HYDRAULIC FLUIDS, COMPONENT MATERIAL, TRIBOLOGY

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FLUID POWER SYSTEMS:
FLUIDS/MATERIALS – PERFORMANCE/RELIABILITY NEXUS

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FLUID POWER RESEARCH CHALLENGES

Recent NFPA technology roadmap identified key research challenges for fluid power – Many challenges involve issues related to fluid and material properties

- Increasing the energy efficiency of fluid power components and systems.
- Improving the reliability of fluid power components and systems (e.g., increasing up-time, reducing maintenance requirements, making fluid power safe and easy to use).
- Reducing the size and weight of fluid power components and systems while maintaining or increasing their power output.
- Building “smart” fluid power components and systems (i.e., ones that perform self-diagnostics and troubleshooting and integrate easily with “plug and play” functionality).
- Reducing the environmental impact of fluid power components and systems (e.g., lowering noise, eliminating leaks).
- Improving and applying the energy storage capabilities of fluid power components and systems.
- Improving and widening the scope of application for fast, accurate, and cost-effective fluid power control.

SIGNIFICANT LOSSES (VISCOS, BOUNDARY, AND LEAKAGE) DUE TO FLOW OF FLUIDS THROUGH THE COMPONENTS AFFECT EFFICIENCY

The rheological and tribological properties of fluids and materials significantly impact overall efficiency, reliability/durability of fluid power components.

"Go with the flow in selecting the right fluid’”, Bill Dimitrakis and Rob Profilet, Lubrizol Corp.

Mechanical power at point of use

Power from prime mover

Components:
- Pumps
- Valves
- Controls
- Hoses/Pipes
- Filters
- Actuators

Mechanical power at point of use
ENERGY EFFICIENCY INVOLVES MORE THAN MECHANICAL AND VOLUMETRIC EFFICIENCY

Mech Effic  Vol Effic

Optimizing FP system performance is dependent on many factors including system design, duty cycle, and fluid/material properties.
Understanding of impact of viscosity, which is not independent of temperature, pressure, shear.
- Effect of viscosity modifier molecular structure on shear stability
- Viscosity-Pressure relationship, which is less known but significantly impacts the system efficiency

Understanding complex interactions between additives, basefluids, and surfaces
- Boundary wear protection by extreme pressure and antiwear setting the floor of the fluid viscosity
- Compatibility between fluid additive chemistry, e.g., extreme pressure, antiwear, and friction modifier, and the contact surface compositions
- Impact of system variables – temperature, pressure, mechanical loading, ....
Hydraulic power system performance depends not only on bulk fluid properties such as viscosity, bulk modulus, thermal conductivity, etc., but also on chemical interactions that occur and fluid material interfaces.

- Understanding the mechanisms involved in the formation of protective tribochemical films is critical to design/formulate fluids and materials for durable, reliable, sustainable energy-efficient fluid power systems.
  - How additives, basefluids, and surfaces interact.

Traditional materials used in hydraulic fluid systems may not be sufficient to achieve energy-efficiency goals. High performance materials, coatings, engineered surfaces required to accommodate more aggressive tribological environment (low viscosity, downsizing, longer ODIs,.....)

Others....
  - Standardization of test protocols, robust protocols, duty cycles...
WHAT ARE YOUR THOUGHTS ON CRITICAL CHALLENGES AND BARRIERS?
UNDERSTANDING SURFACE AND LUBRICANT INTERACTIONS

1. Innovative LabScale Testing – Engine Correlations
2. Structure and Chemistry of Protective Tribochemical Films
3. Mechanistic Models of Lubrication
4. Coating-Lubricant Interactions
5. Oil Aging and Degradation

Characterization

Modeling

Lab testing & Optimization

Bench Marking Technologies
Formulate & Blend

ENGINEERED COATINGS

1. Lubricant Basefluid Development
   - Multifunctional basefluids
   - Hybrid ultra-low-viscosity base fluids

2. Additive Development
   - High performance anti-wear additives
   - Multi-functional viscosity modifiers
   - Multi-functional colloidal additives

3. Materials and Coatings
   - Low friction, wear-resistant coatings
   - Ultra-fast chemical surface treatments
DISCUSSION 3 – FLUIDS & COMPONENT MATERIALS

• Fluids
  o New chemistry
  o Tribology
  o Test standardization
  o Regulation

• Component
  o Electrify
  o Manufacturing improvements
  o Material

• System Optimization
  o Component/fluid development
  o Surface texturing
  o Material

• Integration
  o Modularity
  o Scalability
  o Advanced controls