Applied Compression Systems

ACS
APPLIED COMPRESSION SYSTEMS
"Complete Compressor Packaging Solutions"

# TECHNICAL BULLETIN

## SYNTHETIC COMPRESSOR LUBRICANTS

Today synthetic lubricants are offered by virtually every supplier of compressor fluids and are one of the fastest growing segments of the industry.

While petroleum based lubricants are still widely used, synthetics are rapidly gaining popularity due to their inherent advantages of:

**Reduced Maintenance Costs**

Synthetics offer thermal stability, low volatility, and excellent shear properties when compared to conventional mineral oil lubricants. In addition, synthetics offer excellent solvency to keep the entire system clear of carbon deposits, residues and sludge while providing proper lubrication for extended bearing life. As a result, the oil change intervals can be increased, typically by 4 to 8 times that of conventional mineral oils.

**Reduced Lubricant Consumption**

The low volatility of synthetics allows the top-up consumption to be reduced by between 20% and 30% in smaller compressors and for large compressors this can be of the order of 40%.

**Operating Safety**

Synthetic lubricants have an auto ignition point of about 1100$^0$F as opposed to about 700$^0$F for most petroleum oils.

**Uniformity and Low Coefficient of Friction**

Because synthetic lubricants contain only smooth lubricating molecules, they slip easily across one another. On the other hand, the irregular and odd-shaped molecules of refined lubricants don't slip quite so easily. The ease with which lubricant molecules slip over one another affects the lubricants ability to reduce friction, which in turn, affects wear control, heat control and fuel efficiency.

Uniformity also helps synthetics resist thinning in heat and thickening in cold, which helps them protect better over a compressors operating temperature range.

Because of their uniformly smooth synthetic lubricant molecules are superior friction-reducers to conventional lubricants. Technically, because they slip more easily over one another, synthetics are said to have a lower "coefficient of friction" than conventional lubricants. The less friction in a system, the less heat in it too. Friction and heat are two major contributors to component failure and wear. By controlling friction and heat more effectively, synthetics significantly reduce the incidence of component failure and significantly reduce the rate of component wear.

In addition, uniformly sized synthetic lubricant molecules make them better heat transfer agents than conventional lubricant molecules. Some petroleum lubricant molecules are large and heavy. Others are small and light. As oil flows through the lubrication system, the small, light molecules tend to flow in the center of the oil stream while the large, heavy ones get stuck on the metal surfaces where they crease a barrier against the movement of heat from the component into the oil stream. In effect, the large, heavy molecules work like a blanket around hot components. If those large, heavy molecules are chemically unstable, they may also break down and form deposits on component surfaces, making the blanketing effect even more pronounced.

Since synthetic lubricants have no large heavy molecules, they don't blanket hot components. Instead, every molecule is equally likely to touch the hot component surface and take some of its heat into the oil stream, which carries the heat away. Also, since synthetics tend to be chemically stable, they are not prone to form deposits.

**Energy Savings**

Synthetic lubricants exhibit lower coefficients of friction high thermal stability and superior heat transfer capability. These properties have shown in studies overall improvements of:

- 2% to 5% for rotary screws
- 3% to 7% for rotary vane and reciprocating compressors
- 3% to 5% for centrifugal compressors

**High Viscosity Index**

Lubricant viscosity plays an important role in component efficiency and life expectancy of the compressor. If a component is lubricated with a lubricant whose viscosity is too low, the component will not be protected adequately and will wear excessively. If the component is lubricated with a lubricant whose viscosity is too high, the component will expend excess energy doing its job, which reduces efficiency and may affect the life of other components.

Synthetic lubricants have higher viscosity indexes than conventional petroleum based lubricants, due in part, to the uniformity of synthetic lubricant molecules. Large, heavy lubricant molecules tend to increase lubricant viscosity more in cold temperatures than smaller, lighter lubricant molecules do. Conventional lubricants, which contain some relatively large, heavy molecules, tend to thicken in cold temperatures more than synthetic lubricants do, with their uniformly sized molecules. Since temperature affects the viscosity of conventional lubricants more than it does the viscosity of synthetic lubricants, conventional lubricants have a lower viscosity index than synthetics do.

**Thermal and Oxidative Stability**

Some of the chemicals in conventional petroleum lubricants break down at temperatures within the normal operating range of many air compressors. Some are prone to break down in relatively mild temperatures, if oxygen is present, which it almost invariably is in air compressors. These thermally and oxidatively unstable contaminants do not help the lubrication process in any way. They are present in conventional oils simply because removing them is impossible or too expensive.

When conventional oil breaks down, its coats components with varnish, carbon deposits, and sludge and leave the lubricant thick, hard to circulate and with very poor heat transfer ability.

Because synthetic lubricants do not contain contaminants, they are much more resistant to thermal and oxidative breakdown. That means they can be used in higher temperatures than conventional oils can without breaking down and it means that they are impervious to breakdown at normal operating temperatures. With synthetics, components stay varnish-free, carbon-free and sludge-free.

**Cold Temperature Fluidity**

As you know, paraffin wax hardens at room temperature. Conventional lubricants often contain paraffin, which cause the lubricants to thicken in cold temperatures as paraffin gels.

However, a lubricant must flow readily throughout the compressor or some components go unprotected. Cold-thickened lubricants lose their ability to flow readily, or sometimes even to flow at all. In fact, on cold startups, conventional oils may leave working parts unprotected for periods of time long enough to damage bearings, rotor tips, vanes etc.

Synthetic lubricants do not contain paraffin or other waxes that thicken dramatically in cold temperatures. Synthetic lubricants flow readily in extremely cold temperatures, much colder than those at which conventional oils flow, which provides rapid post-startup lubrication and protection, keeping startup wear in check.

**Low Volatility**

The small, light molecules in conventional lubricants “boil off” at relatively low temperatures: just as you put less energy into throwing a light ball into the air than you do a heavy one, so light molecules require less energy, in the form of heat, to lift out of solution and into the air than heavier molecules do. The tendency of a liquid to boil off is referred to as its “volatility”. Conventional petroleum lubricants are more volatile than synthetic oils are.

Volatility affects more than the rate of oil consumption. Because the light molecules are lost through volatility, volatile oils tend to grow thick with use. Since many rotary compressors rely on differential pressure for oil circulation, this makes them hard to circulate and more energy it consumes, which increases power costs.

Synthetic lubricants lose very little to volatility, because their molecules are uniformly sized. The low volatility of synthetic lubricants keeps performance and fuel economy at their peak.

On the negative side however, synthetic lubricants are many times more expensive than petroleum based lubricants, often attach paint and some seal materials and are susceptible to water washing.

**TYPES OF SYNTHETIC COMPRESSOR LUBRICANTS**

**Diester Lubricants**

Diester based lubricants have the advantage of natural solvency or cleaning action. This will result in cleaner operation, reduced varnishing, and better heat transfer through less fouling. This is particularly beneficial in keeping compressors free of varnish or sludge buildup. Another result is better additive solubility. Polyalphaolefin and mineral oil formulations often take advantage of this by blending in up to ten percent diesters.

The greatest disadvantage of diester fluids is their poor compatibility with some elastomers and polycarbonates, which can result in damage to seal materials, plastic shim stock and filter bowls in down stream filtration. This reduces the use of diesters in many existing compressors. Normal service life is 4000 hours.

**PAO Lubricants**

The polyalphaolefin fluid has some additional advantages. It is non-polar and absorbs less water under high humidity. This property and excellent demulsibility results in longer bearing life. Greater hydrolytic stability promotes extended life in high humidity environments. Polyalphaolefin’s are compatible with all materials normally used with mineral oils. The fluids’ lubricity does not depend on extreme pressure and anti-wear additives, which can reduce oxidative stability or precipitate while in storage. Low pour points are maintained even when higher viscosities are specified. These oils are compatible with polycarbonate filter bowls, elastomers, paints etc. Normal service life is 6000 – 8000 hours.

**Polyglycol Lubricants**

Polyglycol lubricants have been developed from a unique blend of Polyglycol and esters, which together form an exceptional coolant and act to reduce oxidation and deposit formation. They are formulated to address the specific problems associated with conventional rotary screw compressors thermal degradation and deposit formation. These oils offer excellent heat transfer properties, long life, high flash points, low evaporation, low volatility and excellent hydrolytic stability. Because Polyglycol lubricants are not compatible with petroleum oils, care must be taken to make sure that the two are not mixed. Normal service life is 8000 hours.

**Food Grade Synthetic Lubricants**

Are authorized for use in meat and poultry processing plants where incidental contact with food may occur.

## PERFORMANCE COMPARISON

### SYNTHETIC FLUIDS VS MINERAL OIL

| PROPERTIES | MINERAL OIL | POLYALPHA-OLEFIN (PAO) | DIESTER | POLYGLYCOL |
|---|---|---|---|---|
| Viscosity-Temperature Properties | Fair | Good | Very Good | Good |
| Low-Temp Fluidity – Low Pour Point | Poor | Good | Good | Good |
| High Temp Oxidation Resistance With Inhibitors | Fair | Very Good | Good | Fair |
| Compatibility With Mineral Oils | Excellent | Excellent | Good | Poor |
| Low Volatility | Fair | Excellent | Excellent | Good |
| Effect On Most Paints and Finishes | None | None | Slight | Moderate |
| Stability in Presence of Water (Hydrolytic Stability) | Excellent | Excellent | Fair | Very Good |
| Antirust Properties with Inhibitor | Excellent | Excellent | Fair | Good |
| Additive Solubility | Excellent | Good | Good | Fair |
| Elastomer Swelling Tendency Buna Rubber | Light | Nil | Moderate | Light |