Compressors and Compressor Fluids

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Agenda

- Compressor basics
- Compressor types
- Compressor services
- Selection factors for compressor lubrication
- Compressor fluid properties
- CITGO compressor fluid portfolio

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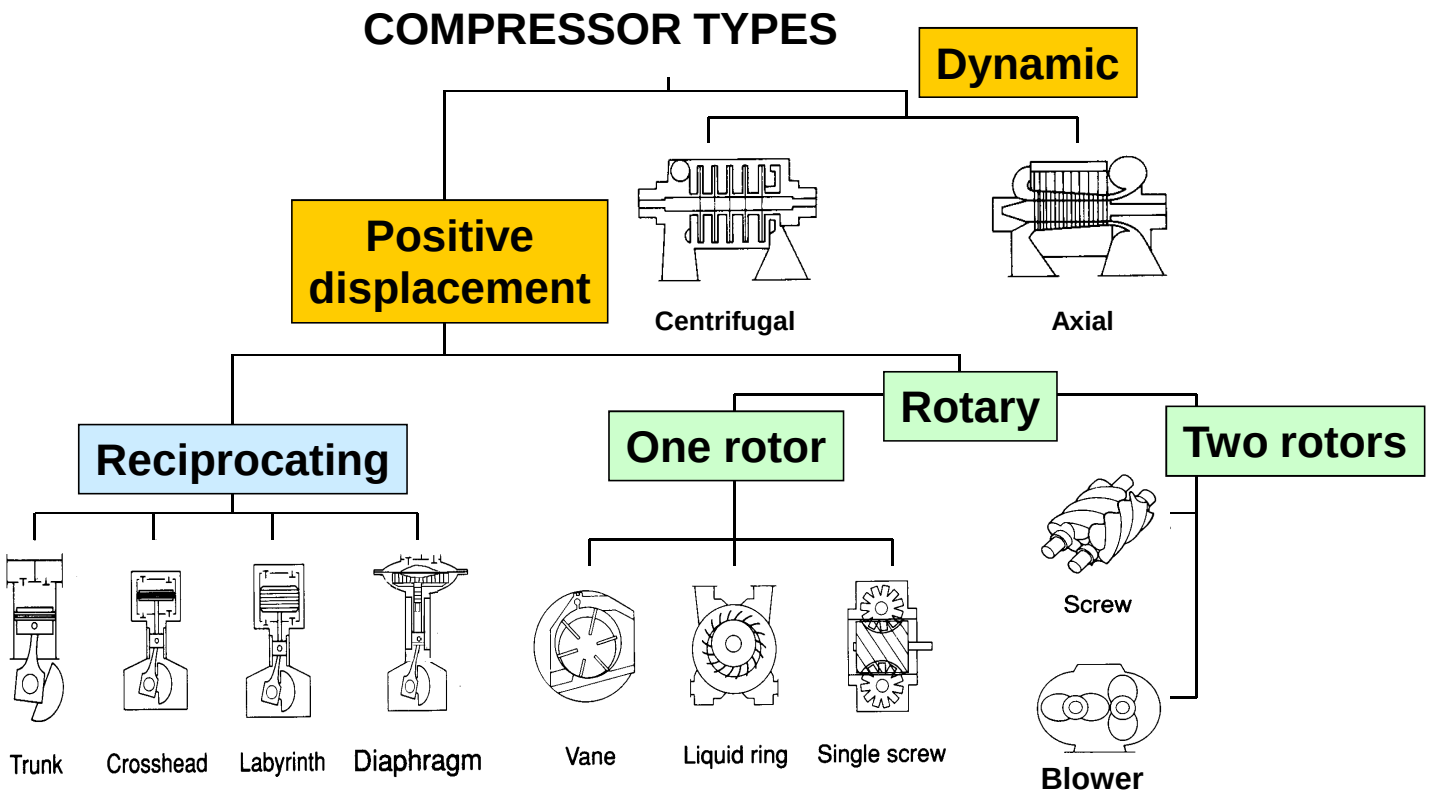
Compressor Basics and Types

Compressor Basics

- A compressor can be thought of as a pump for gases
- Like a pump for liquids, it increases the pressure of the gas
- The compressor takes in gas, compresses it, and delivers it at a higher pressure
- The volume of the gas decreases as it is compressed, and the temperature increases
- Different types of gases can be compressed

$$PV = nRT$$

Types of Compressors



Compressor Usage

- Reciprocating compressors
  - oldest type, still commonly used but in decline (< 15%)
  - able to deliver over wide range of pressures and flow rates
  - usually used to deliver air at up to 150 psi and 3500 ft^3/min
  - can go to very high pressures
    - 5,800 psi - for natural gas reinjection
    - 50,000 psi – Hyper-compressors for LDPE manufacture

- Rotary compressors
  - ~ 85% of market
  - used in industrial air applications for pressures up to 150 psi
  - more compact, quieter and cheaper to run than reciprocating compressors

Compressor Fluid Functions

- Seal the Compression Mechanism
- Transfer Heat from the Compression Area
- Lubricate Moving Parts
- Protect the Metal Parts of the Compressor

Major Compressor OEMs

- Atlas Copco
- Ingersoll-Rand
- Gardner Denver
- Kaeser
- CompAir
- Sullair
- Quincy
- LeROI
- Ariel

OEM Compressor Fluids

- Most compressor OEMs sell their own branded fluids
  - Ensures that the proper lubricant is used
  - Protects brand name
  - Increases OEM revenue
  - Private label - not blended by the compressor OEM
- OEMs often tie equipment warranty and extended warranty to the use of their OEM fluid
  - OEM fluids are generally very high priced
  - After the warranty period, other products may be used

Compressor Fluid Service Providers

- In many cases, an outside company maintains a plant’s compressors, including lubrication
- Compressor fluids are often provided as part of the service
- Service providers often have their own private label compressor fluids, produced by others
- Excellent targets for selling compressor fluids

Compressor Services

Air

Gas

Refrigeration

Vacuum

Compressor Services

- Air
- Gas
  - Natural Gas (Methane)
  - LPG (Propane/Butane)
  - Other Hydrocarbons (e.g. Ethylene)
  - Nitrogen
  - Hydrogen
- Refrigeration
  - Ammonia
  - Hydrofluorocarbons (HFC)
  - Hydrochlorofluorocarbons (HCFC)
- Vacuum

Air Compressors

- The most important use of compressors is the production of compressed air.
- This instant, safe, and flexible source of energy is used to:
  - drive pneumatic tools
  - operate machinery
  - control manufacturing processes of many types
  - provide cooling

Air Compressors

Why are compressors one of the most critical pieces of equipment in the plant?

Air Compressors

Why are compressors one of the most critical pieces of equipment in the plant?

Compressed air runs a lot of different equipment and control systems. Often if the plant loses compressed air, the entire plant shuts down.

Air Compressors

Where do you find compressors when doing lubrication surveys?

Air Compressors

Where do you find compressors when doing lubrication surveys?

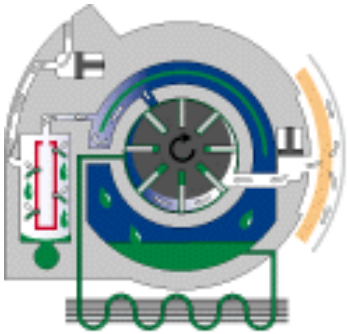
Because compressors generate a lot of heat and noise, they are often located in remote areas of the plant. Sometimes customers have separate rooms or even buildings for air compressors.

Rotary Air Compressors

Principle of operation:

The generation of pressure through a rotating action, where the swept volume decreases resulting in an increase in pressure

The compressor may contain:

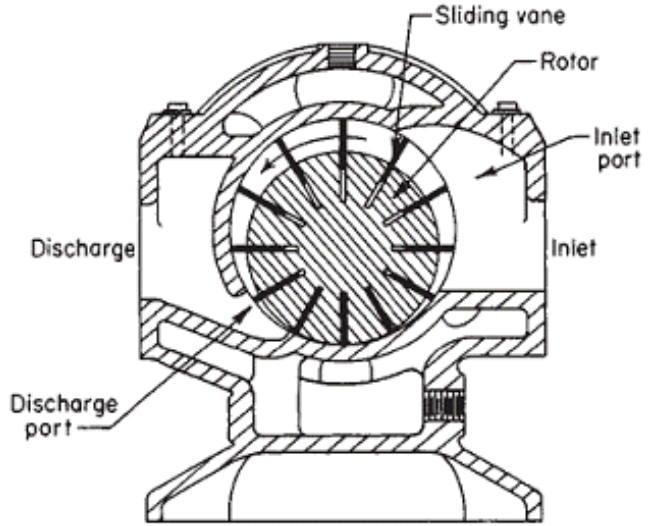


- one rotor
  - sliding vane
  - single screw

- two rotors
  - twin screw

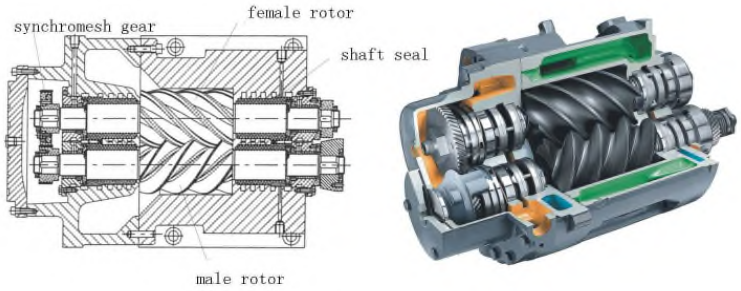
Rotary Vane Compressor

- Air drawn through intake
- Air becomes trapped between rotor and stator wall
- Volume of air decreases by vanes being returned into slots in stator wall
- As volume decreases, pressure increases
- High pressure air passes into primary oil separator
- Traces of oil removed in final separator element
- Air flow regulated by servo-valve



Rotary Screw Compressor

- The ends of the two counter-rotating rotors uncover the inlet and air enters the compression chamber.
- The air is drawn in, compressed between the rotors and the housing formed by a male lobe and a female flute. Injected oil seals the clearances and lubricates the rotors and bearings.
- As the rotors turn, the compartment becomes progressively smaller, thereby compressing the entrapped air.
- Compressed air leaves through the outlet port.



Screw Compressor Structure

Rotary Air Compressor Lubrication

In rotary screw and vane compressors, oil is required to:

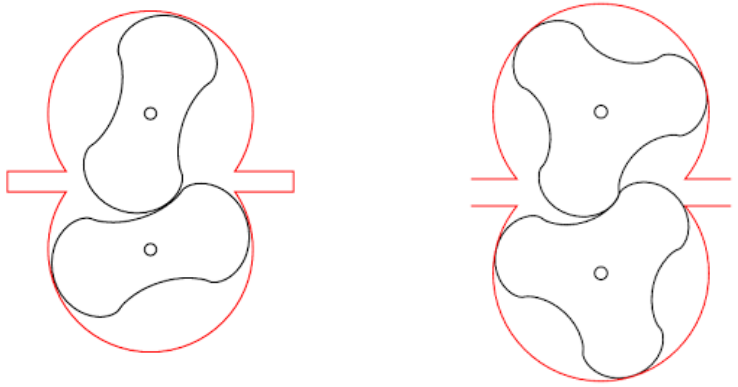
- Lubricate moving parts, especially the vanes (rotary vane) or the intermeshing lobes (screw)
- Seal the internal clearances
- Transfer heat from the gas during compression
- Protect against corrosion
- Keep the oil separator clean

Blower Lubrication

Blowers (e.g. Roots Blower) do not produce the same high pressure as a conventional compressor, but require special lubrication.

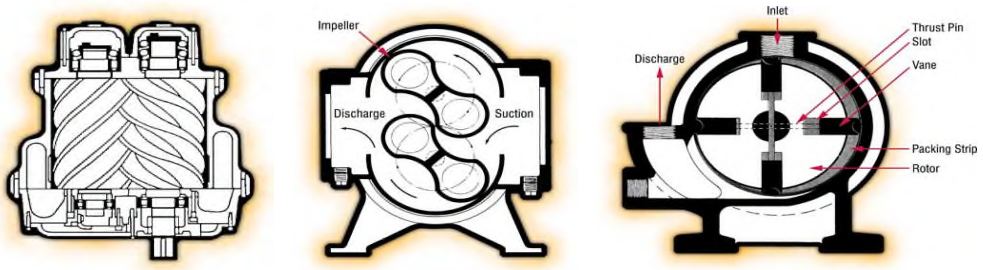
- Synthetic, non-EP R&O fluid

- **CITGO CITGEAR® Synthetic HT Lubricants**



Typical Rotary Air Compressor Problems

- High Compression Temperatures
  - Oxidation and Thermal Stability, Deposit Control
- Condensation of Water
- Air-Oil Separator Blockage
- Foaming and Air Release
- Abrasive Contaminants



Typical Reciprocating Air Compressor Problems

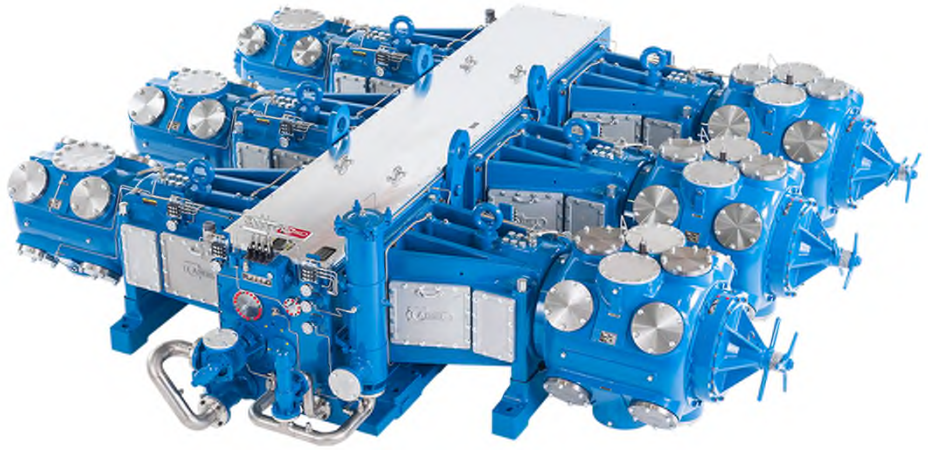
- High Temperature Operation
- Deposit formation on valves and air lines
  - Thin film thermal/oxidative breakdown, can lead to coke formation and safety issues in air lines
- Corrosion resistance properties

Air Compressor Explosions and Fires

- Air compressors running on mineral oil based lubricants can have significant formation of coke deposits
- Those deposits can contain peroxides that initiate the explosion
- The deposit material and any oil in the air combust, leading to an explosion
- Higher pressure and temperature make it more likely
- The use of synthetic compressor lubricants significantly reduces the chance of air compressor explosions and fires

Gas Compressors

- Typically large reciprocating compressor
- Multiple cylinders
- Single or double acting
- High volume
- Driven by a gas engine
- Remote compressor stations



Refrigeration Compressors

- Used in:
  - Air conditioning
  - Refrigeration
  - Freezers

Refrigerants and Lubricants

Refrigerant		Recommended Lubricant
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	PAG, AB, Min Oil
CO_2	R-744	AB, POE

Min Oil = Mineral Oil

AB = Alkylbenzene

POE = Polyol Ester

PAG = Polyalkylene Glycol

Compressor Fluid Composition

- Base Stocks (90-95%)
  - Mineral or Synthetic

- Performance Components
  - Antioxidant
  - Rust Inhibitor
  - Antiwear Additive
  - Corrosion Inhibitor
  - Pour Point Depressant
  - Foam Inhibitor
  - Special Property Additives

Compressor Fluids

Selection Factors

Gear Lubricant Selection Factors

- Type of Compressor
- Gas Being Compressed
- Operating Conditions
- OEM Recommendation
- Prior Lubricant
- Past Problems
- Process Concerns
- Call the Answer Line for Assistance

Compressor Fluid Properties

Compressor Fluid Properties

- Viscosity and Viscosity Index – D445, D2270
- Water Shedding and Demulsibility – D1401, D2711
- Oxidation Stability – D943, D2272
- Thermal Stability – D2070
- Rust Prevention – D665A/B
- Corrosion Prevention – D130
- Foaming Resistance – D892
- Air Release – D3427
- Wear Prevention – D4172

Compressor Fluid Filtration

- Small air compressors usually have no oil filters, or small filters built in
- Larger compressors typically have an oil sump and circulation pump with an in-line filter
- Filters should be changed periodically, based on pressure drop across the filter or OEM recommendations
- Filter pore size should be selected based on the OEM recommendation
- Used filters can be analyzed to determine contaminants and wear metals

Compressor Fluid Analysis

LubeAlert

- Air compressor lubricants
- Natural gas compressor lubricants
- PAG-based gas compressor lubricants
- Refrigeration compressor lubricants

LubeAlert Tests (package GREG)

- Kinematic Viscosity, cSt @ 40°C
- Elemental Analysis (ICP)
- Moisture (hot plate)

CITGO Compressor Fluid Portfolio

CITGO Compressor Fluid Portfolio

Air Compressor Fluids

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

CITGO Compressor Fluid Portfolio

Gas Compressor Fluids

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

CITGO Compressor Fluid Portfolio

Refrigeration Compressor Fluids

- Ice Machine Oil 68
- North Star® Refrigeration Oils 32 and 54
- North Star® Refrigeration Oil 68
- CompressorGard® IPG 100
- Mystik® Ammonia Compressor Oil 68
- Clarion® Synthetic Refrigeration Fluid

CITGO Compressor Fluid Portfolio

Vacuum Pump Fluids

- Pacemaker HV-39
- Pacemaker HV-68
- Clarion CompressorGard 68

CITGO Air Compressor Fluids

- **CITGO Compressor Oils 35LP and 45LP**
  - Reciprocating air and natural gas compressors
  - Non-detergent, non-foaming
  - R&O plus demulsibility
  - 35LP – 115 cSt @ 40°C, 45LP – 171 cSt @ 40°C

- **CITGO CompressorGard® DE**
  - Diester base fluids
  - Superior thermal and oxidation stability
  - Low temperature fluidity
  - Excellent deposit control
  - Check materials compatibility – seals, paints, coatings
  - Reciprocating and rotary air compressors
  - ISO 32, 68, 100, 125, and 150

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CITGO Air Compressor Fluids

- **CITGO CompressorGard® GE**
  - PAG/Alkylated Hydrocarbon base fluids
  - Excellent thermal and oxidation stability and deposit control
  - ISO 32 and 46, dyed blue-green
  - ISO 32 for Sullair Rotary Screw Compressors
  - ISO 46 for Ingersoll-Rand Rotary Screw Compressors

- **CITGO CompressorGard® PAO**
  - Based on Polyalphaolefin (PAO) base fluids
  - Suitable for wide temperature range applications
  - Outstanding thermal and oxidation stability and deposit control
  - Excellent rust protection, antiwear properties, demulsibility
  - Rotary vane, rotary screw, and centrifugal compressors
  - ISO 32, 46, 68, 100, and 150

CITGO Air Compressor Fluids

- **CITGO CompressorGard® PS 68**
  - Semi-synthetic formulation
  - Good thermal and oxidation stability, good deposit control
  - Low fluid carry-over, excellent demulsibility
  - Rotary vane, rotary screw, and centrifugal compressors
  - ISO 68 viscosity grade

- **Clarion® CompressorGard®**
  - Based on Polyalphaolefin (PAO) base fluids
  - Food grade, NSF H-1 registered
  - Suitable for wide temperature range applications
  - Excellent thermal and oxidation stability and deposit control
  - Excellent rust protection, antiwear properties, demulsibility
  - Rotary screw and rotary vane compressors
  - ISO 32, 46, and 68

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CITGO Gas Compressor Fluids

- **CITGO Compressor Oil 7585**
  - Mineral oil based, 267 cSt @ 40°C, 120 VI
  - Reciprocating compressors
  - Sour, wet, high-pressure natural gas
  - Excellent corrosion protection
  - Resistant to water and liquid hydrocarbons

- **CITGO CompressorGard® H**
  - Polyalphaolefin (PAO) base fluids
  - Excellent thermal and oxidation stability and deposit control
  - Excellent low-temperature service
  - Reciprocating compressors
  - Hydrogen, natural gas, sour gas
  - ISO 100 and 220

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CITGO Gas Compressor Fluids

- **CITGO CompressorGard® PAG**
  - Polyalkylene Glycol (PAG) base fluids
  - Reciprocating, rotary screw, and rotary vane compressors
  - Natural gas, CO_2, H_2, He, N_2, NH_3, other polar gases
  - Resistant to gas absorption and hydrocarbon dilution
  - Maintain viscosity better than mineral oil or PAO based fluids
  - ISO 80, 150, and 220

- **CITGO CompressorGard® SS**
  - Semi-synthetic - Group II mineral oil plus synthetic components
  - Excellent thermal and oxidation stability and deposit control
  - Excellent corrosion resistance in sour gas (H_2S) service
  - Reciprocating, rotary screw, and rotary vane compressors
  - ISO 100 and 150

CITGO Gas Compressor Fluids

- **CITGO CompressorGard® XA 200**
  - Group II mineral oil based
  - R&O, excellent thermal and hydrolytic stability
  - Reciprocating compressors
  - Sour, wet, high-pressure gases, CO_2, H_2S, NH_3, SO_2
  - 180 cSt @ 40°C

- **CITGO Gascom® R**
  - Mineral oil based
  - Wet, scrubbed, or processed natural gas
  - Resists washing by water or liquid hydrocarbons
  - ISO 220

CITGO Refrigeration Compressor Fluids

- **CITGO Ice Machine Oil 68**
  - Group II mineral oil based, ISO 68
  - Low pour point
  - Inhibited against foam
  - R-717 Ammonia (NH_3) refrigerant
  - Meets requirements of Frick Refrigeration Oil #3

- **CITGO North Star® Refrigeration Oils 32 and 54**
  - Naphthenic mineral oil based, ISO 32 and 54
  - Very low acid number, low pour and floc points
  - Excellent foam resistance
  - CFC and HCFC refrigerants (R-12, R-22)
  - Not for HFC refrigerant (R-134a)

Clarion Refrigeration Compressor Fluids

CITGO North Star® Refrigeration Oil 68

- Based on a paraffinic/naphthenic mineral oil blend, ISO 68
- Very low acid number, low pour and floc points
- Inhibited against foam
- CFC and HCFC refrigerants (R-12, R-22)
- Not for HFC refrigerant (R-134a)

CITGO CompressorGard® IPG 100

- Based on PAG synthetic fluid
- High viscosity index – increased viscosity at high temperature
- Excellent R&O, antiwear, and water separation properties
- Reciprocating, rotary screw, and rotary vane compressors
- R-290 Propane (C_3H_8) refrigerant

CITGO Refrigeration Compressor Fluids

- **Mystik® Ammonia Compressor Oil 68**
  - Based on naphthenic mineral oils, ISO 68
  - Low pour point
  - Thermally and chemically stable
  - R-717 Ammonia refrigeration systems

- **Clarion® Synthetic Refrigeration Fluid**
  - Based on polyalphaolefin (PAO) synthetic fluid, ISO 68
  - NSF H1 registered for use in food and beverage plants
  - Excellent low-temperature properties
  - Rotary screw compressors
  - Use with ammonia, CO_2, CFC (R-12), HCFC (R-22), mixtures
  - Not for use with HFC (R-134a) refrigerant

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CITGO Vacuum Pump Fluids

- Pacemaker HV-39
  - Based on API Group II mineral oil
  - 42 cSt @ 40°C (low end of ISO 46)
  - Very low vapor pressure
  - For use in direct drive vacuum pumps

- Pacemaker HV-68
  - Semi-synthetic base fluid
  - ISO 68
  - Very low vapor pressure
  - For use in belt driven vacuum pumps

Clarion Vacuum Pump Fluid

- **Clarion® CompressorGard® 68**
  - Based on Polyalphaolefin (PAO) base fluids
  - Food grade, NSF H-1 registered
  - Suitable for wide temperature range applications
  - Excellent thermal and oxidation stability and deposit control
  - Excellent rust protection, antiwear properties, demulsibility
  - Excellent service in vacuum pump applications
  - ISO 68

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CITGO Compressor System Cleaner

- **CITGO CompKleen® Synthetic Cleaner**
  - High performance cleaner
  - Loosen, remove, and suspend the varnish, sludge, and carbon typically found in rotary screw and rotary vane compressors
  - Use prior to each lubricant change
  - Typically 10% dosage
  - Operate system for 40 – 60 hours
  - Drain completely
  - Refill with fresh compressor lubricant
  - Excellent for use in conversion procedures

CITGO Synthetic Compressor Fluids

The following products are part of the Industrial Synthetic Lubricants portfolio:

- CITGO CompressorGard® DE
- CITGO CompressorGard® GE
- Clarion® CompressorGard®
- CITGO CompressorGard® H
- CITGO CompressorGard® PAG
- CITGO CompressorGard® IPG 100
- Clarion® Synthetic Refrigeration Fluid
- CITGO CompKleen® Synthetic Cleaner

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swiftship

These products qualify for the SwiftShip program, which can get product delivered directly to your customer in two to four days. No need to stock expensive synthetic products.

Questions

- Please post your questions using the Q&A function.

How to Contact Us

- Lubes Answer Line

800-248-4684

8:00 AM - 12:00 PM, 1:00 PM – 5:00 PM CT
Monday through Thursday

8:00 AM - 12:00 PM, 1:00 PM – 4:30 PM CT
Friday

lubeshelp@citgo.com

Future Webinars

March 18, 2022	Lubrication and Filtration Training for Trucks and Equipment - Presented by Steve Bowles
April 15, 2022	TBA
April 29, 2022	Tractor Lubrication