CITGO Compressor Lubricants

The webinar will begin in less than 10 minutes.

Mystik LUBRICANTS
CITGO LUBRICANTS
clarion LUBRICANTS

CITGO Compressor Lubricants

The webinar will begin in less than 5 minutes.

Mystik LUBRICANTS

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Webinar starting soon; until then…

TEST YOUR KNOWLEDGE

Compressors are used to move liquids.

True

False

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Webinar starting soon; until then…

TEST YOUR KNOWLEDGE

A diester based compressor fluid leaves the most deposits in compressors.

True

False

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Webinar starting soon; until then…

TEST YOUR KNOWLEDGE

How many Test Package Tiers are offered through the LubeAlert Fluid Condition Monitoring Service?

- 3
- 4
- 5
- 6

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CITGO Compressor Lubricants

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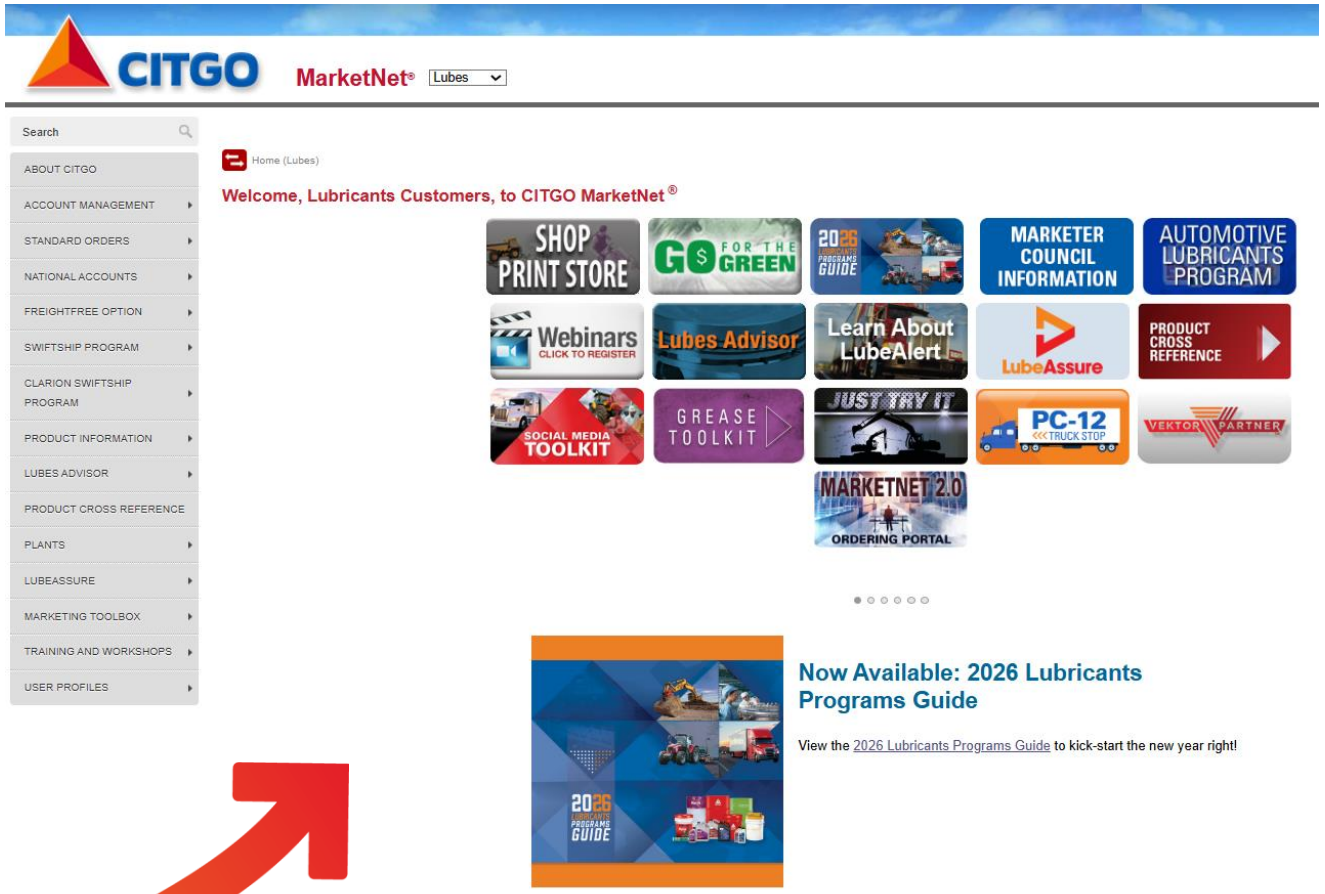
Amber Fessler - NLGI CLGS; STLE CLS & OMA-I

- CITGO Senior Sector Manager
- Materials Engineer
- 14 Years of Experience in Lubricants
- STLE Certified
  - Certified Lubrication Specialist
  - Oil Monitoring Analyst I
- NLGI Certified
  - Certified Lubricating Grease Specialist

Want Resources?

- 2026 Programs Guide
- Support Literature
- Social Media Toolkit
- Webinars

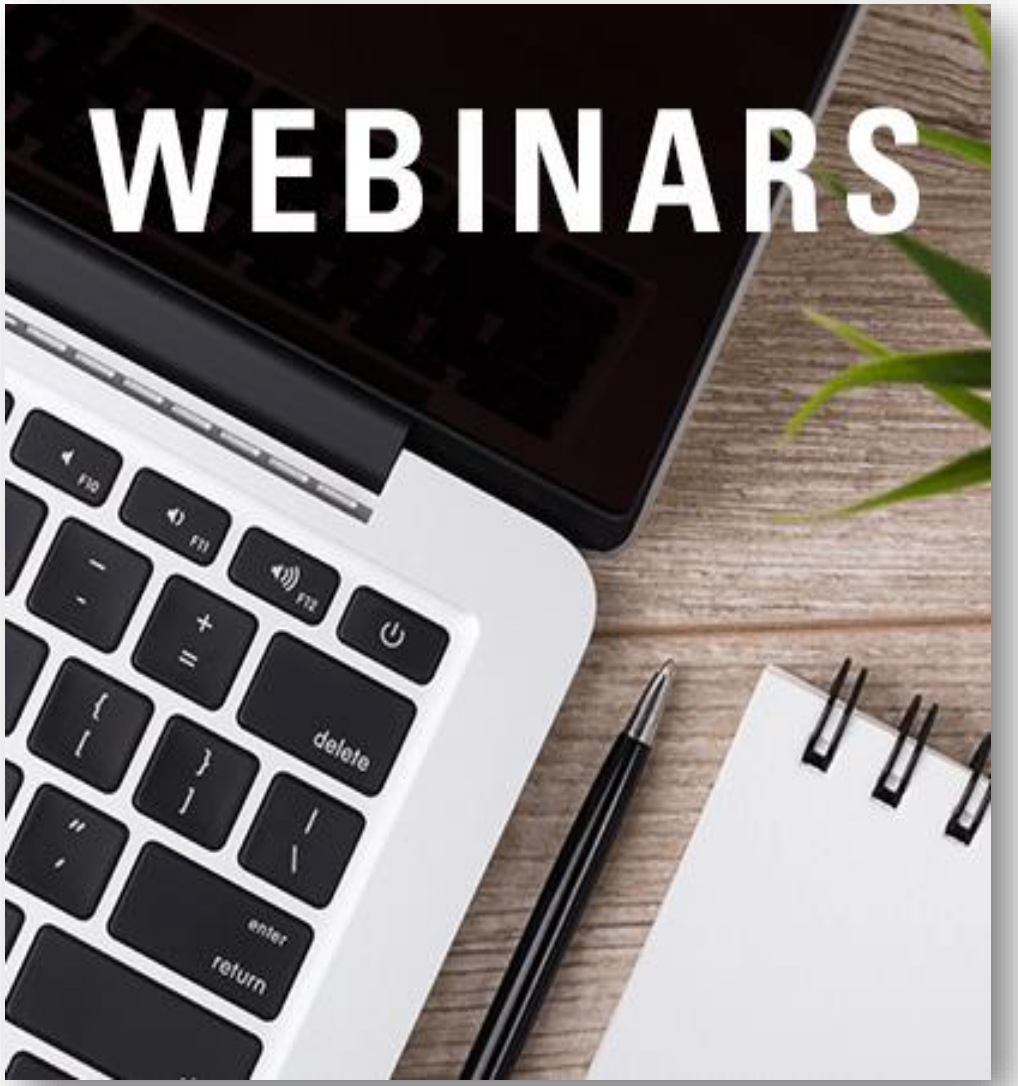


Future Webinars

February 23: Tech Talk: Lubrication in the Construction Industry

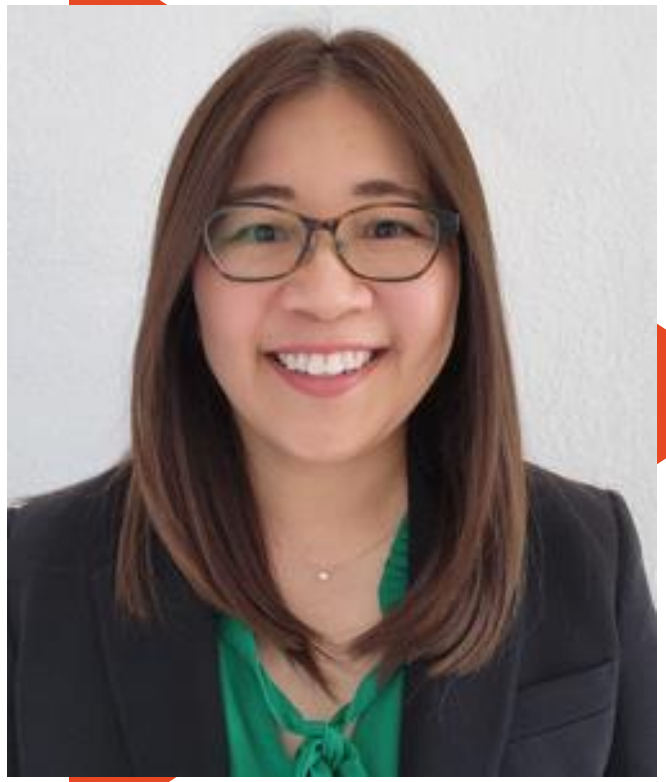
April 6: PC-12 Update: The Next Generation of Heavy Duty Diesel Engine Oils

April 20: Tech Talk: Grease



June Luke – Lean Six Sigma Black Belt

- CITGO Senior Product Specialist
- B.S. and Master of Chemical Engineering with Specialization in Polymer Science and Engineering
- 16+ yrs product/process development and scale-up experience in the chemical and energy industries
  - Lead Research Engineer, Project Lead, and Program Manager for leading lubricant additive and oil marketer companies for industrial and automotive lubricants



Frank Hayes - CLS, OMA, MLA-I, MLT-I, CLGS & CRC

- CITGO Senior Product Specialist
- B.S. Mechanical Engineering
- 28 Years Experience in Lubricants, including with
  - Petro-Canada Lubricants, Sr. Technical Services Advisor
  - Conoco, Lubrication Engineer

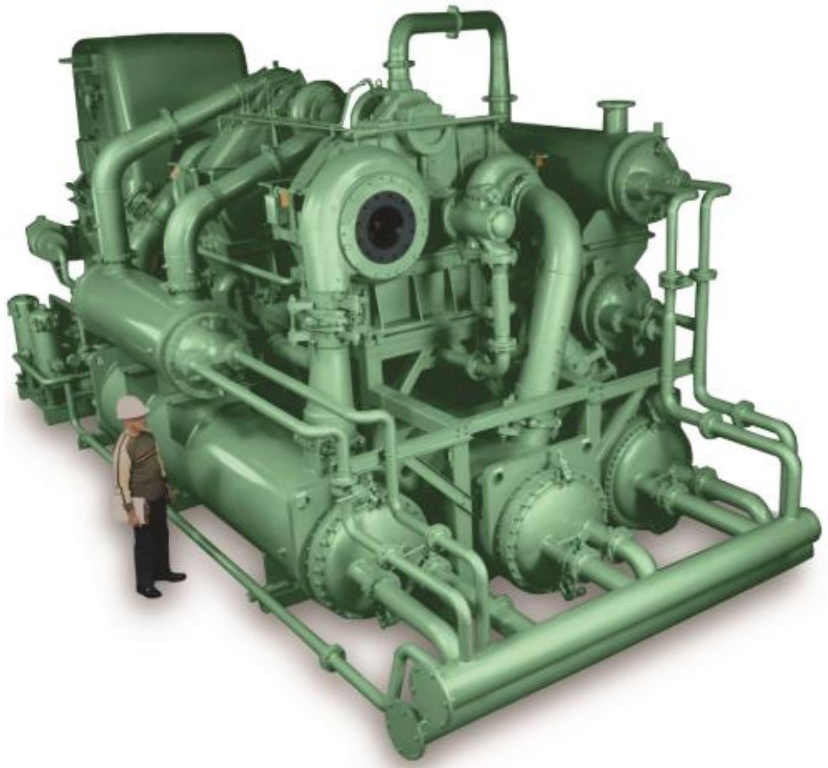
Agenda

- What is a Compressor?
- Compressor Types
- Key Functions of Compressor Lubricants
- Application Types
- CITGO & Clarion Compressor Lubricants
- OEM Cross Reference Chart
- Used Oil Analysis

What is a **Compressor**

What is a **Compressor?**

A compressor is a mechanical device that increases the pressure of a gas. In industry, they are commonly used to compress gases for the purpose of storage or transportation.



References: Images from compressor OEM websites showing various compressor types and capacities (Ingersoll Rand, Kaeser, LeROI).

Compressor
Types

Compressor **Types**

- The criteria for the ***selection of lubricant*** depends on the type of gas to be compressed and the design of the compressor which may have different operating conditions and lubrication needs

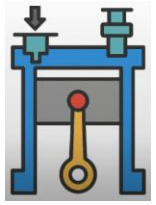
- Two major types of compressors include **positive displacement** and **dynamic**

Compressor **Types**

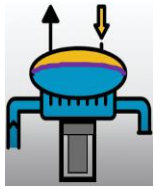
POSITIVE DISPLACEMENT

(↓Volume -> ↑Pressure)

RECIPROCATING



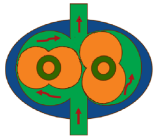
DIAPHRAGM



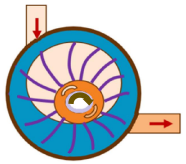
ROTARY SCREW

ROTARY SLIDING VANE

ROTARY LOBE



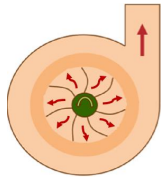
ROTARY LIQUID RING



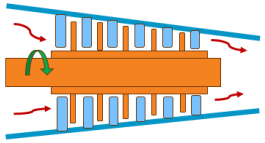
DYNAMIC

(↑Velocity -> ↑Pressure)

CENTRIFUGAL FLOW



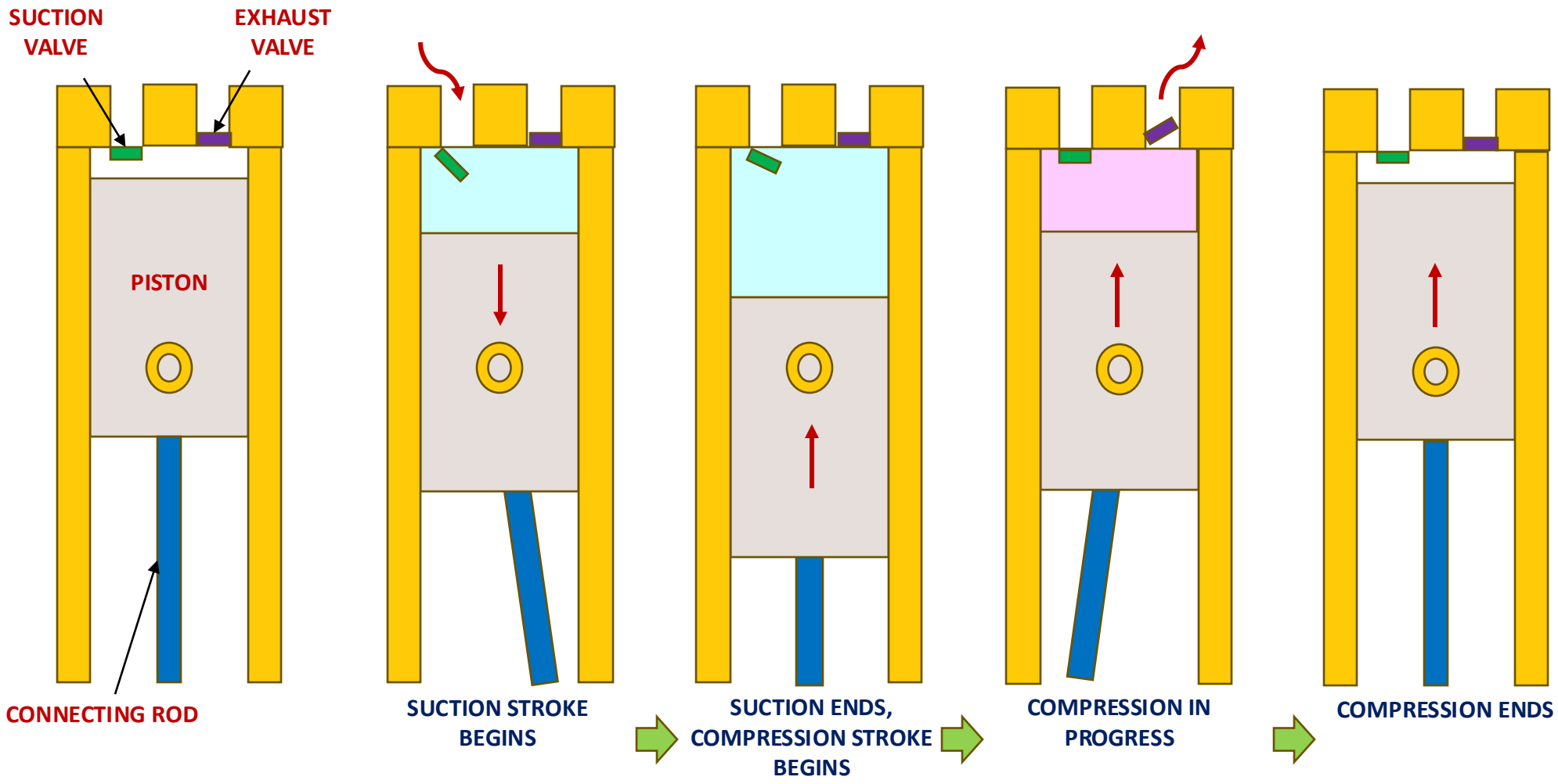
AXIAL FLOW



MIXED FLOW (AXIAL & CENTRIFUGAL COMBINED)

Positive Displacement

Reciprocating Compressor



LUBRICATION METHODS

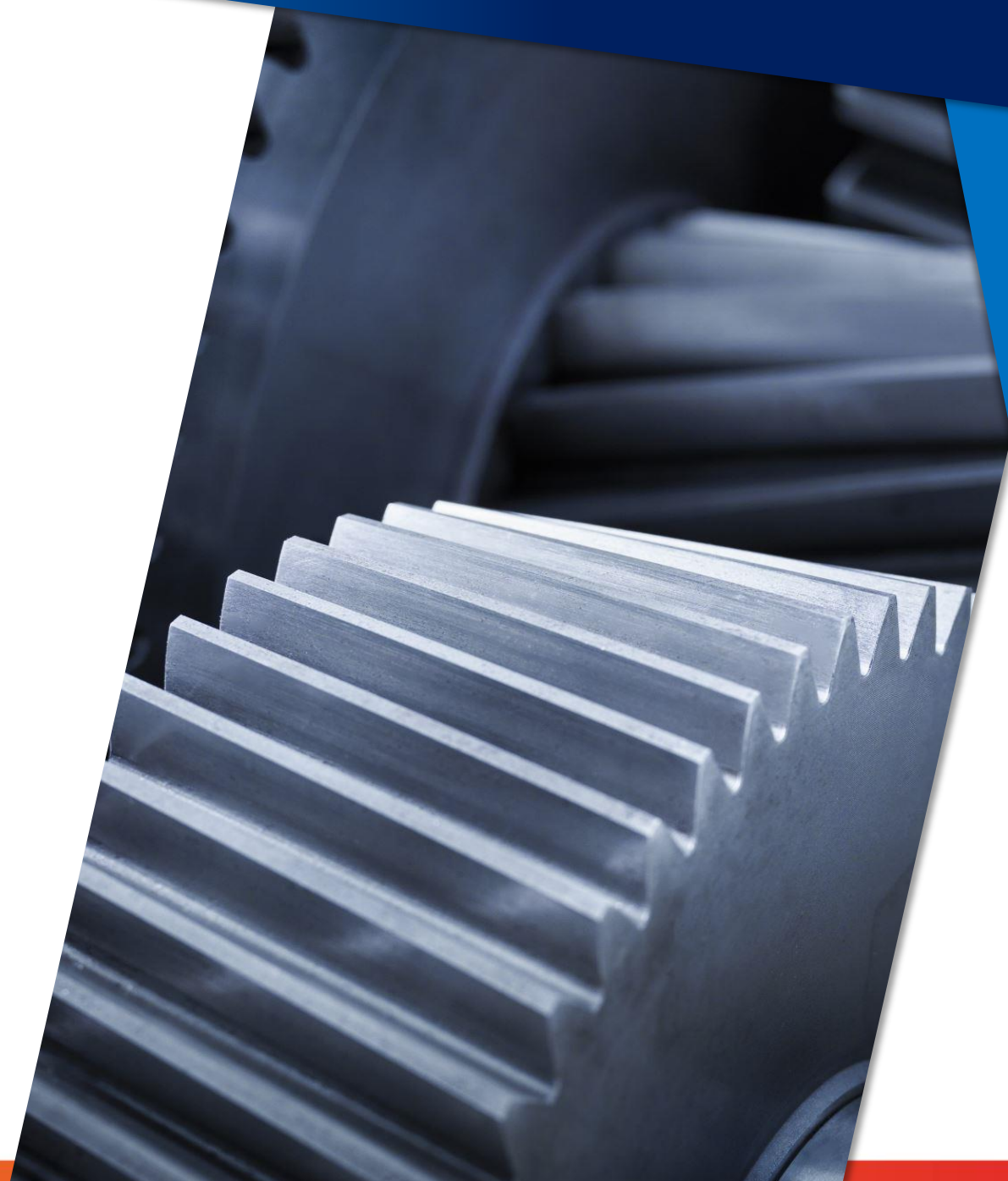
Cylinder Parts

- Cylinders, rings, valves, rod packing in double acting
- Force feed or splash lubrication

Bearing or Running Gear Parts

- Pistons, main and connecting rods, crosshead pin, crankshaft, crosshead guides, bearings
- Splash, flood, or pressure circulation system lubrication

Cylinder and running gear parts may be lubricated from same or separate lube systems



Positive Displacement
Reciprocating Compressor

Cylinder Lubrication

- Oxidation → insolubles → deposits on discharge valves and piping → carbon deposits at high temperatures
- Deposit buildup → discharge valve seating misalignment → gas leak → efficiency loss
- Restricted discharge passages → higher discharge pressure and temperature → rapid oxidation and deposit buildup → carbonaceous deposits ignite at high temperatures -> fires and explosions
- Gas contaminants may be reactive and/or corrosive (e.g. H_2S, HCl, ammonia, oxygen, etc.)
- Metallic wear particles (e.g. iron, copper) may act as a catalyst and promote oil oxidation.
- Air moisture may condense during down time and lead to rust and wear on metal surfaces
- Lubricant helps to reduce friction, cool components, seal piston rings, and prevent wear

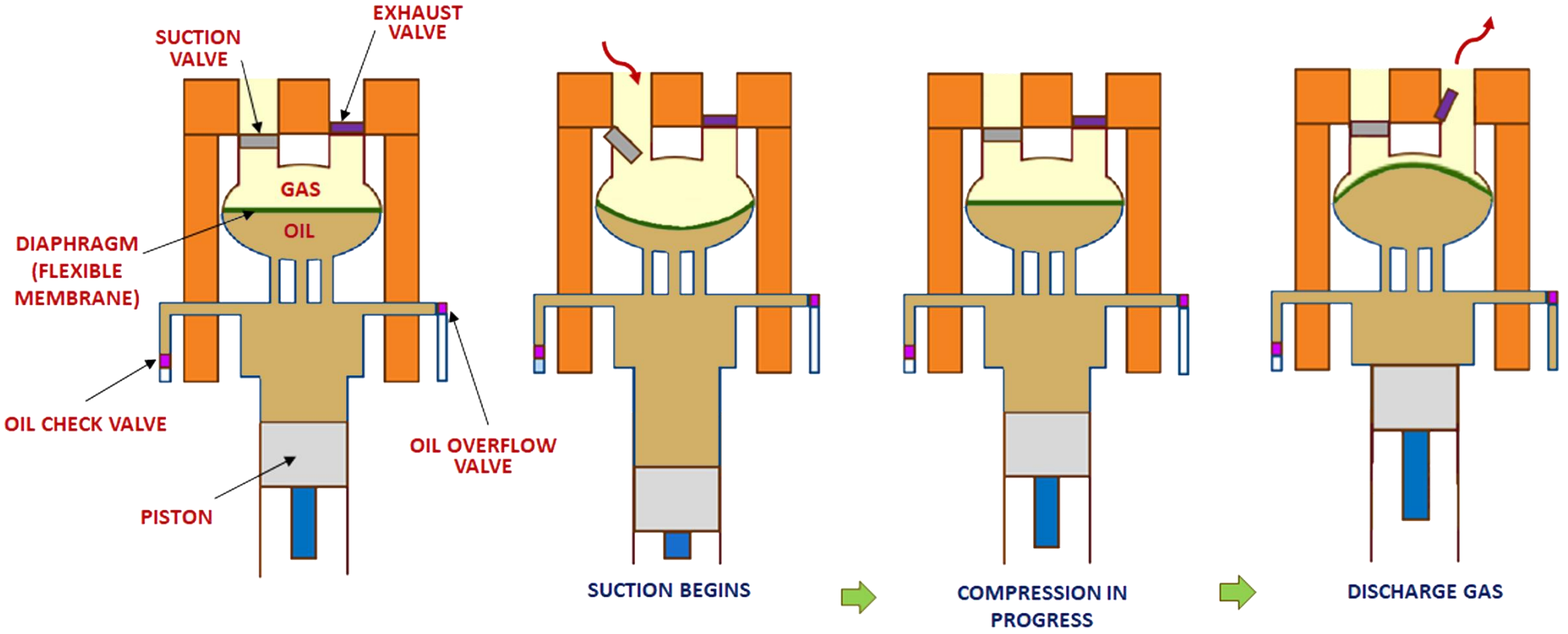
Bearing Lubrication

- Suitable viscosity grade at the operating temperature is most critical to ensure proper flow and lubrication

Common viscosity grades ISO VG 68-460

Positive Displacement

Diaphragm Compressor



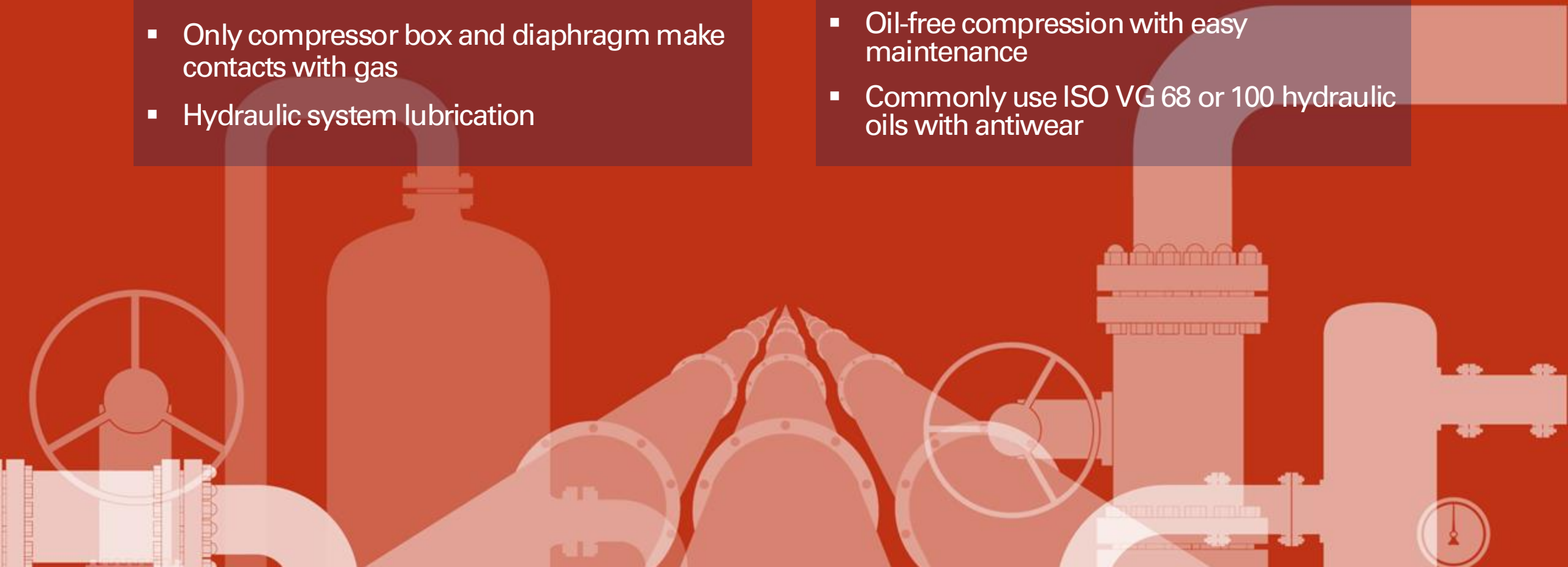
Positive Displacement
Diaphragm Compressor

LUBRICATION METHODS

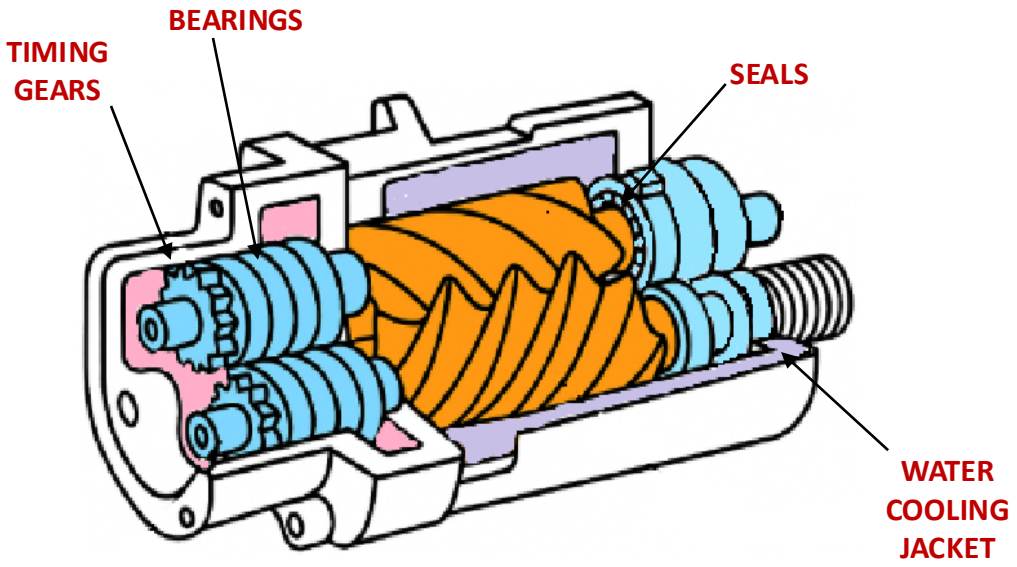
- Only compressor box and diaphragm make contacts with gas
- Hydraulic system lubrication

LUBRICATION

- Oil-free compression with easy maintenance
- Commonly use ISO VG 68 or 100 hydraulic oils with antiwear



Positive Displacement
Rotary Screw Compressor



- May be multistage with intercoolers to achieve higher discharge pressure while improving efficiency and reducing power consumption
- Less maintenance relative to reciprocating compressors due to fewer moving parts
- Compact, space efficient, quiet, continuous flow with minimal pressure variation
- Common in lower pressure applications

Positive Displacement
Rotary Screw Compressor

LUBRICATION METHODS

- Oil flooded lubrication
  - Oil is injected into the cylinder to cool the compressed gas to seal the rotor and to lubricate the moving parts
  - The male rotor drives faster than the female rotor due to fewer and larger lobes
  - External circulation system for oil temperature management and separation
- Oil free or dry screw lubrication
  - No oil is injected, and rotors are not lubricated
  - Delivers oil free gas
  - Timing gears synchronize the rotors and prevent contact
  - External cooling systems or jackets
  - Lubricant for lubricating gears and bearings only

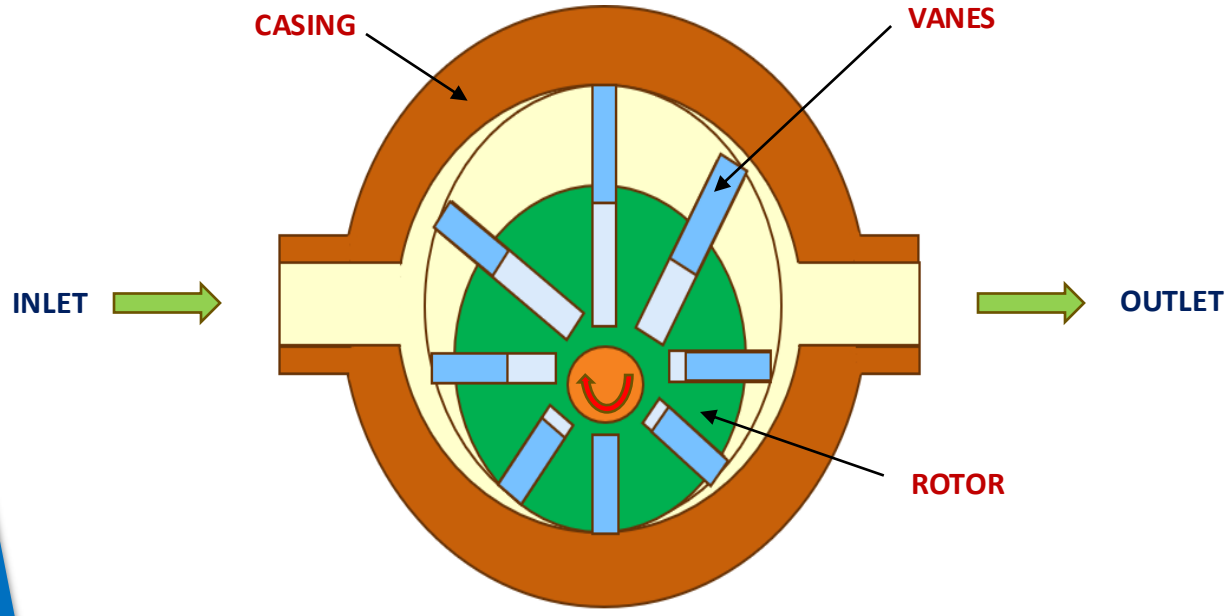
LUBRICATION

- Oil flooded lubrication commonly use ISO VG 32 and 68 oils
- For dry screw lubrication, only gears and bearings require lubrication

Positive Displacement

Rotary Sliding Vane Compressor

- Less moving parts and easier to maintain relative to screw compressors (no timing gears)
- Less expensive than screw compressors at similar capacity, and more compact and quiet
- Screw compressors may be preferred at higher flow rates and pressure applications



Positive Displacement

Rotary Sliding Vane Compressor

LUBRICATION METHODS

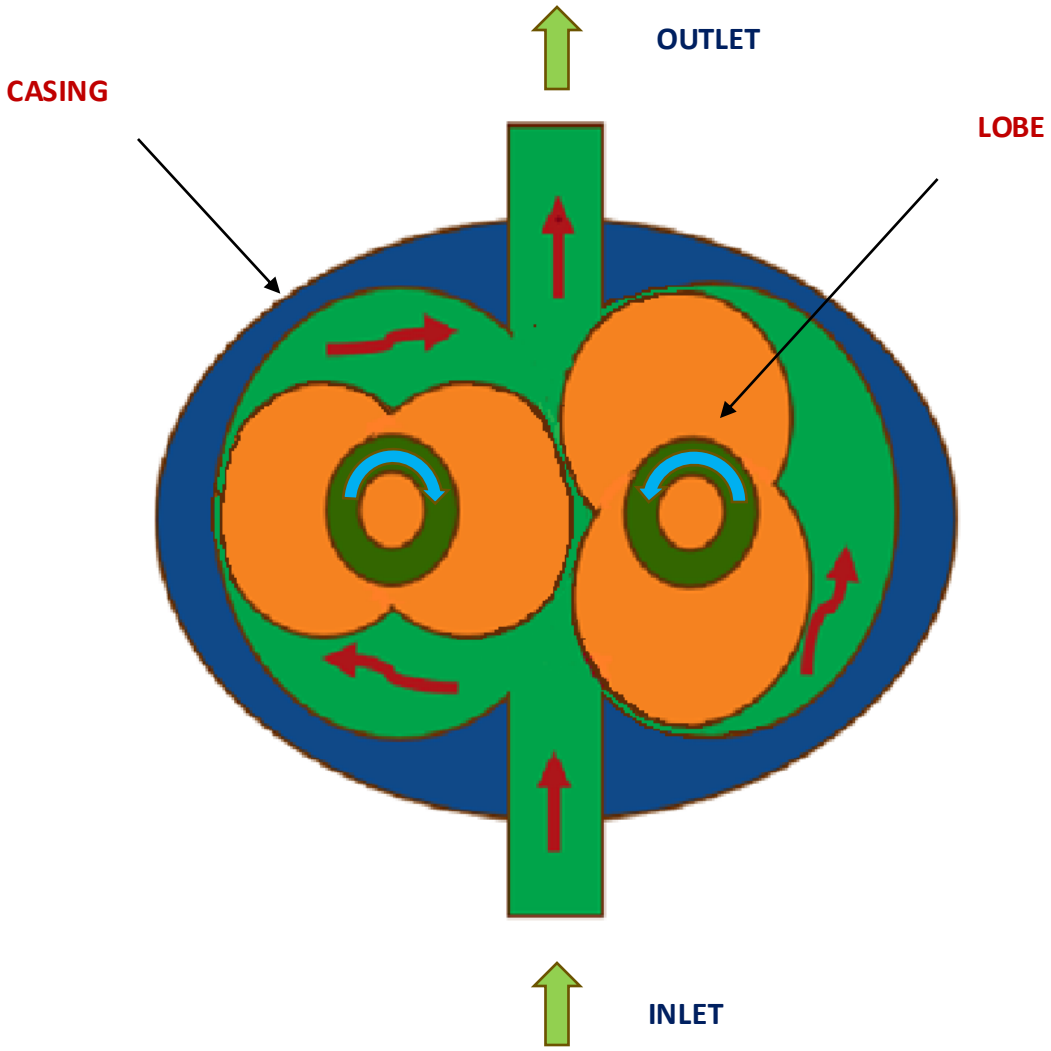
- Air cooled, water cooled, oil cooled or oil flooded, or a combination of <oil and air> or <oil and water> cooled
- The lubricant helps to extend compressor life by lubricating, cooling, sealing, and protecting parts

LUBRICATION

- Commonly use ISO VG 32 to 220 oils
- ISO VG 32 oils for light-duty applications
- ISO VG 100-220 oils for heavy-duty applications
- Synthetic lubricants are recommended for severe operating conditions and help to extend oil life
- ISO VG 68 oil is common

Positive Displacement

Rotary Lobe Compressor



- Compression occurs outside the chamber typically in the discharge piping as it exits the compressor when the downstream pressure is higher than the inlet
- Unlike other rotary compressors, there is no internal compression
- Common in low pressure applications such as vacuum systems, blowers, pneumatic conveyors

LUBRICATION METHODS

Oil Free Lubrication

- Lobes do not touch each other or the casing
- No internal lubrication is required
- Timing gears and shaft bearings require external lubrication

Oil Flooded Lubrication

- Lubricant helps to cool the compressor, protect the bearing and timing gears from wear and corrosion, and seal between the lobe rotors and casing to enable greater pressure capability
- Lubricant is separated from discharge gas and recycled for use

LUBRICATION

- Commonly use ISO VG 150 for normal operating conditions
- Higher temperatures applications may use ISO VG 220
- Heavy-duty applications may require antiwear protection for the gears
- Synthetic lubricants are recommended for severe operating conditions and help to extend oil life

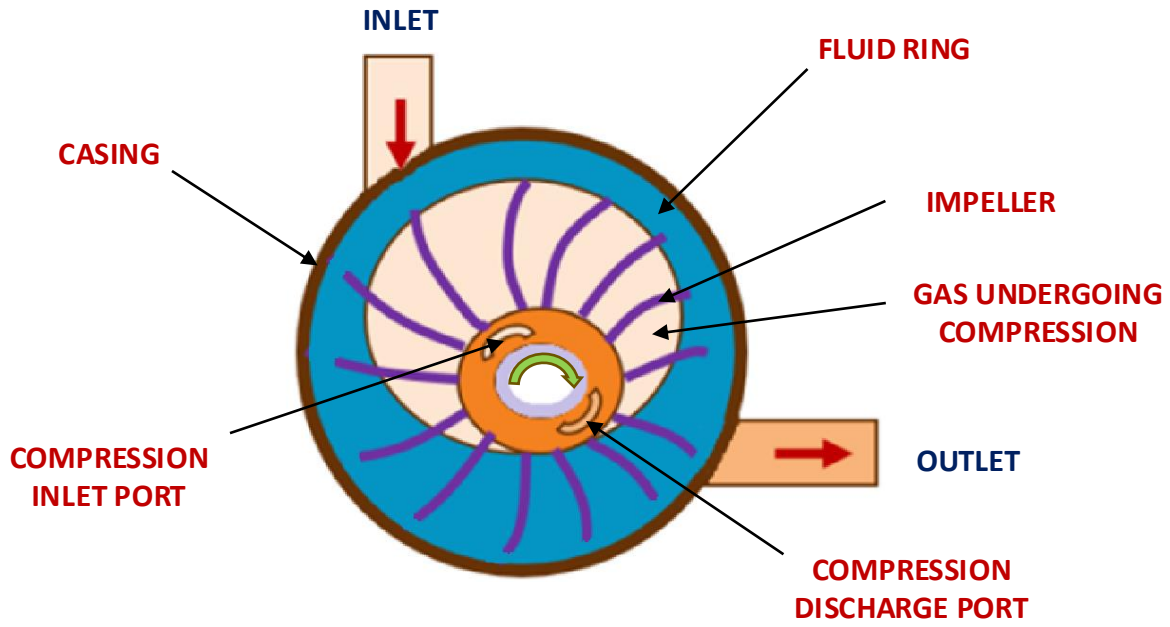
Positive Displacement

Rotary Lobe Compressor

Positive Displacement

Rotary Liquid Ring Compressor

- Liquid ring seals between the rotor and casing, absorbs heat, and cools the compressor
- Liquid ring may absorb and flush contaminants, thus enabling wet and corrosive gas compression
- Less maintenance and wear with no metal-to-metal contact moving parts
- Common in vacuum systems, chemical processing, and food processing



Positive Displacement

Rotary Liquid Ring Compressor

LUBRICATION METHODS

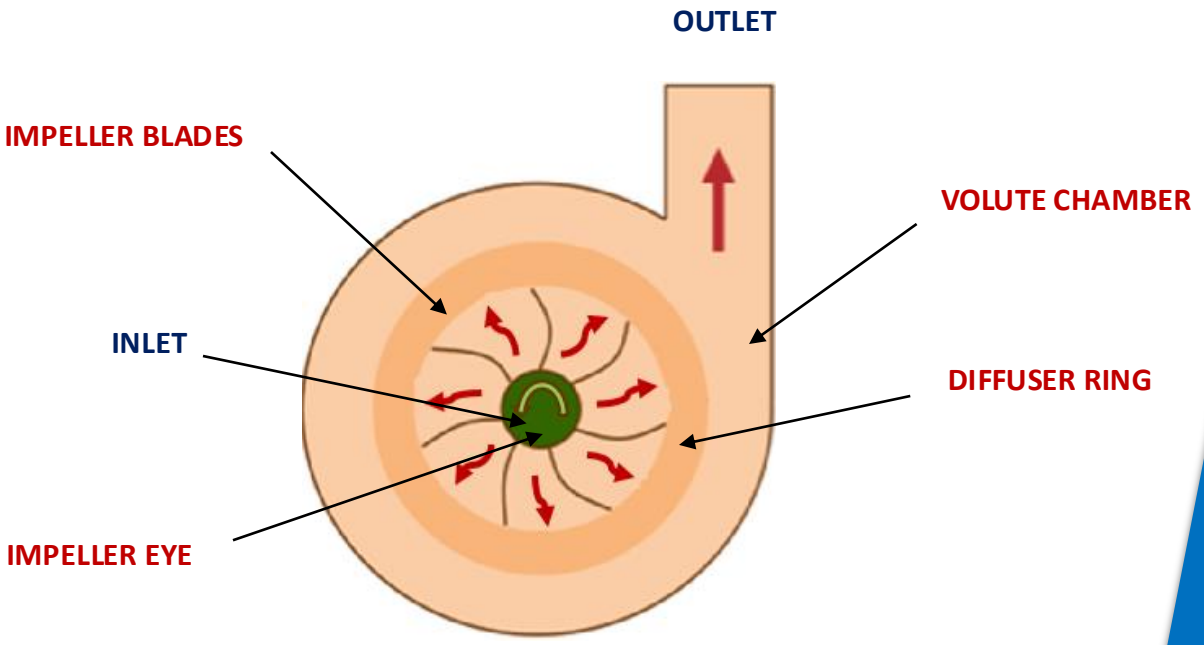
Oil Free Lubrication

- The gas has no contact with the lubricating oil during compression (no internal lubrication)
- The bearings and mechanical seals are lubricated and isolated from the compression chambers

LUBRICATION

- Commonly use ISO VG 46 for normal operating conditions in industrial applications
- ISO VG 32 may be used in low temperature conditions, and ISO VG 100 may be used in high pressure and temperature conditions to provide better wear protection

Dynamic
Centrifugal Flow Compressor



- Gas is drawn into the impeller eye, accelerated by the impeller blades, and pushed outwards by centrifugal forces. As the gas moves through a diffuser, the gas velocity decreases and pressure increases
- Single or multistage with intercoolers
- High flow rates, low vibrations, reliable, and continuous operation
- Low maintenance with less moving parts
- Common in refineries, chemical processing plants, and large-scale industrial applications

Dynamic

Centrifugal Flow Compressor

LUBRICATION

- Commonly use ISO VG 32 or 68 oils
- ISO VG 32 may be used in low temperature conditions
- ISO VG 100 may be used for high pressure and temperature conditions

LUBRICATION METHODS Oil Free Lubrication

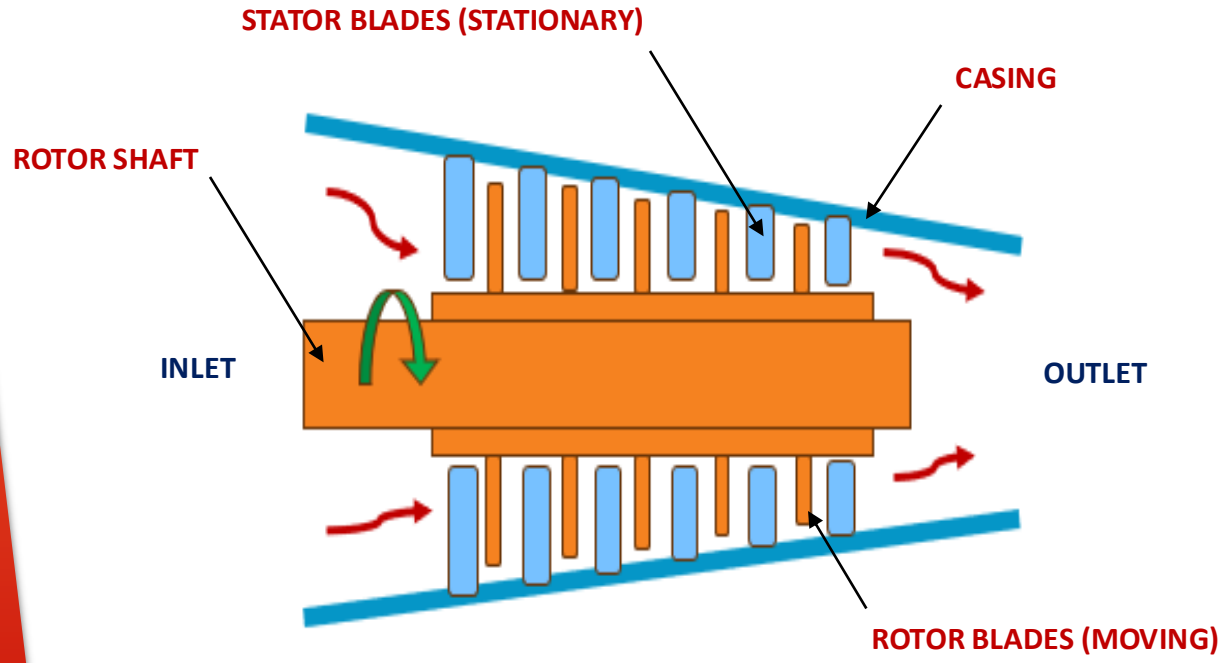
The bearings and gears are lubricated using a pressurized oil circulation system and isolated from gas flow

The oil lubricates the bearings and gears by reducing friction and wear, dissipates heat, provides rust and corrosion protection, prevents varnish and sludge buildup, prevents leaks in mechanical seals, and resists oxidation and thermal breakdown.

The gas has no contact with the lubricating oil during compression (no internal lubrication)

Dynamic
Axial Flow Compressor

- Gas is compressed as it flows parallel to the axis of rotation through alternating rows of moving and stationary blades (low pressure rise per stage, multistage to achieve high pressure). Pressure is further increased as it leaves through a diffuser
  - Smaller diameter (but longer) relative to centrifugal compressors
    - High efficiency at large flow rates
      - Common in moderate pressure and high flow applications such as jet engines and gas turbines



LUBRICATION METHODS

Oil Free Lubrication

- The gas has no contact with the lubricating oil during compression (no internal lubrication)
- Bearings are lubricated using a pressurized oil circulation system and isolated from gas flow
- The oil lubricates the bearings by reducing friction and wear, dissipates heat, provides rust and corrosion protection, prevents varnish and sludge buildup, prevents leaks in mechanical seals, and resists oxidation and thermal breakdown

LUBRICATION

- Commonly use ISO VG 32 to 100 oils
- ISO VG 32 and 46 may be used for low temperature conditions, and ISO VG 68 and 100 may be used for high pressure and temperature conditions to provide better wear protection
- ISO VG 46 and 68 oils are common and offer balanced flow and protection

Dynamic

Axial Flow Compressor

Key Functions of

Compressor Lubricants

Key Functions

Extend Equipment Life

- Reduced friction between moving parts and minimized wear
- Wear protection under high pressure and temperature conditions
- Efficient heat dissipation to prevent overheating
- Excellent oxidation resistance and thermal stability (minimized sludge, varnish, and deposit buildup, stable viscosity)
- Rust and corrosion resistance, even during shutdown
- Excellent foam control and demulsibility to shed water (fast water separation)

Lower Lifecycle Cost

- Less downtime
- Lower maintenance cost (labor and parts)
- Reduced power consumption and improved efficiency through effective cooling, minimized/no leakage, and reduced friction
- Excellent seals and materials compatibility
- Longer oil life (less oil changes and maintenance cost)

Note: AI generated images.

Key Functions

Foam

↓ Lubrication, Cooling
↑ Oxidation, Varnish, Sludge

Thickened Oil

↓ Lubrication, Cooling
↑ Oxidation, Varnish, Sludge

Valve Deposit

↓ Valve Sealing, Cooling, Efficiency
↑ Leakage, Restricted Flow, Wear

Varnish and Sludge

↓ Lubrication, Cooling, Efficiency
↑ Restricted Flow, Wear

Rust and Corrosion

↓ Sealing, Cooling, Efficiency
↑ Surface damage, Friction, Wear

Bearing Wear

↓ Cooling, Efficiency
↑ Friction, Vibration, Wear, Damage

BASE OIL

Formulation viscosity, thermal stability and oxidation resistance

Rust Inhibitor

Ferrous metal protection

Demulsifier

Fast water separation

Seal Compatibility Agent

Minimizes leaks

A high-quality compressor lubricant is a formulated oil with different types and levels of key components designed to extend equipment life

Corrosion Inhibitor

Ferrous and non-ferrous metal protection

Foam Inhibitor

Foam prevention

Viscosity Index Improver

Viscosity Stability

KEY FUNCTIONS

Antiwear Additive

Reduced friction and wear

Oxidation Inhibitor

Minimizes sludge, varnish, and acid formation

Note: Component types and levels are selected based on compressor type, gas, and application. Some components are multi-functional. Components not shown above may be included.

Key Functions

MINERAL OILS

Cost-effective for less demanding applications

Frequent oil change to remove contaminants

SEMI-SYNTHETICS

Cost-effective upgrade from mineral oils with some benefits of synthetics

Note: CITGO offers mineral oil, semi-synthetic, and synthetic compressor lubricants through CITGO lubricants. CITGO offers bio-based and food grade lubricants through CLARION lubricants.

Key Functions

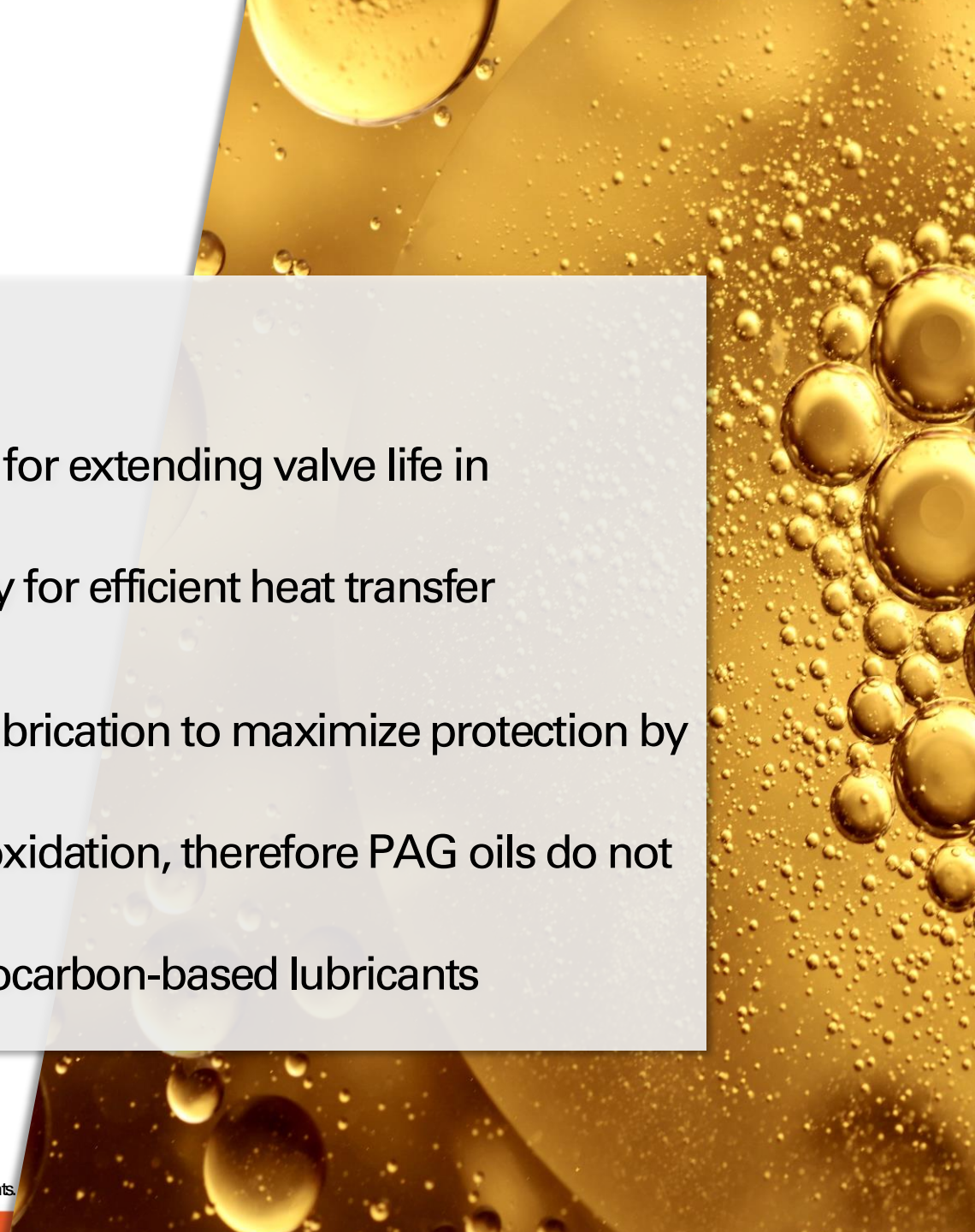
SYNTHETICS

Synthetic Hydrocarbon (PAO, Polyalphaolefin)

- Excellent oxidation resistance and thermal stability help to deliver reliable performance in severe operating conditions
- Fast water separation to minimize rust and corrosion in high moisture or humidity conditions
- Excellent low temperature properties enable optimized flow, reduced friction, and minimized wear
- Commonly co-blended with high-quality esters to enhance additive solubility and ensure seal compatibility
- Reduce operational costs by extending oil drain interval and improving efficiency

Note: CITGO offers mineral oil, semi-synthetic, and synthetic compressor lubricants through CITGO lubricants. CITGO offers biobased and food grade lubricants through CLARION lubricants.

Key Functions



SYNTHETICS

Organic Esters (Diester)

- Excellent solvency and resistance to carbon formation for extending valve life in reciprocating compressors
- Excellent oxidation resistance and thermal conductivity for efficient heat transfer

Polyglycols (PAG, Polyalkylene Glycol)

- Common for natural gas compression in oil-flooded lubrication to maximize protection by minimizing gas absorption and hydrocarbon dilution
- Forms volatile or soluble degradation products upon oxidation, therefore PAG oils do not form deposits or varnish
- PAG (water-soluble) oils are not compatible with hydrocarbon-based lubricants

Note: CITGO offers mineral oil, semi-synthetic, and synthetic compressor lubricants through CITGO lubricants. CITGO offers biobased and food grade lubricants through CLARION lubricants.

Application

Types

Application Types

AIR COMPRESSION

- In 2025, air rotary screw compressors dominate the global market at approximately 28%, followed by air reciprocating compressors at approximately 19%*
- Used in industrial processes and pneumatic systems
  - Manufacturing (rotary screw, reciprocating, centrifugal)
  - Construction (rotary screw, reciprocating)

LUBRICATION

- Excellent demulsibility (fast water separation) for high moisture conditions to minimize rust and corrosion and allow easy water separation
- Excellent oxidation resistance and thermal stability to minimize sludge, varnish, deposit buildup and oil thickening
- Reciprocating air compressors require low carbon deposit formation because carbonaceous deposits may ignite at high temperatures and lead to fire or explosion
- PAO or diester oils are recommended

*Reference: https://www.futuremarketinsights.com/reports/compressor-oil-market.

Application Types

NATURAL GAS COMPRESSION

- In 2025, the global natural gas compression market is approximately 18%*
- Used in oil and gas, power generation, manufacturing, transportation, and chemical industries
  - Gas transmission and distribution (reciprocating, centrifugal)
  - Gas storage (reciprocating, centrifugal, diaphragm)
  - Gas processing and power generation (reciprocating, centrifugal, rotary screw, diaphragm)

LUBRICATION

- For oil flooded lubrication, PAG (water-soluble type) oils are recommended Their low hydrocarbon gas solubility helps to prevent viscosity drop in the pressurized section and lubricant wash away from cylinder walls that may lead to dry running and accelerated wear
- Natural gas with contaminants (sour/wet gas) such as H_2S (hydrogen sulfide) and water may require additional protection against rust and corrosion
- Please note PAG oils are not compatible with hydrocarbon-based lubricants

*Reference: https://www.businessresearchinsights.com/market-reports/natural-gas-compressor-market-125272

Application Types

REFRIGERANT COMPRESSION

- The refrigeration lubricants market is estimated at USD 3.67 billion in 2025 and is expected to reach USD 4.39 billion by 2030*
- Refrigerant lubricant market is 59% mineral oil and 41% synthetic in 2024*
- Used in air conditioning and refrigeration systems in residential, commercial, and industrial sectors
  - Household (reciprocating, rotary vane)
  - Industrial (reciprocating, rotary screw, rotary vane, centrifugal)
  - Cryogenic (reciprocating, rotary screw, centrifugal)

*Reference: https://www.mordorintelligence.com/industry-reports/refrigeration-lubricants-market

Application Types

LUBRICATION

- Refrigeration systems are often closed systems without oil separators. Oil and refrigerant should be miscible to ensure good oil circulation
- Lubricant with proper viscosity that will provide balanced flow at the lowest system temperature and wear protection is recommended

Refrigerant	Examples	Recommended Oils
CFC	R-12	Mineral Oils (Highly refined naphthenic or paraffinic), PAO
HCFC	R-22	Mineral Oils (Highly refined naphthenic or paraffinic), PAO
HFC	R-134a, R-410A	POE, PAG
HFO	R-1234yf	POE, PAG
Natural Refrigerant	R-717 (Ammonia)	Mineral or nonpolar synthetic oils formulated for ammonia
Natural Refrigerant	R-744 (CO_2)	POE or PAG
Natural Refrigerant	R-290 (Propane)	Mineral Oil for older systems, PAO for modern systems
Natural Refrigerant	R-600a (Isobutane)	Mineral Oil for older systems, PAO for modern systems

PAO = Polyalphaolefin, POE = Polyolester, PAG = Polyalkylene Glycol

Application Types

VACUUM PUMP

- A traditional compressor increases pressure above atmospheric. A vacuum pump removes gas from a chamber and creates negative pressure by decreasing pressure below atmospheric
  - Both equipment convert mechanical energy into pressure energy
- Used power plants, packaging, chemical and metal processing, semiconductor and pharmaceutical industries
  - Packaging and laboratory systems (rotary vane)
  - Chemical processing and power plants (rotary liquid ring)
  - Semiconductor and pharmaceutical (rotary screw)
  - Metallurgy (rotary lobe)

LUBRICATION

- Industrial low to medium vacuum pumps (sections and moving parts) may be lubricated by the same lubricants as those for gas compressors
- For high vacuum applications, lubricants with high viscosity, high flash point, no low boiling components, and low vapor pressures at working temperatures are recommended
- Naphthenic or paraffinic mineral oils and synthetic esters are recommended

CITGO & CLARION

Compressor Lubricants

How to Select the Proper Compressor Lubricant?

Refer to owner's manual for proper lubricant recommendation

- Technical Training
- Industry Trends
- Deep Formulation and Application Expertise in Industrial Lubrication
- Comprehensive Product Lines and Cost-Effective Solutions
- World-Class Technical Service and Condition Monitoring

CITGO® & CLARION®
Compressor Lubricants

AIR

Compressor Oils 35LP and 45LP
CompressorGard® PS 68
CompressorGard® PAO
CompressorGard® DE
CompressorGard® GE
Clarion® CompressorGard®

GAS

Gascom® R
Compressor Oils 35LP and 45LP
CompressorGard® 7585
CompressorGard® XA 200
CompressorGard® SS
CompressorGard® H
CompressorGard® PAG

REFRIGERANT

Ice Machine Oil 68
North Star Refrigeration Oils
CompressorGard® IPG
Clarion® Synthetic Refrigeration Fluid

HIGH VACUUM

Pacemaker® HV

Air Compression

Compressor Oils 35LP and 45LP

- Highly refined paraffinic mineral oil based lubricant
- Reciprocating compressors (cylinder lubrication) and older stationary natural gas engines with activated clay filtration
- SAE 30 and 50

CompressorGard® PS 68

- Semi-synthetic ultra high-purity based lubricant
- Rotary screw, rotary vane, and centrifugal compressors
- ISO VG 68

CompressorGard® PAO

- Synthetic PAO based lubricant
- Rotary vane, rotary screw, and centrifugal compressors
- ISO VG 32, 46, 68, 100, and 150

CompressorGard® DE

- Synthetic Diester based lubricant
- Rotary vane, rotary screw, and reciprocating compressors
- ISO VG 68, 100, 125, and 150

CompressorGard® GE

- Synthetic PAG / Alkylated Hydrocarbon based fluid
- ISO VG 32 for Sullair Rotary Screw compressors, ISO VG 46 for Ingersoll-Rand Rotary Screw compressors

Clarion® CompressorGard®

- Synthetic PAO based fluid
- NSF H1 registered for use in food processing plant. Meets US FDA regulation 21 CFR 178.3570 for incidental food contact
- Rotary vane and rotary screw compressors
- ISO VG 32, 46, 68

Gas Compression

Gascom® R Oil

- Highly refined paraffinic mineral based lubricant
- Reciprocating compressors
- Wet, scrubbed, processed gas including natural gas compression
- ISO VG 220

Compressor Oils 35LP and 45LP

- Highly refined paraffinic mineral oil based lubricant
- Reciprocating compressors (cylinder lubrication) and older stationary natural gas engines with activated clay filtration
- Natural gas compression
- SAE 30 and 50

Compressor Oil 7585

- Highly refined paraffinic mineral oil based lubricant
- Reciprocating compressors
- Sour, wet, high-pressure natural gas, high-pressure carbon dioxide, hydrogen sulfide, refinery tail gas, and wellhead gas compression
- SAE 60

CompressorGard® XA 200

- Highly refined paraffinic mineral oil based lubricant
- Reciprocating compressors
- Sour, wet, high-pressure natural gas, syngas, high-pressure wet carbon dioxide and hydrogen sulfide, high-pressure sulfur dioxide, refinery tail gas, and wellhead gas compression
- SAE 60

CompressorGard® SS

- Semi-synthetic based lubricant
- Rotary screw, rotary vane, and reciprocating compressors
- Natural gas compression
- ISO VG 100, 150, 220

CompressorGard® H

- Synthetic PAO based lubricant
- Reciprocating compressors
- Natural gas, H_2, and sour gas compression
- ISO VG 100, 220

CompressorGard® PAG

- Synthetic PAG based lubricant
- Rotary screw, rotary vane, and reciprocating compressors
- Natural gas, CO_2, H_2, He, N_2, NH_3, and others
- Minimizes gas absorption and hydrocarbon dilution
- ISO VG 100, 150, 220

Refrigerant Compression

Ice Machine Oil 68	▪ Highly refined paraffinic mineral oil based lubricant ▪ Rotary screw and reciprocating compressors and industrial evaporating ice machines ▪ Ammonia compression ▪ ISO VG 68
North Star® Refrigeration Oils	▪ Highly refined mineral oil based lubricant ▪ Air conditioner and refrigeration compressors where low temperature fluidity is required ▪ Not recommended for R-134a ▪ ISO VG 54 (naphthenic) and 68 (paraffinic)
CompressorGard® IPG	▪ Synthetic polyglycol based lubricant ▪ Rotary screw, rotary vane, and reciprocating compressors ▪ Propane compression ▪ ISO VG 100, 150
Clarion® Synthetic Refrigeration Fluid	▪ Synthetic PAO based lubricant ▪ NSF H1 registered for use in food processing plant. Meets US FDA regulation 21 CFR 178.3570 for incidental food contact ▪ Rotary screw compressors ▪ Ammonia, CO_2, CFC, and HCFC compression. Not recommended for R-134a ▪ ISO VG 68

High-Vacuum **Pump**

Pacemaker® HV Oils

- Highly refined paraffinic mineral oil based lubricant
- High-vacuum pumps
- HV-39 is for direct-drive vacuum pumps such as Welch, Yellow Jacket, Precision, Leybold-Heraeus, Edwards and Alcatel
- HV-68 is for belt-driven vacuum pumps such as Welch and Cenco
- ISO VG 39 and 68

References: Images from Welch OEM websites showing various belt-driven vacuum pumps.

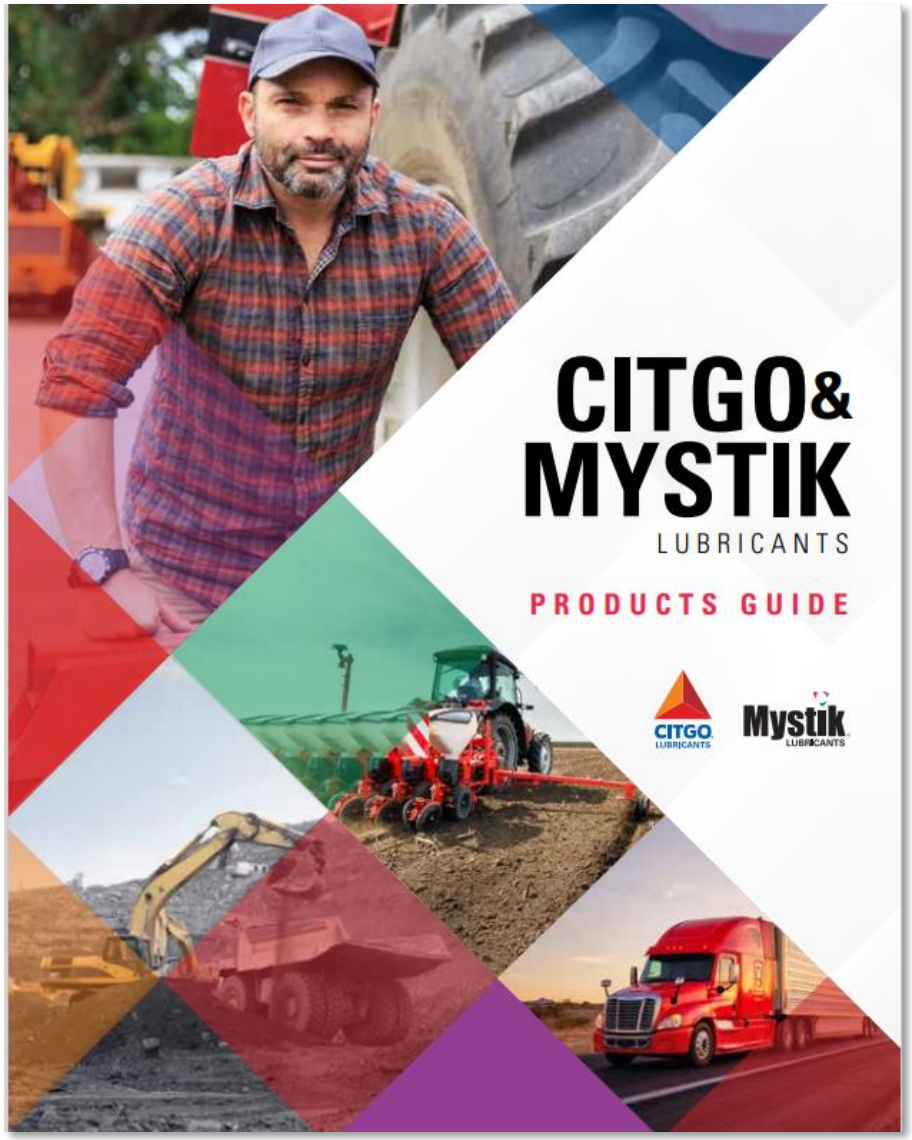
OEM
Cross Reference

Compressor OEM Fluid Cross-reference

OEM	Product Name	CITGO Product Name	Mat. Code	Competitive Product Co
Atlas Copco	Atlas Copco HD Roto Fluid	CompressorGard PAO 46	632532001	Mineral Special Processed Oil, ISO 46
	Atlas Copco HD Roto Fluid Plus	CompressorGard PAO 46	632532001	Group III, ISO 46
	Atlas Copco Paroil M	CompressorGard PAO 46	632532001	Mineral Oil, anti-wear, ISO 46
	Atlas Copco Paroil S 46	CompressorGard PAO 46	632532001	PAO, ISO 46
	Atlas Copco Paroil S 68	CompressorGard PAO 68	632533001	PAO, ISO 68
	Atlas Copco Roto-H Plus	CompressorGard PAO 32	632531001	Mineral oil, ISO 32
	Atlas Copco Roto-Inject	CompressorGard PAO 46	632532001	Ashless, AW mineral oil, ISO 46
	Atlas Copco Roto Xtend Duty Fluid	CompressorGard PAO 46	632532001	PAO, ISO 46
	Atlas Copco Roto Xtreme Duty Fluid	No Product		Polyol Ester, ISO 46

Compressor OEM Fluid Cross-reference - (Cont'd.)

OEM	Product Name	CITGO Product Name	Mat. Code	Competitive Product Co
Gardner Denver	Gardner Denver Aeon 500	CompressorGard PAO 100	632534001	Mineral oil, ISO 100 - for reciprocating compressors
	Gardner Denver Aeon 800	CompressorGard PAO 46	632532001	R&O, Mineral oil, ISO 46 - for rotary screw compressors
	Gardner Denver Aeon 2000	CompressorGard PAO 46	632532001	R&O Mineral oil, ISO 46
	Gardner Denver Aeon 4000	CompressorGard PAO 46	632532001	Mineral/synthetic blend, ISO 46
	Gardner Denver Aeon 5000	CompressorGard DE 68	632525001	Diester, ISO 68 - for reciprocating compressors
	Gardner Denver Aeon 6000 FG	Clarion CompressorGard 46	632541009	USDA H1, FDA 21CFR 178.3570, PAO, ISO 46
	Gardner Denver Aeon 9000 SP	CompressorGard PAO 46	632532001	PAO, ISO 46



Air Compressor
OEM Fluid Cross-References

Used Oil Analysis

Review

Benefits of
Used Oil Analysis

- Track Equipment Condition Trends
- Increase Operational Efficiency and Production
- Decrease Maintenance Costs
- Decrease Unexpected Downtime
- Increase Equipment Resale Value
- Optimize Lubricant Useable Life

How to Optimize Compressor Life…

Sample monthly to track trends

Condemn based on complementary data points

Take Action:

- Based on trends
- At or near condemning limits

Monitor:

- Viscosity
- Water
- Metals
- Acid Number
- Oxidation
- Particle Count

…with Used Oil Analysis

Used Oil Analysis Data Ranges
Compressors

Property	Start Flagging	Condemn
Viscosity	+/- 10% change	+/- 25% change
Water (wt%)	0.2 = 2000 ppm	0.5 = 5000 ppm
Iron (ppm) Other Metals (ppm)	5 2	10 5
Acid Number (mgKOH/g)	+0.5	+1
Oxidation (abs/.01mm)	20	25
Particle Count (ISO 4406 Code)	16/14/11	>18/16/13

Natural Gas Screw Compressor – Gas Dilution

ISO 150 Fluid

Metals (ppm)						
Iron (Fe)	4	5	4	4	2	4
Chromium (Cr)	<1	<1	<1	<1	<1	<1
Lead (Pb)	<1	1	<1	<1	<1	<1
Copper (Cu)	<1	<1	<1	<1	<1	<1
Tin (Sn)	<1	<1	<1	<1	<1	<1
Aluminium (Al)	1	<1	<1	1	2	1
Nickel (Ni)	<1	<1	<1	1	<1	<1
Silver (Ag)	<1	<1	<1	<1	<1	<1
Titanium (Ti)	<1	<1	<1	<1	<1	<1
Vanadium (V)	<1	<1	<1	<1	<1	<1
Contaminants (ppm)						
Silicon (Si)						
Sodium (Na)						
Potassium (K)						
Additives						
Magnesium (Mg)						
Calcium (Ca)	10	8	8	7	13	14
Barium (Ba)	<1	<1	<1	<1	2	<1
Phosphorus (P)	80	76	77	68	208	209
Zinc (Zn)	7	5	4	7	6	3
Molybdenum (Mo)	<1	1	<1	1	<1	<1
Boron (B)	<5	<5	<5	<5	<5	<5
Contaminants						
Water (%)	<.1	<.1	<.1	<.1	<.1	<.1
Physical Tests						
Viscosity (cSt 40C)	104.0	118.0	111.0	138.0	44.5	46.6
Physical / Chemical						
Acid Number (mgKOH/g)	0.07	0.06	0.07	0.02	0.04	0.04
Oxidation (Abs/0.1mm) E2412/D7414	12	12	11	11	18	18
Nitration (Abs/0.1mm) E2412	4	4	2	2	4	3
Additional						
Antimony	<1	<1	2	1	<1	<1

Data trends from right to left

Polyalkylene Glycol in Screw Compressor
ISO 220

Metals (ppm)			
Iron (Fe)	6	7	9
Lead (Pb)	1	<1	1
Copper (Cu)	8	14	18
Tin (Sn)	4	6	7
Aluminium (Al)	1	1	2
Silver (Ag)	<1	<1	<1
Contaminants (ppm)			
Silicon (Si)	18	19	19
Sodium (Na)	22	7	4
Potassium (K)	25	16	8
Additives (ppm)			
Magnesium (Mg)	<1	<1	<1
Calcium (Ca)	1	<1	1
Phosphorus (P)	1399	1603	1510
Zinc (Zn)	2	1	1
Molybdenum (Mo)	<1	<1	1
Boron (B)	<5	<5	<5
Contaminants			
Water (%)	<.1	<.1	<.1
Physical Tests			
Viscosity (cSt 40C)	221.0	220.0	222.0
Physical / Chemical			
Acid Number (mgKOH/g)	0.85	1.01	1.02
Oxidation (Abs/0.1mm) E2412/D7414	3	5	5
Nitration (Abs/0.1mm) E2412	4	5	6

Shaft and Bearing Wear; Possible Fluid Cooler Leak

Water Jacket or Fluid Cooler Leak

PAG fluids maintain viscosity with “wet” gas

Data trends from right to left

Natural Gas Screw Compressor

Engine Oil in Comp Fluid

Metals (ppm)						
Iron (Fe)	7	9	7	6	4	7
Chromium (Cr)	<1	<1	<1	<1	<1	<1
Lead (Pb)	<1	<1	<1	<1	<1	<1
Copper (Cu)	<1	1	1	<1	<1	<1
Tin (Sn)	<1	1	<1	<1	<1	<1
Aluminium (Al)	<1	<1	<1	<1	2	<1
Nickel (Ni)	<1	<1	<1	<1	<1	<1
Silver (Ag)	<1	<1	<1	<1	<1	<1
Titanium (Ti)	<1	<1	<1	<1	<1	<1
Vanadium (V)	<1	<1	<1	<1	<1	<1
Contaminants (ppm)						
Silicon (Si)	1	1	<1	<1	1	1
Sodium (Na)	32	23	18	17	14	32
Potassium (K)	<1	<1	<1	<1	<1	<1
Additives (ppm)						
Magnesium (Mg)	7	6	6	5	4	7
Calcium (Ca)	97	73	62	52	40	97
Barium (Ba)	<1	<1	<1	<1	<1	<1
Phosphorus (P)	44	46	42	42	43	44
Zinc (Zn)	18	11	8	8	9	18
Molybdenum (Mo)	1	1	1	<1	<1	<1
Boron (B)	<5	<5	<5	<5	<5	<5
Contaminants						
Water (%)	<.1	<.1	<.1	<.1	<.1	<.1
Physical Tests						
Viscosity (cSt 40C)	114.0	113.0	112.0	113.0	110.0	114.0
Physical / Chemical						
Acid Number (mgKOH/g)	0.22	0.09	0.11	0.08	0.13	0.22
Oxidation (Abs/0.1mm) E2412/D7414	25	20	20	20	19	25
Nitration (Abs/0.1mm) E2412	3	2	2	2	2	
Additional						
Antimony	<1	<1	<1	<1	<1	<1

Data trends from right to left

Rotary Screw Air Compressor
Water

Metals (ppm)						
Iron (Fe)	1	<1	<1	7	<1	<1
Chromium (Cr)	<1	<1	<1	<1	<1	<1
Lead (Pb)	<1	<1	<1	<1	<1	<1
Copper (Cu)	2	4	3	6	6	5
Tin (Sn)	<1	<1	1	<1	<1	<1
Aluminium (Al)	<1	1	1	<1	<1	<1
Contaminants						
Water (%)		<.1		0.85	0.19	0.21
Contaminants (ppm)						
Silicon (Si)	2	<1	<1	<1	<1	2
Sodium (Na)	<1	<1	<1	1	<1	<1
Potassium (K)	<1	1	<1	<1	1	<1
Additives (ppm)						
Magnesium (Mg)	<1	<1	<1	<1	<1	<1
Calcium (Ca)	1	2	<1	<1	<1	3
Barium (Ba)	<1	<1	<1	<1	<1	<1
Phosphorus (P)	221	175	191	183	157	185
Zinc (Zn)	7	11	7	6	6	7
Molybdenum (Mo)	<1	<1	<1	<1	<1	<1
Boron (B)	<5	<5	<5	<5	<5	<5
Contaminants						
Water (%)	<.1	0.85	0.19	0.21	<.1	<0.05
Physical Tests						
Viscosity (cSt 40C)	32.5	33.0	32.8	33.7	34.2	33.7
Additional						
Antimony	1	1	<1	2	1	1

Data trends from right to left

Reciprocating Natural Gas Compressor

With Engine Oil

Metals (ppm)						
Iron (Fe)	2	2				
Chromium (Cr)	<1	<1				
Lead (Pb)	<1	<1				
Copper (Cu)	<1	<1				
Tin (Sn)	<1	<1				
Aluminium (Al)	2	3				
Nickel (Ni)	<1	<1				
Silver (Ag)	<1	<1				
Titanium (Ti)	<1					
Vanadium (V)	<1	<1				
Contaminants (ppm)						
Silicon (Si)	2	2				
Sodium (Na)	<1	<1				
Potassium (K)	<1	<1				
Additives (ppm)						
Magnesium (Mg)	8	8				
Calcium (Ca)	1214	1272				
Barium (Ba)	<1	<1				
Phosphorus (P)	275	284				
Zinc (Zn)	329	342				
Molybdenum (Mo)	1	1				
Boron (B)	<5	<5				
Contaminants						
Water (%)	<.1	<.1	<.1	<.1	<.1	<.1
Physical Tests						
Viscosity (cSt 40C)	125.0		124.0	124.0	123.0	122.0
Physical / Chemical						
Acid Number (mgKOH/g)	0.53	0.49	0.55	0.48	0.53	0.59
Oxidation (Abs/0.1mm) E2412/D7414	5	5	5	5	6	5
Nitration (Abs/0.1mm) E2412	3	3	3	3	3	3
Additional						
Antimony	<1	<1	<1	1	<1	<1

Additives (ppm)	
Magnesium (Mg)	8
Calcium (Ca)	1214
Barium (Ba)	<1
Phosphorus (P)	275
Zinc (Zn)	329
Molybdenum (Mo)	1
Boron (B)	<5
Contaminants	
Water (%)	<.1
Physical Tests	
Viscosity (cSt 40C)	125.0
Physical / Chemical	
Acid Number (mgKOH/g)	0.53

Data trends from right to left

Reciprocating Natural Gas Compressor
Wear Metals

Metals (ppm)						
Iron (Fe)	7	7	20	6	8	3
Chromium (Cr)	<1	<1	<1	<1	<1	<1
Lead (Pb)	2	2	4	1	4	2
Copper (Cu)	7	7	29	5	20	10
Tin (Sn)	<1	<1	2	<1	1	1
Aluminium (Al)	2	<1	1	<1	<1	1
Nickel (Ni)	<1	<1	<1	<1	<1	<1
Silver (Ag)	<1	<1	<1	<1	<1	<1
Titanium (Ti)	<1	<1	1	<1	<1	<1
Vanadium (V)	<1	<1	<1	<1	<1	<1
Contaminants (ppm)						
Silicon (Si)	2	3	5	3	2	2
Sodium (Na)	3	3	5	3	2	1
Potassium (K)	1	<1	<1	<1	<1	<1
Additives (ppm)						
Magnesium (Mg)	5	5	6	6	7	7
Calcium (Ca)	1136	1184	1166	1216	1104	1141
Barium (Ba)	<1	<1	<1	<1	<1	<1
Phosphorus (P)	261	271	276	263	262	261
Zinc (Zn)	313	326	317	329	306	314
Molybdenum (Mo)	1	1	1	1	1	1
Boron (B)	<5	<5	<5	<5	<5	<5
Contaminants						
Water (%)	<0.05	<.1	<.1	<.1	<.1	<.1
Physical Tests						
Viscosity (cSt 100C)	11.0	11.5	12.0	12.3	10.1	11.4
Additional						
Antimony	<1	<1	<1	<1	<1	<1

Data trends from right to left

Centrifugal Air Compressor
Particle Count

Metals (ppm)						
Iron (Fe)	1	1	1	<1		
Chromium (Cr)	<1	<1	<1	<1		
Lead (Pb)	<1	1	<1	<1		
Copper (Cu)	<1	<1	<1	<1		
Tin (Sn)	1	<1	<1	<1		
Aluminium (Al)	<1	<1	<1	<1		
Nickel (Ni)	<1	<1	<1	<1		
Silver (Ag)	<1	<1	<1	<1		
Titanium (Ti)	<1	<1	<1	<1		
Vanadium (V)	<1	<1	<1	<1		
Contaminants (ppm)						
Silicon (Si)	1	<1	1	<1		
Sodium (Na)	<1	<1	<1	<1		
Potassium (K)	<1	<1	<1	1		
Additives (ppm)						
Magnesium (Mg)	<1	<1	<1	<1		
Calcium (Ca)	<1	1	1	2		
Barium (Ba)	<1	<1	1	<1		
Phosphorus (P)	3	3	7	4		
Zinc (Zn)	2	4	1	3		
Molybdenum (Mo)	<1	<1	<1	<1		
Boron (B)	<5	<5	<5	<5		
Contaminants						
[illegible]	0	0	0.001	0		
Physical Tests						
Viscosity (cSt 40C)	33.0	32.7	33.1	34.0	33.0	33.0
Physical / Chemical						
Acid Number (mgKOH/g)	0.01	0.01	0.01	0.03	0.01	0.01
Particle Count						
ISO 4406 Rating	16/14/11	16/14/11	15/13/9	17/16/13	16/14/12	16/15/13
> 4 Micron (particles/ml)	366	368	206	870	390	566
> 6 Micron (particles/ml)	134	132	61	336	150	285
> 14 Micron (particles/ml)	16	14	4	45	34	64
> 21 Micron (particles/ml)	4	3	1	8	23	30
> 38 Micron (particles/ml)	<1	<1	<1	1	1	3
[illegible]						
Antimony	<1	<1	<1	1	<1	<1

Physical Tests	
Viscosity (cSt 40C)	33.0
Physical / Chemical	
Acid Number (mgKOH/g)	0.01
Particle Count	
ISO 4406 Rating	16/14/11
> 4 Micron (particles/ml)	366
> 6 Micron (particles/ml)	134
> 14 Micron (particles/ml)	16
> 21 Micron (particles/ml)	4
> 38 Micron (particles/ml)	<1

Data trends from right to left

Rotary Vane Vacuum Pump
SAE 30

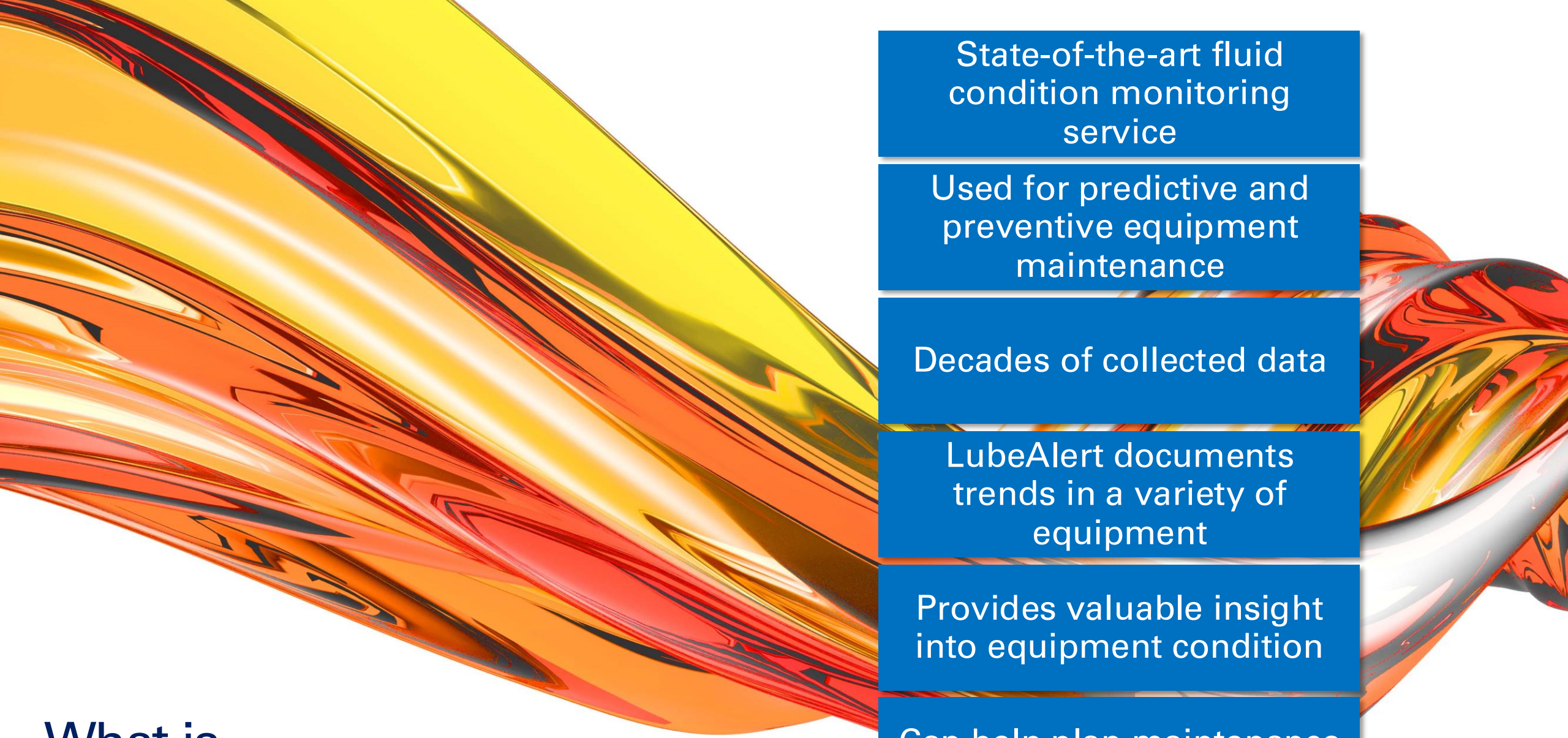
Metals (ppm)	
Iron (Fe)	5
Chromium (Cr)	<1
Lead (Pb)	1
Copper (Cu)	<1
Tin (Sn)	1
Aluminium (Al)	1
Nickel (Ni)	<1
Silver (Ag)	<1
Titanium (Ti)	<1
Vanadium (V)	<1
Contaminants (ppm)	
Silicon (Si)	8
Sodium (Na)	7
Potassium (K)	1
Additives (ppm)	
Magnesium (Mg)	602
Calcium (Ca)	821
Barium (Ba)	<1
Phosphorus (P)	724
Zinc (Zn)	770
Molybdenum (Mo)	39
Boron (B)	12

Contaminants	
Water by Karl Fischer %	0.062
Physical Tests	
Viscosity (cSt 100C)	12.6
Physical / Chemical	
Acid Number (mgKOH/g)	1.63
Particle Count	
ISO 4406 Rating	24/23/19
> 4 Micron (particles/ml)	126760
> 6 Micron (particles/ml)	68711
> 14 Micron (particles/ml)	4947
> 21 Micron (particles/ml)	869
> 38 Micron (particles/ml)	66
Additional	
Antimony	2

- **Oil Flooded Vacuum Pump**
- **Viscosity High for SAE 30**
- **High Particle Count**
- **Particles from Vane to Rotor Contact**
- **Moist/Salty Air Intake**
- **Not Suitable for continued use**

LubeAlert®

Fluid Condition Monitoring Service



What is LubeAlert

State-of-the-art fluid condition monitoring service

Used for predictive and preventive equipment maintenance

Decades of collected data

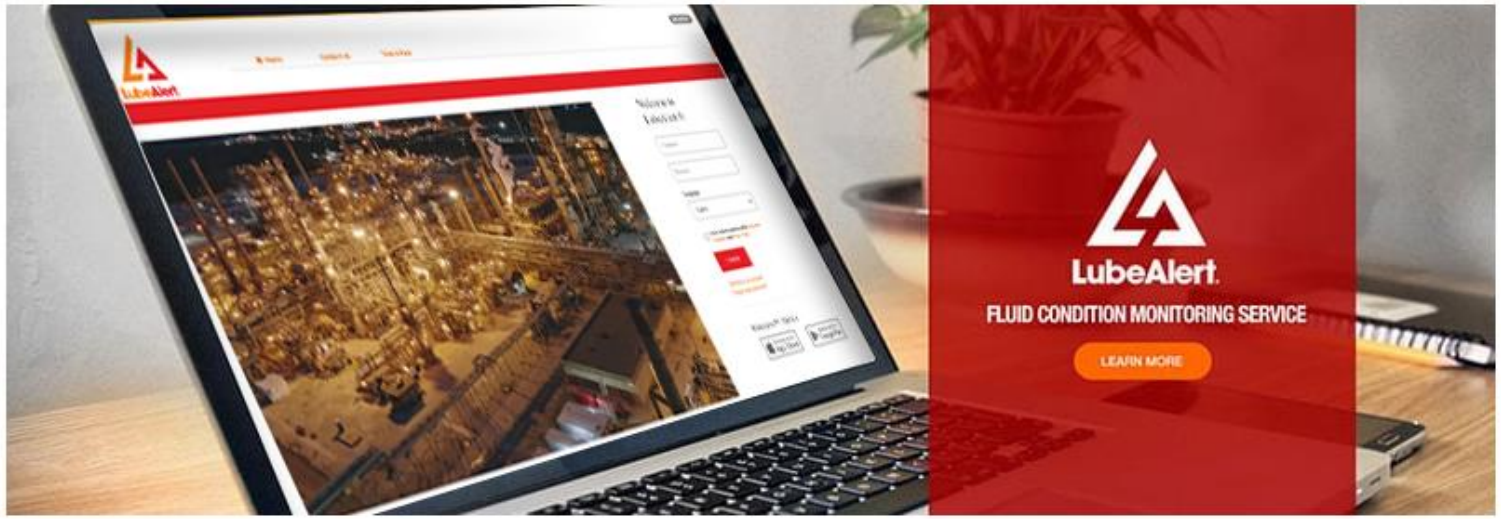
LubeAlert documents trends in a variety of equipment

Provides valuable insight into equipment condition

Can help plan maintenance activities

LubeAlert on MarketNet

Click



CITGO LubeAlert® Fluid Condition Monitoring Service - Flexible, Responsive and Quality Driven

The CITGO LubeAlert® Fluid Condition Monitoring Service is a tool used for predictive and preventative equipment maintenance. LubeAlert provides state-of-the-art oil analysis methods for engines, compressors, hydraulic systems, gears, turbines and many other lubricated components used in a variety of industries. With decades of collected data, trends can be generated for a variety of equipment. With WebTrieve for LubeAlert, customers can gain valuable insight into equipment and fluid condition, and plan maintenance activities. For more information, check out the FAQs, review the LubeAlert Program Guide, and review the Sample Submission Guide to learn how to submit samples for analysis.

LubeAlert Test Packages

- Five Tiers
- Component Based Menu
- Shipping Bundles
- Add–on Tests

LubeAlert
Test Packages

LubeAlert BASIC	Elemental Metals by ICP	Fuel Soot %	Fuel Dilution %	Water by Crackle	Viscosity @ 40	Viscosity @ 100	Acid Number	Base Number by FTIR	Ox/Nit/Sul by FTIR	Particle Count	Particle Quantification Index	Test Package Tier Level
	ASTM D5185	ASTM D7844	Viscosity Shift ASTM D7593	Crackle or ASTM D6304	ASTM D445	ASTM D445	ASTM D664	ASTM E2412	ASTM E2412	ASTM D7647	ASTM D8184	
Diesel Engine	X	X	X	X		X		X	X			Tier 1
Gasoline Engine	X			X		X		X	X			
Transmission	X			X		X			X			
Differential	X			X		X			X			
Stationary Gas Engine	X			X		X	X		X			Tier 2
All Gearboxes	X			X	X		X		X			
Natural Gas Compressor	X			X	X		X		X			
Air Compressor	X			X	X		X		X			
Refrigeration Compressor	X			X	X		X		X			
Industrial Hydraulics	X			X	X		X		X			
Bearings	X			X	X		X		X			
Gas Turbine	X			X	X		X		X			

LubeAlert BASIC

- Tier 1
- Tier 2

LubeAlert
Test Packages

LubeAlert ADVANCED	Elemental Metals by ICP	Fuel Soot %	Fuel Dilution %	Water by Crackle	Viscosity @ 40	Viscosity @ 100	Acid Number	Base Number by FTIR	Ox/Nit/Sul by FTIR	Particle Count	Particle Quantification Index	Test Package Tier Level
	ASTM D5185	ASTM D7844	Viscosity Shift ASTM D7593	Crackle or ASTM D6304	ASTM D445	ASTM D445	ASTM D664	ASTM E2412	ASTM E2412	ASTM D7647	ASTM D8184	
Diesel Engine	X	X	X	X		X		X	X		X	Tier 3
Gasoline Engine	X			X		X	X	X	X		X	
Stationary Gas Engine	X			X		X	X	X	X		X	
Transmission	X			X		X	X		X		X	
Differential	X			X		X	X		X		X	
All Gearboxes	X			X	X		X		X		X	
Natural Gas Compressor	X			X	X		X		X	X		Tier 4
Air Compressor	X			X	X		X		X	X		
Refrigeration Compressor	X			X	X		X		X	X		
Industrial Hydraulics	X			X	X		X		X	X		
Bearings	X			X	X		X		X	X		
Gas Turbine	X			X	X		X		X	X		

LubeAlert ADVANCED

- Tier 3
- Tier 4

LubeAlert
Test Packages

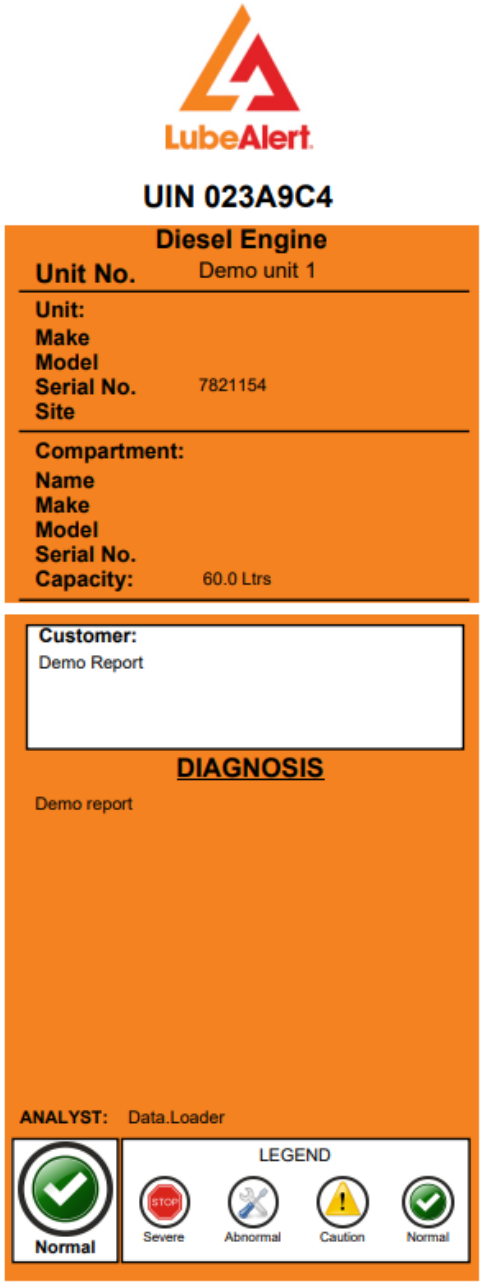
LubeAlert ADVANCED	Elemental Metals by ICP	Glycol Contamination	iPh	Water by Crackle	Viscosity @ 40	Viscosity @ 100	Acid Number	Base Number by FTIR	Ox/Nit/Sul by FTIR	Particle Count	Particle Quantification Index	Test Package Tier Level
	ASTM D5185	ASTM D2982	ASTM D7946	Crackle or ASTM D6304	ASTM D445	ASTM D445	ASTM D664	ASTM E2412	ASTM E2412	ASTM D7647	ASTM D8184	
Landfill/Biogas Gas Engine	X	X	X	X		X	X	X	X		X	Tier 5

LubeAlert ADVANCED

- Tier 5

LubeAlert
Data Reports

- Baseline reference data
- EPA RICE NESHAP monitoring
- Competitive comparisons
- Diagnostician Comments
- Severity Flagging
- Trend Graphs



LubeAlert

UIN 023A9C4

Diesel Engine

Unit No. Demo unit 1

Unit:
Make
Model
Serial No. 7821154
Site

Compartment:
Name
Make
Model
Serial No.
Capacity: 60.0 Ltrs

Customer:
Demo Report

DIAGNOSIS

Demo report

ANALYST: Data.Loader

Normal

LEGEND: Severe, Abnormal, Caution, Normal

DATE SAMPLED	10-Nov-12	02-Oct-12	08-Aug-12
DATE RECEIVED	14-Jan-13	05-Dec-12	12-Oct-12
DATE REPORTED	16-Jan-13	07-Dec-12	17-Oct-12
LAB NO.	80000153891	80000153885	80000153881
SIF NO.	13687092	13687086	13687082
TIME ON UNIT Hrs	9302	50516	7555
TIME ON OIL Hrs	500	500	500
OIL BRAND	[redacted]	[redacted]	[redacted]
OIL TYPE			
OIL GRADE	SAE 40	SAE 40	SAE 40
OIL ADDED			
FILTER			
OIL CHANGED	Not Changed	Not Changed	Not Changed
WO NUMBER	[redacted]	[redacted]	[redacted]
Metals (ppm)			
Iron (Fe)	6	6	8
Chromium (Cr)	<1	<1	<1
Lead (Pb)	1	2	1
Copper (Cu)	2	2	2
Tin (Sn)	<1	<1	1
Aluminium (Al)	1	1	2
Nickel (Ni)	<1	<1	<1
Silver (Ag)	<1	<1	<1
Vanadium (V)	<1	<1	<1
Contaminants (ppm)			
Silicon (Si)	3	3	6
Sodium (Na)	2	<1	16
Potassium (K)	<5	<5	8
Water (%)	NotDetected	NotDetected	0.10
Additives (ppm)			
Magnesium (Mg)	7	7	8
Calcium (Ca)	2952	2796	2742
Barium (Ba)	<1	<1	<1
Phosphorus (P)	42	40	38
Molybdenum (Mo)	43	36	31
Boron (B)	<5	<5	<5
Physical Tests			
Viscosity (cSt 100C)	14.9	15.2	12.5
Soot (%) Infrared D7844	0.4	0.3	0.3
PQ Index	<10	<10	833
Physical / Chemical			
Base Number (mgKOH/g)	9.5	8.9	9.0
Oxidation (Abs/0.1mm) E2412/D7414	13	8	5

Page 1 of 2

LubeAlert
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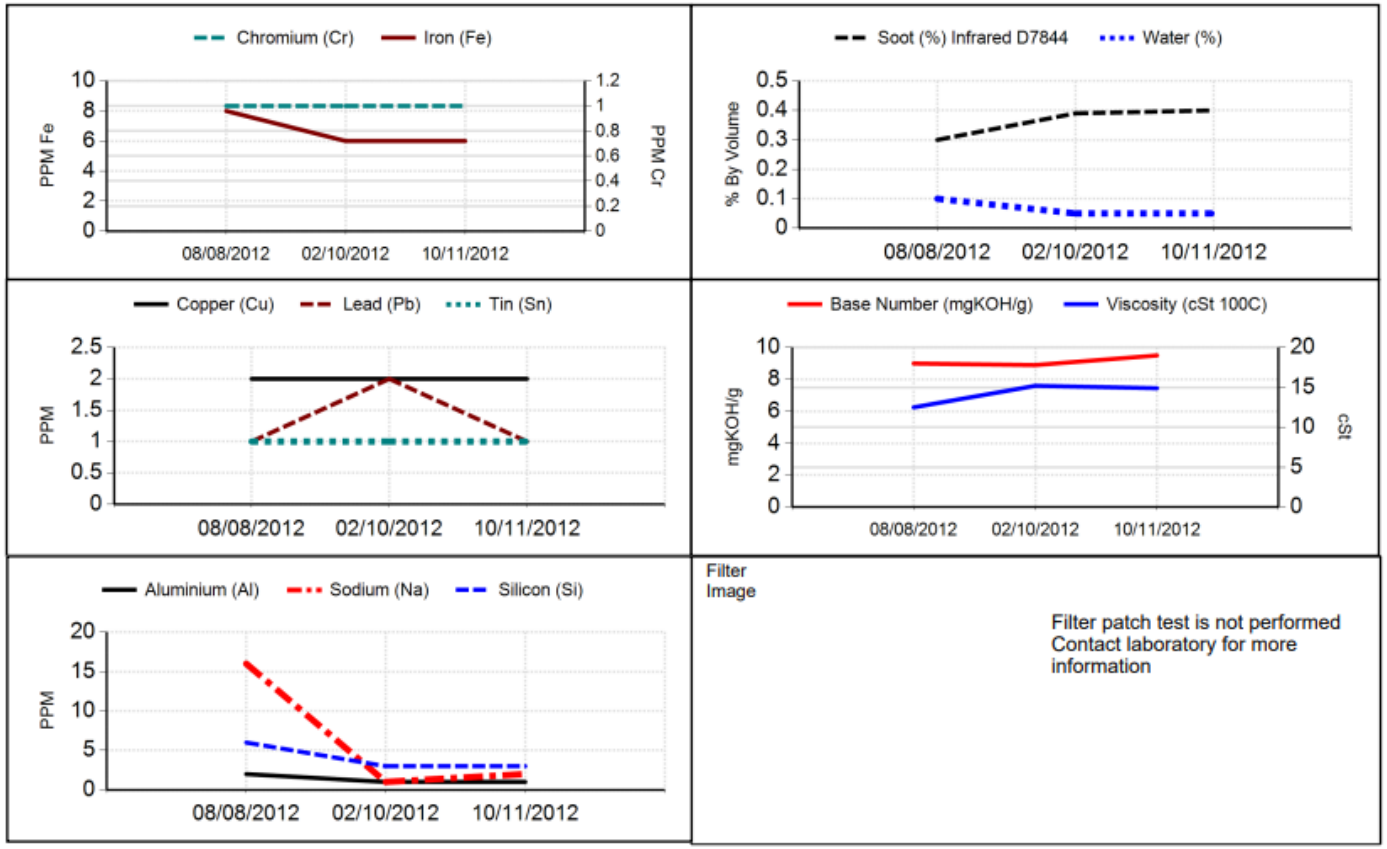

Since services are based on samples and information supplied by others, and since corrective actions, if any, are necessarily taken by others, these services are rendered without any warranty or liability of any kind beyond the actual amount paid to ALS Tribology for the services. Reported recommendations are based on interpretations of the generated test results and historical data. Certain test results appearing in this report may have been tested at other ALS laboratories within the Tribology divisional network.

Demo

0487 v1.1

(844) 669-5608

UIN 033A9B4

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Building 200 Suite 245
Norcross, GA 30093

Valley View, Ohio - 410
6180 Halle Dr. Suite D
Valley View, OH 44125

Kansas City, Kansas - 430
935 Sunshine Road
Kansas City, KS 66115

Phoenix, Arizona - 440
3319 West Earll Drive
Phoenix, AZ 85017

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Prague

New Zealand
Wellington

South America
Santiago de Chile, Belo Horizonte, Brazil

Southeast Asia
Kuala Lumpur, Singapore

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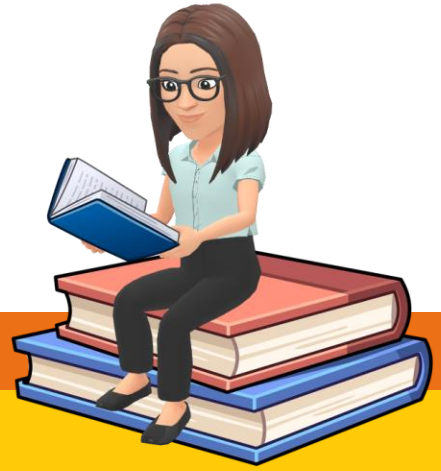
Questions?



Please post your questions using the Q&A function.

For technical inquiries or issues:
Lubes Answer Line 800-248-4684
lubeshelp@citgo.com

CITGO LUBRICANTS

Thank You!

See you next time