Contaminants in Lubricants & Contamination Control

The webinar will begin in less than 10 minutes.

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Contaminants in Lubricants & Contamination Control

The webinar will begin in less than 5 minutes.

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Contaminants in Lubricants & Contamination Control

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AGENDA

1 TYPES OF CONTAMINANTS

2 SOURCES OF CONTAMINATION

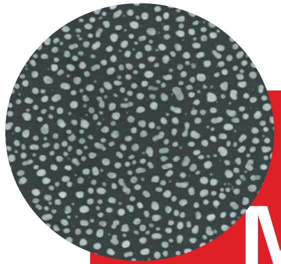
3 CONTROLLING CONTAMINATION

Types of Contaminants

- Solids
- Liquids
- Gases
- Other

Solid Contaminants

DIRT



METAL PARTICLES

SOFT INSOLUBLE

SOOT

Dirt

Environmental

- Silicon
- Aluminum
- Calcium
- Sodium
- Potassium
- Magnesium
- Iron

Industrial

- Concrete dust
- Clinker
- Coal or coke fines
- Cellulose fiber

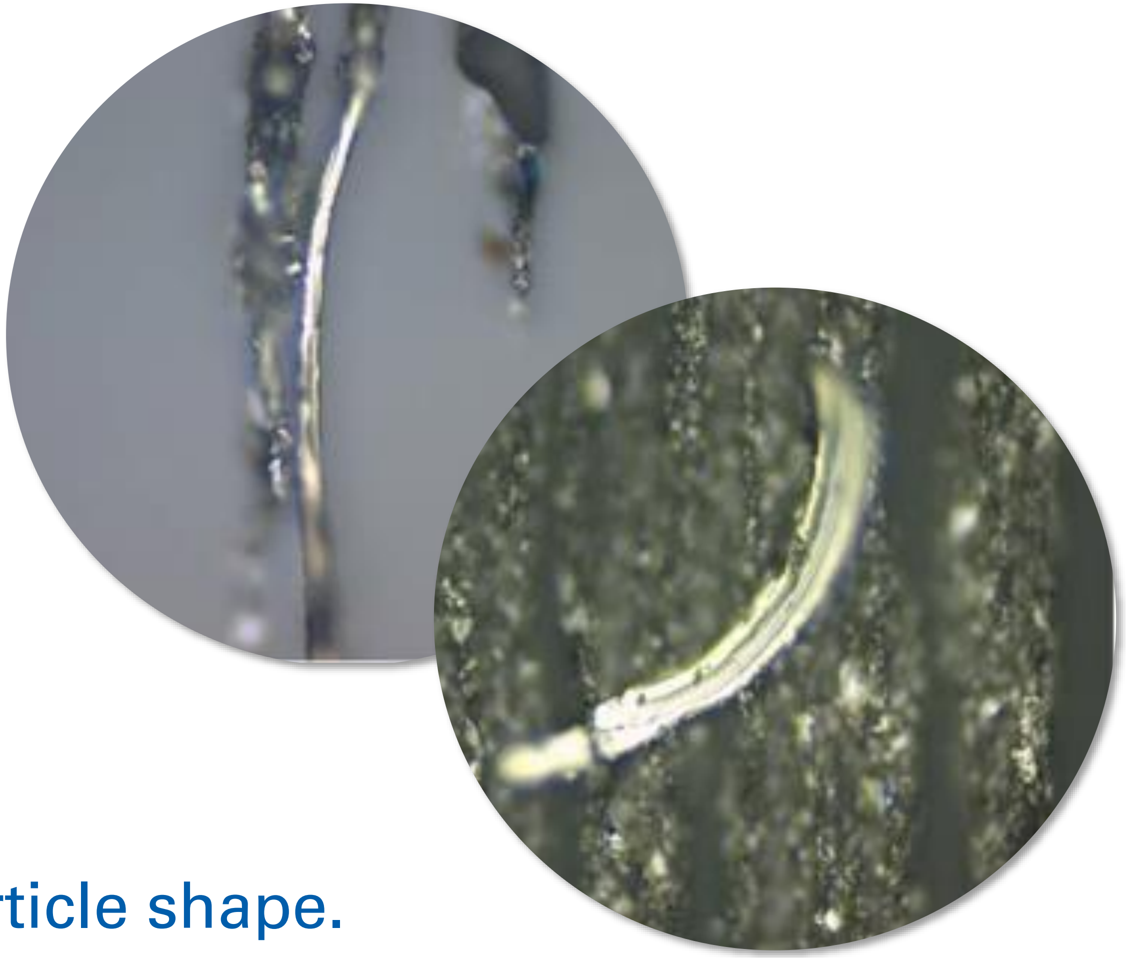
Metal Particles

Typically produced in wear processes

Wear modes include:

- Adhesive (rubbing/sliding)
- Abrasive (cutting)
- Fatigue
- Erosive
- Corrosive
- Cavitation
- Polishing
- Fretting
- Electrical Discharge

Each produces a characteristic particle shape.



Soft Insoluble

Primarily produced by oxidation processes.

Varnish

Sludge

Lacquer

Soot

Typically formed during the combustion process in diesel engines.

- Particle size: very small, averaging 0.078 microns
- When they agglomerate in the oil, the size becomes large enough to cause problems.
- Texture: very hard
- Agglomerations of soot can cause severe wear in an engine.

Sources of Contamination

Solids

- New Oil
- Unsealed Tanks or Drums
- Oil Transfer Containers
- Funnels
- Ventilation and Breathers
- Seals
- Wear
- Service and Manufacturing Debris

Solid Contamination Control

DIRT & METALS	SOFT INSOLUBLE	SOOT
▪ 3-micron filtered desiccant breathers ▪ 10-micron to 3-micron staged filter skid ▪ 10-micron to 3-micron in-line staged filtration ▪ Magnetic plates	▪ Oil soluble cleaners ▪ Electrostatic filtration	▪ Current API heavy-duty engine oils

Liquid Contamination

- Water
- Fuel
- Other Lubricants
- Coolant (Glycol)
- Wash-down Chemicals

Water

Pervasive

Found almost everywhere

Even in new lubricants

Can have multiple negative effects on the performance of a lubricant.

Water in in-service lubricants can range in concentration from low ppms in well-maintained oil (e.g., transformer oil) to 30% or more in a grossly contaminated system.

How Much Water is Typically in Oil?

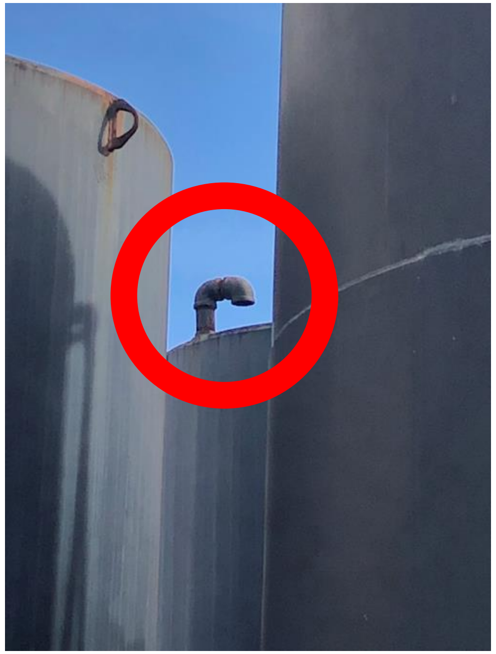
- Most new lubricating oils contain trace amounts of dissolved water
  - Typically, less than 100 ppm (0.01 %)
- Transformer oils and high dielectric strength hydraulic oils are specially treated to reduce water concentration (<30 ppm, 0.003 %)

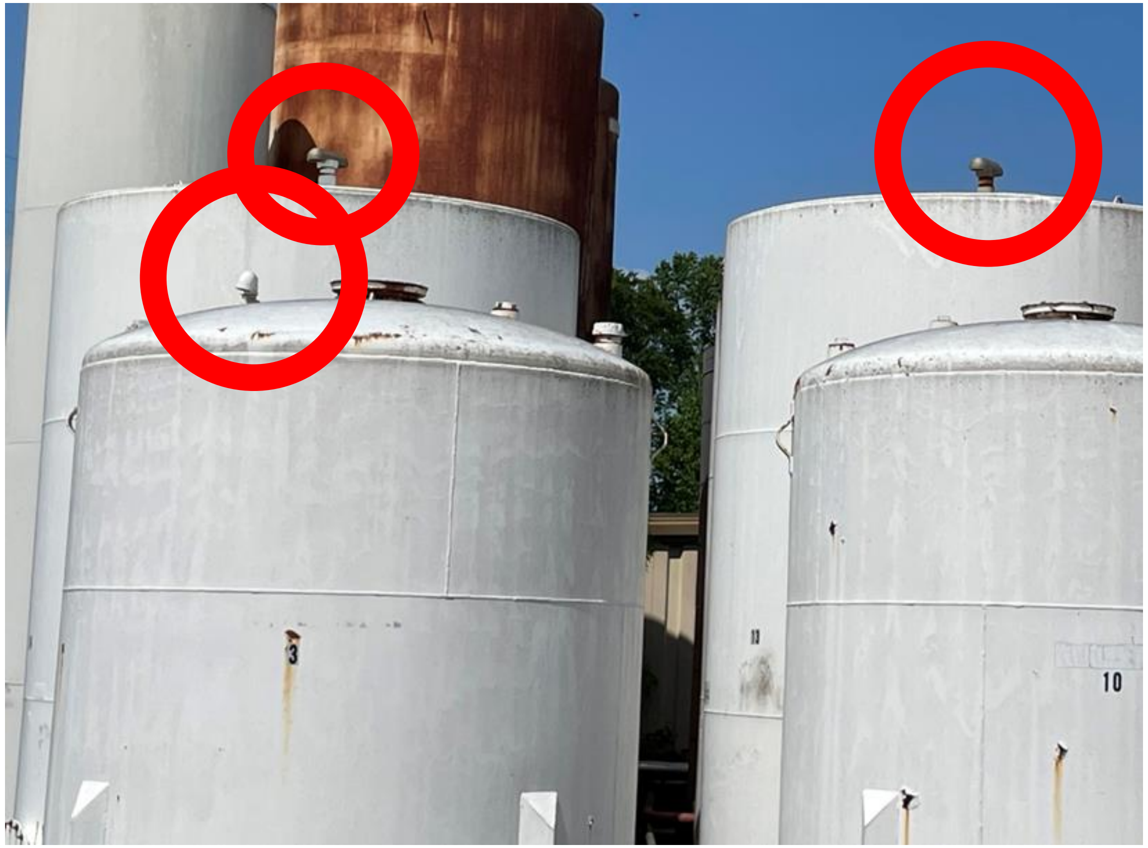
The 3 Forms of Water

New oil should **never** contain emulsified or free water!

Where Does the Water Come From?

- The atmosphere (humidity, precipitation)
- Improper or ineffective vent or breather
- Improper lubricant storage
- Cooling system leaks
- Condensation
- Equipment wash-down





Dissolved Water

A small amount of water dissolves in oil, causing no change in appearance, and no decrease in performance.

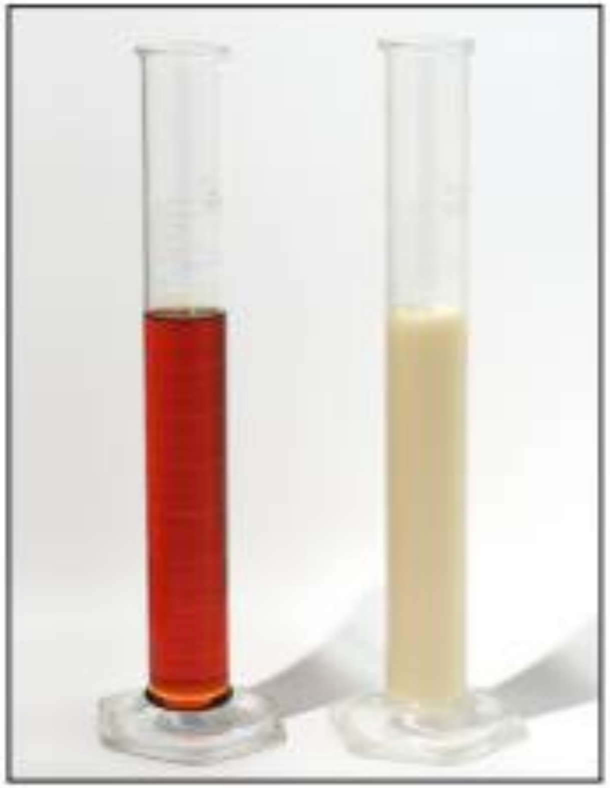
The lubricant typically begins to become hazy at the following water concentrations:

Turbine oils, bearing and circulating oils	~100 to 150 ppm
Hydraulic oils	~150 to 200 ppm
Industrial gear oils	~200 ppm
Engine oils	~400 ppm
Synthetic fluids	
PAO	~300 ppm
Diester	~2000 ppm
PAG	~3000 ppm

Other Forms of Water

Emulsified Water

As the oil is churned in service, the water forms a stable emulsion.



Free Water

Water droplets in the oil merge to form a layer of free water.

Effects of Water on Lubricant Performance

Lubricating Film Degradation	▪ Loss of hydrodynamic film in journal bearings ▪ Flash vaporization leading to erosive wear in rolling element bearings
Viscosity Increase	▪ Potential reduction of oil flow or increasing the pressure required to pump the oil ▪ Viscosity increase due to water can mask other issues, such as fuel dilution
Oxidation	▪ The oil oxidation rate is increased in the presence of water ▪ The presence of catalytic metals (copper, tin, lead) also contributes to an increase in oxidation rate

Effects of Water on Lubricant Performance

Hydrolysis

- Esters (diesters, phosphate esters) can react with water, breaking down into organic acids and alcohols
- Hydrolytic degradation destroys the base fluid in the lubricant, and the formation of organic acids can cause corrosion on metal surfaces

Additive Degradation

- Certain anti wear, extreme pressure and oxidation inhibitor additives can also undergo hydrolysis
- Additive effect can be diminished or removed completely from the lubricant, and acidic by-products to be formed

Additive Loss

- Detergents, dispersants, rust inhibitors and demulsifiers can be dissolved in the water phase
- Effectively removing them from the lubricant, along with their positive effects on lubricant performance

Effects of Water on Lubricant Performance

Hydrogen Embrittlement

- Water can be decomposed into hydrogen and oxygen ions
- Hydrogen ions then cause metallurgical changes in bearing surfaces, leading to subsurface cracking and eventually pitting and spalling

Filter Performance

- Water can quickly degrade filter performance
- Paper (cellulose) filters that perform very well with dry oil can disintegrate when exposed to water and release fibrous material into the oil

Water: Sources of Contamination

Environmental
- Headspace condensation
- Rain and snow
- Hygroscopic tendency

Hose Sprays
- High-pressure wash
- Fire suppression

Steam System

Process Water

Heat Exchangers

Combustion Condensate

Fuel

Fuel dilution is a serious issue for many vehicle fleets. Fuel dilution can reach greater than **20%** in vehicles with high idle times.

Reduced Oil Viscosity – Fuel dilution causes the viscosity of engine oil to decrease sharply.

In one study, the effect of fuel dilution on oil viscosity was determined:

5% fuel dilution	viscosity reduced 20%
10% fuel dilution	viscosity reduced 35%
15% fuel dilution	viscosity reduced 48%

The dilution effect is greater with higher-viscosity oils.

Fuel Dilution

Additive Dilution Effects

- Reduced detergency
- Reduced wear protection
- Reduced oxidation inhibition
- Reduced resistance to acid formation - corrosion

OIL VOLUME INCREASE

OIL COATING WASH OFF

LOW OIL PRESSURE & LOWER OIL FLOW RATE

OIL VOLATILITY INCREASE

Causes of Fuel Dilution

Stop-and-go Driving

- Incomplete fuel combustion

Cold Weather Start-up

- Lower than optimum combustion temperature

Fuel Injector Issues

- Fuel not atomized adequately

Poor Combustion

- Fuel not burned completely

Other Lubricants

Cross-contamination with a different lubricant can be the cause of some unique problems. Contamination of thousands of gallons of turbine oil by as little as one quart of engine oil can ruin the air release, foam resistance and water separation properties of the turbine oil.

To a less dramatic extent, the addition of a different viscosity grade of hydraulic oil into a hydraulic system can cause degradation of the system performance.

Mixing of competitive products in an industrial system can have serious effects. Additive packages, and even base oils, can be incompatible.

Effects of Coolant (Glycol) Contamination

- Oil Thickening
- Emergence of Organic Acids
- Additive Degradation
- Oil Filter Plugging and Eventual By-Pass
- Formation of Abrasive Oil Balls
- Elemental Evidence of Coolant Contamination

Wash-down Chemicals

In the food and beverage industry, equipment and facilities are washed down on a regular schedule, often with aggressive wash-down chemicals. Those chemicals can degrade additives and wash grease out of equipment.

Frequent relubrication of food and beverage processing equipment may be necessary.

Liquid Contamination Control

Several Technologies Exist For Water Removal:

- Settling
- Vacuum Dehydration
- Water Absorbing Filter Element
- Centrifugation

Tightly closed tank and reservoir hatches help to keep water and wash-down chemicals out of lubricant systems

Gas Contamination

- Air
- Natural Gas
- Refrigerant Gases

Air

New oil typically contains up to 5% dissolved air

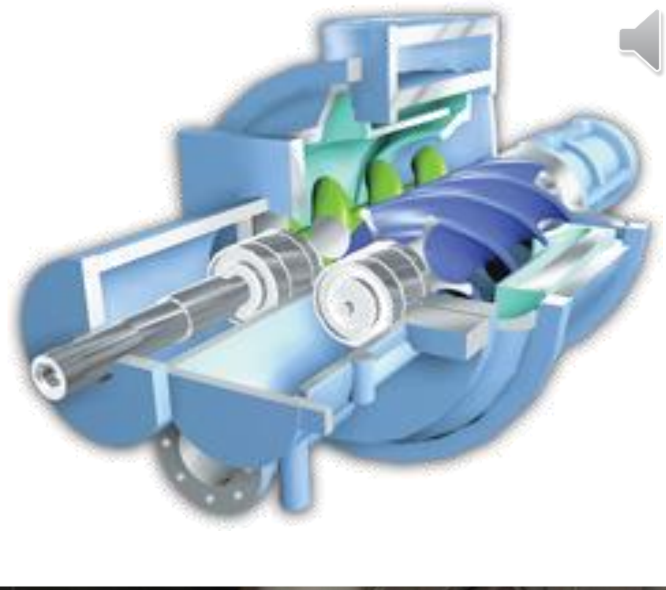
Air in Oil: 4 Phases

Dissolved Air	Entrained Air	Foam	Free Air

- Air in oil can result in an accelerated depletion of antioxidant additives and possible oil oxidation.
- Other effects include micro dieseling, viscosity increase, foaming, rust, corrosion, sludge and varnish formation and cavitation.

Natural Gas

The lubricants used in natural gas compressors can absorb a significant portion of the gas.



Mineral oils can absorb more gas and suffer significant dilution. Higher molecular weight hydrocarbons have a greater dilution effect than methane.

Polyalkylene glycol (PAG) based fluids have greater resistance to gas dilution.

Refrigerant Gases

Refrigerants	Recommended Lubricants
CFC R-12	Min Oil POE AB
HCFC R-22	Min Oil POE AB
HFC R-134a	POE
Ammonia R-717	Min Oil AB
Propane R-290	Min Oil AB
CO_2 R-744	AB

The lubricants used in refrigeration compressors must be compatible and to a certain degree miscible with the refrigerant.

Gas Contamination Control

Several methods are available for removing dissolved gas from a lubricant

- Heating
- Vacuum Degasification
- Membrane Separation

Other Contaminants

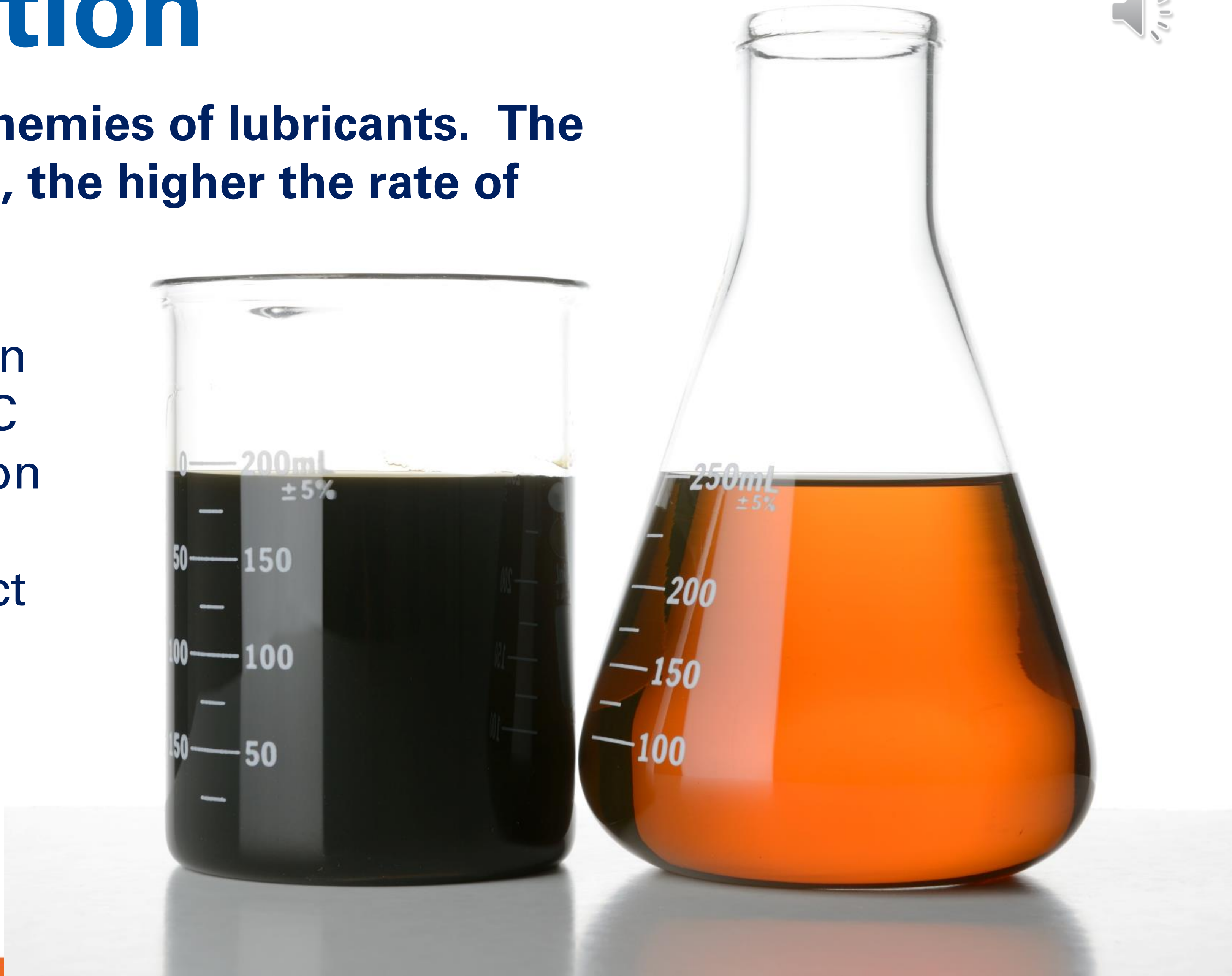
Heat

Radiation

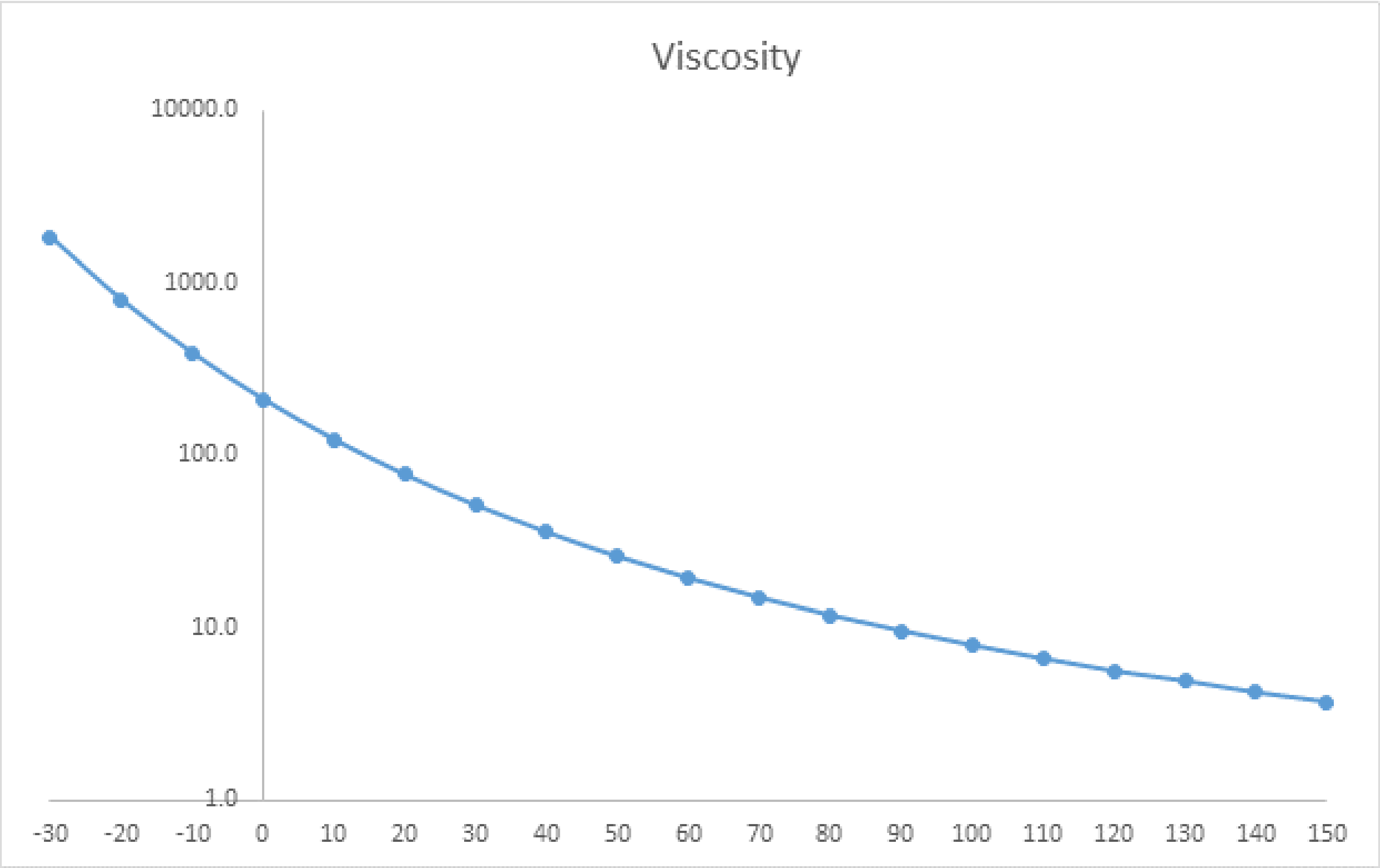
Heat: Oxidation

Heat is one of the worst enemies of lubricants. The higher the oil temperature, the higher the rate of oxidation.

For every 10°C (18°F) rise in oil temperature above 60°C (140°F), the rate of oxidation doubles, cutting the oxidation life of the product in half.



Heat: Viscosity



An increase in temperature causes the viscosity of oil to decrease. The proper viscosity for the lubrication of the application may not be maintained at too high a temperature.

Radiation

Only a consideration in nuclear power applications.

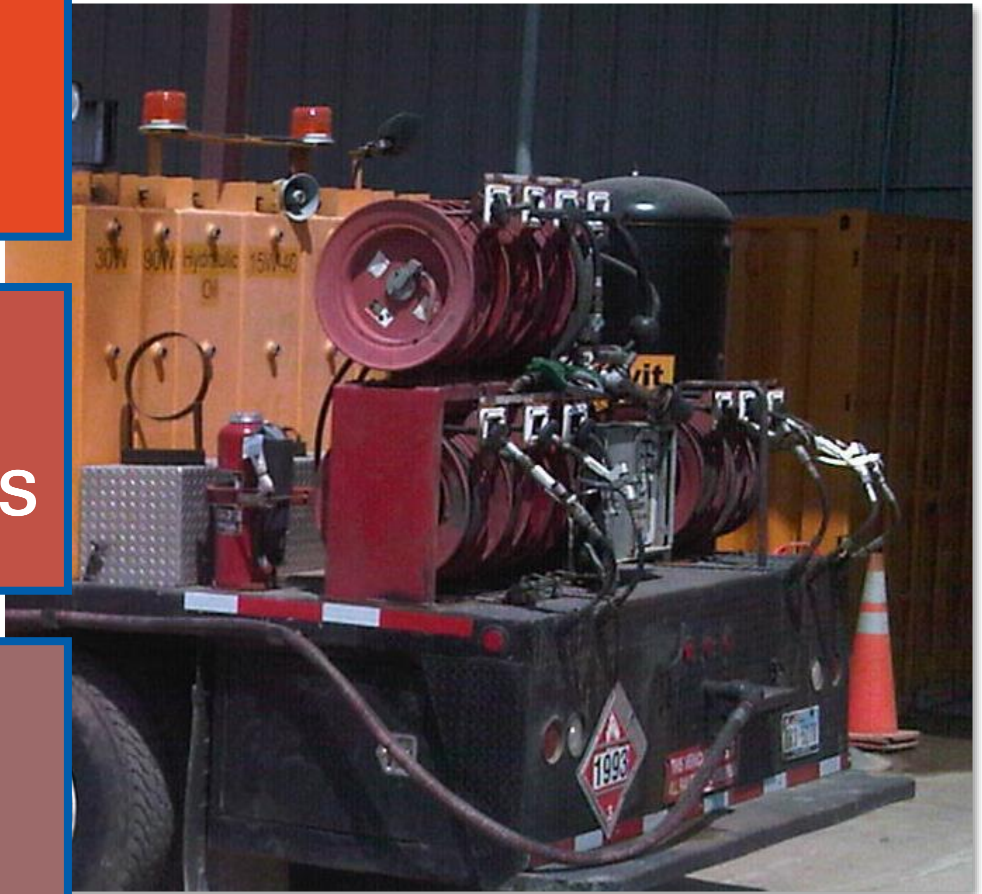
Lubricants used in nuclear power plants **must** have proven resistance in the case of radiation exposure.

Other Sources of Contamination

Transfer Lines

Transfer Containers

Human Error



Controlling Contamination

Exclusion	Removal

Exclusion

- New oil
- Ventilation and breathers
- Seals
- Wear generation
- Service and manufacturing debris
- Filter dumping

The cost of keeping dirt out of oil is probably only about 10 percent of what it will cost to remove it from the oil.

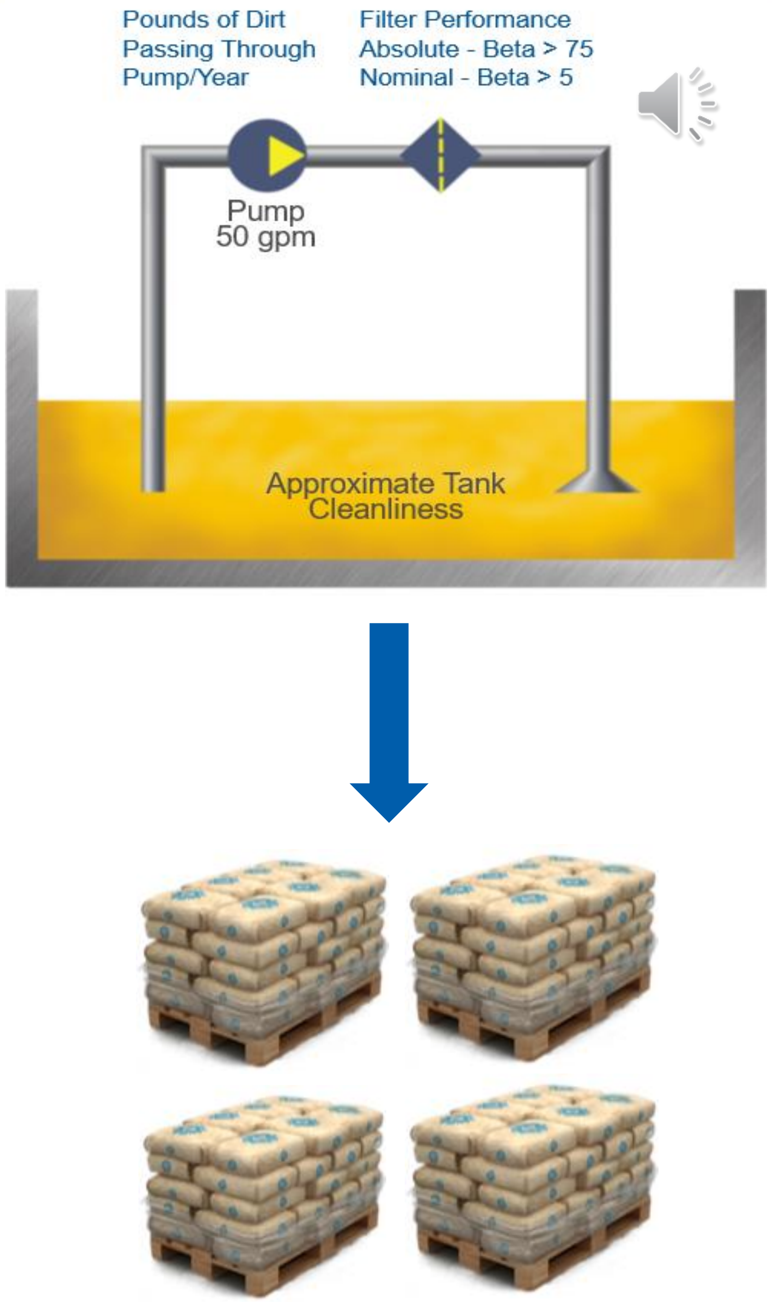
Removal

- Proper filters for circulating systems
- Off-line filters for some splash/bath-lubricated machines
- Filter carts for other machines
- Proper sump and reservoir design and management
- Timely filter servicing

The cost of using high-performance filters over a machine's life will generally be much less expensive than using cheap, low-efficiency filters.

The Importance of Controlling Contamination

Filter	ISO Code	Dirt (lbs.)	50-lb. bags	Relative Pump
25-micron nominal	21/18	6,784	136	1
10-micron nominal	19/16	1,809	36	1.9
10-micron absolute	16/13	211	4.2	4.4
6-micron absolute	14/11	53	1	8.8
3-micron absolute	12/9	14	0.28	15



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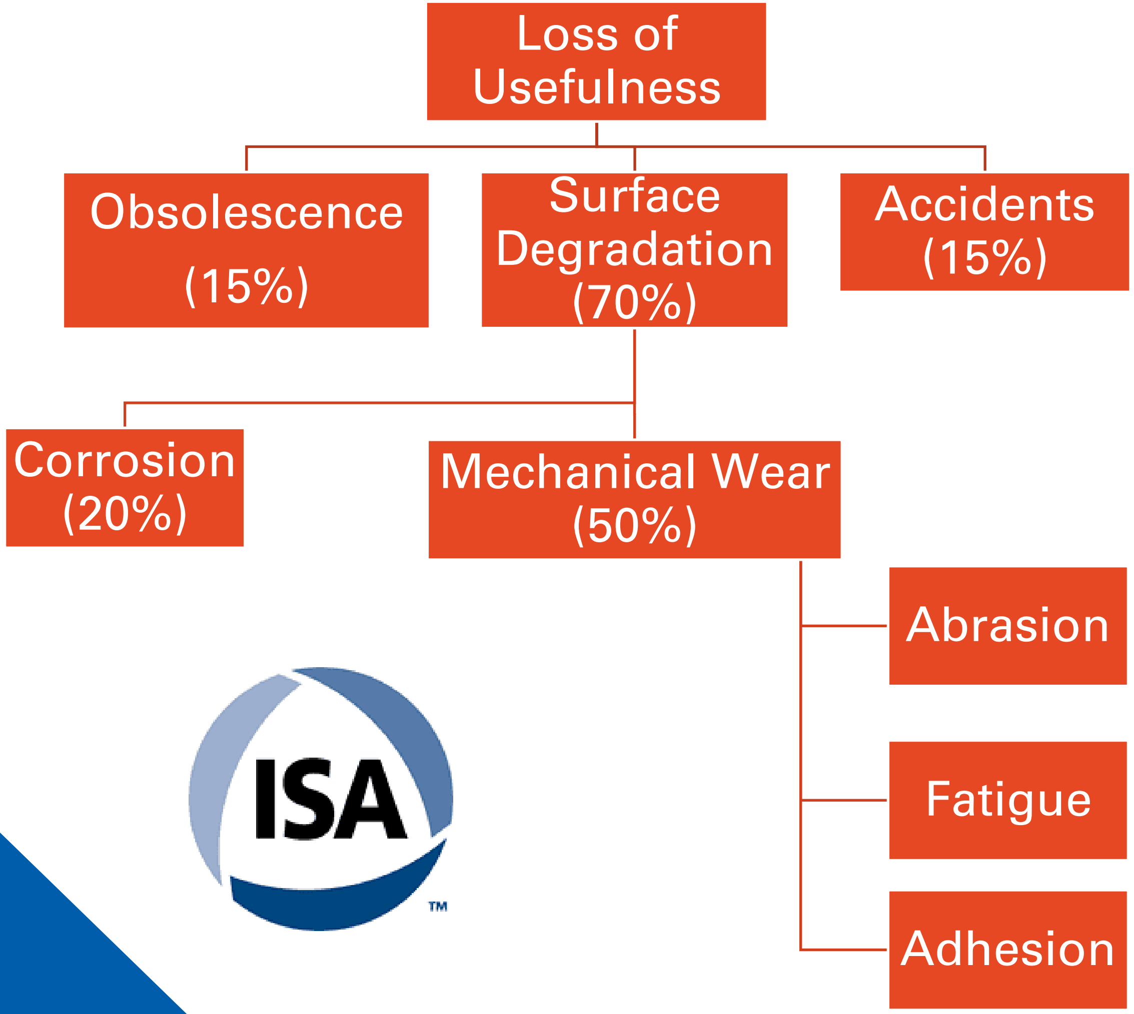
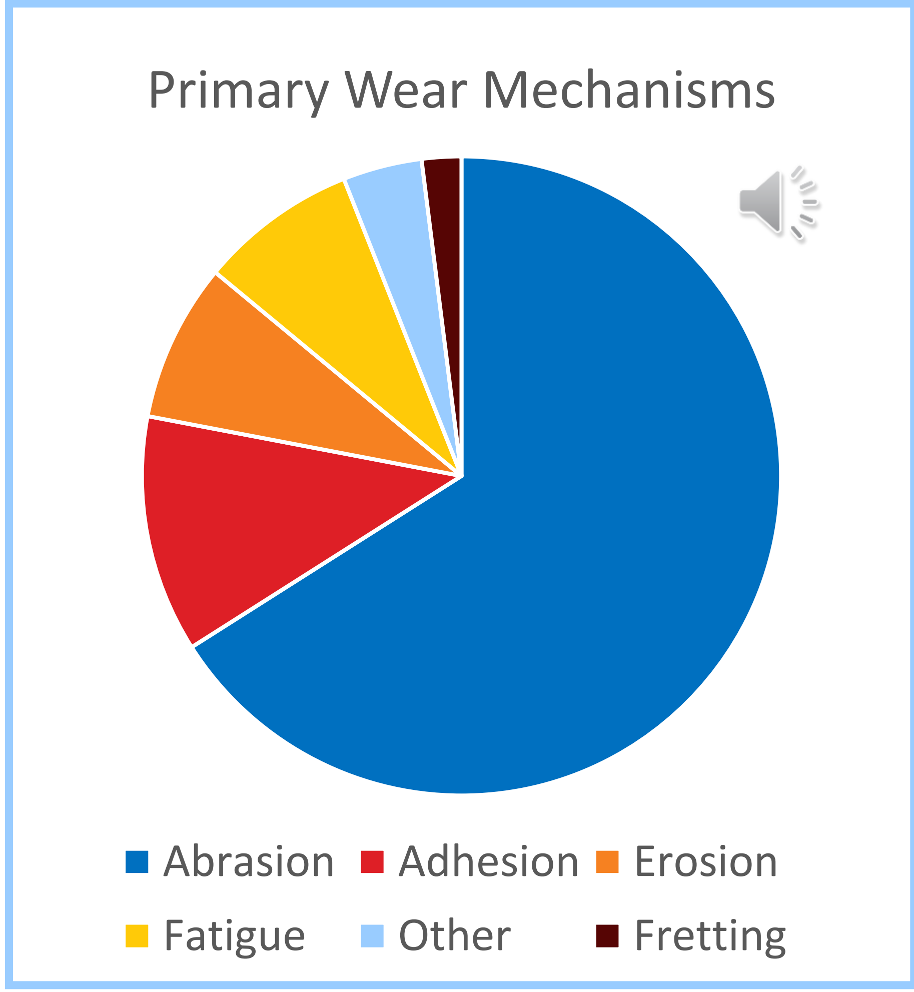
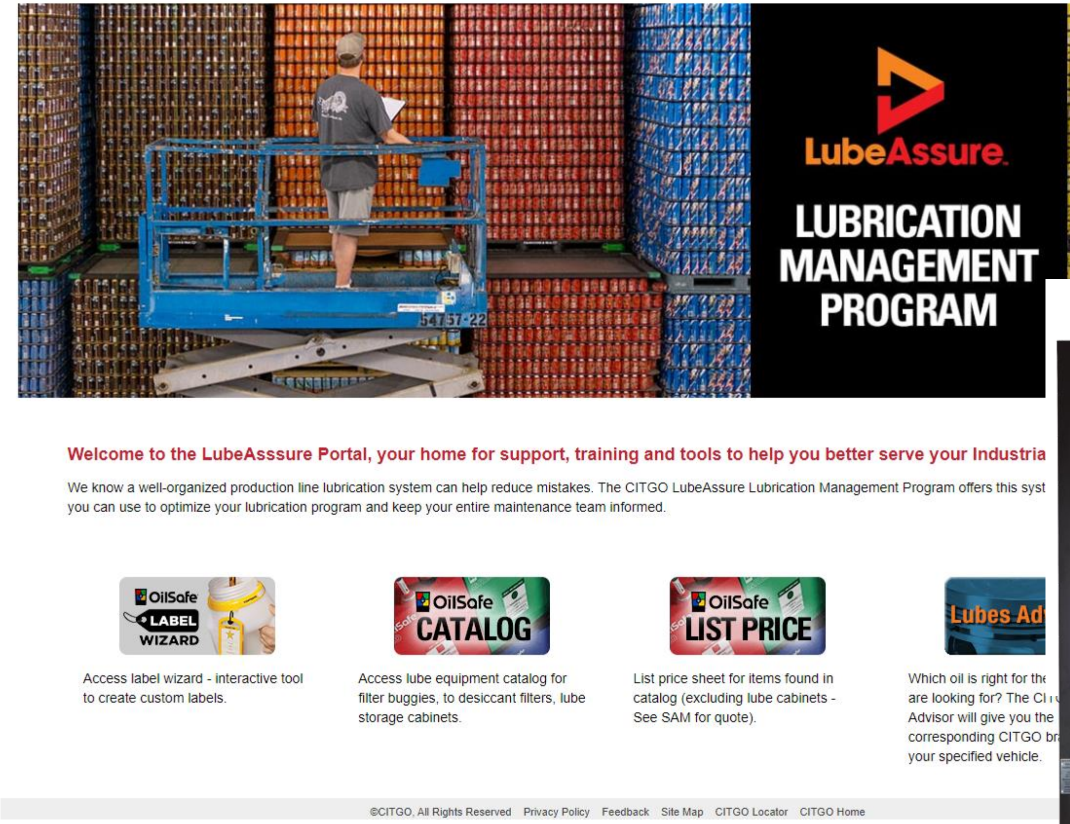
The Importance of Controlling Contamination

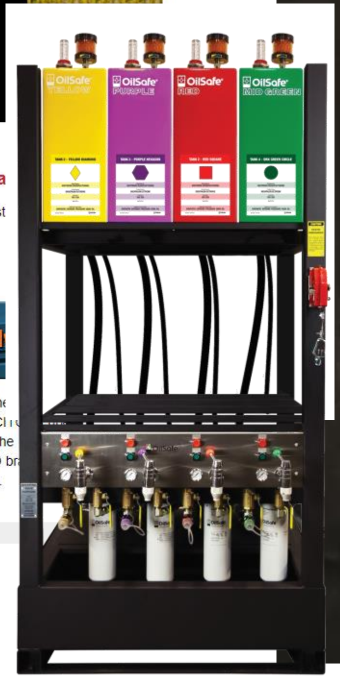
82% of mechanical wear is caused by particle contamination





Running an Efficient Lube Room





Questions?

Please post your questions using the Q&A function.

Contact Us

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Thank You!

See you next time!