The Application and Use of Soltex Products in Hydrocarbon Lubricants and Lubrication Systems – Lubrication Technology

Lubrication Technology

- Function and purpose of the lubricant
- Hydrodynamic lubrication
- Boundary lubrication
- Extreme pressure (EP) lubrication

Lubricant Function and Purpose

- Keep moving parts apart
- Reduce friction
- Protect against wear
- Transfer heat
- Transfer power
- Remove dirt and debris in conjunction with detergent/dispersant/filtration

Reduce Friction and Wear

- Some wear always occurs even in a fully lubricated system
- Amount of wear depends on lubrication regime
- Lubrication regime is determined by the load on the moving parts
- Higher loads result in higher lube temperatures and increased friction and wear

Hydrodynamic Lubrication

- Characterized by very low wear and low friction
- (Friction is resistance to movement between two surfaces.
- Operates at low loads
- The oil forms a hydrodynamic wedge that fully separates the surfaces beyond the level of the surface asperities
- At higher loads the hydrodynamic wedge breaks down and metal to metal contact results

Hydrodynamic Lubrication

- Hydrodynamic lubrication is a primarily a function of the viscosity of the lubricant
- Higher viscosity oils are better hydrodynamic lubricants than thinner oils
- However lubricant viscosity must be balanced against increased energy requirement
- Trend is lower viscosity, energy efficient oils

Boundary Lubrication

- To meet the demands of more energy efficient oils, lubrication other than hydrodynamic is required
- As the hydrodynamic wedge breaks down with increasing load, temperatures at the metal surface increases
- Boundary lubrication involves the addition of certain additives to the base oil that under the conditions of increased surface temperature can combine with the metal surface to form a mono-molecular layer.

Boundary Lubricants

- Boundary lubricants are compounds that consist of a long hydrocarbon tail and a polar head group
- The polar head group attaches to the metal surface
- Important to note; this is an electrostatic attraction and not a true chemical reaction
- The long hydrocarbon tail projects out from the metal surface and provides a lubricating mono-molecular that prevents metal to metal contact and reduces wear

Boundary Lubricants

- As long as the “oil like” hydrocarbon tail is attached to the metal surface it can’t be squeezed out as is the case with the hydrodynamic wedge
- The mono-molecular film has the lubricating properties of a base oil but is more permanent and not dependent on viscosity
- It is critical that the layer be mono-molecular – ball bearing effect

Boundary Lubricants

- In general the polar head group is provided by either organo-metallic compounds or compounds of oxygen or nitrogen or both
- Metallic compounds are usually of the cationic type i.e. organic salts of calcium or magnesium or molybdenum
- Compounds of nitrogen or oxygen are non-ionic and are usually reaction product derivatives of maleic anhydride with PIB to give PIB succinic anhydrides (PIBSA) and PIB succinic imides (PIBSI)
- The choice of cationic or non-ionic type depends on the formulation and possible interactions with other additives

Boundary Lubricant Mechanism

- Lube base-stocks are typically non-polar
- The rule of thumb is that “like dissolves like” so lube base-stocks would have tendency to dissolve additives that are non-polar
- However boundary lubricants necessarily need to have a polar end to attach to the metal surface
- The long hydrocarbon chain associated with the boundary lubricant provides solubility in the base-oil
- Therefore since the boundary lubricant is soluble in the base-stock it always available to the surface to replenish and maintain the mono-molecular layer

Extreme Pressure (EP) Lubrication

- At even higher loads boundary lubrication also breaks down allowing metal to metal contact and rapidly increasing wear
- Surface temperatures dramatically increase
- EP additives added to the lubricant base-stock react with the metal surface to form new metal compounds
- Results in harder metal surface

EP Additives

- All EP additives contain the elements of S or P or Zn (sometimes Mo) or combinations of all
- EP additives also have long chain hydrocarbon groups but only serve as carrier to afford solubility of the additive in the base-stock
- High surface temperatures are required to initiate the additive reaction with the metal surface
- Characterized by high initial wear (break-in)

Other Lubricant Functions

- Fully formulated lubricant which consists of base-stock plus additives
- Prevent wear and reduce friction as discussed, but also;
- Transfer heat
- Transfer power
- Remove dirt and debris in conjunction with detergent/dispersant/filtration