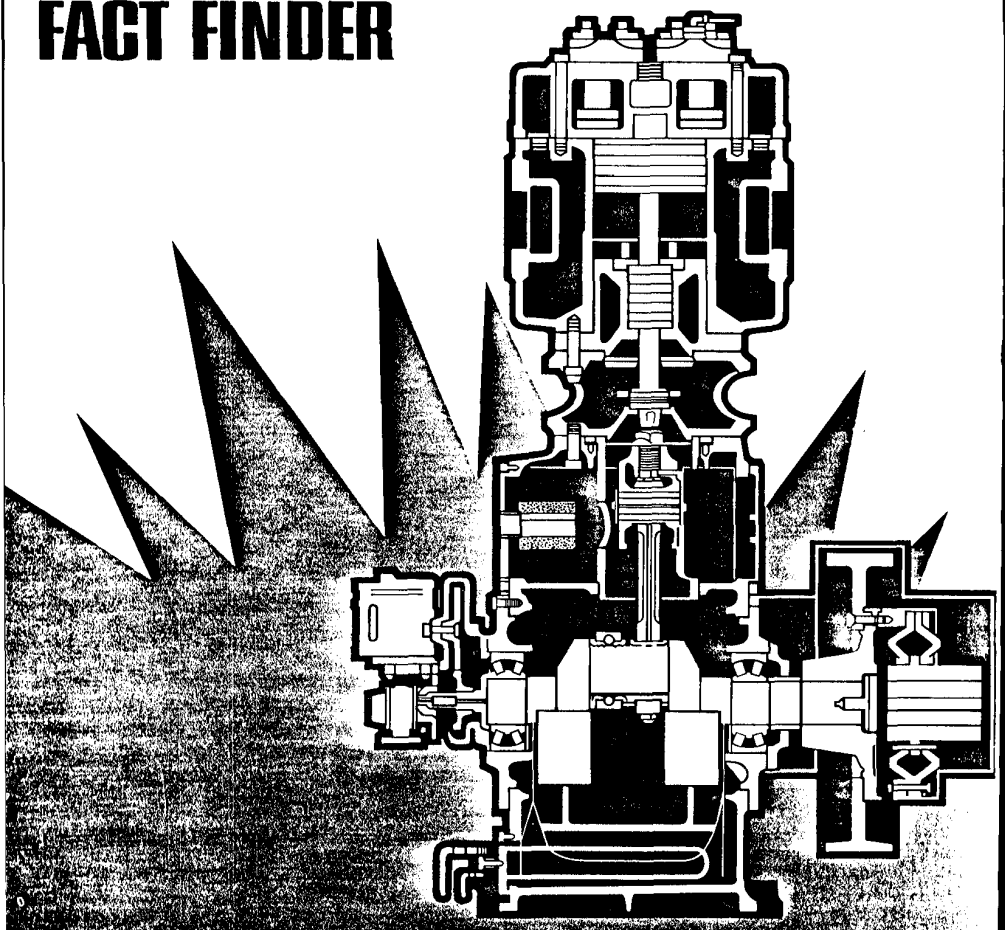
PYDRAUL® FACT FINDER

Fire Resistant Lubricants For Air Compressors



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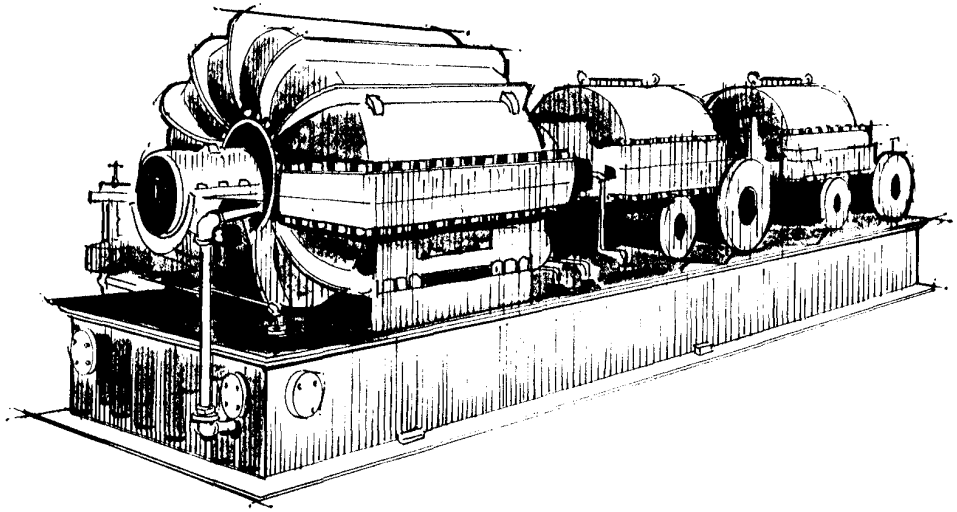

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The PYDRAUL Air Compressor Fact Finder

. . . is designed to make the many facts and features about Pydraul® fire-resistant lubricants for air compressors quick and easy to find. We hope you will find it helpful in working with these safety lubricants for air compressors—Pydraul AC, Pydraul AC Winter Grade 28, and Pydraul 625.

Special safety lubricants for air compressors provide three important advantages over petroleum oil: safety from fire and explosion, virtual elimination of valve deposits, and lower maintenance costs. By eliminating combustible mists and minimizing carbonaceous residues, Pydraul lubricants reduce the threat of compressor fires and explosions.

Pydraul lubricants also reduce compressor maintenance costs. By eliminating deposits on exhaust valves, in coolers, and in piping, these lubricants greatly reduce the costs of compressor down-time and cleaning. These lower maintenance costs alone usually justify using Pydraul lubricants for air compressors.

For air compressors which operate in low ambient temperatures, Pydraul AC Winter Grade 28, a low temperature lubricant, is recommended. Pydraul 625 is recommended for compressors requiring a high viscosity lubricant.

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How Compressor Fires & Explosions May Occur

There are several theories concerning the mechanisms of fires and explosions in air compressor systems, but one point is common in every case: petroleum oil lubricants are directly involved.

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.

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.

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.

The variety of fire and explosive conditions that may occur in air compressors lubricated with petroleum oil are many and unpredictable. This danger and unpredictability raises the need for eliminating the *source* of carbon deposits, the basic cause of most air compressor fires and explosions.

Fire- and explosion-resistant Pydraul air compressor lubricants essentially eliminates this basic cause by minimizing carbon deposits. Their superior oxidation resistance adds to their ability to prevent explosions. And by their inherent ability to resist burning in air, Pydraul lubricants substantially reduce the threat of fire.

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 625 -A	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.	~~1.300 - 1.400~~ 1.302 - 1.34	~~1.345 - 1.385~~ 1.285 - 1.325	~~1.275 - 1.295~~ 1.235 - 1.[illegible]
Neutralization No. (acidity) (mg KOH/gm) max.	0.30	0.15	0.15
Moisture (max.)	0.15%	0.15%	0.15%
VISCOSITY Centistokes @ 100°F. 210°F.	125 to 145 ~~5.7 to 6.2~~ 6.72 - 7.5	~~82 to 92~~ ~~4.6 to 5.0~~ [illegible]	26 to 30 ~~3.5 to 3.9~~ [illegible]
Saybolts as measured: @ 100°F. 210°F.	~~625.7 SSU~~ 628.0 ~~45.0 SSU~~ 49.0	~~408.8 SSU~~ [illegible] ~~42.1 SSU~~ [illegible]	~~132.5 SSU~~ [illegible] ~~38.2 SSU~~ [illegible]
"Absolute Saybolts" (SSU x Density) @ 100°F. 210°F.	~~845 SSU~~ 829 ~~59 SSU~~ 60	~~550 SSU~~ 545 ~~50 SSU~~ 60	~~180 SSU~~ 165 ~~52 SSU~~ [illegible]
Pour Point	+30°F. +10°F	~~+20°F.~~ [illegible]	~~-0°F.~~ -25°F
Compressibility x 10^{-6} sq. in./lb.	2.66 2.50*	2.66 [illegible]*	~~2.66~~ [illegible]*
Maximum Exit Air Temperature	350°F.	350°F.	-350°F.
Boiling Point °F. at 760 mm Hg.	~~724°F.~~ 770	~~688°F.~~ 787°F	~~688°F.~~ [illegible]
Coefficient of Thermal Expansion per °F.	0.00040 .0048	~~0.00040~~ .00045	~~0.00040~~ [illegible]
Specific Heat (BTU/lb./°F.) (@ 77°F.)	0.28 0.30*	~~0.32~~ 0.31*	~~0.32~~ [illegible]
Thermal Conductivity BTU/hr./ft./°F.	~~0.065~~ 0.062*	~~0.066~~ 0.064*	~~0.066~~ [illegible]
~~Vapor Pressure Hg @ 200°F.~~	~~0.00mm~~ .004	~~0.0×10^{-3}~~ 1.3×10^{-4}	~~0.0×10^{-3}~~ 1.6×10^{-4}
Bulk Modulus (Room Temp. 1000-6000 psi)	~~375,000~~ 400,000*	~~375,000~~ 400,000	~~375,000~~ 380
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 °C.	Temperature °F.	Vapor Pressure mm Hg → Center		
		PYDRAUL AC	PYDRAUL 625	PYDRAUL AC-WINTER GRADE 28
0	32	~~2.0~~ 3.5 x 10^{-6}	0.30 ~~1.0~~ x 10^{-6}	5.5 x 10^{-6}
10	50	~~6.8~~ 11.0 x 10^{-6}	1.1 ~~3.0~~ x 10^{-6}	17.5 ~~1~~ x 10^{-6}
20	68	~~2.0~~ 3.3 x 10^{-5}	4.0 ~~9.3~~ x 10^{-6}	50 ~~1~~ x 10^{-6}
40	104	~~1.5~~ 2.4 x 10^{-4}	3.8 ~~7.3~~ x 10^{-5}	3.5 ~~8 x 10^{-6}~~ x 10^{-4}
60	140	~~9.6~~ 11.5 x 10^{-4}	2.3 ~~4.8~~ x 10^{-4}	1.6 ~~6 x 10^{-5}~~ x 10^{-3}
80	176	~~4.7~~ 5.0 x 10^{-3}	1.2 ~~2.5~~ x 10^{-3}	6.6 ~~3 x 10^{-4}~~ x 10^{-3}
100	212	~~2.0~~ 1.7 x 10^{-2}	0.55 ~~1.0~~ x 10^{-2}	2.2 ~~1.5 x 10^{-3}~~ x 10^{-2}
150	302	~~0.8~~ 0.26	.13 ~~0.3~~	~~6.5 x 10^{-2}~~ 0.31
200	392	~~6.1~~ 2.2	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

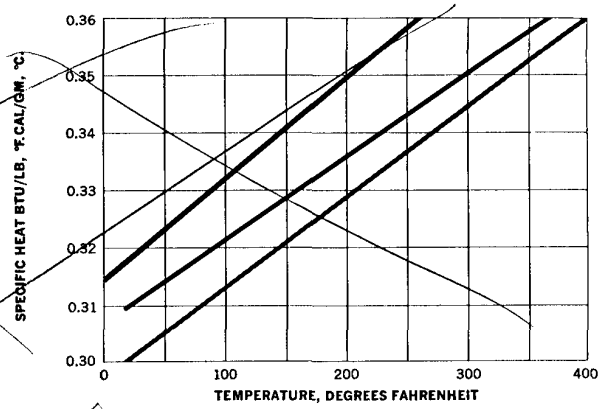


FIGURE 2
SPECIFIC GRAVITY PLOT:

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).

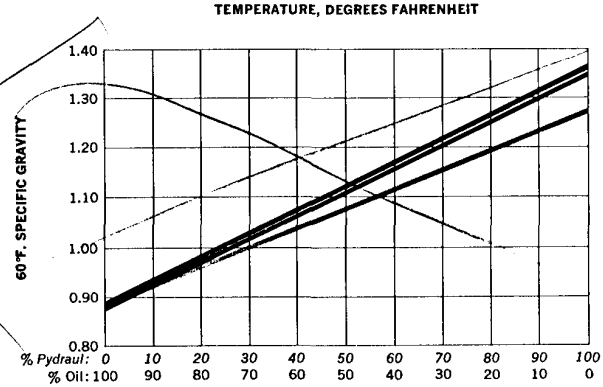
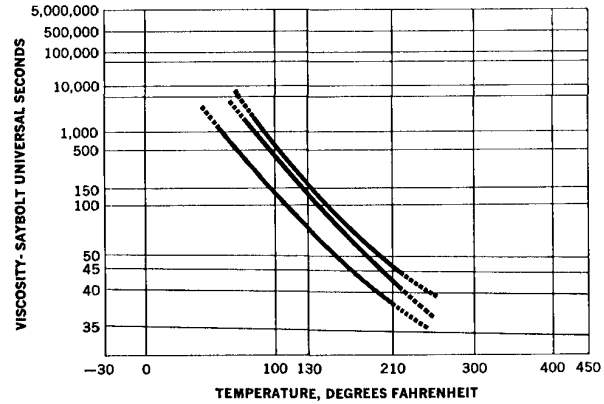


FIGURE 3
TYPICAL VISCOSITIES

PYDRAUL 625

PYDRAUL AC

PYDRAUL AC WINTER GRADE 28



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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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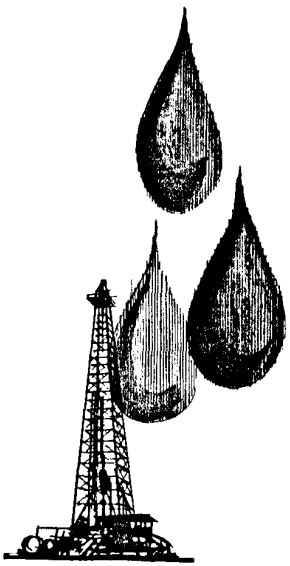
PYDRAUL Provides The Lubricating Qualities Of Premium Petroleum Oil

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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Lubricating Qualities

TABLE 3
FILM STRENGTH

	JAW LOAD (LBS.)	TORQUE (LBS. INCHES)
Pydraul 625	4100	89
Pydraul AC	3600	98
Pydraul AC Winter Grade 28	3700	92

TABLE 4
WEAR UNDER CONTINUOUS LOAD

	1st 10 MINUTES	2nd 10 MINUTES
Pydraul 625	0.000618	0.000332
Pydraul AC	0.000428	0.000285
Pydraul AC Winter Grade 28	0.000450	0.000330

TABLE 5
TIMKEN (EXTREME PRESSURE)*

Pydraul 625	21,200 psi
Pydraul AC	23,250 psi
Pydraul AC Winter Grade 28	18,000 psi

*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 625	PYDRAUL AC	PYDRAUL AC WINTER GRADE 28
10 kg	0.26	0.32	0.30
40 kg	0.62	0.70	0.65

TABLE 7
PUMP TEST*
(Vickers V-105-E., 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.

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

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Mixing Compatibility

TABLE 8
PYDRAUL WITH OTHER HYDRAULIC FLUIDS

FYRQUEL (Formerly Cellulube)	625	AC	AC-WG28
90	YES	YES	YES
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

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.

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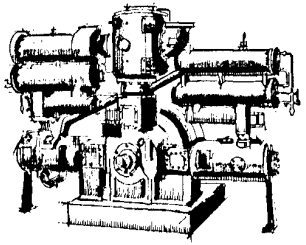
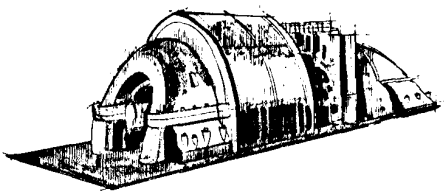
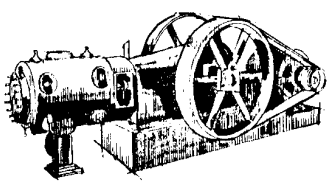
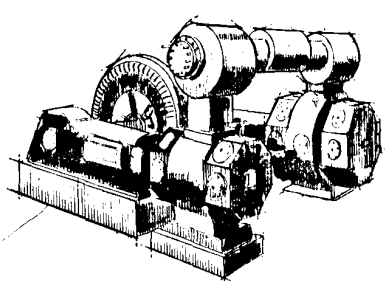


American Messer Corporation
Bury Compressor Company
Carrier Corporation
Chicago Pneumatic Tool Company
Clark Brothers Company,
division of Dresser Industries
Cooper-Bessemer Corporation
DeLaval Steam Turbine Company
Gardner-Denver Company
Ingersoll-Rand Company
Joy Manufacturing Company
Kinney Manufacturing,
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.

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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, certain precautions are advisable.

Skin contact. Repeated or continuous skin contact with Pydraul fluids should be avoided. Pydraul fluids act as a solvent and repeated or prolonged skin contact can cause dry skin and chapping.

Eye contact. Although eye irritation studies using Pydraul fluids at full strength indicate Pydraul to be an irritant, there is no evidence to show Pydraul causes permanent eye tissue damage. If Pydraul fluids are splashed or sprayed into the eyes, moderately severe pain and irritation may result. 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.

Air samples were taken from the line of a Joy Manufacturing air compressor which had operated on Pydraul AC for three years. Filter paper and silica gel samples were collected and analyzed using a Beckman Spectrophotometer after iso-octane or iso-propanol extraction. No concentrations of the major components of Pydraul AC could be detected.

No serious hazard is anticipated from vapors of Pydraul fluids; however, 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 simply good industrial practice for any compressor fluid or lubricant.

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