COPY

DATE 2/23/70

JOB PYDRAUL® FACT FINDER - ~~Fire Resistant Lubricants for Air Compressors.~~

INSIDE FRONT COVER: Contents (to be determined)

6/27/70 1st proof
1st wk. in July - printed

PAGE 1

HEAD: The ~~PYDRAUL~~ Air Compressor Fact Finder

COPY: . . . is designed to make the many facts about Pydraul® fire resistant lubricants for air compressors--Pydraul ~~AC~~ AC-A Pydraul ~~AC~~ AC-A Winter Grade 28 and Pydraul 625A--easy to find.

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

Set in 4-color.

* Safety from Fire and Explosion

Pydraul eliminates combustible mists and minimizes carbonaceous residues -- greatly reducing the threat of compressor fires and explosions.

* Lower Maintenance Costs

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

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Monsanto

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Head: How Compressor Fires & Explosion Occur

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

Subhead: 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.

Subhead: The Shortcomings of Safety Devices

Safety devices do not completely eliminate fire and explosion possibilities. A ~~recent~~ 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.[2] 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.

Subhead: Explosion Tests at 1300 ~~PSI~~ 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.

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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.

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P. 2, Cont'd.

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

	PYDRAUL 625A	PYDRAUL AC-A	PYDRAUL AC-A WINTER GRADE 28
PHYSICAL PROPERTIES Appearance	Clear ~~Cloudy~~ Blue Liquid	Clear Blue Liquid	Clear Blue Liquid
Spec. Gravity 25°/25°C.	1.30-1.34 ~~1.360-1.400~~	1.285-1.325 ~~1.345-1.385~~	1.235-1.255 ~~1.275-1.295~~
Neutralization No. (acidity) (mg KOH/gm) max.	0.30 ~~0.30~~	0.15	0.15
Moisture (max.)	0.15%	0.15%	0.15%
VISCOSITY Centistokes @ 100°F.	125 to 145	85 to 95 ~~82 to 92~~	26 to 30
210°F.	6.7 to 7.2 ~~5.7 to 6.2~~	5.9 to 6.3 ~~4.6 to 5.0~~	3.8 to 4.2 ~~3.5 to 3.9~~
Saybolts as @ 100°F.	628.0 ~~625.7~~ SSU	417.0 ~~408.8~~ SSU	132.8 ~~132.5~~ SSU
measured: 210°F.	49.0 ~~45.9~~ SSU	46.2 ~~42.1~~ SSU	39.3 ~~38.2~~ SSU
"Absolute Saybolts" @ 100°F.	829 ~~845~~ SSU	545 ~~550~~ SSU	165 ~~180~~ SSU
(SSU x Density) 210°F.	65 ~~59~~ SSU	60 ~~50~~ SSU	45 ~~52~~ SSU
Pour Point	+10°F. ~~+30°F.~~	+5°F. ~~+20°F.~~	-25°F. ~~0°F.~~
Compressibility x 10^{-6} sq. in./lb.	2.50* ~~2.66~~	2.50* ~~2.66~~	2.63* ~~2.66~~
Maximum Exit Air Temperature	350°F.	350°F.	350°F.
Boiling Point °F. at 760 mm Hg.	770°F. ~~724°F.~~	787°F. ~~688°F.~~	810°F. ~~688°F.~~
Coefficient of Thermal Expansion per °F.	0.0048 ~~0.00040~~	0.00045 ~~0.00040~~	0.00041 ~~0.00040~~
Specific Heat (BTU/lb./°F.) (@ 77°F.)	0.30* ~~0.28~~	0.31* ~~0.32~~	0.33* ~~0.32~~
Thermal Conductivity BTU/hr./ft./°F.	0.062* ~~0.065~~	0.064* ~~0.066~~	0.068* ~~0.066~~
Vapor Pressure Hg @ 200°F.	~~0.09mm~~	~~2.0×10^{-2}~~	~~2.0×10^{-2}~~
Bulk Modulus (Room Temp. 1000-6000 psi)	~~375,000~~ 400,000*	~~375,000~~ 400,000	~~375,000~~ 380,000
Surface Tension Dynes/cm @ 25°C.	40.2	45.0	41.0
Solubility in Water	Negligible	Negligible	Negligible

*Estimated

COMPATIBILITY WITH METALS

Pydraul air compressor lubricants are compatible with all construction metals including aluminum. In most operations, aluminum bearing surfaces that have been anodized will wear as long as any other metal bearing lubricated with Pydraul lubricants.

TABLE 2 | VAPOR PRESSURE

Temperature		Vapor Pressure mm Hg		
°C.	°F.	PYDRAUL AC-A	PYDRAUL 625A	AC-A PYDRAUL AC-WINTER GRADE 28
0	32	3.5 ~~2.0~~ x 10^{-6}	0.30 ~~1.0~~ x 10^{-6}	5.5 x 10^{-6}
10	50	11.0 ~~6.8~~ x 10^{-6}	1.1 ~~3.0~~ x 10^{-6}	17.5 ~~1~~ x 10^{-6}
20	68	3.3 ~~2.0~~ x 10^{-5}	4.0 ~~9.3~~ x 10^{-6}	50 ~~1~~ x 10^{-6}
40	104	2.4 ~~1.5~~ x 10^{-4}	3.8 ~~7.3~~ x 10^{-5}	3.5 x 10^{-4} ~~8~~ x 10^{-6}
60	140	11.5 ~~9.6~~ x 10^{-4}	2.3 ~~4.8~~ x 10^{-4}	1.6 x 10^{-3} ~~6~~ x 10^{-5}
80	176	5.0 ~~4.7~~ x 10^{-3}	1.2 ~~2.5~~ x 10^{-3}	6.6 x 10^{-3} ~~8~~ x 10^{-4}
100	212	1.7 ~~2.0~~ x 10^{-2}	0.55 ~~1.0~~ x 10^{-2}	2.2 x 10^{-2} ~~1.6~~ x 10^{-3}
150	302	0.26 ~~0.8~~	0.13 ~~0.3~~	0.31 ~~6.5~~ x 10^{-2}
200	392	2.2 ~~6.1~~	1.4 ~~8.5~~	~~10~~ 2.3

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

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FIGURE 1
SPECIFIC HEAT

PYDRAUL 625

PYDRAUL AC

PYDRAUL AC WINTER GRADE 28

Temp °F.	Pydraul 625	Pydraul AC	Pydraul AC Winter Grade 28
30	0.320	0.310	0.298
60	0.325	0.314	0.305
100	0.335	0.320	0.310
200	0.350	0.335	0.330
300	0.390	0.350	0.345

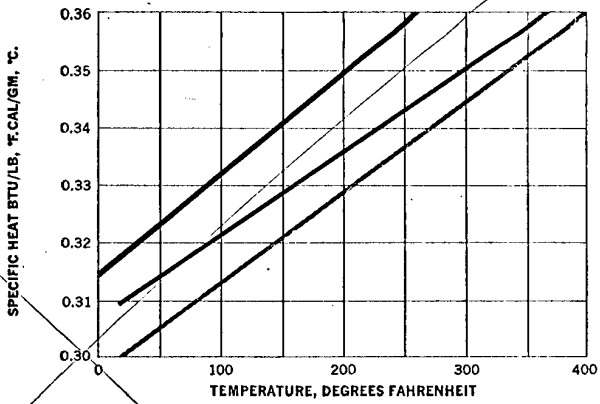


FIGURE 2
SPECIFIC GRAVITY PLOT:

Pydraul—Oil Mixtures at 60°F.

PYDRAUL 625

PYDRAUL AC

PYDRAUL AC WINTER GRADE 28

TO USE CHART . . .

Obtain specific gravity of mixture, then read horizontally along specific gravity line to intersection of graph. Read down to composition of mixture (% Pydraul in italics).

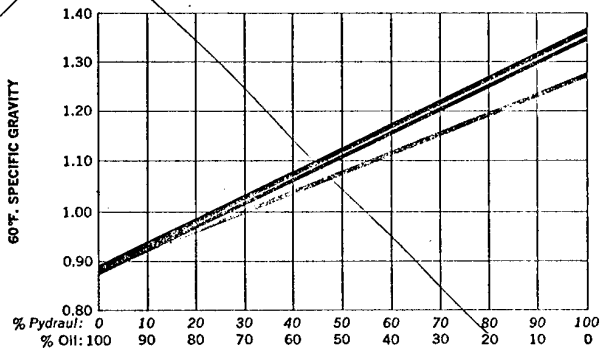


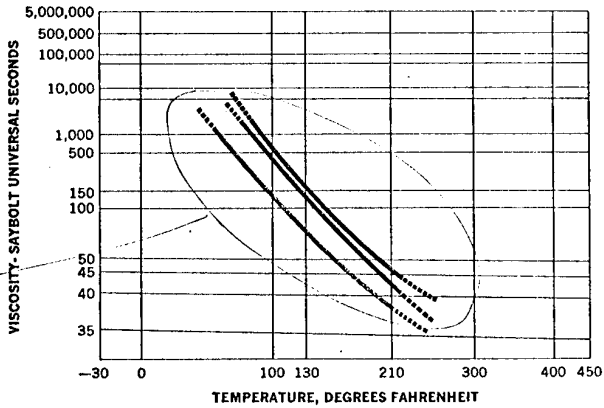
FIGURE 3 ~~2~~ 1
TYPICAL VISCOSITIES

PYDRAUL 625A

PYDRAUL AC-A

PYDRAUL ~~AC~~ AC-A WINTER GRADE 28

Draw new curves from graphs 1, 2 & 3



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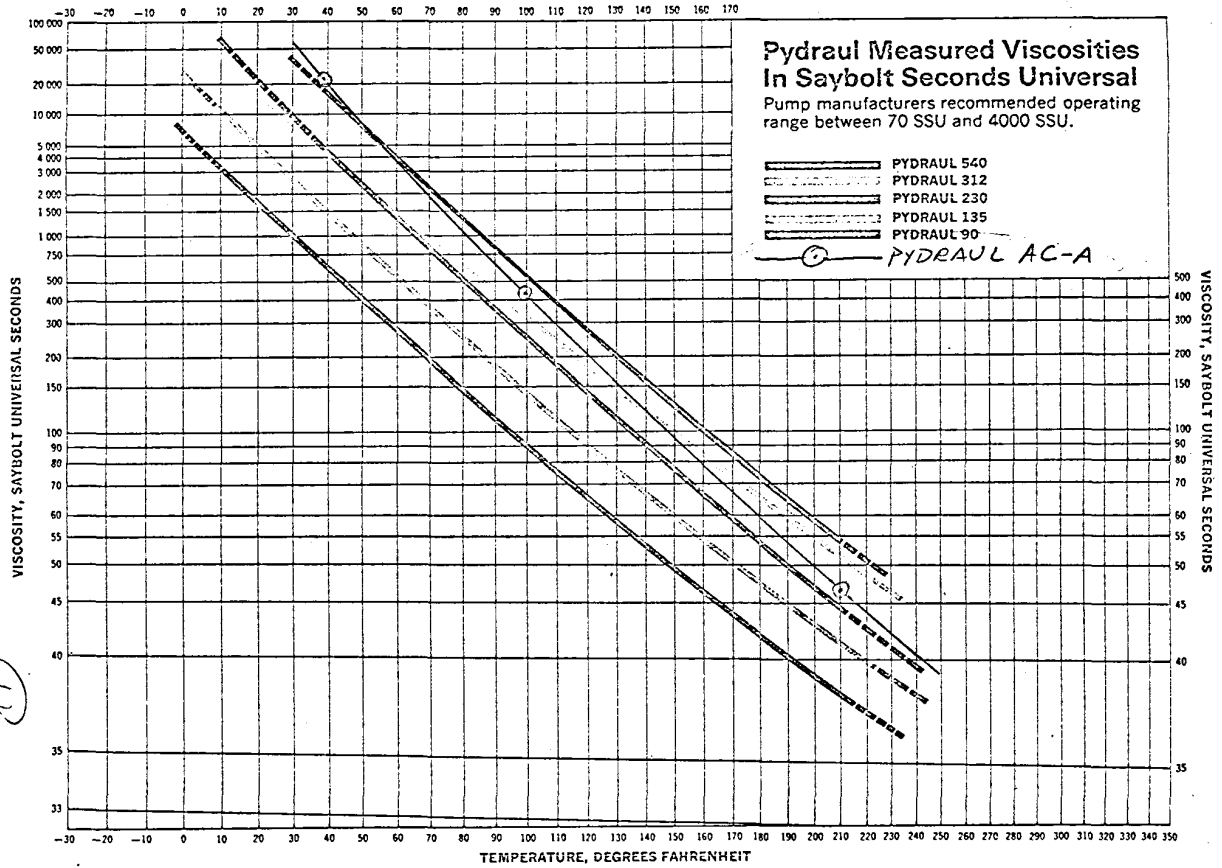

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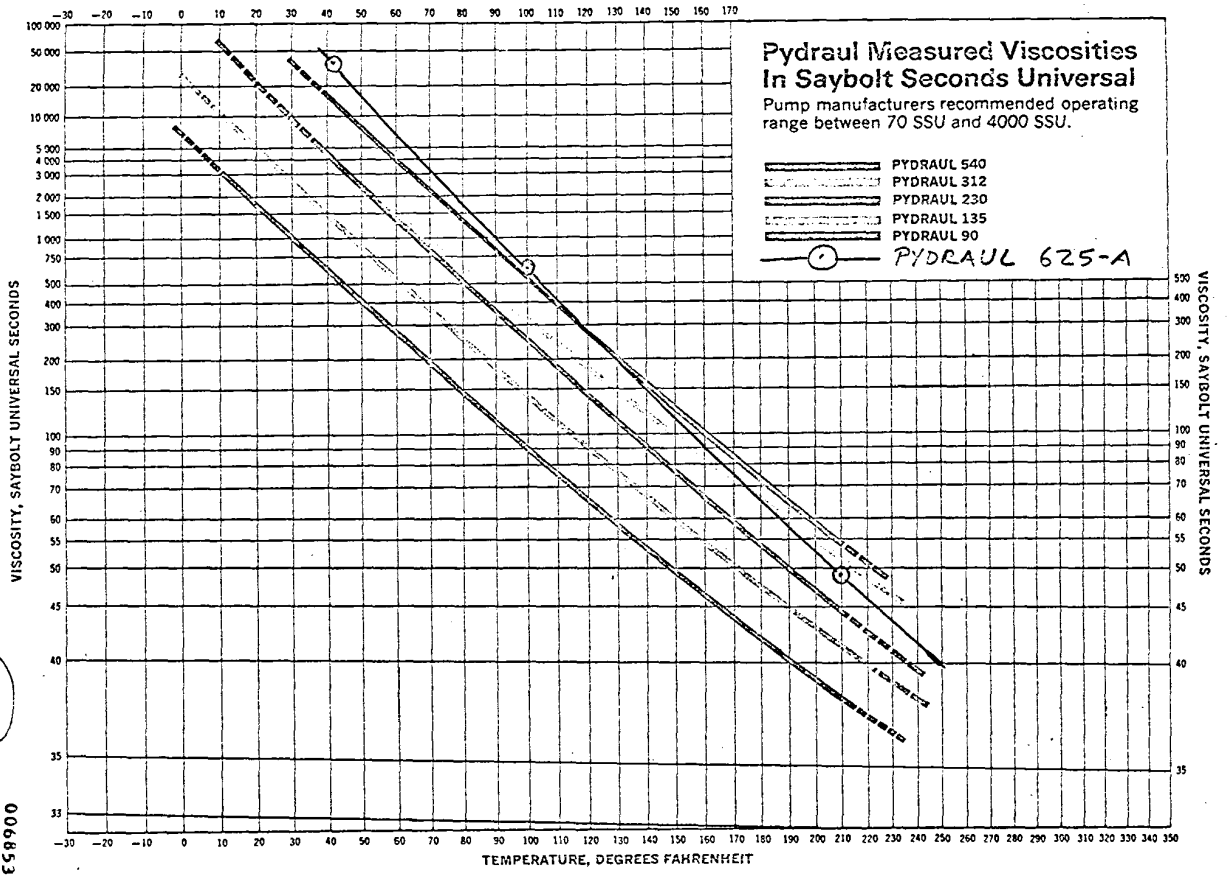

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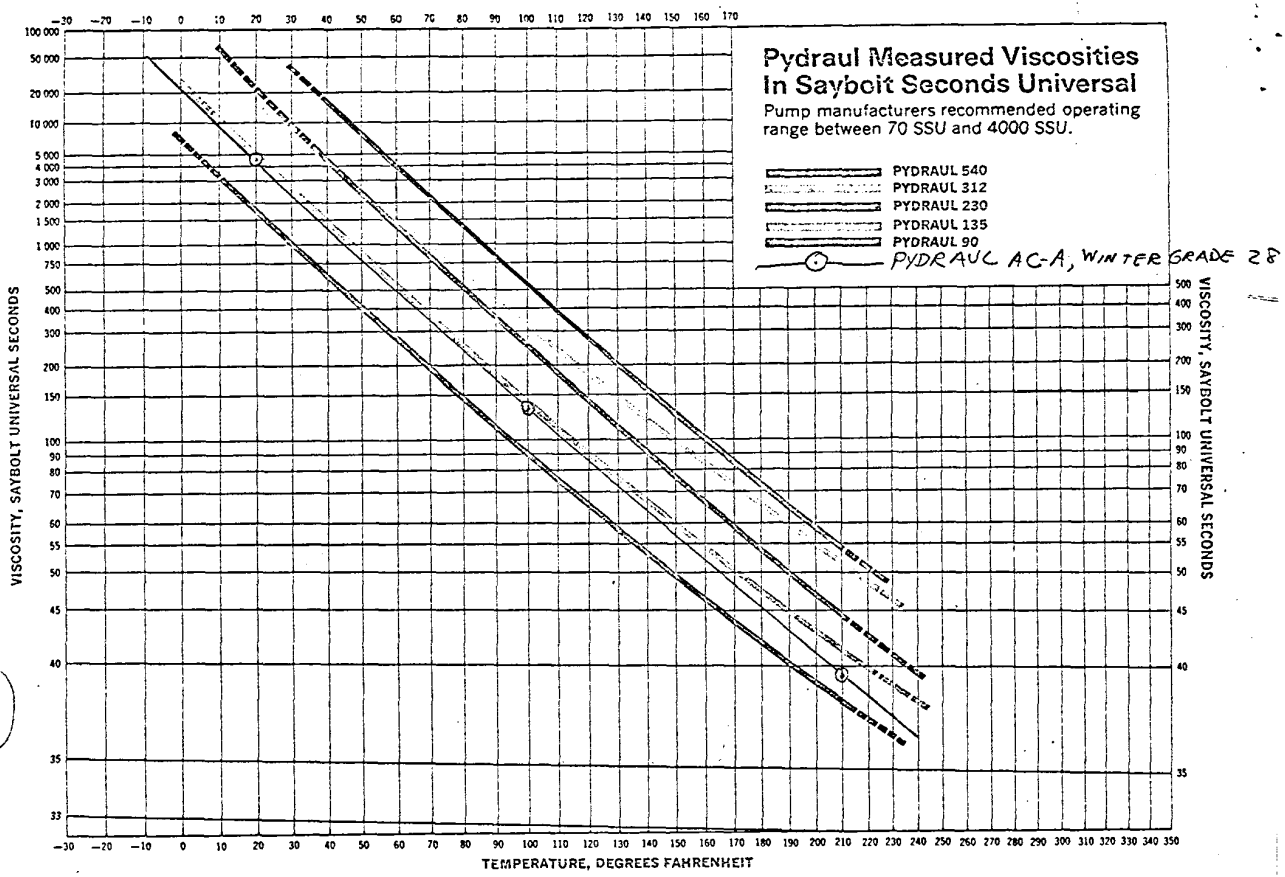
Pydraul Measured Viscosities
In Saybolt Seconds Universal
Pump manufacturers recommended operating range between 70 SSU and 4000 SSU.
PYDRAUL 540
PYDRAUL 312
PYDRAUL 230
PYDRAUL 135
PYDRAUL 90
PYDRAUL AC-A, WINTER GRADE 28
VISCOSITY, SAYBOLT UNIVERSAL SECONDS
VISCOSITY, SAYBOLT UNIVERSAL SECONDS
TEMPERATURE, DEGREES FAHRENHEIT

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Pydraul

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 during these hours of machine operation has a Pydraul fluid contributed to a fire--and never since their introduction in 1954 has any Pydraul fire-resistant compressor lubricant caused a compressor fire or explosion.

FIRE-RESISTANCE TESTS OF PYDRAUL AC-A, PYDRAUL AC-A WINTERGRADE AND PYDRAUL 625A

TEST	RESULTS
High Pressure Spray Test AMS-3150C and Federal Test Method Std. 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-extinquishes 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.

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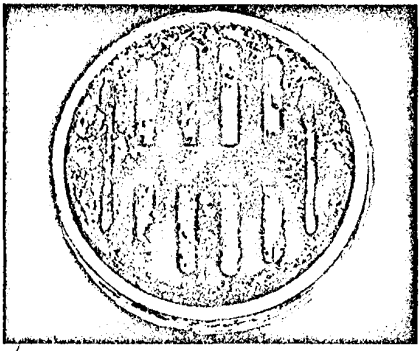
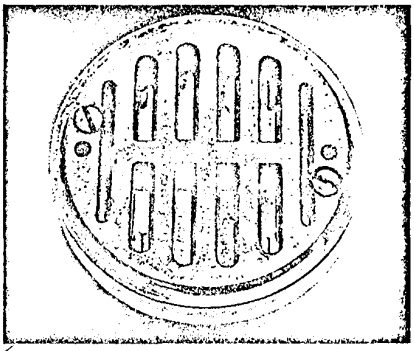
PYDRAUL AC-A Virtually Eliminates Valve Deposits

Compressor Data: 142 CFM, 6" LP Bore, 5" HP Bore, 5" Stroke, 870 RPM, 100 psi air



500 hours on premium petroleum oil



500 hours on Pydraul AC-A

The photos compare exhaust valve deposits formed during individual 500-hour operations on two lubricants: a premium grade petroleum oil . . . and Pydraul ~~AC~~ AC-A*.

A glance at the photo of the valve lubricated with petroleum oil shows considerable carbon deposit build-up after 500 hours operation. The improvement in the valve condition in the photo on the right is obvious—virtually no carbon deposits after 500 hours operation with Pydraul ~~AC~~ AC-A. In the particular case, the compressor operator expects to get 7500 to 10,000 hours of service from Pydraul ~~AC~~ AC-A without shutting down—a 15- to 20-fold increase in operating time without a shutdown. Result: substantial maintenance savings in time and money—and virtual elimination of the fuel source of most air compressor fires and explosions.

*No photographs available of Pydraul 625 and Pydraul AC Winter Grade 28, but results are at least identical.

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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
Engineering Sales Department
800 North Lindbergh Blvd.
St. Louis, Mo. 63166
Telephone: (314) 694-2286
(Joseph A. Brink)

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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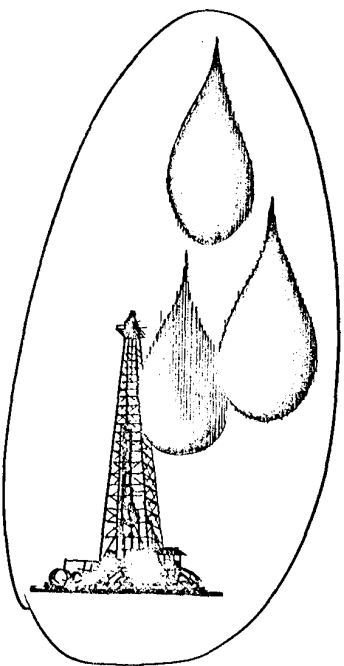
PYDRAUL Provides The Lubricating Qualities Of Premium Petroleum Oil

Long years of service in air compressors of almost every type have proved the lubricating qualities of Pydraul air compressor lubricants equivalent to those of premium petroleum oil.

Typical are the statements below from engineers reporting the performance of Pydraul as a lubricant.



"Lubricating properties of Pydraul AC have been very satisfactory. Wear measurements on Molypak rings taken approximately five months later indicate 0.003" wear. This is normal and considered very good. No corrosion of cylinder liners, valves and piping has been experienced, and service is very satisfactory."

Compressor equipment: Cooper-Bessemer JM5

"Pydraul AC—outside of reducing the fire hazard—also provides very satisfactory lubrication and protection of valves . . . It seems rather logical to assume that the complete absence of deposits due to progressive oil oxidation and consequent high temperatures, shall help improve valve performance and maintenance. The higher gravity of Pydraul seems to result in better mechanical separation, and its water-like permanent cleanliness does not interfere with the cleanliness of surfaces contacted."

Compressor equipment: Joy Manufacturing WN-112-E

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PYDRAUL Provides The Lubricating Qualities Of Premium Petroleum Oil

TABLE 3
FILM STRENGTH FALEX LOAD TEST

	PASSING LOAD JAW LOAD (LBS.)	TORQUE (LBS. INCHES)
Pydraul 625A	4250 4100	89
Pydraul AC-A	4025 3600	98
Pydraul AC-A Winter Grade 28	4175 3700	92

TABLE 4
WEAR UNDER CONTINUOUS LOAD
FALEX WEAR TEST

	1st 10 MINUTES WT. LOSS, PIN (mg)	2nd 10 MINUTES WT. LOSS, BLOCKS
Pydraul 625A	1.1 0.000618	5.8 0.000332
Pydraul AC-A	0 0.000428	0.5 0.000285
Pydraul AC-A Winter Grade 28	0.6 0.000450	0.9 0.000330

TABLE 5
TIMKEN (EXTREME PRESSURE)*

	OK LOAD (lbs.)	FILM STRENGTH (psi)
Pydraul 625A	30 21,200 psi	11,700
Pydraul AC-A	45 23,250 psi	15,100
Pydraul AC-A Winter Grade 28	24 18,000 psi	8,600

*Film strength—Typical Petroleum Oil (measured by Timken Extreme Pressure)—5,000 to 8,000 psi.

TABLE 6
SHELL FOUR-BALL WEAR
(167°F., 1 hour, 630 rpm., mm scar diameter)

STEEL ON STEEL	PYDRAUL 625A	PYDRAUL AC-A	PYDRAUL AC-A WINTER GRADE 28
10 kg	0.23 0.26	0.23 0.32	0.42 0.80
40 kg	0.60 0.62	0.67 0.70	0.66 0.65
STEEL ON BRONZE 10 kg	0.46	0.48	0.43

TABLE 7
PUMP TEST*
(Vickers V-105-C., 140°F., 1000 hours.)

	PYDRAUL 625	PYDRAUL AC
Ring, grams (loss or gain)	−0.0013	−0.0076
Vane, grams (loss or gain)	−0.0015	+0.0014
Bushing 2015 grams (loss or gain)	−0.0045	+0.0040
Bushing 2016 grams (loss or gain)	−0.0050	+0.0045

*No data is presently available on Pydraul AC Winter Grade 28.

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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 AC	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.

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OK.

table

PYDRAUL Is Used As A Lubricant For Air Compressors Made By All 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 (right) 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.

Mixing Compatibility

Pydraul AC-A, Pydraul AC-A Wintergrade 28 and Pydraul 625A are completely miscible in all proportions with competitive synthetic lubricants such as Fyrquel* 150, 220, 300, 500 and Houghto-Safe** 1010, 1120 and 1130.

*Registered trademark of Stauffer Chemical Company
**Registered trademark of E. F. Houghton Co.

150	YES	YES	YES
220	YES	YES	YES
300	YES	YES	YES
550	YES	YES	YES
HOUGHTO-SAFE			
1010	YES	YES	YES
1055	YES	YES	YES
1120	YES	YES	YES
1130	YES	YES	YES

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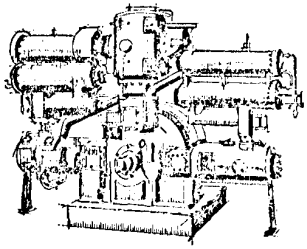

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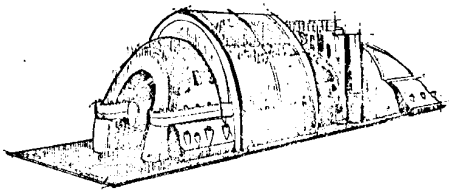
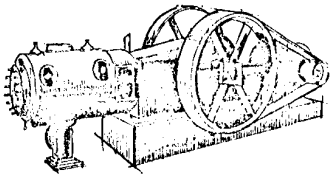
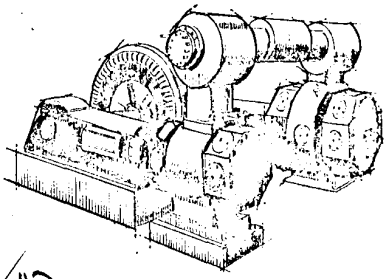
American Messer Corporation
Bury Compressor Company
Carrier Corporation
Chicago Pneumatic Tool Company
Clark Brothers Company,
division of Dresser Industries
Cooper-Bessemer Corporation
DeLaval Steam Turbine Company
Gardner-Denver Company
Ingersoll-Rand Company
Joy Manufacturing Company
Kinney Manufacturing,
division of The New York
Air Brake Company
Norwalk Company, Incorporated
Schramm, Incorporated
Worthington Corporation







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.

↓ Move to "Drop Size", p.9

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Safe

Handling

There has been no reported case in many years of service to indicate any special health hazard with Pydraul air compressor lubricants. However, as with all specialized industrial fluids and lubricants, certain precautions are advisable.

Animal toxicity screening studies indicate Pydraul AC-A, Pydraul AC-A Wintergrade 28 and Pydraul 625A may be considered only slighly toxic from the standpoint of accidental ingestion or skin absorption. It does not appear to have any significant potential for skin or eye irritation. Because these fluids have excellent solvent properties, repeated or prolonged skin contact could lead to de-fatting and drying of the skin; thus reasonable personal hygiene practices are recommended to avoid prolonged and repeated skin exposure.

If Pydraul fluids are splashed or sprayed into the eyes, moderately severe pain and irritation may result. There is no evidence to show Pydraul causes permanent eye tissue damage. Eyes should be thoroughly flushed with water and the workman referred to a physician. To relieve irritation, physicians have used 1% pontocaine solution, as well as the ophthalmic cortisone acetate solution.

Vapor inhalation. At room temperatures, there is no vapor inhalation hazard from Pydraul fluids. Although there has been no problem with high concentrations of vapors, inhalation of vapors at high temperatures should be prevented.

If the compressed air is to be used for air line masks, respirators and other inhalation equipment, it is always recommended that a commercial filter cartridge for air-supplied masks be incorporated in the compressor air line to remove any foreign matter. This is good industrial practice for any compressor fluid or lubricant.

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