Using the Mobil Refrigeration Lubricant Selection Guide for Industrial Systems

To help determine the appropriate refrigeration lubricant required for your system, use our Mobil-branded Refrigeration Lubricant Selection Guide (available through your local representative or ExxonMobil Technical Help Desk) and follow the steps below:

Step 1. Obtain or confirm the following information on the application:

a. Refrigerant fluid in use

b. Evaporator is of dry type (oil carryover is < 15%) and evaporator temperature

c. Compressor type and outlet temperature

If the evaporator is confirmed to be of the flooded type (oil carryover to the evaporator is >15%), please contact your local representative or Technical Help Desk for assistance. If oil carryover to the evaporator is <15%, please proceed to **Step 2.**

Step 2. Use the Mobil-branded Refrigeration Lubricant Selection Guide to identify potential Mobil-branded refrigeration lubricant(s) for the application information confirmed in **Step 1.** If the product selector tool indicates both mineral and synthetic lubricants are acceptable for the application, synthetic lubricants will generally offer a higher level of performance than mineral oils with respect to equipment protection, compressor efficiency, and oil life.

Step 3. If the equipment is under warranty, confirm that the Mobil-branded lubricant(s) indicated by the product selector are approved/accepted for use by the builder.

Step 4. As refrigeration oils are sensitive to water contamination, procure oil in a package size that avoids storage of half-used containers.

Step 5. In changing refrigeration oil technology or brands, ensure thorough flushing of the system to minimize product contamination.

For more information on all Mobil Industrial Lubricants and services, contact your local company representative or visit www.mobilindustrial.com.

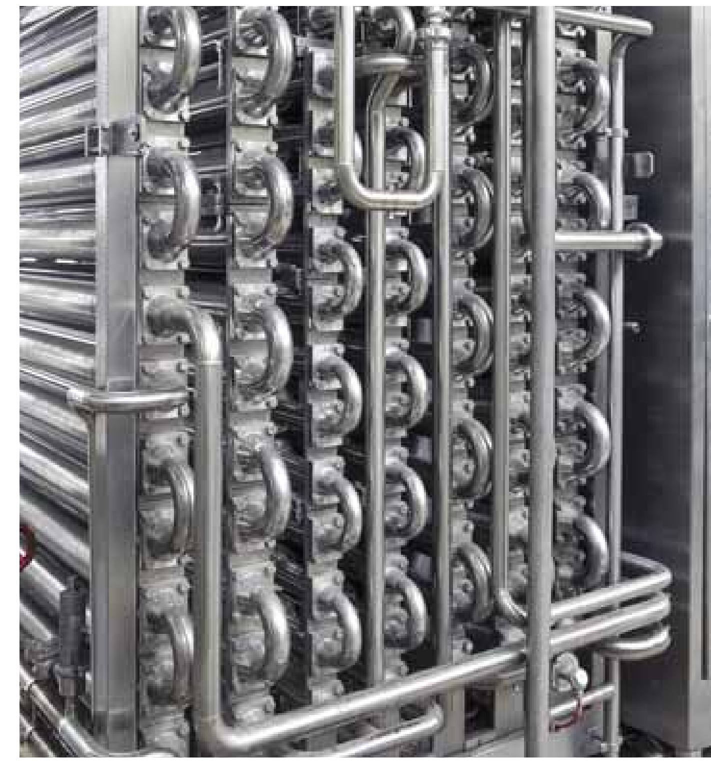
Mobil

Technical Topic

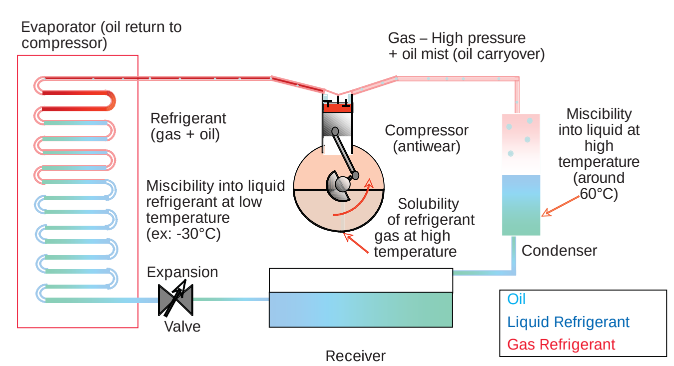
Refrigeration Lubricant Selection for Industrial Systems

Industrial Refrigeration Systems: An Introduction

Many of today's industrial refrigeration systems are compression-type systems (as opposed to absorption-type systems) where cooling is generated based on the evaporation of a refrigerant fluid such as Freon, ammonia, or carbon dioxide (CO_2). As illustrated below, the basic elements of these refrigeration units include the compressor, condenser, expansion valve, and evaporator. The refrigerant fluid flows under pressure through the expansion valve to the evaporator, where it changes state from liquid to vapor in order to generate the cooling effect. The cold refrigerant vapor, once at low pressure, is then compressed, raising its temperature and pressure. It then flows through the condenser, where it cools down and liquefies. The cooled refrigerant then flows again, under high pressure, through the expansion valve for the next cycle.



Refrigeration Process — Basics (compressor application)



For a given application, the refrigerant fluid is selected based on the following criteria:

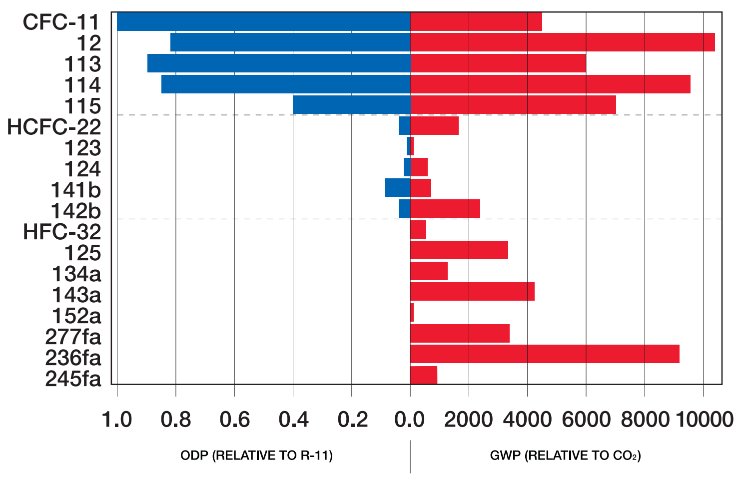
- Application requirements — nature and amount of cooling, evaporator temperature range, etc.
- Refrigerant thermodynamic characteristics
- Safety considerations, such as flammability and toxicity
- Cost — refrigerant and operational
- Regulatory compliance

Refrigerant Fluids

Refrigerant fluid technologies are generally referred to by their ASHRAE classification (ANSI-ASHRAE Standard 34-2001):

- R717 — Ammonia
- R12 — Chlorofluorocarbon (CFC)
- R22 — Hydrochlorofluorocarbon (HCFC)
- R600a — Isobutane
- R744 — Carbon dioxide (CO_2)
- R134a, R404a, R507 — Hydrofluorocarbons (HFC)

CFCs were banned under the Montreal Protocol (1989) due to Ozone Depletion Potential (ODP). HCFCs are in the process of being canceled due to their Global Warming Potential (GWP). Refer to the graph on the next page for refrigerant ODP and GWP ratings.



Ozone depletion potential (ODP) contrasted to global warming potential (GWP) for key single-compound refrigerants. CFCs generally have high ODP and GWP. HCFCs generally have much lower ODP and GWP. HFCs offer near-zero ODP, but some have comparatively high GWPs.

Selection of Refrigeration Lubricants

From a technical standpoint, the lubricant selected for a refrigeration system must

- be suitable for lubricating the type of compressor used in the refrigeration system
- have the appropriate miscibility and solubility characteristics with the refrigerant fluid

Refrigeration Compressor Lubrication

Three types of compressors are predominantly used in industrial refrigeration systems:

- **Reciprocating compressors** — the oil lubricates cylinders, connecting rods, and journal and thrust bearings; and maintains good sealing in compressing the refrigerant
- **Screw compressors** — the oil lubricates the screw(s) (except in dry screw units), and sliding and thrust bearings; maintains good sealing; and cools down compressed gas
- **Centrifugal compressors** — the oil lubricates sliding, antifriction, and thrust bearings as well as shaft packing and multipliers gears; provides proper sealing; and in many cases cools the compressor parts

Scroll or rotary vane compressors are also used in some refrigeration systems.

Compatibility of Lubricant with Refrigerant Fluid

- **Miscibility** (important at the evaporator portion of the refrigeration circuit):

Generally large refrigerant systems, particularly those using ammonia as a refrigerant, are equipped with oil separators. In these systems, it is desirable to use a lubricant that is immiscible or has low miscibility with the refrigerant fluid. With systems not equipped with oil-separation capability, the lubricant carried over from the compressor into the evaporator must be sufficiently miscible with the refrigerant at the evaporator temperature so that the refrigerant fluid–lubricant blend remains in one phase after expansion in the evaporator and at a sufficiently low viscosity to travel through to the compressor. If the lubricant separates in the evaporator due to poor miscibility with the refrigerant fluid, or the blend viscosity is high, fluid is likely to get trapped in the evaporator and adversely affect the system's cooling capacity and efficiency.

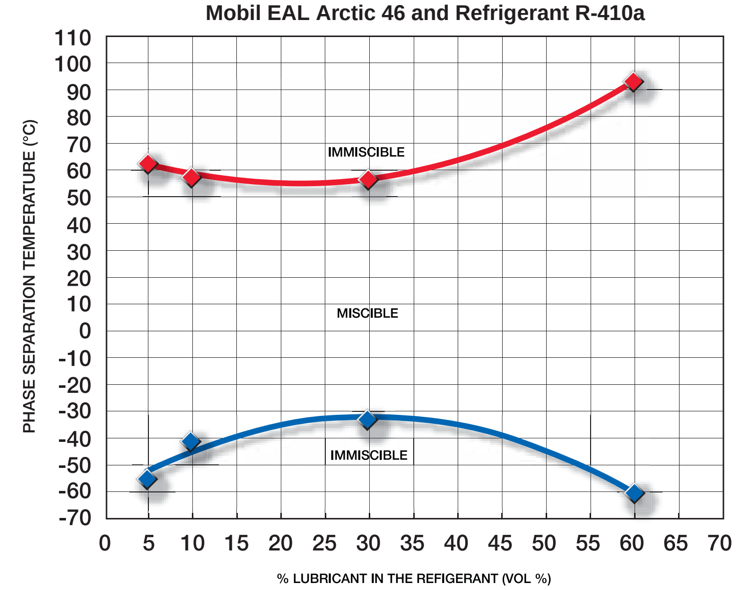
Miscibility curves are used to ensure that the lubricant selected matches miscibility requirements for the application. Miscibility charts are specific to lubricant-refrigerant combinations and are read based on the evaporator temperature and the percentage of oil carried over into the evaporator for the application in question. For typical industrial systems, oil carryover is 15% or less. At the evaporator temperature and expected oil carryover percentage for the application, the lubricant-refrigerant blend must remain in one phase. For example, as shown in Chart A, Mobil EAL Arctic 46 is suitable for use with refrigerant R-410a at evaporator temperatures between -40ºC and +57ºC at 15% expected oil carryover.

- **Solubility** (important at the compressor portion of the refrigeration circuit):

Another important consideration for proper lubricant selection is to ensure that the viscosity of the lubricant, after absorption of gaseous refrigerant at the high compressor temperature, is sufficient for effective lubrication of the compressor.

Chart A

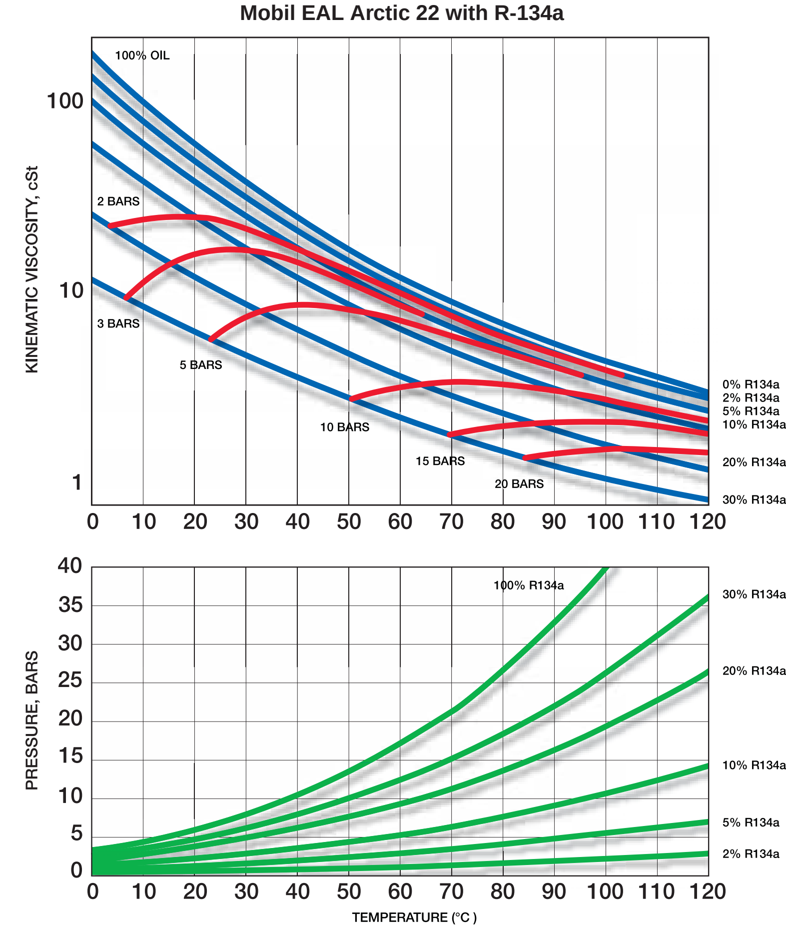
Mobil EAL Arctic 46 and Refrigerant R-410a



Viscosity/Pressure/Temperature curves (VPT curves), shown in Chart B, are used for this purpose and are specific to lubricant-refrigerant combinations. The viscosity of the lubricant-refrigerant blend at the temperature and pressure of the compressor outlet is read from the chart and validated against the builder-recommended optimum viscosity to lubricate the compressor.

Chart B

Mobil EAL Arctic 22 with R-134a



- **Lubricant Technologies**

For each refrigerant type, the table below shows compatible lubricant technology choices and available Mobil-branded refrigeration product lines.

Refrigerant Type	Lubricant Technology	Mobil-branded Products Line(s)
CFC and HCFC	Mineral Naphthenic	Mobil Gargoyle Arctic
	Mineral Paraffinic	
	Polyalphaolefin (PAO)	Mobil Gargoyle Arctic SHC 200
	Alkylbenzene (AB)	Mobil Zerice S
HFC	Polyol Ester (POE)	Mobil EAL Arctic
Ammonia	Mineral Naphthenic	Mobil Gargoyle Arctic
	Mineral Paraffinic	
	PAO/AB	Mobil Gargoyle Arctic SHC NH68
Carbon Dioxide (CO_2)	PAO	Mobil Gargoyle Arctic SHC 200
	Esters	
	Polyalkylene Glycol (PAG)	
Hydrocarbon	PAG	
	Mineral Naphthenic	Mobil Gargoyle Arctic

Mobil Industrial Lubricants Applications Expertise

Copies of miscibility and VPT curves for Mobil-branded refrigeration oils and various refrigerant fluids are available from our Technical Help Desk. A selection guide is also available to help you and your sales representative make the right choice of lubricants for your particular applications.

Conclusion

The selection of a high-quality refrigeration lubricant is driven by the type of compressor, application parameters, and, most important, the refrigerant fluid. We offer a wide range of synthetic and mineral oil–based refrigeration oils that are equipment-builder approved, and suitable for a broad range of industrial refrigeration applications.

(continued on back page)