Industrial Lubricants 2008

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Hazelwood UK.
Agenda

- Introduction to Industrial Applications
- Hydraulic Fluids
- Industrial Gear Oils
- Compressor Fluids

Applications
Systems & Fluids
Operational Trends
OEM Design & Specifications
Performance Durability
Lower Operational Costs
2006 Global Industrial Lubricant Consumption ~ 9 million mt

- Hydraulic
- Metalworking
- Turbine & Circulating
- Industrial Gear
- Other Industrial
- Grease
- Compressor (non Refrigeration)
Hydraulic Systems
(and fluid interactions)
An Introduction to Hydraulics - What, Why & How?

- Hydraulics is the use of a liquid for the transmission of force
  - to perform some function of work
  - basically movement

- Fluid flow moves the mechanical parts of the hydraulic system (actuators)
  - these actuators perform our work

- Fluid pressure provides the force behind this movement
Of course a complete system is needed to drive the actuator

- Reservoir to hold the hydraulic fluid
- Electric motor or diesel engine to drive the hydraulic pump
- Hydraulic Pump which causes the fluid to flow
- Control Valves provide a restriction in the circuit thus generating pressure. They also control the direction of fluid flow
- Actuators which perform the work
- Filters to remove damaging particles
- Hydraulic fluid as the media which transmits power
A Simple Hydraulic Circuit
Key Components Within A Hydraulic System

Hydraulic Pumps

- **Vane Pumps**
  - Vane pumps generate high fluid flows and can move large cylinders
  - Require strong Antiwear additives to prevent steel on steel wear

- **Piston Pumps**
  - Piston pumps can generate very high pressure for large forces
  - These types tend to be more expensive to manufacture
  - Require less antiwear chemistry but thermal stability is very important due to the yellow metals used on the piston shoes
Axial Piston Pump

Oil pulled into piston barrel behind piston

Drive shaft

Swash plate
Piston shoe
Piston
Piston barrel
Valve plate

Position of piston in cycle
A Typical Axial Piston Pump

CAUTION – YELLOW METAL
Yellow Metal Compatibility - Cincinnati Thermal Stability Test

Chemical attack – poor formulating
Vane Pumps

- Rotor rotates within cam ring
- Vanes move in/out of rotor slots maintaining contact with the ring

CAUTION – Strong Anti Wear Needed
Vane Pump Cam Ring

Lack of sufficient antiwear chemistry - Excessive wear
- Poor Formulating
Hydraulic Valves

- Narrow clearances require clean fluids which don’t develop sludge or varnish
- Thermal and oxidative stability are important to prevent breakdown blocking valve clearances

Hydraulic Cylinders

- The sliding motion needs to be smooth & free of any sticking Fluid frictional characteristics are important
- Cylinder seals prevent leakage of the oil into the environment and prevent external dirt entering the system Fluid compatibility with the elastomeric seal material is critical
Reservoirs

- Hydraulic fluids recover their original state in the reservoir
  An oil’s ability to rapidly release air, collapse foam & shed water is important

- Otherwise problems of cavitation, corrosion, oxidation and general degradation of hydraulic performance can occur
Hydraulic Fluids - There are many different types

Choosing the correct fluid for an application is critical

- Different equipment
- Different end use Industries
- Different operating environments
  - Mineral Oil Based
  - Fire Resistant Types
  - Biodegradable Fluids
Hydraulic Fluids - Mineral Oil Based

• The majority of all hydraulic fluids used
  HLP  HM  HF-0  HLP-D

• Can be monograde …. or ‘multigrade’ with the addition of a Viscosity Modifier polymer, these are called HVLP or HV types

• Most are Zinc based
  - using zinc dialkyldithiophosphate (ZDDP)
  - antiwear additive but also an excellent antioxidant

• Some zinc free or ashless formulations sold
Hydraulic Fluids - Fire Resistant Types

- For use in dangerous operating environments
  - typically Steel Plants & Mining

- Provide a level of flammability resistance

- Resist the start of a fire & suppress its spread
  - but do not necessarily extinguish it

- Four main FR fluid types

<table>
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<tr>
<th>Type</th>
<th>Composition</th>
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<tr>
<td>HFA</td>
<td>95% water + 5% oil/additives</td>
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<tr>
<td>HFB</td>
<td>60% oil/additives + 40% water</td>
</tr>
<tr>
<td>HFC</td>
<td>60% polyglycol/additives + 40% water</td>
</tr>
<tr>
<td>HFD</td>
<td>100% polyolester or phosphate ester/additives</td>
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Hydraulic Fluids - Biodegradable Types

• Use special base stocks that break-down (biodegrade in the environment)

• More commonly found in environmentally sensitive markets such as Northern Europe

• Additives are chosen to be non toxic or polluting to the environment eg zinc free antiwear

• European EcoLabel is the current target
  - biodegradability
  - toxicity
  - renewability
  - ISO 15380 HEES
Additives Used in Hydraulic Oils

- Antioxidants
- Antiwear & Extreme Pressure
- Friction Modifiers
- Rust Inhibitors
- Yellow Metal Deactivators
- Viscosity Modifiers
- Pour Point Depressants
- Demulsifiers
- Anti-Foams

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Hydraulics - Operational Trends
OEM & Operational Trends, Their impact on Hydraulic Fluids
Key Trends Shaping the Hydraulics Industry

- Higher Performance
- Longer life oils - Extended drain intervals
- Energy Efficiency
- Environmental considerations
- Improved Reliability

Robust & Durable Fluid Performance Can Eliminate Risk – Lower Cost of Operations
Higher Performance … places more stress on fluids

Higher power outputs from more compact systems

- Higher pressures ➔ 320 bar common (450 bar peaks, even 600 bar)
  More antiwear protection required

- Increased Temperatures ➔ 90 to 100 C (130 C transients)
  More oxidative & thermal stability required

- Compact systems ➔ eg. Small oil reservoirs (less oil + high flow rates)
  Less time for air and water release

  Air >>> Cavitation, oxidation & hydraulic degradation
  Water >>> Corrosion, hydrolysis (acids & sludges)
  Less heat dissipation

- Tighter tollerances ➔ Requires cleaner oils with good filtration & low sludge
## Longer Life Oils – Extended Drain

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<th>Equipment Manufacturer</th>
<th>Previous Interval</th>
<th>Today’s Interval</th>
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<td>Volvo</td>
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<tr>
<td>JCB</td>
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Multigrade (HV) Oils
- OEMs are calling for higher quality

- HV oils provide less viscosity change with temperature
- Equipment can be operated over wide temperature ranges - multi-season
- Energy Efficiency can be improved - cold weather start-up
  - hot climate protection (less thinning)
- HV oils ensure less cavitation / sluggish hydraulic control
Monograde 100 VI

Expanded Operating Conditions

13 cSt Oil becoming too thin for effective lubrication

Polymer containing Multigrade 155 VI

860 cSt Oil becoming too thick for pumping

Expanded Operating Conditions
Multigrade (HV) Oils
- OEMs are calling for higher quality

Need to be formulated with hydraulic quality polymers
  - Polymethacrylates (PMA)

OEMs calling for improved shear stability
  - 20 hr VW KRL test
  - Parker Denison have max 8 cSt loss in T6H20C
  - Bosch Rexroth limit 15 % loss max
  - Eaton Vickers expect 10 % loss max

Parker (Denison) have major concerns over filterability
Awareness of the need for robust wet oil performance

- **Hydrolytic Stability**
  - additive hydrolysis can cause acidity & sludges
  - finer filters can block, oil flow impeded & bearing performance degraded
  - acidity can destroy delicate yellow metals used in piston pumps

- **Filterability**
  - many oils will not filter as efficiently when wet
    - especially if other contaminants are present
    - Parker Denison (and other OEMs) concerned with this

- **Wear performance can be compromised when wet** eg. HF-0 pump testing
Hydraulic OEMs

- Eaton (Vickers) (6 %)
- Parker Denison (14 %)
- Bosch Rexroth (8 %)
- Volvo CE
- Hitachi
- Caterpillar
- Komatsu
- JCB
- Sauer Danfoss
- Komatsu
Parker Denison

- Parker Denison France maintain Global fluid approvals
  - HF-1 for Piston Pumps & HF-2 for Vane Pumps
  - HF-0 for all types of Denison Pumps

- T6H20C ‘Hybrid’ Pump is used
  - Contains both vane + piston units in a single housing
  - Cyclic test conditions simulate real world hydraulic operation
  - 300 hours dry (110°C) and 300 hours wet (80°C 1% water)
  - Wet phase often differentiates poorer quality oils (wear protection)

- EOT pump assessment by Parker Denison France
  - Piston (350 mg) Vane + Pin (15 mg) weight loss
  - Cam ring profile
  - Bench testing (oxidation, corrosion, hydrolytic & thermal stability)

- Denison have real concerns over the quality of high VI multigrade polymers
  - Due to filterability issues most approvals were withdrawn
  - Lubrizol Additive + shear stable polymer maintained its official approval

- New T7C Vane Pump design requires higher cleanliness level NAS Class 6
Eaton Hydraulics (Vickers)

• Two Main Specifications:
  - M-2950-S for mobile applications using 35VQ25 pump test
  - I-286-S for industrial applications using V-104C pump test

• V-104C pumps no longer manufactured:
  - ASTM D2882 withdrawn
  - alternative test units from Tokimec & Conestoga
  - currently under ISO review (BFPA running RR)
  - DIN 51524-2 still requires V-104C

• 35VQ25 pump, still working through hardware issues:
  - pass/fail weight loss limits relaxed
  - Lubrizol instrumental in helping Eaton resolve issues

• New technologies: HLA vehicle system uses stored hydraulic energy for vehicle acceleration eg delivery trucks
Bosch Rexroth Group

- Very large recent business growth
- Ralf Hutschenreuter >>>> new view of fluids, believes in performance & quality fluids
- Recognise the limitations of older 90220 spec - Intend to introduce update
  - based on DIN 51524-2
  - thermal stability test (CM) to be added
  - increased focus on oxidation, hydrolytic stability, elastomers
  - new high pressure axial piston pump test under development
- Being developed under Lubrizol advice and guidance
Caterpillar

- Wish to extend drain intervals 2,000 – 4,000 – 8,000 hours
- Prefer hydraulic oils to emulsify any contaminating water
- Require HVI oils (145 VI) with shear stability
- Still mandate 900 ppm Zinc
- Moving to dedicated hydraulic type oils for severe applications

Poclain

- Poclain split into two separate companies
  - Excavator construction transitioned to Case Poclain/CNH
  - Hydraulic components transitioned to Poclain Hydraulics (PH)
- PH produce low speed high torque hydraulic motors (off-highway OVMs)
- PH have a favoured ‘Poclain hydraulic oil’ - other approvals not possible
- Shear stability is important (in house 600 bar injector test)
- Require FZG 11 fail and call for 800 to 1000 ppm Zinc
DIN 51524

General Industry Standards

Part - 1  Light duty circulating oils
- 2  Antiwear hydraulic oils
- 3  High VI (polymer treated) antiwear oils (HV or HVLP)

- Mid tier spec upgraded in ‘06 to reflect the need for improved performance
  - ISO 13357 filterability method added (dry + wet testing)
  - Cleanliness classification ISO 4406 21/19/16
  - VI increased to 140 min for Part 3 HV oils & KRL shear test added

JCMAS HX-1

Base line performance for Japanese OEMs – issued 2004
- Komatsu 35+35 piston pump
- 35VQ25 vane pump
- Microclutch friction test 0.08 minimum friction
- Seals SRE NBR/L and AU-1
- ISO VG 32 / 46 multi & monogrades
Hydraulic Specs 1950 – 2004

- 2004 - Denison HF-0 T6H20C hybrid pump (obsoleted T6C/P46 pumps)
- 1997 - Denison HF-2 (Wet/Dry Operation T6C Vane Pump Test Replaces T5C)
- 1978 - Vickers 35VQ25 (Vane Pump Wear)
- 1977 - Denison HF-0 (Vane/T5C and Piston Pump/P46 wear)
- 1974 - Cincinnati Milacron (Valve Sticking)
- 1971 - Denison HF-2 (Vane Pump Wear)
- General Antiwear - Vickers V104C (Vane Pump Wear)

Performance Change

Time
Overall …. It’s a tough world for Hydraulic Oils

• Less Oil + More Work = Increased Fluid Stress

• Specifications have not necessarily kept pace

• Formulating to just meet a specification may no longer work

• Today’s equipment requires higher performing fluids if trouble free operation is to be achieved

• Careful additive and base oil selection is more critical today

• A robust quality additive can lower the End User’s operating cost
  Longer pump life …$$$$
  Fewer replacement filters …$$$$
  Less valve stick …$$$$
  Less unscheduled maintenance …$$$$
  Minimise lost production …$$$$$$$$$$$$$$
Another way to look at this ....
Remember what’s in a can of hydraulic oil

Choose your additive carefully!

~ 99% ‘Oil’

~1% Additives
Sometimes VM
Current Generation Performance Additives
Current Generation Performance Additives
eg. Lubrizol 5703 – Approved by Denison – Used Globally

- LZ 5703 in suitable base stocks surpasses the requirements of Denison HF-0
- LZ 5703 has several Denison HF-0 approvals using the T6H20C Hybrid test
- Multigrade Hybrid HF-0 is still valid with LZ 7775 polymer
- LZ 5703 easily surpasses DIN 51524-2 HLP
- Eaton Vickers Vane Pump performance
- Passes JCMAS HX-1
- Cincinnati Machine Thermal Stability

- Is there anything better?
Next Generation
Cleaner Hydraulic Technology
Remember ….

It’s a tough world for Hydraulic Oils

- Hydraulic systems are getting smaller
- Oil residence times can be very short
- Systems are built with higher power densities
- Oil temperatures are higher
- Oil pressures have generally increased
- OEMs agree these trends are leading to more frequent problems in high performance hydraulic systems
Comparing Today’s HF-0 Type Hydraulic Oils

• OEMs tell us that as operating conditions become more severe then varnish formation often increases

• Hydraulic systems deliver non optimal performance when sludge & varnish are present

• Evidence points to an increase in varnish & sludge problems in the field

• Standard tests do not show the increased stress placed on many fluids today – hence Lubrizol’s extended duration work
Lubrizol’s Extended Duration Pump Testing

- Extended 35VQ-25 vane pump testing is able to demonstrate varnishing
- After 500 hours a tenacious varnish deposit starts to form when testing traditional hydraulic oils
- 1000 hours at full pressure & temperature really shows an oil’s potential for varnish

**Test conditions:**
- Temperature = 95° C
- Pressure = 207 Bar
- Speed = 2,400 rpm
- Oil volume = 197 litres
Why is varnish so bad for a hydraulic system?

Hydraulic system performance is generally degraded

- Higher friction is seen with an oxidized oil
- Varnish can cause hydraulic valves to stick - especially proportional types
- Component lives are shortened (valves, filters, pumps, bearings, seals)
- Oil flow is hindered and cooling capacity is often lost
- Potential system failures lead to equipment downtime and loss of income
Traditional fluid technology
6 weeks’ continuous use
95° C  207 Bar
Eaton Vickers  35VQ25
Low deposits fluid technology
6 weeks’ continuous use
95° C  207 Bar
Eaton Vickers  35VQ25
Performance profile

- Hybrid Pump HF-0 has been granted
- Easily surpasses DIN 51524-2 HLP
- Eaton Vickers Vane Pump performance
- Cincinnati Machine Thermal Stability

Advantages over current technologies:

- Clean, no varnish, deposit-free hydraulic system
- Longer oxidation life enables extended drains (>3500 hrs D943)
- Excellent wear characteristics (FZG dls 12)
- High thermal stability (1.8 mg sludge in CM test)
Plastic Injection Molder

A Case Study demonstrating where Clean Technology can improve the operators profitability
Plastic Injection Example (North East USA)

• 3 or 4 servo valves per machine
  10% of valves replaced annually due to varnish sticking issues

• Typical cost for new valve $3100 ($2050 for reconditioned unit)

• One hour maintenance time to replace valve at $50/hour

• A large Injection molding facility may replace 60 valves per year
  60 valves x $3100 = $186,000/year
  Maintenance time is 60 valves x $50 = $3090

• Total cost*due to varnish = $189,850 each year

* Not including lost production or cost for replacement pumps/filters
• Varnish can be prevented with new severe duty hydraulic fluids

• Valve replacement is minimized whilst operational availability increased

• Reducing or preventing varnish can save the operator money

• Look beyond the the specs . . . . Not all hydraulic fluids are the same!
Question:
If OEMs are so concerned about HV Multigrade quality, what advances have there been in hydraulic oil polymers?
Viscosity Index .... Temperature Operating Range

- 13 cSt Oil becoming too thin for effective lubrication
- 860 cSt Oil becoming too thick for pumping
- Monograde 100 VI
- Polymer containing Multigrade 155 VI

Hydraulic Oil Polymers

- Increase the VI of hydraulic oils and thus widen the temperature in which the equipment can efficiently operate

- Polymethacrylate types have the optimum properties for hydraulic operation

Cold oil
Low polymer solubility

Hot oil
High polymer solubility

Polymethacrylate (PMA)
Novel PMA Polymer Breakthrough

- A new polymer is now available for hydraulic fluids using controlled living radical polymerization process
- Allows more precise control of polymer chain formation and permits structures unachievable by conventional means
- Significant performance benefits over conventional VM polymers are delivered

- *Asteric* Controlled Architecture Polymers
How Asteric Technology Works

Conventional (linear) PMAs

Asteric PMAs

Shape under typical conditions

Shape under high shear stress

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Polymer Chain-Breaking Under Shear
## Asteric LZ 87705 Formulating Advantage

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<tr>
<td></td>
<td>150 VI</td>
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<td>KV cSt @ 40C</td>
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<td>KRL Shear Stability</td>
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<td>KV cSt @ 100C after shear</td>
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<td>% Viscosity Loss</td>
<td>14.2%</td>
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LZ 87705 required ~ 35% lower treat rate and allowed heavier starting base oil blends.
Temperature Operating Ranges of Hydraulic Fluids
Based on fluid viscosity >13 cSt and <860 cSt
Asteric VM Technology has Greater VI Increase for Equivalent SSI compared to other VM Chemistries

Blended to same viscosity at 100°C in 4 cSt oil

- **PIB**
- **PMA**
- **PAO**
- **Asteric VM Technology**
Asteric Polymer Denison Pump Test Performance

Denison HF-0 Test 600 Hr. Combined Ring/Vane Wear

- **Wear, mg**
  - 0
  - 50
  - 100
  - 150
  - 200
  - 250
  - 300

- **Denison HF-0 Test 600 Hr. Combined Ring/Vane Wear**
  - **87705**
  - **PMA-A**
  - **PMA-B**
  - **PMA-C**

- **Antiwear Performance**
  - **Borderline**
  - **Excellent**
LZ 87705 Denison Pump Test Result

Denison HF-0 300 Hr. Dry Phase & 300 Hr. Wet Phase Results

<table>
<thead>
<tr>
<th>Wear, mg</th>
<th>Dry</th>
<th>Wet</th>
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Asteric Polymer

Conventional Polymer
Industrial Gear Oils
Global Industrial Gear Oil Consumption ~ 900k mt

- Steel: 21%
- Mining: 20%
- Construction: 9%
- Agriculture: 9%
- Off-Highway: 7%
- Off-Highway: 21%
- Manufacturing: 10%
- Energy: 3%
- Other: 20%
Open or Closed gearboxes
Different lubricant application methods
Modern Gearbox design trends are leading to smaller more efficient units with higher power densities (higher speed, greater loads, increased torque, more compact units)

Formulating Industrial Gear Oils has evolved to reflect modern gearbox manufacture – greater performance and system protection is targeted

- Improved Oxidation resistance for cleaner oils with longer oil life
- Thermally stable (non sludging) for cleaner gearboxes at higher temperatures
- Demulsibility – retention over time and over a wider temperature range
- Resistance to micropitting
- Improved bearing protection – wear & corrosion, FAG & SKF tests
- Improved elastomer compatibility
Thermal Stability

Clean Gearboxes

Greater Efficiency
Good Demulsibility (water shedding) helps Lubrication

Industrial gearboxes often suffer water ingress

This can seriously impact the quality of lubrication

"even a very small percentage water [the order of 0.05%] has an enormous effect on the ability of the lubricant to separate the moving parts, leading to metal contact. In bearings this causes deterioration of the rolling surfaces and ultimately leads to premature failure."

Schaeffler (FAG)

An effective modern oil must retain it’s demulsibility in service

The water must be shed quickly & also at different temperatures
Effect of Water on Bearing Life

Relative Life

Water Concentration (ppm)
Important to shed water quickly & also at different temperatures

ASTM D1401 test
Time to 3ml emulsion

Test Temperature °C
**Micropitting** - also known as Grey Flecking

A wear process influenced by the physical & and chemical properties of the oil as well as type of gears and their surface finish & operating conditions. Generally a short duration effect.

Often connected with large Wind Turbine Gearboxes – **but not exclusively**
**Flender (Siemens)**

- Very significant Gearset manufacturer - now part of Siemens
- Build all types of Industrial transmissions - emphasis on quality and efficiency
- Maintain an oil approval scheme - tightened up on approval administration
- Have a comprehensive specification based on DIN 51517-3 +++
- Focus heavily on micropitting protection - FVA 54 test (FZG rig)
- Extensive elastomer compatibility
  - due to field problems ~ especially PAGs
  - proposed increase in test duration from 168hrs to 1000hrs
- Own the largest Wind Turbine transmission builder WINERGY
Hansen Transmissions (Suzlon)

- One of the more well known WT transmissions builders
- Market products on Low noise/Durability/Low weight
- Higher performance steels - ‘Significant Power Squeeze’
- Have a comprehensive specification and maintain a fluid approval scheme
- Hansen have tightened their spec (May 07) ‘Bearing Four step requirements’
David Brown (Textron.Inc USA)

- Controlled from the USA
- Confirmed that fluid approvals are not possible
- Specification not being rewritten – no one appointed to do it
- Now reliant on current IGO standards and what is currently approved

Renk

- Based in Augsburg Germany – Principle owner MAN AG
- Manufacture industrial transmissions in Germany France and USA
- Require DIN 51517-3 CLP quality fluids
- Now require evidence of good field performance for 2-3 years
Other General Industrial Gear Specifications
Deutsches Institut fur Normung DIN 51517

DIN 51517-1 (C)  Light duty circulating oils
    -2 (CL)  Higher oxidation & corrosion protection
    -3 (CLP)  Full EP Industrial Gear oils

DIN 51517  Last updated in Jan-2004  (Correction Nov 2005)

- FAG FE8 bearing test (30mg roller)
- DIN 53538 elastomer limits specified & mandatory
- D-2893 6% oxidation vis increase is now mandatory

Rework under consideration

- revision of elastomer requirements under discussion
- many current oils failing to meet NBR rupture elongation
- proposed relaxation from -30% to -40%
- Micropitting FVA 54 and Flender foam test considered – not accepted
Industrial Gears
Wind Turbines
Wind Turbines – Why are they Important? ..... Clean Energy

Wind Turbines are a growing application area for lubricants

Wind Turbine Lubricants - Europe

![Graph showing the increase in lubricant use from 2000 to 2025 in Europe](image)
Wind Turbines – Why is their lubrication difficult?

You have to get here to change the lubricant

Very Large Gear Sets

Severe Engineering Geometry

Challenging Lubrication

Even more Challenging Access!
Wind Turbines

Synthetic PAO gear oils preferred
- maximum oil life
- better pressure-viscosity characteristics
- superior low temperature performance

Some mineral based formulations used in Asia
Wind Turbines – Oil Approval Hierarchy

**Turbine Assembler**  
*eg. Vestas*

**Transmission suppliers**  
Winergy – Hansen – Moventas

**Subcomponent suppliers**  
FAG SKF NSK – bearings

Specifications rely very heavily on:

- All the baseline tests (DIN 51517-3 etc)
- Paint & Adhesives compatibility
- Plus more Elastomers
- Many Bearing tests
- And Micropitting
- And then Field Testing
Compressors squeeze a gas into a smaller volume - for storage, transport or operation of pneumatic tools.
Compressors

• Many Applications:
  - Portable …. spraying, rock drills
  - Stationary …. factory ring mains
  - Process …. refinery & chemical plant
  - Refrigeration …. a/c & chillers

• Positive Displacement - reciprocating, rotary - vane or screw
  - successive volumes of gas are trapped in an enclosed space & squeezed into a smaller volume

• Dynamic Turbo Compressors - axial flow, centifugal
  - high speed impeller accelerates gas to high velocity and packing it into a fixed volume
Rotary Screw

Rotors can have external timing gears
(no contact occurs)

OR

One rotor drives the other
(contact antiwear may be needed)

Reciprocating

Need rust & oxidation
(no need for antiwear)
Compressor Lubrication – can be a very severe operation

- Compression raises temperatures and leads to moisture condensation

- Reservoir temperatures are modest but oil carry over temps can be very high

- Different gasses can lead to oil compatibility issues
  - air, refrigeration, hydrocarbon gas, chemical - ammonia, chlorine

- Oil and air mixing at high temps leads to oxidation
  - acidity, oil thickening, sludge & varnish deposits

- Oil-Gas separation is very important
  - leaving gas in the oil can cause foaming, wear, oxidation
  - leaving oil in the gas causes contamination issues - medical, scuba
Compressor Lubrication – can be a very severe operation

<table>
<thead>
<tr>
<th>DIN 51506 classification</th>
<th>Exhaust air temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>VB and VBL</td>
<td>Up to 140°C</td>
</tr>
<tr>
<td>VC and VCL</td>
<td>Up to 160°C</td>
</tr>
<tr>
<td>VDL</td>
<td>Up to 220°C</td>
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</tbody>
</table>
Compressor Trends

- OEMs frequently have their own branded oil
  - must be used during warranty period
  - afterwards users often switch
  - gaining OEM approvals very difficult

- Screw compressor types are the most common

- OEMs designing smaller compressors
  - less oil
  - running hotter
  - better air release, foam control & demulsibility needed

- Gp II & III base stocks of growing interest for extended life oils

- Full synthetics (PAO) commonly used
  - low volatility
  - high temperature operations
  - longest life
Reciprocating Types – Special Caution

- Oil carry over droplets accumulate around compressor exhaust valves
  - decompose to form coke residues
  - additive ash cause further problems
  - deposits interfere with valve sealing and reduce valve efficiency
  - or worse still can lead to spontaneous ignition

- Pneurop test is used in the lab to quantify this oxidation/coking tendency

- Over-lubrication can increase the level of deposits and make the problem worse
  - Use correct lube at the correct feedrate
Industrial Lubricant Summary

- Applications for Industrial lubricants are many and varied
- A common thread is that Industrial specifications have not evolved at the same pace as engine oils
- OEM equipment design has raised fluid performance requirements
- End User operating trends place more stress on the oil today
- Higher performing oils are available that are more robust & improve durability
- These oils enable operators to achieve greater performance from their equipment
- They help eliminate risk and lower the cost of operations hence improving throughput and profitability
Lubrizol Industrial Products
Thank You For your Time and Attention