE ESTER HYDRAULIC FLUIDS

Development

Fire protection for industrial hydraulic operations began with Pydraul in 1951. Pydraul® fluids have since provided industry with millions of machine hours of safe operation.

New ways are continuously being explored to improve the excellent performance records of Pydraul fluids. From the first Pydraul fluid, (Pydraul F-9) the family has grown to ten specially tailored, fire-resistant safety fluids. Each answers a major but specific hydraulic fluid need for industrial use. In addition to guarding against fire, each Pydraul fluid lubricates as well as premium grade oil. Pydraul fluids have answered the need of virtually every industrial operation, indoors and out—from the sub-zero, outdoor hydraulic lift operations for refineries and blast furnaces to the low-viscosity fluid demands of high-speed, precision machine tools.

Reformulation

The Pydraul Fluids in this Selector were reformulated in 1971 to remove all chlorinated components. Monsanto has developed a series of ALL PHOSPHATE ESTER fluids known as the Pydraul E Series which exhibit performance superior to presently available phosphate ester hydraulic fluids.

Pydraul E Series fluids are named for their viscosity at 100° F in centistokes (e.g. Pydraul 30E has 100° F viscosity of 30 centistokes). The E designation for these Pydraul fluids denotes straight phosphate ester—with no chlorinated components.

Pydraul 30E, Pydraul 50E, Pydraul 65E, Pydraul 90E (for air compressors) and Pydraul 115E are a unique family of fluids. They offer improved thermal and oxidative stability with corresponding long service life compared to present competitive products.

With unique low temperature fluids Pydraul 10E and Pydraul 29E LT added to the above line, the Pydraul E Series is the most complete line of phosphate ester fluids offered for industrial hydraulic service.

Performance

Pydraul fluids offer a wide range of viscosities from which you can select the proper range specified by your hydraulic equipment manufacturer. Whichever Pydraul fluid you select, each provides the same protection against fire, premium lubricity, ease of maintenance, and freedom from corrosive action and foam. Pydraul hydraulic fluids also offer several additional benefits—

Reduced Fire Insurance Rates

Pydraul substantially reduces fire hazards from hydraulic operations and fire threats to surrounding structure and equipment. Insurance premiums for plants using Pydraul are often lower than premiums for operations using petroleum oil.

Longer Pump Life

Machines which operate on water-based fluids frequently require pump repair or replacement as often as every two or three months. Machines which use Pydraul hydraulic fluids can operate on the same pump for several years. Pydraul hydraulic fluids give the same long pump life as the finest grade petroleum oil.

No Corrosion Problems

Any metal hydraulic system component in contact with Pydraul will not rust. Pydraul hydraulic fluids do not lose anti-rust properties even after extended use.

Maximum Equipment Response

Pydraul never produces excessive froth or foam during normal operations to interfere with hydraulic equipment response. Because Pydraul hydraulic fluids lubricate as well as premium petroleum oils, Pydraul permits equipment to operate at optimum response capability.

Inspection and Replacement Down-Time Are Virtually Eliminated

Pydraul hydraulic fluids are designed to be permanent. Pydraul fluids do not wear out. Except for normal "make-up" requirements, you never have to add new Pydraul to hydraulic systems. Pydraul eliminates "drain and change" periods; it does not have to be inspected in your system from month to month—or replaced from year to year.

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Pydraul "E" series 2

	PYDRAUL® 10-E	PYDRAUL 29-E-LT
PHYSICAL PROPERTIES Appearance	Clear Blue Liquid	Clear Blue Liquid
Spec. Gravity 25/25°C.	1.088—1.091	1.093—1.113
Neutralization No. (mg KOH/g) max.	0.25	0.35
Moisture (max.) %	0.10	0.15
VISCOSITY		
Centistokes @ 100°F.	10.0 cs	30.9 cs
@ 210°F.	2.4 cs	6.9 cs
SSU @ 100°F.	60 SSU	145 SSU
@ 210°F.	35 SSU	49 SSU
Absolute SSU @ 100°F.	60.5 SSU	158 SSU
(SSU x Density) @ 210°F.	35 SSU	51 SSU
Pour Point	−70°F.	−45 °F.
Bulk Temp. Max. (continuous operation)	175°F.	175 °F.
Boiling Point °F. at 760 mm Hg	707°F.	500 °F.
Coefficient of Thermal Expansion per °F.	0.00044	0.00040
Specific Heat BTU/lb./°F. @ 77°F.	0.42	0.39
Thermal Conductivity BTU/hr./ft./°F.	0.047	0.0757
Vapor Pressure mm Hg @ 200°F.	0.002	0.002
Bulk Modulus (Room Temp. 1000-6000 psi)	328,000	370,000
Rust Test ASTM D-665	Pass	Pass
Foam Test ASTM D-892	Pass	Pass
Solubility in Water	Negligible	Negligible
FIRE RESISTANCE TESTS		
Factory Mutual Spray Test. Test fluid sprayed at 1000 psi through orifice, passing through flame of propane torch.	Fail	Pass
Factory Mutual Channel Iron Test. Test fluid sprayed at 1000 psi through orifice, onto hot channel iron at 1300°F.	Fail	Pass
Hot Manifold Test (Federal Test Method Std. 791). Test fluid dripped on at 1300°F.	Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.
Factory Mutual Approval. FM	No	Yes

Fire-resistance Advantages of Pydraul
Pydraul fluids protect hydraulic equipment and personnel with *permanent* fire protection. Pydraul fluids contain no water to evaporate and do not leave a flammable residue. During their many millions of machine hours of use, Pydraul fluids have been accidentally sprayed over molten metal, through electrical arcs, into flames and sparks. They pass all of the important ignition tests for fire-resistance.

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PYDRAUL 30-E	PYDRAUL 50-E	PYDRAUL 65-E	PYDRAUL 115-E
Clear Blue Liquid	Clear Blue Liquid	Clear Blue Liquid	Clear Blue Liquid
1.150–1.170	1.140–1.160	1.125–1.145	1.145–1.165
0.15	0.15	0.15	0.15
0.10	0.10	0.10	0.10
32 cs 4.8 cs 150 SSU 42 SSU 174 SSU 47 SSU	49 cs 5.9 cs 231 SSU 46 SSU 262 SSU 50 SSU	67.3 cs 7.1 cs 312 SSU 50 SSU 349 SSU 54 SSU	122 cs 9.1 cs 565 SSU 56 SSU 644 SSU 61 SSU
−15 °F.	−5 °F.	0 °F.	+10 °F.
225°F.	225 °F.	225 °F.	225 °F.
725 °F.	750 °F.	780 °F.	820 °F.
0.00035	0.00035	0.00035	0.00035
0.36	0.37	0.38	0.38
0.0737	0.0730	0.0726	0.0721
0.002	0.002	0.001	<0.001
390,000	392,000	395,000	397,000
Pass	Pass	Pass	Pass
Pass	Pass	Pass	Pass
Negligible	Negligible	Negligible	Negligible
Pass	Pass	Pass	Pass
Pass	Pass	Pass	Pass
Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.
Yes	Yes	Yes	Yes

FOLLOWING IS A PARTIAL LIST OF APPLICATIONS FOR THE PYDRAUL FLUIDS:

STEEL INDUSTRY
continuous casters
rolling mills
furnaces
scrap chargers
stripper cranes
arc welders
combustion controls
mobile equipment

ALUMINUM INDUSTRY
stripper cranes
direct chill casters
furnaces
rolling mills
shearers
combustion controls
mobile equipment

FORGING AND EXTRUSION
forge presses
extrusion presses
billet manipulators

FOUNDRIES
furnaces
molding lines

DIECASTING
diecast machines
trim presses

FABRICATION
forming presses
welders
furnaces

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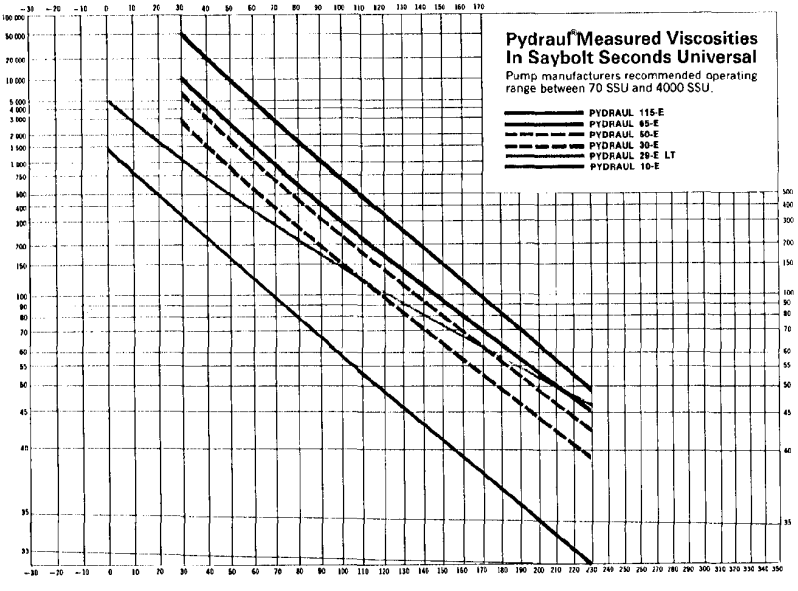
Pydraul "E" series 4



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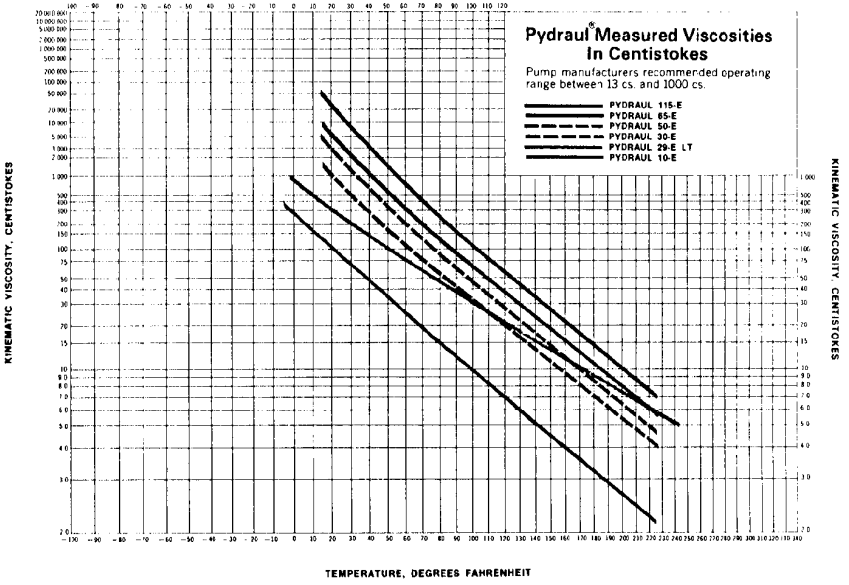

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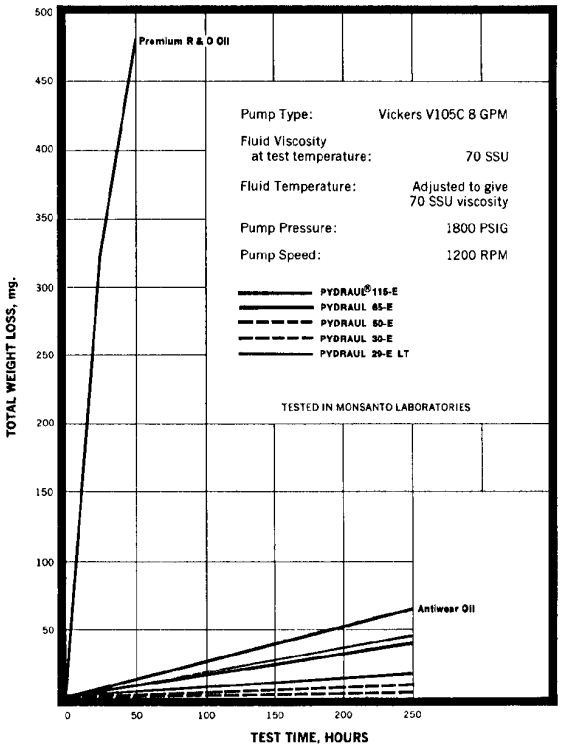
Pydraul "E" series 6

In a more severe Vickers hydraulic pump test (V-105-C pump), the Pydraul fluids performed as well as commercial antiwear oils and proved far superior to premium R & O oil (rust and oxidation inhibited).



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MIXING COMPATIBILITY

Pydraul® With Other Pydraul Fluids

	10-E	29-E LT	30-E	50-E	65-E	115-E
10-E	—	YES	YES	YES	YES	YES
29-E LT	YES	—	YES	YES	YES	YES
30-E	YES	YES	—	YES	YES	YES
50-E	YES	YES	YES	—	YES	YES
65-E	YES	YES	YES	YES	—	YES
115-E	YES	YES	YES	YES	YES	—
230-C	YES	YES	YES	YES	YES	YES
312-C	YES	YES	NO	YES	YES	YES
540-C	YES	YES	NO	YES	YES	YES

Pydraul® With Other Hydraulic Fluids

	10-E	29-E LT	30-E	50-E	65-E	115-E
FYRQUEL*						
90	YES	YES	YES	YES	YES	YES
150	YES	YES	YES	YES	YES	YES
220	YES	YES	YES	YES	YES	YES
300	YES	YES	YES	YES	YES	YES
550	YES	YES	YES	YES	YES	YES
HOUGHTO-SAFE**						
1010	YES	YES	YES	YES	YES	YES
1115	YES	YES	YES	YES	YES	YES
1120	YES	YES	YES	YES	YES	YES
1130	YES	YES	YES	YES	YES	YES
1055	YES	YES	YES	YES	YES	YES

*Fyrquel is a registered trademark of Stauffer Chemical Company.
**Houghto-Safe is a registered trademark of E. F. Houghton Company.

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Pydraul "E" series 8

CONVERTING TO PYDRAUL IS EASY

Regardless of the type hydraulic fluid being used, converting a system to low-cost Pydraul fluids is easy. Virtually every type of equipment which uses fire-resistant hydraulic fluid has been converted to Pydraul fluids. Most equipment manufacturers are experienced in Pydraul fluid conversions and should be consulted.

If changing seals is necessary, equipment manufacturers can recommend what seals to change, and many carry a supply of correct seals. Laboratory tests and operational experience show Viton*, Teflon*, and silicone the preferred elastomers for compatible seals. Please refer to the following section on seal and packing information for compatibility of Pydraul with other elastomers.

To replace other fluids which are compatible with Pydraul and where compatible seals are in the system, it is only necessary to add Pydraul as make-up fluid. It is not necessary to drain or clean. When converting from petroleum oils, non-compatible synthetic fluids, water-glycol fluids, or water-in-oil emulsions, the following steps are recommended. These conform to USA Standard B93.5—1966.

Please ask the Monsanto fluids specialist for recommendations and assistance. He may be reached by phoning the nearest sales office, listed on the inside back cover of this brochure.

Change-Over Procedures

Changing from Petroleum Oil

1. Completely drain and clean the system. Small amounts of oil will not interfere with the performance of Pydraul, but resistance to fire is reduced by the amount of oil left in the system.
2. Drain and blow out pipelines. Manually clean valves and reservoirs.
3. Open or remove and drain valves. Replace gaskets, packings, and seals with those compatible with Pydraul. It is particularly important to change dynamic seals. Static seals do not necessarily have to be changed if they are not leaking. Non-compatible static seals will have to be replaced when the part is disassembled for maintenance.
4. Remove pumps, accumulators, and cylinders, if necessary, for draining. Replace packings, seals, gaskets, and bladders with those compatible with Pydraul.
5. Check component functions before the system is closed and fluid is added.
6. If your system cannot be completely drained, you may have to flush it with a small amount of Pydraul.

Changing from Water-Glycol or Water-in-Oil Emulsion

1. Drain and clean system thoroughly. Remove all traces of water. Empty all lines and low points or dead pockets in components.
2. Clean with steam or warm water. Follow by blowing with dry air.
3. Check sealing materials, hoses, and accumulator bags. Replace if necessary with compatible materials.
4. Install a minimum charge of Pydraul and operate the system from 16 to 24 hours. During this period, inspect the reservoir. If water or other contaminants float to the top, skim them off.
5. Drain the flushing charge immediately after shut-down while the fluid is warm. Drain all isolated points or parts which do not drain back to the reservoir. If water is apparent in fluid clinging to walls, wipe down all accessible parts.

Changing from Phosphate Esters (Other Than Pydraul)

The Pydraul E Series fluids are compatible in all proportions with competitive phosphate esters and may be added as make-up to these fluids.

*Registered trademark of E. I. Du Pont de Nemours & Co., Inc.

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SEALS AND PACKINGS INFORMATION

Materials compatible with Pydraul hydraulic fluid are necessary for dynamic or moving seals. For static seals they are preferred, but not essential. The following table indicates materials recommended, depending on the Pydraul fluid selected.

PYDRAUL® FLUID	BUTYL	EPR	VITON	TEFLON	NYLON	SILICONE	BUNA N	NEOPRENE	NATURAL RUBBER
10-E	R	R	U	R	R	S	U	U	U
29-E LT	R	R	R	R	R	R	U	U	U
30-E	R	R	R	R	R	R	U	U	U
50-E	R	R	R	R	R	R	U	U	U
65-E	R	R	R	R	R	R	U	U	U
115-E	R	R	R	R	R	R	U	U	U

R—Recommended S—Satisfactory U—Unsatisfactory

This list of component manufacturers is a guide to obtaining seals compatible with Pydraul fluids. Please contact your equipment manufacturer or seal supplier for their most current recommendations.

Acushnet Process Company
776 Belleville Avenue
New Bedford, Massachusetts 02745

Anchor Packing Company
401 North Broad Street
Philadelphia, Pennsylvania 19108

Bearings, Inc.
3634 Euclid Avenue
Cleveland, Ohio 44115

A. W. Chesterton Company
Everett
Massachusetts 02149

Chicago Rawhide Manufacturing Company
1311 Elston Avenue
Chicago, Illinois 60622

C. E. Conover & Company, Inc.
333 Passaic Avenue
Fairfield, New Jersey 07006

Crane Packing Company
6400 Dakton Street
Morton Grove, Illinois 60053

Garlock Packing Company
Palmyra
New York 14522

Goshen Rubber Company, Inc.
P. O. Box 416
Goshen, Indiana 46526

Greene, Tweed & Company
North Wales
Pennsylvania 19454

Hercules Packing Corporation
11061 Walden Road
Alden, New York 14004

International Packing Corporation
Bristol
New Hampshire 03104

Johns-Manville
22 East 40th Street
New York, New York 10016

C. W. Marsh Company
36 Hudson Street
Muskegon, Michigan 49441

Minnesota Rubber Company
3630 Wooddale Avenue
Minneapolis, Minnesota 55416

Parker Seal Company
10567 Jefferson Boulevard
Culver City, California 90230

Plastic & Rubber Engineering, Inc.
756 East Florence Avenue
Los Angeles, California 90001

Plastic & Rubber Products Company
2100 Hyde Park Boulevard
Los Angeles, California 90047

Precision Rubber Products Corporation
Hartmann Drive
Lebanon, Tennessee 37087

Raybestos-Manhattan, Inc.
Packing Division
Passaic, New Jersey

Reliable Rubber Products
Eddyington
Pennsylvania 19020

Rockwell Mechanical Packing Company, Inc.
1634 Long Beach Avenue
Los Angeles, California 90021

W. S. Shamban Company
11617 West Jefferson Boulevard
Culver City, California 90230

Vellumoid Company
Rockdale Street and Beaman Avenue
Worchester, Massachusetts 01606

The James Walker Packing Company, Inc.
P. O. Box 75
Chicago Heights, Illinois 60411

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Pydraul "E" series 10

FILTERS AND HOSES

Filters/ Most standard oil filters are satisfactory. You can use active earth or clay types. Filter manufacturers include:

Briggs Filtration Division
Bowser Corporation
Cookeville, Tennessee

Capital Engineering Company
5839 S. Ashland Avenue
Chicago, Illinois

Commercial Filters Corporation
(Honan-Crane)
Lebanon, Indiana

Cuno Engineering Corporation
Sub. of American Machine
& Foundry
4627 S. Vine Street
Meriden, Connecticut

Dollinger Corporation
20 Centre Park
Rochester 3, New York

Fulflo Specialties Company, Inc.
410 Fancy Avenue
Blanchester, Ohio

Hilliard Corporation
98 W. Fourth Street
Elmira, New York

Marvel Engineering Company
7227 North Hamlin Avenue
Chicago 45, Illinois

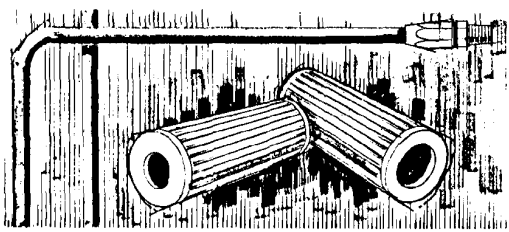
Pall Corporation
32 Sea Cliff Avenue
Glen Cove, L. I., New York

Purolator Products
1000 New Brunswick Avenue
Rahway, New Jersey

Rosaen Filter Corporation
1776 E. Nine Mile Road
Hazel Park, Michigan

Schroeder Bros. Corporation
101 Nichol Avenue
McKees Rocks, Pennsylvania

Serfilco Division
Service Filtration Corporation
7408 North Milwaukee
Niles, Illinois 60648



Hoses/ Although both neoprene and buna elastomers swell somewhat in Pydraul, hose of these materials have given satisfactory service when made of a reinforced braid construction. Butyl, nylon or Viton are preferred when new hoses are installed. Suppliers include:

Anchor Coupling Company
3600 N. Fourth Street
Libertyville, Illinois

Eastman Mfg. Company
(See Imperial-Eastman Corp.)
Department T. R.
6300 West Howard Street
Chicago 48, Illinois

Electric Hose & Rubber Co.
1201 Duro Street
Wilmington, Delaware

Gates Rubber Company
999 South Broadway
Denver, Colorado 80217

Imperial-Eastman Corp.
6300 W. Howard Street
Chicago, Illinois

Lewis Products
Hohenwald, Tennessee 38462

Samuel Moore Co.
Mantua, Ohio

Resistoflex Corp.
Roseland, New Jersey

Stratoflex, Inc.
222 Roberts Cutoff Rd.
Fort Worth, Texas

Weatherhead Corp.
302 E. 131st Street
Cleveland, Ohio 44108

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OTHER COMPONENTS

Swivel Couplings
Systems for Pydraul fluids often contain swivel couplings. Some suppliers are:

Chiksan Division
FMC Corporation
332 N. Brea Boulevard
Brea, California

Pipe Joint Sealers
. . . can be bought from:

American Sealants Company
(See Loctite Corporation)
115 N. Mountain Road
Hartford 11, Connecticut

Crane Packing Company
6410 Oakton Street
Morton Grove, Illinois

Dow Corning Corporation
Midland, Michigan

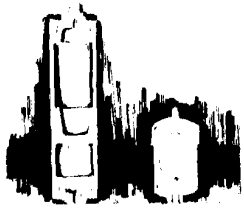
Friesland Plastics Company
Friesland, Wisconsin

General Electric Company
Insulating Materials Department
1 Campbell Road
Schenectady 6, New York

Permatex Company
Department T. R.
Flagler Court Building
West Palm Beach, Florida

W. S. Shamban & Company
11617 W. Jefferson Boulevard
Culver City, California

Shell Chemical Company
110 W. 51st Street
New York, New York



Accumulators
. . . many hydraulic systems for Pydraul contain an accumulator which uses a bladder to separate the fluid from air or nitrogen pressure. For these, a rubber compatible with the fluid is necessary. Suppliers include:

Greer Hydraulics, Inc.
5930 W. Jefferson Boulevard
Los Angeles, California

Paints
. . . resistant to Pydraul are supplied by:

Amercoat Corporation
Department T
Brea, California

Andrew Brown Paint Company
5413 S. District Boulevard
Los Angeles, California

Carboline Company
32-R Hanley Industrial Court
St. Louis, Missouri

Carrol Products
148 Marine Street
Farmingdale, New York

Finch Paint & Chemical Company
Torrence, California

W. P. Fuller & Company
1645 W. Valencia Drive
Fullerton, California

The Glidden Company
900 Union Commerce Building
Cleveland, Ohio

Interchemical Corporation
Finishes Division
1255-T Broad Street
Clifton, New Jersey

Lowe Brothers Company
Third & Madison Streets
Dayton, Ohio

Magna Coatings & Chemical Corporation
1785 N. Eastern Avenue
Los Angeles, California

Nycote Laboratories
15002 Delano Street
Van Nuys, California

Pittsburgh Plate Glass Company
One Gateway Center
Pittsburgh 22, Pennsylvania

Rinshed-Mason Company
5935 Milford
Detroit, Michigan

Royalty Paint & Varnish Company
Pasadena, California

Saran Protective Coatings Company
2415 Burdette at Reed
Ferndale, Michigan

Sherwin-Williams Company
101 Prospect Avenue, N. W.
Cleveland, Ohio

Titanine, Inc.
Seagrave Corporation
Elmwood & Morris Avenues
Union, New Jersey

U. S. Paint, Lacquer & Chemical Company
2101 Singleton
St. Louis, Missouri

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Pydraul "E" series 12

RECLAIMING PYDRAUL FLUIDS

Pydraul hydraulic fluid lost from leaks and spills can be reclaimed because it is exceptionally stable and resistant to water and other contaminates. If fluid losses are appreciable—fluid recovery can result in considerable savings. Simply placing a container beneath leaks until they can be repaired will save some fluid. Where drip pans have been used beneath hydraulic machinery, more than half of the total Pydraul leakage has been reclaimed.

This dollar-saving recovery appears especially advantageous because it isn't practical to reclaim either water glycol or water-oil emulsions except to filter out large dirt particles. Reclaiming Pydraul fluid helps make it the most economical fire-resistant fluid available.

Reclaiming Pydraul consists of two steps: removing water, and filtering dirt or other solid particles.

Water Removal . . . Water does not mix with Pydraul and will, therefore, form a layer on top. A drum reserved for contaminated fluid with a side and end bung, placed horizontally on a cradle about two feet off the floor, is a simple and effective settling chamber. Salvaged fluid can be added through a large funnel in the top opening and Pydraul periodically drained off through the lower opening.

For a more elaborate system, permanently installed settling tanks, or a commercial installation can be used.

A second method is centrifuging. Suitable units are made by DeLaval and Sharples Co. Centrifuges operate swiftly . . . will separate water from large volumes of fluid in a short time.

Final Filtration . . . A number of filtration units are available complete with filter pump and motor. Other systems use filter media such as cotton linters, felt or metal screens. Attapulgus clay and Fuller's earth may be used to help keep the fluid clean, reduce moisture and lower neutralization number. Diatomaceous earth filtration is recommended for solid particles removal only. Paper and fiber type filters are recommended for water and particle removal but are ineffective for lowering neutralization number (acidity) values.

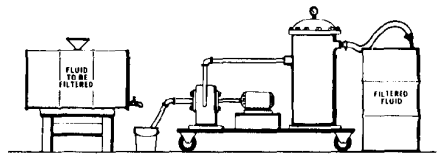
TOXICITY AND SAFE HANDLING

Acute animal studies indicate that the Pydraul E Series Fluids can be classed as practically non-toxic when considered as an industrial fluid. They are non-irritating when the skin is exposed to the fluid.
However, this product should not contact or in any way contaminate food, animal feed, food products, food packaging materials, pharmaceuticals or any items which may directly or indirectly be ultimately ingested by humans. Any contact may contaminate these items to the extent that their destruction may be required.

Due to their low order of toxicity, the Pydraul E Series require no special handling precautions. However, as in handling any chemical, good hygienic procedures should be followed. In case of skin contact, wash off with soap and water. In the case of eye contact, flush with copious amounts of water.

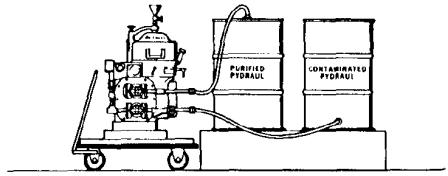
While Pydraul E Series (Pydraul C Series, also AC Series, Santosafe W/G) fluids pose no serious problems with respect to the environment, as a concerned supplier to industry, Monsanto urges the user to maintain a tight system, to correct leakage promptly and to exercise care in the handling and disposal of this and all other such products.

FLUID PURIFICATION SYSTEM



CENTRIFUGE SYSTEM FOR PURIFICATION

Filters in the 3 to 5 micron range are recommended for Pydraul filtration and reclamation. Such filter media will not affect the basic Pydraul formulation.



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Pydraul "C" series 1

SECTION 2

PHOSPHATE ESTER BASE HYDRAULIC FLUIDS

Development

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Reformulation

The Pydraul fluids in this Selector were reformulated in 1971 to remove all chlorinated components. Monsanto has developed a series of phosphate ester base fluids known as the Pydraul C Series which exhibit performance superior to other phosphate ester base products.

The Pydraul C Series products, as with the Pydraul E Series straight phosphate ester line, are based on a unique phosphate ester. This gives the Pydraul C Series improved thermal and oxidative stability with corresponding long service life compared to competitive products.

Performance

Pydraul fluids offer a wide range of viscosities from which to select the proper range specified by the hydraulic equipment manufacturer. Whichever Pydraul fluid selected, each provides safety, premium lubricity, ease of maintenance, and freedom from corrosive action and foam. These Pydraul fluids have positive viscosity index values and are shear stable.

Introduction of Low Cost Series of Pydraul Safety Fluids

Pydraul 312 (now Pydraul 312-C) was the first of Monsanto's new series of low cost high performance fire-resistant hydraulic fluids. Introduced to the market in 1965, this chemistry was the latest innovation in synthetic safety hydraulic fluids. Pydraul 312-C is augmented with two other viscosity grade fluids which combine proved high performance with low cost.

Besides providing safe hydraulic operations, these Pydraul fluids offer lubrication equal to or even better than premium grade oils; freedom from corrosive action and foam; ease of maintenance; permanence—they don't "wear out."

These new lower cost Pydraul fluids are unique formulations of synthetic fluids blended with selected high viscosity low volatility petroleum fractions. The results are a series of fire-resistant hydraulic fluids which match or excel existing hydraulic fluids—including synthetics, premium grade petroleum oils, and water base fluids—but which sell in the price range of water-glycol fluids.

Reduced Fire Insurance Rates

Pydraul substantially reduces fire hazards from hydraulic operations and fire threats to surrounding structure and equipment. Insurance premiums for plants using Pydraul are often lower than premiums for operations using petroleum oil.

Longer Pump Life

Machines which operate on water-based fluids frequently require pump repair or replacement as often as every two or three months. Machines which use Pydraul hydraulic fluids can operate on the same pump for several years. Pydraul hydraulic fluids give the same long pump life as the finest grade petroleum oil.

No Corrosion Problems

Any metal hydraulic system component in contact with Pydraul will not rust. Pydraul hydraulic fluids do not lose anti-rust properties even after extended use.

Maximum Equipment Response

Pydraul never produces excessive froth or foam during normal operations to interfere with hydraulic equipment response. Because Pydraul hydraulic fluids lubricate as well as premium petroleum oils, Pydraul permits equipment to operate at optimum response capability.

Inspection and Replacement Down-Time Are Virtually Eliminated

Pydraul hydraulic fluids are designed to be permanent—they do not wear out. Normal "make-up" requirements are usually all that is needed for new Pydraul. Pydraul eliminates "drain and change" periods; it does not have to be inspected in your system from month to month—or replaced from year to year.

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WATER_PCB-00005410

Pydraul "C" series 2

PHYSICAL PROPERTIES	
Appearance	
Spec. Gravity 25/25°C.	
Neutralization No. (mg KOH/g) max.	
Moisture (max.) %	
VISCOSITY	
Centistokes @ 100°F.	
@ 210°F.	
SSU @ 100°F.	
@ 210°F.	
Absolute SSU @ 100°F.	
(SSU x Density) @ 210°F.	
Pour Point	
Bulk Temp. Max. (continuous operation)	
Boiling Point °F. at 760 mm Hg	
Coefficient of Thermal Expansion per °F.	
Specific Heat BTU/lb./°F. @ 77°F.	
Thermal Conductivity BTU/hr./ft./°F.	
Vapor Pressure mm Hg @ 200°F.	
Bulk Modulus (Room Temp. 1000-6000 psi)	
Rust Test ASTM D-665	
Foam Test ASTM D-892	
Solubility in Water	
FIRE RESISTANCE TESTS	
Factory Mutual Spray Test. Test fluid sprayed at 1000 psi through orifice, passing through flame of propane torch.	
Factory Mutual Channel Iron Test. Test fluid sprayed at 1000 psi through orifice, onto hot channel iron at 1300°F.	
Hot Manifold Test (Federal Test Method Std. 791). Test fluid dripped on at 1300°F.	
Factory Mutual Approval. FM.	**FM**

Fire-resistance Advantages of Pydraul
Pydraul fluids protect hydraulic equipment and personnel with *permanent* fire protection. Pydraul fluids contain no water to evaporate and do not leave a flammable residue. During their many millions of machine hours of use, Pydraul fluids have been accidentally sprayed over molten metal, through electrical arcs, into flames and sparks. They pass all of the important ignition tests for fire-resistance.

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PYDRAUL® 230-C	PYDRAUL 312-C	PYDRAUL 540-C
Clear Green Liquid	Clear Green Liquid	Clear Green Liquid
1.040—1.060	1.010—1.030	1.015—1.035
0.30	0.30	0.30
0.15	0.15	0.15
46.2 cs 6.9 cs 215 SSU 49 SSU 224 SSU 49 SSU	66 cs 8.4 cs 309 SSU 54 SSU 311 SSU 52 SSU	106 cs 10.5 cs 491 SSU 61 SSU 498 SSU 59 SSU
—70 °F.	—10°F.	0°F.
200°F.	200°F.	200°F.
500°F.	540°F.	545°F.
0.00038	0.00036	0.00036
0.41	0.41	0.40
0.0755	0.0760	0.0749
0.24	0.20	0.22
332,000	330,000	336,000
Pass	Pass	Pass
Pass	Pass	Pass
Negligible	Negligible	Negligible
Pass	Pass	Pass
Pass	Pass	Pass
Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.	Intermittent flashing but does not propagate to pan below.
Yes	Yes	Yes

FOLLOWING IS A PARTIAL LIST OF APPLICATIONS FOR THE PYDRAUL FLUIDS:

STEEL INDUSTRY
continuous casters
rolling mills
furnaces
scrap chargers
stripper cranes
arc welders
combustion controls
mobile equipment

DIECASTING
diecast machines
trim presses

ALUMINUM INDUSTRY
stripper cranes
direct chill casters
furnaces
rolling mills
shearers
combustion controls
mobile equipment

FABRICATION
forming presses
welders
furnaces

FORGING AND EXTRUSION
forge presses
extrusion presses
billet manipulators

FOUNDRIES
furnaces
molding lines

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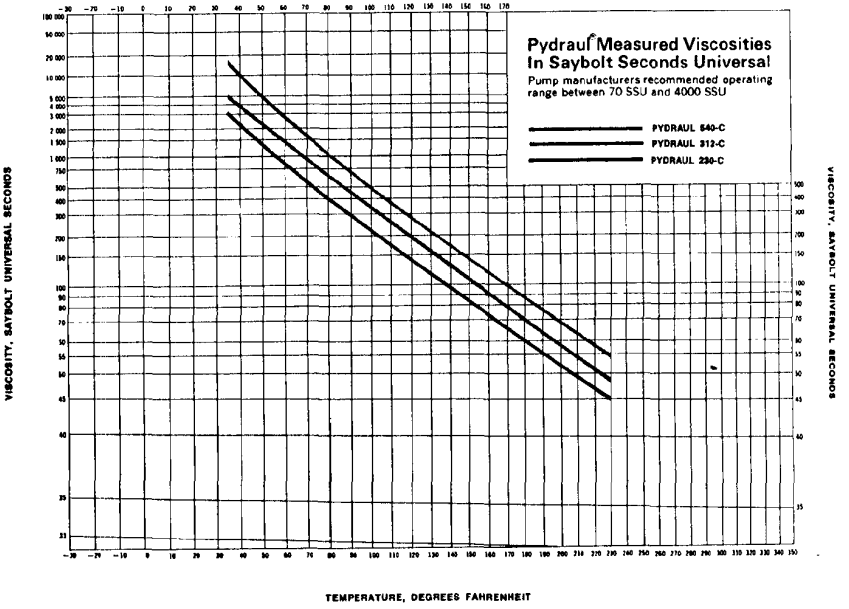
Pydraul "C" series 4



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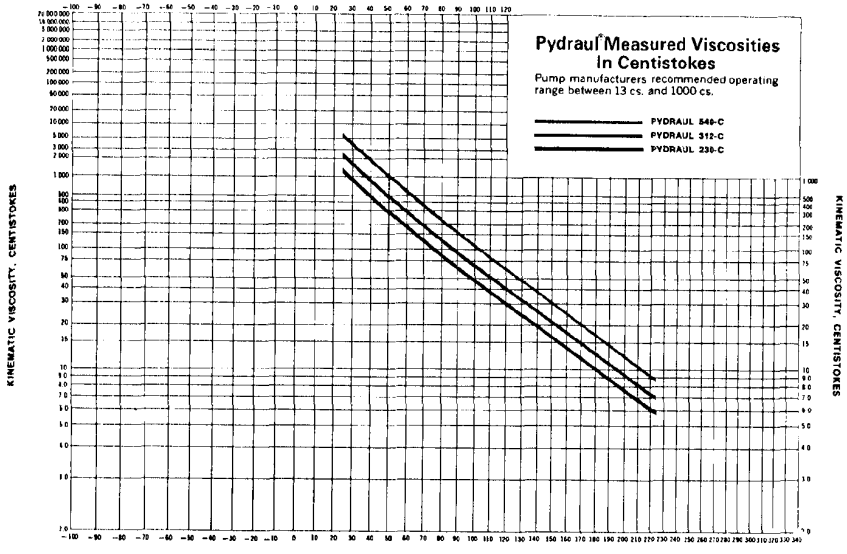

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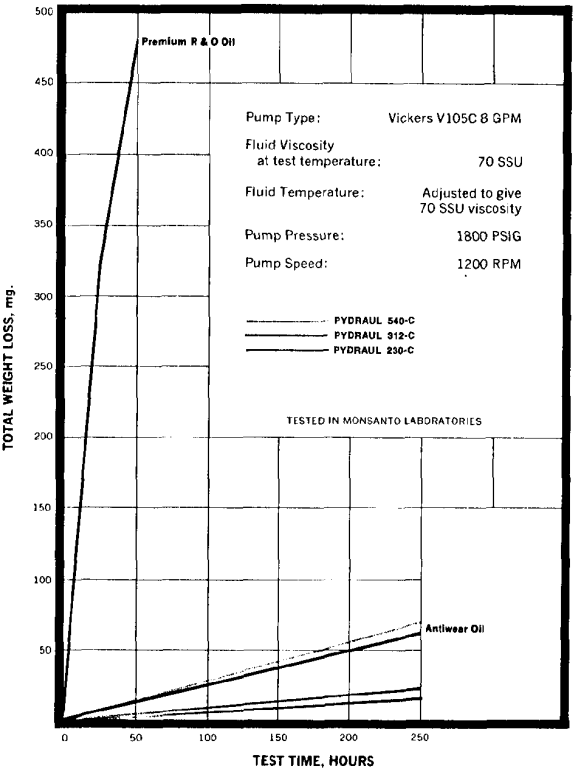
WATER_PCB-00005414

Pydraul "C" series

In a more severe Vickers hydraulic pump test (V-105-C pump), the Pydraul fluids performed as well as commercial antiwear oils and proved far superior to premium R & O oil (rust and oxidation inhibited).



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MIXING COMPATIBILITY

Pydraul® With Other Pydraul Fluids

	230-C	312-C	540-C
230-C	—	YES	YES
312-C	YES	—	YES
540-C	YES	YES	—
10-E	YES	YES	YES
29-E LT	YES	YES	YES
30-E	YES	NO	NO
50-E	YES	YES	YES
65-E	YES	YES	YES
115-E	YES	YES	YES

Pydraul® With Other Hydraulic Fluids

FYRQUEL*	230-C	312-C	540-C
90	NO	NO	NO
150	YES	NO	NO
220	YES	YES	YES
300	YES	YES	YES
550	YES	YES	YES
HOUGHTOSAFE**			
1010	NO	NO	NO
1115	YES	NO	NO
1120	YES	YES	YES
1130	YES	YES	YES
1055	YES	YES	YES

*Fyrquel is a registered T.M. of Stauffer Chem. Co.
**Houghtosafe is a registered T.M. of E. F. Houghton Co.

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WATER_PCB-00005416

Pydraul "C" series 8

CONVERTING TO PYDRAUL IS EASY

Regardless of the type hydraulic fluid being used, converting a system to low-cost Pydraul fluids is easy. Virtually every type of equipment which uses fire-resistant hydraulic fluid has been converted to Pydraul fluids. Most equipment manufacturers are experienced in Pydraul fluid conversions and should be consulted.

If changing seals is necessary, equipment manufacturers can recommend what seals to change, and many carry a supply of correct seals. Laboratory tests and operational experience show Viton*, Teflon*, and silicone the preferred elastomers for compatible seals. Please refer to the following section on seal and packing information for compatibility of Pydraul with other elastomers.

To replace other fluids which are compatible with Pydraul and where compatible seals are in the system, it is only necessary to add Pydraul as make-up fluid. It is not necessary to drain or clean. When converting from petroleum oils, non-compatible synthetic fluids, water-glycol fluids, or water-in-oil emulsions, the following steps are recommended. These conform to USA Standard B93.5—1966.

Please ask the Monsanto fluids specialist for recommendations and assistance. He may be reached by phoning the nearest sales office, listed on the inside back cover of this brochure.

Change-Over Procedures

Changing from Petroleum Oil

1. Completely drain and clean the system. Small amounts of oil will not interfere with the performance of Pydraul, but resistance to fire is reduced by the amount of oil left in the system.
2. Drain and blow out pipelines. Manually clean valves and reservoirs.
3. Open or remove and drain valves. Replace gaskets, packings, and seals with those compatible with Pydraul. It is particularly important to change dynamic seals. Static seals do not necessarily have to be changed if they are not leaking. Non-compatible static seals will have to be replaced when the part is disassembled for maintenance.
4. Remove pumps, accumulators, and cylinders, if necessary, for draining. Replace packings, seals, gaskets, and bladders with those compatible with Pydraul.
5. Check component functions before the system is closed and fluid is added.
6. If your system cannot be completely drained, you may have to flush it with a small amount of Pydraul.

Changing from Water-Glycol or Water-In-Oil Emulsion

1. Drain and clean system thoroughly. Remove all traces of water. Empty all lines and low points or dead pockets in components.
2. Clean with steam or warm water. Follow by blowing with dry air.
3. Check sealing materials, hoses, and accumulator bags. Replace if necessary with compatible materials.
4. Install a minimum charge of Pydraul and operate the system from 16 to 24 hours. During this period, inspect the reservoir. If water or other contaminants float to the top, skim them off.
5. Drain the flushing charge immediately after shut-down while the fluid is warm. Drain all isolated points or parts which do not drain back to the reservoir. If water is apparent in fluid clinging to walls, wipe down all accessible parts.

Changing from Phosphate Esters (Other Than Pydraul)

The Pydraul C Series fluids are compatible in all proportions with most competitive phosphate esters and may be added as make-up to these fluids. Refer to the compatibility table on page 7 of this section for specific fluid combinations.

*Registered trademark of E. I. Du Pont de Nemours & Co., Inc.

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SEALS AND PACKINGS INFORMATION

Materials compatible with Pydraul hydraulic fluid are necessary for dynamic or moving seals. For static seals they are preferred, but not essential. The following table indicates materials recommended, depending on the Pydraul fluid selected.

PYDRAUL® FLUID	BUTYL*	EPR	VITON*	NYLON	TEFLON*	SILICONE	BUNA-N	NEOPRENE	NATURAL RUBBER
230-C	M	M	R	R	R	R	U	U	U
312-C	M	M	R	R	R	R	U	U	U
540-C	M	M	R	R	R	R	U	U	U

R—RECOMMENDED M—MARGINAL U—UNSATISFACTORY

*Although generally classified as marginal with those Pydraul fluids, butyl and EPR (ethylene propylene rubber) have proved satisfactory in equipment operating under certain conditions of temperature, fluid cleanliness, maintenance, etc. For best service under general all-around operating conditions, elastomers of Viton, Fluorel, Teflon, and silicone are recommended.

This list of component manufacturers is a guide to obtaining seals compatible with Pydraul fluids. Please contact your equipment manufacturer or seal supplier for their most current recommendations.

Acushnet Process Company
776 Belleville Avenue
New Bedford, Massachusetts 02745

Anchor Packing Company
401 North Broad Street
Philadelphia, Pennsylvania 19108

Bearings, Inc.
3634 Euclid Avenue
Cleveland, Ohio 44115

A. W. Chesterton Company
Everett
Massachusetts 02149

Chicago Rawhide Manufacturing Company
1311 Elston Avenue
Chicago, Illinois 60622

C. E. Conover & Company, Inc.
333 Passaic Avenue
Fairfield, New Jersey 07006

Crane Packing Company
6400 Dakton Street
Morton Grove, Illinois 60053

Garlock Packing Company
Palmyra
New York 14522

Goshen Rubber Company, Inc.
P. O. Box 416
Goshen, Indiana 46526

Greene, Tweed & Company
North Wales
Pennsylvania 19454

Hercules Packing Corporation
11061 Walden Road
Alden, New York 14004

International Packing Corporation
Bristol
New Hampshire 03104

Johns-Manville
22 East 40th Street
New York, New York 10016

C. W. Marsh Company
36 Hudson Street
Muskegon, Michigan 49441

Minnesota Rubber Company
3630 Wooddale Avenue
Minneapolis, Minnesota 55416

Parker Seal Company
10567 Jefferson Boulevard
Culver City, California 90230

Plastic & Rubber Engineering, Inc.
756 East Florence Avenue
Los Angeles, California 90001

Plastic & Rubber Products Company
2100 Hyde Park Boulevard
Los Angeles, California 90047

Precision Rubber Products Corporation
Hartmann Drive
Lebanon, Tennessee 37087

Raybestos-Manhattan, Inc.
Packing Division
Passaic, New Jersey

Reliable Rubber Products
Eddyington
Pennsylvania 19020

Rockwell Mechanical Packing Company, Inc.
1634 Long Beach Avenue
Los Angeles, California 90021

W. S. Shamban Company
11617 West Jefferson Boulevard
Culver City, California 90230

Vellumoid Company
Rockdale Street and Beaman Avenue
Worchester, Massachusetts 01606

The James Walker Packing Company, Inc.
P. O. Box 75
Chicago Heights, Illinois 60411

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*Registered trademarks of E. I. Du Pont de Nemours & Co., Inc.

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Pydraul "C" series 10

FILTERS AND HOSES

Filters/ Most standard oil filters are satisfactory. You can use active earth or clay types. Filter manufacturers include:

Briggs Filtration Division
Bowser Corporation
Cookeville, Tennessee

Capital Engineering Company
5839 S. Ashland Avenue
Chicago, Illinois

Commercial Filters Corporation
(Honan-Crane)
Lebanon, Indiana

Cuno Engineering Corporation
Sub. of American Machine
& Foundry
4627 S. Vine Street
Meriden, Connecticut

Dollinger Corporation
20 Centre Park
Rochester 3, New York

Fulflo Specialties Company, Inc.
410 Fancy Avenue
Blanchester, Ohio

Hilliard Corporation
98 W. Fourth Street
Elmira, New York

Marvel Engineering Company
7227 North Hamlin Avenue
Chicago 45, Illinois

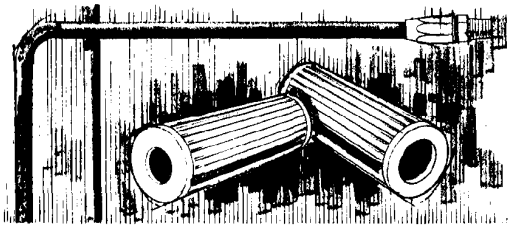
Pall Corporation
32 Sea Cliff Avenue
Glen Cove, L. I., New York

Purolator Products
1000 New Brunswick Avenue
Rahway, New Jersey

Rosaen Filter Corporation
1776 E. Nine Mile Road
Hazel Park, Michigan

Schroeder Bros. Corporation
101 Nichol Avenue
McKees Rocks, Pennsylvania

Serfilco Division
Service Filtration Corporation
7408 North Milwaukee
Niles, Illinois 60648



Hoses/ Although both neoprene and buna elastomers swell somewhat in Pydraul, hose of these materials have given satisfactory service when made of a reinforced braid construction. Butyl, nylon or Viton are preferred when new hoses are installed. Suppliers include:

Anchor Coupling Company
3600 N. Fourth Street
Libertyville, Illinois

Eastman Mfg. Company
(See Imperial-Eastman Corp.)
Department T. R.
6300 West Howard Street
Chicago 48, Illinois

Electric Hose & Rubber Co.
1201 Duro Street
Wilmington, Delaware

Gates Rubber Company
999 South Broadway
Denver, Colorado 80217

Imperial-Eastman Corp.
6300 W. Howard Street
Chicago, Illinois

Lewis Products
Hohenwald, Tennessee 38462

Samuel Moore Co.
Mantua, Ohio

Resistoflex Corp.
Roseland, New Jersey

Stratoflex, Inc.
222 Roberts Cutoff Rd.
Fort Worth, Texas

Weatherhead Corp.
302 E. 131st Street
Cleveland, Ohio 44108

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WATER_PCB-00005419

OTHER COMPONENTS

Swivel Couplings
Systems for Pydraul fluids often contain swivel couplings. Some suppliers are:

Chiksan Division
FMC Corporation
332 N. Brea Boulevard
Brea, California

Pipe Joint Sealers
. . . can be bought from:

American Sealants Company
(See Loctite Corporation)
115 N. Mountain Road
Hartford 11, Connecticut

Crane Packing Company
6410 Oakton Street
Morton Grove, Illinois

Dow Corning Corporation
Midland, Michigan

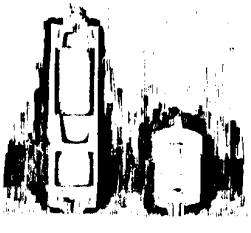
Friesland Plastics Company
Friesland, Wisconsin

General Electric Company
Insulating Materials Department
1 Campbell Road
Schenectady 6, New York

Permatex Company
Department T. R.
Flagler Court Building
West Palm Beach, Florida

W. S. Shamban & Company
11617 W. Jefferson Boulevard
Culver City, California

Shell Chemical Company
110 W. 51st Street
New York, New York



Accumulators
. . . many hydraulic systems for Pydraul contain an accumulator which uses a bladder to separate the fluid from air or nitrogen pressure. For these, a rubber compatible with the fluid is necessary. Suppliers include:

Greer Hydraulics, Inc.
5930 W. Jefferson Boulevard
Los Angeles, California

Paints
. . . resistant to Pydraul are supplied by:

Amercoat Corporation
Department T
Brea, California

Andrew Brown Paint Company
5413 S. District Boulevard
Los Angeles, California

Carboline Company
32-R Hanley Industrial Court
St. Louis, Missouri

Carrol Products
148 Marine Street
Farmingdale, New York

Finch Paint & Chemical Company
Torrence, California

W. P. Fuller & Company
1645 W. Valencia Drive
Fullerton, California

The Glidden Company
900 Union Commerce Building
Cleveland, Ohio

Interchemical Corporation
Finishes Division
1255-T Broad Street
Clifton, New Jersey

Lowe Brothers Company
Third & Madison Streets
Dayton, Ohio

Magna Coatings & Chemical Corporation
1785 N. Eastern Avenue
Los Angeles, California

Nycote Laboratories
15002 Delano Street
Van Nuys, California

Pittsburgh Plate Glass Company
One Gateway Center
Pittsburgh 22, Pennsylvania

Rinshed-Mason Company
5935 Milford
Detroit, Michigan

Royalty Paint & Varnish Company
Pasadena, California

Saran Protective Coatings Company
2415 Burdette at Reed
Ferndale, Michigan

Sherwin-Williams Company
101 Prospect Avenue, N. W.
Cleveland, Ohio

Titanine, Inc.
Seagrave Corporation
Elmwood & Morris Avenues
Union, New Jersey

U. S. Paint, Lacquer & Chemical Company
2101 Singleton
St. Louis, Missouri

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WATER_PCB-00005420

Pydraul "C" series 12

RECLAIMING PYDRAUL FLUIDS

Pydraul hydraulic fluid lost from leaks and spills can be reclaimed because it is exceptionally stable and resistant to water and other contaminates. If fluid losses are appreciable—fluid recovery can result in considerable savings. Simply placing a container beneath leaks until they can be repaired will save some fluid. Where drip pans have been used beneath hydraulic machinery, more than half of the total Pydraul leakage has been reclaimed.

This dollar-saving recovery appears especially advantageous because it isn't practical to reclaim either water glycol or water-oil emulsions except to filter out large dirt particles. Reclaiming Pydraul fluid helps make it the most economical fire-resistant fluid available.

Reclaiming Pydraul consists of two steps: removing water, and filtering dirt or other solid particles.

Water Removal . . . Water does not mix with Pydraul and will, therefore, form a layer on top. A drum reserved for contaminated fluid with a side and end bung, placed horizontally on a cradle about two feet off the floor, is a simple and effective settling chamber. Salvaged fluid can be added through a large funnel in the top opening and Pydraul periodically drained off through the lower opening.

For a more elaborate system, permanently installed settling tanks, or a commercial installation can be used.

A second method is centrifuging. Suitable units are made by DeLaval and Sharpies Co. Centrifuges operate swiftly . . . will separate water from large volumes of fluid in a short time.

Final Filtration . . . A number of filtration units are available complete with filter pump and motor. Other systems use filter media such as cotton linters, felt or metal screens. Attapulgus clay and Fuller's earth may be used to help keep the fluid clean, reduce moisture and lower neutralization number. Diatomaceous earth filtration is recommended for solid particles removal only. Paper and fiber type filters are recommended for water and particle removal but are ineffective for lowering neutralization number (acidity) values.

TOXICITY AND SAFE HANDLING

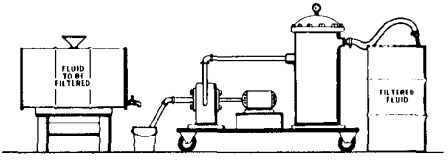
Animal studies indicate that the Pydraul C Series Fluids can be classed as practically non-toxic when considered as an industrial fluid. They are non-irritating when the skin is exposed to the fluid.

However, this product should not contact or in any way contaminate food, animal feed, food products, food packaging materials, pharmaceuticals or any items which may directly or indirectly be ultimately ingested by humans. Any contact may contaminate these items to the extent that their destruction may be required.

Due to their low order of toxicity, the Pydraul C Series require no special handling precautions. However, as in handling any chemical, good hygienic procedures should be followed. In case of skin contact, wash off with soap and water. In the case of eye contact, flush with copious amounts of water.

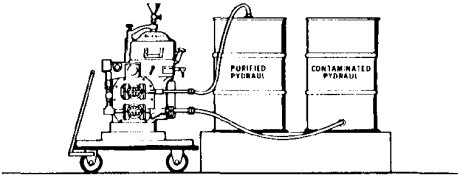
While Pydraul E Series (Pydraul C Series, also AC Series, Santosafe W/G) fluids pose no serious problems with respect to the environment, as a concerned supplier to industry, Monsanto urges the user to maintain a tight system, to correct leakage promptly and to exercise care in the handling and disposal of this and all other such products.

FLUID PURIFICATION SYSTEM



CENTRIFUGE SYSTEM FOR PURIFICATION

Filters in the 3 to 5 micron range are recommended for Pydraul filtration and reclamation. Such filter media will not affect the basic Pydraul formulation.



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WATER_PCB-00005421

Santosafe® W/G

WATER/GLYCOL HYDRAULIC FLUIDS

The new Santosafe® W/G series of fire resistant water/glycol hydraulic fluids are designed for use in hydraulic systems working in areas with a source of heat or ignition that creates a potential fire hazard if petroleum oils are used.

Santosafe W/G fluids are mixtures of water, ethylene glycol, a high viscosity lubricating and thickening agent and selective additives for corrosion protection.

When compared to other commercial water/glycol fluids, Santosafe W/G fluids show improved pump performance and lubricity, meaning significantly longer component life and less maintenance costs.

Santosafe W/G fluids also exhibit excellent corrosion protection to metals, high VI, low pour points and excellent heat transfer properties that make the fluids acceptable for a wide range of operating temperatures.

Fire Resistance

The fire resistance of Santosafe W/G fluids depends upon their water content. The Santosafe W/G fluids contain between 40-45% water and are considered "fire resistant" as long as the water content is maintained. Exposure to elevated temperatures can cause boiling and evaporation which will reduce the safety of this fluid. Every precaution should be taken to prevent a reduction in water content.

Corrosion Protection

Santosafe W/G fluids contain special additives to give improved liquid and vapor phase corrosion protection. Tests show compatibility with steel, stainless steel, aluminum, nickel, tin, copper and copper alloys. Zinc, galvanized iron and cadmium plated parts should not be used.

Heat Transfer

Water and water containing fluids such as Santosafe W/G are known to be excellent heat transfer media. As a result, Santosafe W/G fluids provide lower operating temperatures than other common hydraulic fluids.

Storage & Handling

Santosafe W/G fluids do not require special handling precautions; normal procedures for handling hydraulic fluids should be used. Because these fluids are water-soluble, spillage can be removed with water.

Santosafe W/G fluids can be stored up to six months without problems. For extended storage the fluid should be agitated in some manner to redistribute the vapor phase inhibitor.

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WATER_PCB-00005422

Santosafe® W/G 2

TYPICAL PHYSICAL PROPERTIES

FLUID SANTOSAFE®		W/G 15	W/G 20	W/G 30
Appearance		Red Liquid with a slight haze		
Specific Gravity @ 20/20° C		1.076	1.08	1.073
Water Content (% by weight)		43.4	43.0	40.0
Viscosity				
Centistokes	@ 130°F	21.1	28.0	29.7
	100°F	32.6	47.0	59.3
	0°F	499.6	700	1050
Saybolts as measured				
	130°F	97	130	140
	100°F	150	200	275
	0°F	2300	2600	4600
Absolute Saybolts (SSU x density)	130°F	104	140	150
	100°F	161	216	296
	0°F	2475	2808	4950
Viscosity Index		155 min.	155 min.	155 min.
Pour Point Min.		−40°F	−40°F	−40°F
pH at 25°C		9.4	9.4	9.3
Alkaline Content (ml. 0.1N HCl to neutralize 100 ml. of fluid to pH 5.5)		164	165	176
Rust Test (ASTM)		Pass	Pass	Pass
Flash Point (COC)		None	None	None
Weight per gallon, lbs @ 60° F		9.00	9.00	9.00

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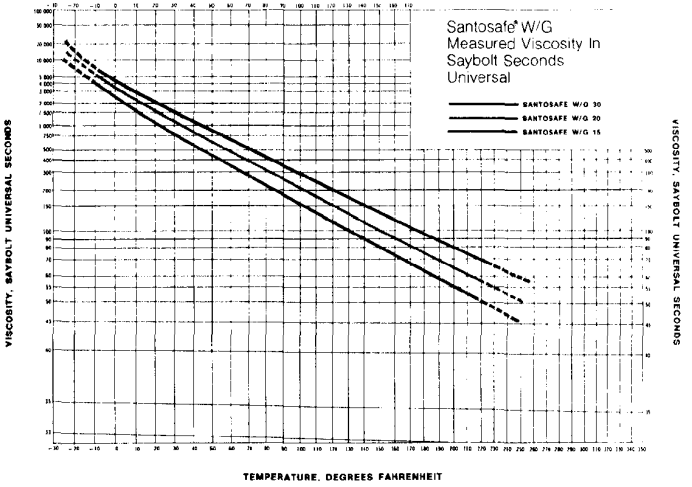

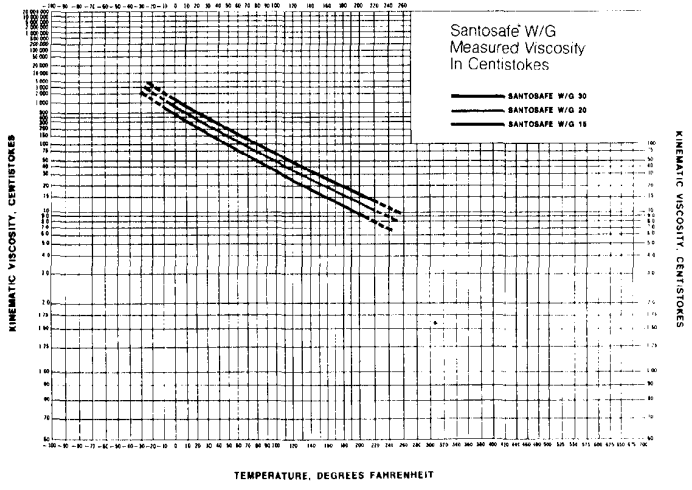

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Santosafe® W/G 4

LUBRICATION AND PERFORMANCE

Santosafe W/G fluids will perform satisfactorily in all types of hydraulic pumps at rated speeds and pressures recommended by the pump manufacturers. Of course the fluid itself must be kept free of contamination and in good condition chemically. Proper maintenance procedures (i.e., adequate filtration, proper fluid temperature, viscosity and alkalinity control) are vital to good performance.

Lubrication:

Usage in vane type pumps at pressures to 2000 psig and speeds to 1200 RPM are well within the capabilities of Santosafe W/G fluids. The fluids have also performed in axial piston pumps at 3500 psig and 1200 RPM.

Higher speeds (1750 RPM) generally require lowering the pressure to attain equivalent service. Use of Santosafe W/G fluids is not recommended in radial piston pumps. Gear pumps with bronze sleeve bearings present no difficulties and can be operated at full capacity. Heavily loaded needle bearings may require derating or a change in the type of bearing to a more suitable configuration.

Santosafe W/G fluids exhibit the best pump wear seen when compared to commercial water glycols in standard pump tests due to the high level of anti-wear protection in Santosafe W/G formulation.

In all tests to date no sludge formation or serious corrosion was found. Pumping efficiency showed no significant change.

Low Pressure Systems:

Pump tests on Santosafe W/G fluids at pressures of 1000 psig in vane pumps show less than 0.1% total wear.

High Pressure:

As a result of the low wear in low pressure tests, tests were made more severe to discover the fluids' capabilities. Table I shows the results for a V105E Vickers Vane pump. The wear rates of 71mg and 57mg are considered excellent.

Table II (page 5) shows even more severe tests of Santosafe W/G compared to 3 other commercially available hydraulic fluids.

The results of the V105C Vickers Vane pump show Santosafe W/G superior to all fluids tested.

These results indicate Santosafe W/G can operate in the most critical systems with good performance.

Table I

VICKERS PUMP TEST

FLUID	SANTOSAFE® W/G 15	W/G 20
Pump Type	V105E	V105E
Pump Capacity (GPM)	2	2
Fluid Temperature (°F)	130°F	130°F
Pressure (PSIG)	1000	1000
Duration (Hrs)	1000	1000
Total Wear in Mg. (Ring+Vanes)	71	57

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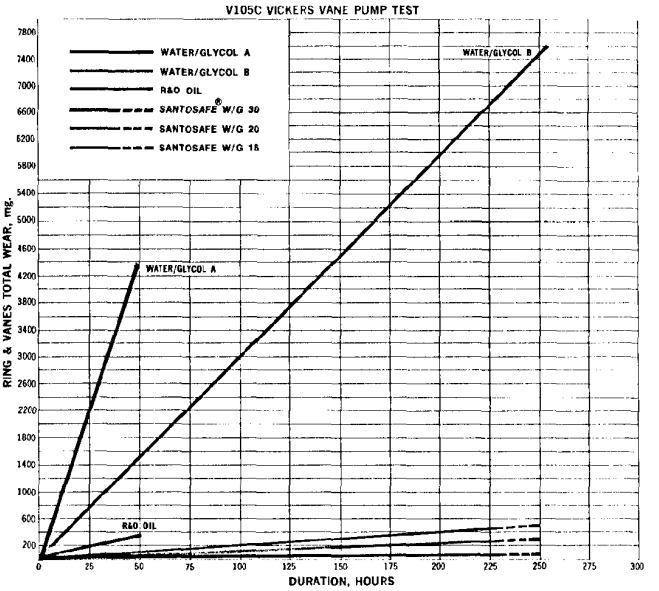

Table II

FLUID	SANTOSAFE® W/G 15	SANTOSAFE W/G 20	SANTOSAFE W/G 30	WATER/GLYCOL A	WATER/GLYCOL B	R&O OIL
Pump Type	V105C	V105C	V105C	V105C	V105C	V105C
Pump Capacity	8 GPM	8 GPM	8 GPM	8 GPM	8 GPM	8 GPM
Fluid Temperature	140°F	140°F	140°F	140°F	140°F	150°F
Pressure (PSIG)	1800	1800	1800	1800	1800	1800
Speed	1200 RPM	1200 RPM	1200 RPM	1200 RPM	1200 RPM	1200 RPM
Duration (Hrs)	258	260	260	49*	258	50*
Wear						
Ring	476.0 mg	275.7	56.3	4,365.8	7,552.2	332.2
Vanes	60.1 mg	48.2	17.5	17.9	40.6	11.5
Total	536.1 mg[1]	323.9[2]	73.8[3]	4,383.7[2]	7,592.8[3]	343.7[4]

* Test discontinued due to irregular wear causing high internal leakage essentially causing test failure. (System pressure could not be maintained.)

1. Ring showed even wear—no washboarding. Rotor and end plates were in excellent condition. Light varnish on vanes.
2. Ring showed excessive wear and washboarding. Heavy varnish deposits on vanes and rotor.
3. Ring showed medium washboarding and searing wear. Vanes and end plates showed light wear and medium varnish deposits.
4. Ring showed excessive washboarding and searing wear. Vanes and end plates showed light wear and medium varnish deposits.

Tests conducted in Monsanto laboratories.

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Santosafe® W/G 6

COMPATIBILITY

Hoses, Packings and Seals:
No special hoses, seals or packings are needed when changing over from petroleum oil to Santosafe W/G fluids. The following materials have been found compatible with Santosafe W/G:

Natural Rubber	Butyl
SBR	Chloroprene
Viton*	Nitrile Rubber
Teflon*	EPR

Fabricated neoprene, homogeneous Buna N and Viton are the most common seals used. Nylon, butyl or neoprene is common for hoses.

Because of the water content materials such as leather, cork, untreated cotton and cellulose packing should not be used.

Paints:

Solvent properties of Santosafe W/G fluids make conventional paints unsuitable. When converting systems, questionable paint should be removed and the surface left unpainted or painted with a compatible paint. Most leading paint suppliers handle compatible paints for water glycols.

Filters:

Fine mesh metal screens and water proofed cotton or cellulose fiber filters are satisfactory for Santosafe W/G fluids. The use of active clay or other adsorbent filters is not recommended because they could remove constituents of the Santosafe W/G formulation.

Pipe Dopes:

Santosafe W/G fluid may dissolve certain pipe dopes. Use only types known compatible with water/glycol fluids.

*Registered trademarks of E. I. Du Pont de Nemours & Co., Inc.

TOXICITY AND SAFE HANDLING

Santosafe W/G fluids are materials of low toxicity by all means of testing. They are not skin irritants or sensitizers and will cause only mild eye discomfort on contact with the liquid. The organic components have very low vapor pressure and are consequently not expected to have vapor inhalation toxicity.

On the basis of the toxicological, physical and chemical properties of Santosafe W/G fluids, no precautionary labeling is used on the containers.

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To place an order for Pydraul products from Monsanto dial toll free 800-325-3850.

Monsanto

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In This Pocket...

*Santosafe® W/G Maintenance Guide

*Pydraul® Air Compressor Fact Finder

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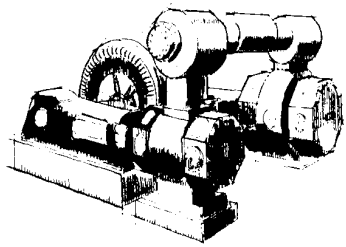
Pydraul® fact finder

AIR COMPRESSOR LUBRICANTS

Bulletin number IC/FF-2



The Pydraul® Air Compressor Fact Finder . . . is designed to make the many facts about Pydraul® fire resistant lubricants for air compressors—Pydraul 30E, Pydraul 90E and Pydraul 115E—easy to find.

These safety lubricants for air compressors were specially developed to offer you:

Safety from Fire and Explosion
Pydraul reduces combustible mists and minimizes carbonaceous residues—greatly reducing the threat of compressor fires and explosions.

Lower Maintenance Costs
Pydraul reduces deposits on exhaust valves, in coolers and in piping. You save the costs of compressor downtime and cleaning. Many compressor users find these savings alone justify using Pydraul lubricants.

PYDRAUL
AIR COMPRESSOR LUBRICANTS BY Monsanto

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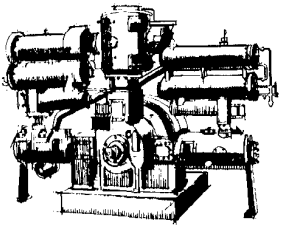
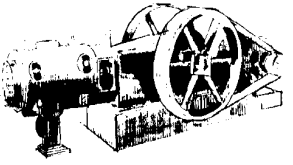
Pydraul® fact finder

HOW COMPRESSOR FIRES & EXPLOSIONS OCCUR





Every theory about the mechanisms of compressor fires and explosions hold one idea in common: petroleum oils are directly involved.

Petroleum Oil Mists & Films

Mist and accumulated films from petroleum oil in compressor systems can, under a variety of conditions, break down into combustible gases and carbonaceous residues that can ignite and produce an explosion, a receiver fire—or both. The U. S. Bureau of Mines[1] found that carbon deposits in air compressors lubricated with petroleum oil *form a "carbon-oxygen complex."* Oxidation forms this complex, and accelerated by heat, this oxidation process can lead to an explosion.

The Shortcomings of Safety Devices

Safety devices do not completely eliminate fire and explosion possibilities. A study on "The Mechanism of Explosions In Starting Air Lines,"[2] based on an exhaustive survey of compressor operations at 53 companies, reports that a stuck or leaking air check valve permits the engine being started to pack the section of line between the check and air timing valve with an explosive "oil residue-air" mixture. A pressure wave will force this mixture upstream into the main air line—and coupling this with good flame propagation in the power cylinder, the condition is laid for explosion in the pipe system.

Air line explosions and fires may even occur without the engine being started or before the ignition is turned on. Carbon and rust particles in a "hot" air line, due to operating an overheated compressor too long—hardly an improbable condition—can become saturated with oil, and with the flow of starting air, can cause these oil-saturated particles to flame.

Explosion Tests at 1300 PSI

The Walter Kidde Company, makers of fire extinguishing equipment, warns in a study[3] that users of high pressure air should guard against introducing a shock wave into high pressure lines by *suddenly opening a plug cock in air compressor* systems using petroleum oil. This report showed that in a 1-inch diameter tube, the inside walls filmed with oil, a sudden admission of air at pressures above 1300 psi caused combustion.

How can you eliminate the conditions that cause fires and explosions in air compressors? Eliminate the *source* of carbon deposits, the basic cause of most air compressor disasters—petroleum oil.

Substitute fire- and explosion-resistant Pydraul.

1. "The Carbon-Oxygen Complex as a Possible Initiator of Explosions and Formation of Carbon Monoxide in Compressed Air Systems," by Busch, Berger, and Schrenk, Bureau of Mines paper R.I.4465, June 1949.
2. "The Mechanism of Explosions in Starting Air Lines," by Ridgway, Robert S., **Petroleum Refiner,** June 1958.
3. "Oil Combustion Phenomena in High Pressure Air Systems," M .W. Weibel, Walter Kidde & Co., Inc., Report R-831, copyright 1952.

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Table 1

PHYSICAL PROPERTIES	PYDRAUL® 30E	PYDRAUL 90E	PYDRAUL 115E
Appearance	Clear Blue Liquid	Clear Blue Liquid	Clear Blue Liquid
Spec. Gravity 25°/25°C.	1.150-1.170	1.145-1.165	1.145-1.165
Neutralization Number (Acidity) (mg KOH/gm) max.	0.15	0.15	0.15
Moisture (max.)	0.10%	0.10%	0.10%
VISCOSITY			
Centistokes @ 100°F.	30-34	85-95	115-125
Centistokes @ 210°F.	4.6-5.0	7.7-8.1	8.9-9.3
Saybolts @ 100°F.	150 SSU	415 SSU	565 SSU
210°F.	42 SSU	52 SSU	56 SSU
"Absolute Saybolts" @ 100°F.	173 SSU	473 SSU	695 SSU
(SSU x Density) @ 210°F.	47 SSU	57 SSU	61 SSU
Pour Point	—15°F.	+10°F.	+10°F.
Compressibility x 10^{-6} sq. in./lb.	2.56	2.53	2.52
Maximum Exit Air Temperature	350°F.	350°F.	350°F.
Boiling Point °F. at 760 mm Hg.	725°F.	805°F.	820°F
Coefficient of Thermal Expansion per °F.	0.00035	0.00035	0.00035
Specific Heat (BTU/lb. °F.) (@ 77°F.)	0.36	0.38	0.38
Thermal Conductivity BTU/hr./ft./°F.	0.0737	0.0723	0.0721
Bulk Modulus (Room temp. 1000-6000 psi)	390,000	396,000	397,000
Solubility in water	Negligible	Negligible	Negligible

Table 2—Vapor Pressure

Temperature		Vapor Pressure mm Hg		
°C.	°F.	PYDRAUL® 30E	PYDRAUL 90E	PYDRAUL 115E
0	32	5.0×10^{-6}	2.4×10^{-6}	1.0×10^{-6}
10	50	1.6×10^{-5}	8.0×10^{-6}	3.8×10^{-6}
20	68	4.5×10^{-5}	2.4×10^{-5}	1.1×10^{-5}
40	104	3.1×10^{-4}	1.9×10^{-4}	1.0×10^{-4}
60	140	1.4×10^{-3}	9.2×10^{-4}	5.1×10^{-4}
80	176	5.6×10^{-3}	4.3×10^{-3}	2.6×10^{-3}
100	212	2.0×10^{-2}	1.6×10^{-2}	1.0×10^{-2}
150	302	0.3	0.25	0.2
200	392	2.2	2.0	1.8

Vapor Density = 11.2 compared to value for air of one (1).

Compatibility With Metals

Pydraul air compressor lubricants are compatible with all construction metals including aluminum. *Aluminum load bearing surfaces should be hard-anodized for maximum equipment life.*

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Pydraul® fact finder

FIRE RESISTANCE

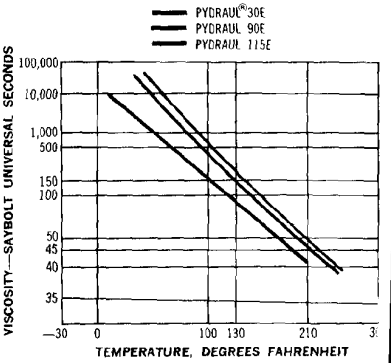


Pydraul fire-resistant fluids and lubricants have worked in industry since 1951, providing many millions of machine hours of fire-free operation. Never since their introduction in 1954 has any Pydraul fire-resistant compressor lubricant caused a compressor fire or explosion.

FIRE-RESISTANCE TESTS OF PYDRAUL 30E, PYDRAUL 90E AND PYDRAUL 115E

TEST	RESULTS
High Pressure Spray Test AMS-3150C and Federal Test Method St. 791. Test fluid sprayed at 1000 psi through orifice, passing through flame of oxyacetylene torch, 6000°F.	Does not flash or ignite up to 3½ feet from orifice.
Atomized Spray Test (procedure used by Factory Mutual Engineering Division). Test fluid heated to 140°F. sprayed at 1000 psi from atomized cone type nozzle. A torch is passed through this spray 2 feet and 2 to 6 inches from the orifice.	Local burning by torch at 6 inches and 2 feet from orifice. Flames self-extinguish immediately when torch removed.
Hot Manifold Test (Federal Test Method Std. 791). Test fluid dripped on tube at 1300°F.	Does not flash or burn.
Molten Metal Ignition Test. Test fluid exposed to the surface of aluminum alloy at 1200°F., to test for spontaneous ignition.	Does not ignite.

Figure 1—Typical Viscosities



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CONVERTING TO PYDRAUL IS EASY

First, simply drain the petroleum oil and wipe the crankcase or lubricator.

Thoroughly clean the exhaust valves and interstage equipment before filling the crankcase or lubricator with Pydraul. Pydraul will loosen carbonaceous deposits, varnishes and sludge. Unless these loosened deposits are cleaned from the system, they could clog pipelines and components, requiring additional downtime and production loss. Once the valves have been thoroughly cleaned of potentially dangerous carbon deposits, Pydraul lubricants will keep them clean—and let compressors run longer between maintenance shutdowns.

STANDARD CHECK FOR COMPRESSORS—Plastic separator bowls.
Not all plastic separator bowls are suitable for Pydraul service. Certain plastics are "crazed" or softened when exposed to Pydraul. Bowls made of glass, brass, steel, and these plastics—polycarbonate, polyethylene, or nylon—are recommended for use with Pydraul. If you have a question regarding the resistance of a particular plastic, Monsanto will be happy to advise you.

Diaphragm valves. Pydraul lubricants have a softening effect on neoprene and buna N rubber diaphragms normally used for petroleum oil service. These diaphragms should be replaced with butyl rubber, EPR (ethylene propylene rubber), fluoroelastomer, silicone or other compatible elastomer materials resistant to Pydraul fluids. Diaphragm sheeting is available from normal sources of supply.

All diaphragms in unloading valves or downstream control valves should be replaced at the time of changeover. Diaphragms in valving downstream from separator systems or drying systems need not be replaced at changeover time, but should be changed on a preventative maintenance schedule as soon as practicable after operation on Pydraul is begun.

For air compressors supplying air for instrumentation functions, mist eliminator systems are recommended to remove lubricant mists and moisture from air streams. A Monsanto development, a Brink® mist eliminator is a particularly effective system, available from Monsanto in a series of low-cost mist eliminator systems to operate at all capacities. For information on a Brink series suitable for your compressor system, write to:

Monsanto Enviro-Chem Systems, Inc.
800 North Lindbergh Blvd.
St. Louis, Mo. 63166
Telephone: (314) 694-2286
(Joseph A. Brink)

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SPECIAL CHECK FOR SPLASH-LUBRICATED COMPRESSORS

Crankcase paint. Pydraul air compressor lubricants will soften and loosen some paints from crankcase interiors. These paint particles could block the lubricant passages. For this reason, it is a good practice to remove paint from crankcase interiors *before* Pydraul is added to the system. Standard paint removers are adequate for removing this paint.

SPECIAL CHECK FOR FORCE-FEED LUBRICATORS

Sight-glass fluid. If a separate force-feed lubricator of the type normally filled with water and glycerine is used, one of two changes is necessary: either replace the sight-glass fluid with one heavier than Pydraul or insert a metal bobber in the sight-glass. Pydraul fluids are heavier than water or glycerine and will not rise through these standard sight-glass liquids. Fluorochemical 101, a clear liquid supplied by the Minnesota Mining and Manufacturing Company, has a higher density than Pydraul and is a completely satisfactory replacement.

Metal bobbers. The alternate to using Fluorochemical 101 is to modify the sight-glass lubricator by inserting a simple metal bobber. The bobber is installed by draining the sight-glass liquid, removing the guide wire and inserting the bobber. Operation of the lubricator is then indicated by movement of the bobber with each stroke of the pump plunger instead of counting the drops as with guide wires. Bobbers are available for either McCord, Manzell, or Lincoln Engineering lubricators. Modification of the Madison-Kipp lubricator requires replacement of the entire sight-glass.

Vacuum-sight lubricators. Vacuum-sight lubricators require no modification for Pydraul usage.

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WATER_PCB-00005435

Pydraul® fact finder

LUBRICATION DATA

DROP SIZE

Drop size of a lubricant is important to determine an adequate lubricant injection rate to insure proper compressor lubrication. The rate of lubrication is controlled by noting the drops per unit of time.

The drop size for the fluids tabulated below were determined by noting the number of drops formed at room temperature (75°F.) on a 1 mm I.D. by 3½ mm O.D. glass tip. (Larger or smaller drops will result if different sized tips are used.)

Fluid	Drops per cubic centimeter
Medium weight petroleum oil	33
Pydraul 90E	39

When installing new equipment, it is best to start with an increased lubricant feed rate and reduce this rate by successive increments. Inspection of cylinder walls and valves will indicate the proper degree of wetting.

Table 3

Falex Wear Test		
	WT. LOSS, PIN (mg.)	WT. LOSS, BLOCKS (mg.)
Pydraul® 30E	0.1	0.2
Pydraul 90E	0.7	1.0
Pydraul 115E	1.0	0.3

Table 4

Shell Four-Ball Wear (167°F., 1 hour, 630 rpm., mm scar diameter)			
STEEL ON STEEL	PYDRAUL® 30E	PYDRAUL 90E	PYDRAUL 115E
4 kg	0.47	0.28	0.29
10 kg	0.50	0.32	0.39
40 kg	0.64	0.54	0.56
STEEL ON BRONZE			
10 kg	0.46	0.35	0.45
40 kg	0.97	0.65	0.66

MIXING COMPATIBILITY

Pydraul 30E, Pydraul 90E and Pydraul 115E are completely miscible in all proportions with competitive synthetic phosphate ester lubricants.

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WATER_PCB-00005436

USES BY MAJOR MANUFACTURERS

New air compressors of most types and sizes produced by major compressor manufacturers can be manufactured for lubrication with Pydraul. The manufacturers listed (below) have manufactured compressors equipped for Pydraul, upon specification of the buyer, for over ten years. Many compressors have operated on Pydraul lubricants continually with exhaust air temperatures of 350°F. Pydraul is also used to lubricate cylinders in compressors operating at pressures over 4500 psig.

American Messer Corporation

Atlas Copco

Bury Compressor Company

Carrier Corporation

Chicago Pneumatic Tool Company

Clark Brothers Company, division of Dresser Industries

Cooper-Bessemer Corporation

DeLaval Steam Turbine Company

Gardner-Denver Company

Ingersoll-Rand Company

Joy Manufacturing Company

Kinney Manufacturing, division of The New York Air Brake Company

Norwalk Company, Incorporated

Schramm, Incorporated

Worthington Corporation

TOXICITY AND SAFE HANDLING

Acute animal studies indicate that the Pydraul E Series Fluids can be classed as practically non-toxic when considered as an industrial fluid. They are non-irritating when the skin is exposed to the fluid.
However, this product should not contact or in any way contaminate food, animal feed, food products, food packaging materials, pharmaceuticals or any items which may directly or indirectly be ultimately ingested by humans. Any contact may contaminate these items to the extent that their destruction may be required.

Due to their low order of toxicity, the Pydraul E Series require no special handling precautions. However, as in handling any chemical, good hygienic procedures should be followed. In case of skin contact, wash off with soap and water. In the case of eye contact, flush with copious amounts of water.

While Pydraul E Series (Pydraul C Series, also AC Series, Santosafe W/G) fluids pose no serious problems with respect to the environment, as a concerned supplier to industry, Monsanto urges the user to maintain a tight system, to correct leakage promptly and to exercise care in the handling and disposal of this and all other such products.

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320 Interstate North Parkway
Suite 500
Tel. (404) 432-7111

BOSTON, MASSACHUSETTS 02149
Everett Station
Tel. (617) 387-5010

CHICAGO, ILLINOIS
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Des Plaines, Illinois 60018
Tel. (312) 296-6688

CINCINNATI, OHIO 45206
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DETROIT, MICHIGAN
500 Northland Towers West
Southfield, Michigan 48075
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HOUSTON, TEXAS 77027
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WATER_PCB-00005438

SANTOSAFE W/G

HYDRAULIC FLUIDS BY Monsanto

Maintenance Guide

WATER CONTROL AND MAKEUP

Bulletin number IC/FF-22

It is important that the water content of Santosafe®W/G fluids be held at 42% ±4% by *weight* in order to assure fire resistance, lubricity and viscosity characteristics. The fluid should be checked frequently after initial installation to get an average evaporation rate of the water. A regular schedule can then be set depending on the system needs.

Water content can be checked by viscosity measurement or distillation using a modified ASTM D95 procedure (substitute benzene for benzene-toluene solvent) or the Karl Fischer methods.

Readjustment of the fluid by viscosity or water content must be done only with distilled, deionized or controlled boiler feed water.

Table III shows the effect of water content changes on the viscosity of Santosafe W/G fluids.

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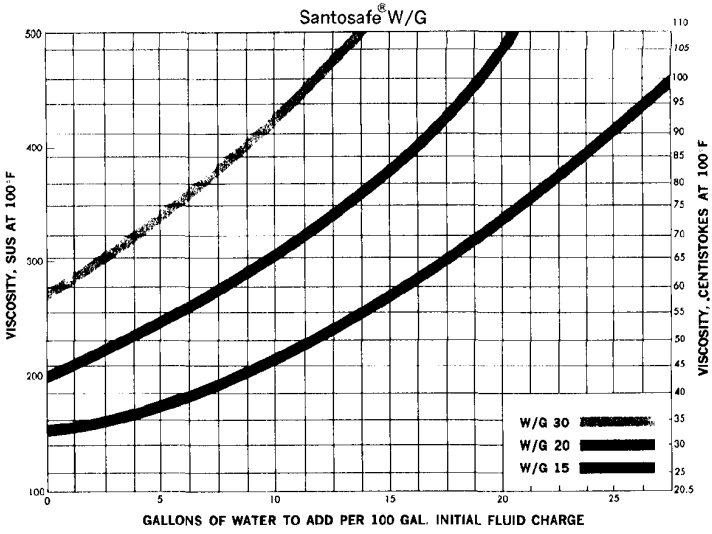

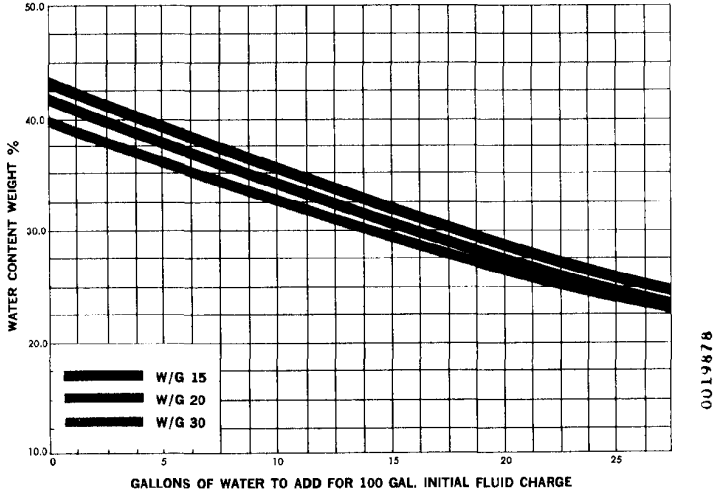

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ALKALINITY CONTROL

It is extremely important to control the alkalinity of Santosafe W/G fluids within prescribed limits. A periodic check and adjustment of alkalinity assures continued good performance of the fluid. When alkalinity drops below the prescribed minimum limit the corrosion inhibition and antiwear characteristics of the Santosafe W/G could be lessened and result in reduced performance.

Alkalinity is defined as the ml. of 0.1N HCl necessary to neutralize 100 ml. of Santosafe W/G to a pH of 5.5. If the alkalinity values fall below the specification, morpholine may be added to the fluid according to Table IV.

Any time water content is adjusted, the fluid alkalinity should be checked after 24 hours. A regular schedule should be set, depending on system needs, for alkalinity checks. Morpholine should be handled with care since it is an organic base. Avoid skin or eye contact.

In addition to determination of alkalinity by 0.1N HCl titration a simple method is available for field use. This procedure is based on the use of Quantab 1160 Base Titrators (made by Ames Co., Div. of Miles Laboratories, Elkhart, Ind., and available through lab supply houses). This procedure follows:

1. Measure 90 ml of distilled water into a 100 ml graduate;
2. Add 10 ml of the Santosafe W/G fluid from the system to be tested. This measurement should be accurate to insure proper alkalinity reading.
3. Stopper graduate and shake well to mix fluid and water.
4. Place about 10 ml of the diluted fluid into a 150 ml beaker or similar sized glass container.
5. Remove the end tab of a Quantab 1160 titrator and place opened end into 10 ml sample of fluid (see 4.).
6. After the fluid has wetted the entire column (approx. 15 to 20 minutes) read the height of the color alteration on the Quantab as shown by a change from blue to green opposite the Quantab scale.
7. If the Quantab scale reading is 3.2 or above, no alkalinity adjustment is required. If the scale reading is below 3.2, add 2 quarts of morpholine for each 100 gallons of fluid in the system.

   (*NOTE:* The 3.2 value is an approximate value since each lot of Quantab 1160 may have a different calibration curve. In terms of % alkalinity (NaOH) this corresponds to a value of 0.05. Use this value to determine the minimum scale reading for each lot of Quantab).

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WATER_PCB-00005441

Table IV

MORPHOLINE ADDITION

CHART

ALKALINITY	QUARTS OF MORPHOLINE TO BE ADDED PER 100 GALLONS OF FLUID IN THE SYSTEM
150-180	None
125-150	1
100-125	2
75-100	3
50- 75	4

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