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TURBINOL® -- FIRE RESISTANT TURBINE LUBRICANTS

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Monsanto

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INCREASED FIRE SAFETY IN INDUSTRIAL OPERATIONS

Over the past quarter century, owners and operators of capital equipment have become increasingly aware of the potential fire hazards from functional fluids and lubricants. The concern has ranged from operation of electrical transformers to aircraft, to die-casting machines, hydraulic presses, air compressors, electronic signal equipment, and to turbines. In every case, the individual or the industry's move to fire-resistant fluids and lubricants was initially stimulated by the incidence of costly fires.

The same history is repeating itself in the operation of turbines and their related power off-take equipment. The development of unattended gas turbine power package units has made the need for fire resistant lubricants and control-actuating fluids more pressing and in some installations almost mandatory.

Monsanto was one of the first chemical manufacturers to recognize the need for fire resistant hydraulic fluids and lubricants. Over a quarter century of research has developed a variety of functional fluids for specific applications all sharing the common property of fire resistance; all physically and chemically stable; all designed for optimum operation in specific equipment.

The first synthetic lubricants with fire resistance and suitable properties for turbine applications were offered by Monsanto in 1953. Since that time, the continuing research in fundamental properties and formulation have developed a series of improved fluids and progressively higher operating performance. The culmination of this research and development is the current series of Turbinol fluids that are recommended as turbine lubricants, for lubricating off-take equipment and for hydraulic controls.

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GENERAL DESCRIPTION

* Turbinol fluids are built with stable phosphate-ester type base stocks and selectively formulated to possess maximum resistance to oxidation and hydrolysis.

* Turbinol fluids have higher oxidation resistance and greater thermal stability (by test and by actual use) than either petroleum oils or other synthetic lubricants offered for turbine and turbine-related use.

* Turbinol fluids offer excellent lubricity, provide high performance turbines with minimum-wear lubrication that assures long-term, trouble-free operation at high operating temperatures.

* Turbinol fluids are fire resistant and pass all recognized tests for judging fire safety. They are Factory Mutual approved.

* Turbinol fluids are specially formulated in a range of viscosities and with performance properties that fit them particularly for the applications recommended:

Turbinol 50	A 220 SSU viscosity fluid specially designed for electro-hydraulic control systems on steam turbines where bearing lubrication is provided by other fluids in a separate system.
Turbinol 1122	A 150 SSU viscosity high performance fluid designed for gas turbine bearing lubrication and for bearings on connected load equipment, such as gas compressors and electrical generators.
Turbinol 1223	A 220 SSU viscosity fluid for turbine bearing lubrication and for use in associated electro-hydraulic control systems.

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TYPICAL PERFORMANCE

The performance of a lubricant in any application is related to the characteristics of the lubricant, the system itself, the duty cycle and the operating environment. A number of standard laboratory and bench tests are used universally to predict lubricant performance but such data must be supported by full-scale rig tests and/or actual field use.

Turbinol fluids show excellent results in a range of tests as shown in the data that follows:

	TURBINOL®		
	50	1122	1223
LUBRICATION DATA			
Four-Ball Wear Test, (scar diameter in mm.) 625 rpm, 167°F., 1 hr.			
Steel/Steel			
10 Kg. load	0.45	0.40	0.44
40 Kg. load	0.62	0.58	0.58
Steel/Bronze			
10 Kg. load	0.39	0.42	0.42
40 Kg. load	0.63	1.01	0.65
FOAM TEST ASTM D-892 Sequence 1,2,3	Pass	Pass	Pass
RUST TEST ASTM D-665 24-Hr. Distilled Water	Pass	Pass	Pass
ALCOR DEPOSITION TEST (Oil at 250°F., 48 hrs. 1000 ml./min. air flow)			
Tube temperature, °F.	450°	450°	450°
Overall rating	25.2	22.7	29.5
Critical temperature, °F.	510°	515°	>460°
Filter deposit, mg.	0.1	0.8	0.4

(In this test, the fluid in air is passed through an electrically heated tube at various temperatures. The thermal stability is reported as the amount of deposition on the tube and the amount that flakes off to be caught by the filter.)

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STABILITY & CORROSION DATA

(Oxidation and Corrosion Tests by Federal Test Method Standard Number 791a, Method 5308.)

	TURBINOL® 50	TURBINOL® 1122	TURBINOL® 1223
1. 168 hrs., 5ℓ/hr. air, 250°F.			
Viscosity % change @100°F.	+6.9	+3.6	+4.6
Acidity, TAN Change	0.00	+0.02	0.00
Metal weight change, mg./cm^2			
Magnesium	0.00	-0.02	0.00
Aluminum	+0.01	+0.02	+0.01
Cadmium	+0.03	+0.04	+0.03
Steel	+0.04	-0.01	+0.04
Copper	-0.16	-0.16	-0.16
2. 72 hrs., 5ℓ/hr.air, 347°F.			
Viscosity % change @ 100°F.	+13.6	+7.8	+19.8
Acidity, TAN Change	+ 2.23	+3.50	+2.18
Metal weight change, mg./cm^2			
Magnesium	+ 0.04	+0.04	+0.04
Aluminum	+ 0.03	+0.01	+0.01
Cadmium	+ 0.04	+0.03	+0.04
Steel	0.00	+0.04	+0.04
Copper	- 0.25	0.00	0.16

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TYPICAL PROPERTIES

	TURBINOL®		
	50	1122	1223
GENERAL PHYSICAL PROPERTIES.			
Appearance	Bluish-green oil	clear amber oil	clear amber oil
Specific Gravity 25°/25°C.	1.150	1.173	1.142
Pour Point, °F.	-5	-20	-5
Moisture, %, Maximum	0.10	0.10	0.10
Acidity, mg KOH/g, Maximum	0.15	0.10	0.10
Vapor Pressure, mm Hg.@200°F.	0.002	0.002	0.002
Solubility in Water	Nil	Nil	Nil
PHYSICAL PROPERTY VARIATION WITH TEMPERATURE			
Viscosity, SSU			
40°F.	3000	1480	3460
60°F.	1000	525	1150
100°F.	231	150	240
150°F.	80	62	76
210°F.	46	42.1	45.9
Viscosity, cs.			
40°F.	725	320	750
60°F.	200	120	240
100°F.	49	31.9	51.7
150°F.	14.5	11.0	15.5
200°F.	6.5	5.4	6.9
210°F.	5.90	4.82	6.02
Density, g./ml.			
40°F.	1.145	1.20	1.14
100°F.	1.115	1.17	1.11
210°F.	1.075	1.13	1.07
Specific Heat, Btu./lb.°F.			
60°F.	0.37	0.36	0.37
100°F.	0.38	0.38	0.38
150°F.	0.40	0.39	0.40
200°F.	0.42	0.41	0.42
Thermal Conductivity, Btu./Hr. ft°F.			
60°F.	0.073	0.074	0.073
100°F.	0.073	0.074	0.073
150°F.	0.073	0.073	0.073
200°F.	0.072	0.073	0.072

(Graphs of SSU and CS Viscosity vs. Temperature)

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FIRE RESISTANT PROPERTIES

The fire resistance of phosphate-ester based fluids have been widely proved in applications as diverse as turbine lubricants, hydraulic fluids, and air compressor lubricants -- this last requiring fire resistance in mist form. A variety of basic tests have been developed to demonstrate fire resistance. As the following data shows, Turbinol fluids show excellent fire resistance by the most stringent test procedures.

	TURBINOL®		
	50	1122	1223
Flash Point, COC., °F.	480°	470°	480°
Fire Point, COC., °F.	620°	650°	620°
Autoignition, °F., (ASTM D-2155)	910°	1050°	910°
Autoignition, °F., (ASTM D-286)	>1000°	>1000°	>1000°
High Pressure Spray Test (AMS 3150C)	----- Intermittent Flashing ---- Self extinguishing		
Hot Manifold Test (Federal Test Method Std. 791a)			
@ 1300°F.	----- Flashes, does not propagate----		
@ 950°F.	- - - - Does not flash or burn - - - - -		
Molten Metal Test @ 1300°F.	----- No Ignition -----		
Factory Mutual Spray Test (Fluid sprayed at 1,000 psi from oriface and passing through flame of propane torch)	---	Pass	Pass
Factory Mutual Channel Iron Test (Fluid sprayed at 1,000 psi through oriface on to hot channel iron @ 1,300°F.)	---	Pass	Pass

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COMPATIBILITY WITH MATERIALS

Metals & Other Lubricants

Turbinol lubricants are compatible with all commonly used metals of construction and with tin babbit bearing alloys.

Turbinol fluids are miscible in all proportions with other phosphate-ester type lubricants. They are not compatible with petroleum base lubricants. Turbinol fluids will dissolve only 3-5% of most types of petroleum oil.

Packings, Seals, Hose, Bladders, Wire Insulation

Turbinol fluids are compatible with a wide variety of elastomeric and polymeric materials. Components made of these are available from a variety of suppliers. For information purposes, Turbinol fluids are classed as straight synthetic fluids formulated with triamyl phosphate base stocks. Components made of the following materials are compatible with Turbinol fluids:

- Butyl rubber
- Ethylene-propylene rubber
- Ethylene-propylene terpolymers
- Viton
- Teflon
- Nylon
- Silicone
- Polyethylene
- Polyimide

Paints

Many paint suppliers offer coatings based on the following (cured) resins which are satisfactory for use with Turbinol fluids:

- Epoxy
- Phenolic
- Polyurethane
- Nylon

Filters

All turbine lubricants should be filtered free of particulate contamination to insure optimum performance. Turbinol lubricants are no exception. Most oil-type filters are suitable for use with Turbinol lubricants providing all components of the filter are constructed with compatible materials. Active earth filters are satisfactory and may be used to reduce the acidity normally developed over prolonged use.

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CONVERSION TO TURBINOL LUBRICATION & HYDRAULIC CONTROL

Adopting the fire resistant Turbinol fluids for safer turbine operation is quite simple. However, in all cases the equipment manufacturer should be consulted to make sure compatible seals, hoses and paints have been used and/or to determine if any mechanical adjustments are warranted to adequately circulate sufficient fluid with the viscosity characteristics of the Turbinol fluid to be used. In addition, Monsanto fluid specialists are available for assistance in conversion.

Conversion from any currently available commercial fire resistant fluid is simply direct replacement, by drain and re-fill or by using Turbinol as make-up. Detailed lubricant-lubricant compatibility is available from your Monsanto representative.

Conversion from petroleum lubricants is only slightly more complex, since Turbinol fluids will dissolve only a small amount of oil. The following are the minimum requirements necessary for conversion:

Completely drain and clean the system. (Small amounts of oil left behind will not interfere with Turbinol performance but may separate and collect in certain areas of the system thus reducing the system's fire resistance.) After draining system, blow out all pipes and manually clean bearing pedestals and reservoir. Replace gaskets, packings, seals as required if they are not of compatible materials. Add a partial charge of Turbinol fluid, circulate and check component functioning. Inspect the fluid condition after circulation. If amounts of oil left behind by the clean out have deteriorated the partial charge, it should be considered a flush and discarded. When system is clean, add the Turbinol lubricant and check system operation.

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TOXICITY AND SAFE HANDLING

Acute animal studies indicate that Turbinols 50, 1122, and 1223 can be classified as practically non-toxic when considered as an industrial fluid. They are non-irritating when the skin is exposed to the fluid.

However, these products 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 Turbinol fluids 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.

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