THE FUNCTIONAL ATTRIBUTES AND UTILIZATION OF BORATES IN LUBRICATION TECHNOLOGY
BORON

- Discovered in 1808 by Sir Humphrey Davy
- Brittle, black semi metallic substance
- Tends to form planar compounds
THE USE OF BORON IN LUBRICANT FORMULATION

BORON NITRIDE (BN)

- Planar hexagonal structure
- Similar to graphite
- Works well as a solid lubricant

- Ceramic
  - Exceptional thermal stability
  - Stable in acids
THE USE OF BORON IN LUBRICANT FORMULATIONS

OIL SOLUBLE BORIC ACID ESTERS

- Lubrizol Corp. 1986
- Used as an anti-wear additive in engine oil formulations
- Exhibits some rust inhibition properties
- Poor hydrolytic stability
THE USE OF BORON IN LUBRICANT FORMULATIONS

OIL SOLUABLE BORATED AMINES

- Watts et al., Infineum, late 1990’s
- Friction modifier and anti-wear additives for engine oils
- Useful in automatic transmission fluids
- High treat rates
THE USE OF BORON IN LUBRICANT FORMULATIONS

Borated amine and borate ester

- Compared to traditional phosphorus additives
- Tested for engine exhaust emissions
- Determined that tailpipe emissions are reduced using boron additives
- No reduction in catalytic converter performance

Morris et al. SAE International June 2004
THE USE OF BORON IN LUBRICATION FORMULATIONS

BORIC ACID NANOPARTICLES

- Used to improve diesel fuel lubricity
- Problem dispersing particles
- Substantial friction reduction
- Problems related to suspension
- Does not tolerate water

Argonne National Lab, Transforum Vol. 7 No. 2 August 2007
Ali Erdimer, Nanolubricants, 2008 John Wiley & Sons
NEW TECHNOLOGY
BORATE NANOPARTICLES

COMBINES THE BEST OF EXISTING TECHNOLOGY

- Produced using unique manufacturing process
- Create planar structures on metal surfaces
- Stable suspension
- Tolerate water
- Almost half the friction reduction of boric acid 0.037

Cantor, N. Tribology and Lubrication Technology, August 2009
NEW TECHNOLOGY

BORATE NANOPARTICLES PERFORMANCE ESTABLISHED

- Difficulties lie in delivering nanoparticles to active site where friction is occurring
- Improved hydrolytic stability can lead to more environmentally friendly applications

IMPROVED DELIVERY SYSTEM

- Transports nanoparticles to where they are needed
- Keeps particles in suspension
NEW TECHNOLOGY

THE DELIVERY SYSTEM IS A SPECIAL SYNTHETIC ESTER MATRIX

- Made from natural, renewable ingredients
- Highly surface active
- Forms a strong lubricating film
  - Film is self healing
- Superior anti-wear performance
- Will not agglomerate like boric acid
- Tolerant of water
  - Soluble in oil and other hydrocarbons
NEW TECHNOLOGY

DELIVERY MUST BE ABLE TO COVER ALL METAL CONTACTS

- Additive must be able to exist and perform in high friction contact areas
  - Nanoborate blended into the ester matrix which has a polar adhesive interaction with the metal surface
  - A chelation bond to the metal develops
  - Unlike anti-wear additives in oil which take up to 20 minutes to perform, nanoborate takes no time.
NEW TECHNOLOGY

COMBINATION OF BORATE NANOPARTICLES AND ESTER CARRIER

- Gives improved stability and performance
- Offers the opportunity to formulate water-based lubricants
  - Replace oil as carrier with water
  - Ester/nanoparticulate borate combined with emulsifier forms emulsion lubricant when blended into water
PERFORMANCE

FOUR BALL WEAR

- 0.35 mm scar vs. 0.80 mm base oil

FOUR BALL LOAD

- Standard lithium-complex grease held a load of 700 kg
PERFORMANCE

LOAD CARRYING CAPACITY

- Oil alone ----------------------------------------------- 500 lbs
- Oil with boron nitride-------------------------------- 1250 lbs
- Oil with PTFE------------------------------------------ 2500 lbs
- Oil with ester/nanoparticulate borate------------------ 4000 lbs
- Water-based emulsion with nanoparticulate borate------ 4000 lbs
EMULSION LUBRICANT

- Easy to spray
- No VOC
- Excellent lubricity – COF 0.037
- Very little odor
- Non-toxic
- Non-flammable
- Biodegradable
- Made from renewable resources
NEW TECHNOLOGY
NEW OPPORTUNITIES

- Allows new formulations of new products eliminating toxic anti-wear and extreme pressure AW/EP additives

- Formulate readily biodegradable and non-toxic lubes and greases

- Outperforms AW/EP additives presently used in lubricants

- Lower the bottom line while offering a superior product
AVAILABLE FOR CONSUMERS

- Although directed towards industry for new product development we have made it available for the public

- Add 1.12 oz per quart of oil or 6 oz for aver 5 qt sump

- MPG gains are realized due to the dramatic drop in friction

- Wear is reduced upwards of 90%

- Increased power is realized

- Less emissions

- Use at every oil drain, very cost effective
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