

OEM vs Aftermarket Oil

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Five Factors To Consider Before Making The Switch to Aftermarket Oil

Oil formulation is more critical than ever to maintaining uptime, productivity and equipment life. Aftermarket oil may not be up to the task.

This guide explores five factors to consider before making the switch from original equipment manufacturer oil to aftermarket oil.



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PROTECT YOUR INVESTMENT: FIVE FACTORS TO CONSIDER BEFORE MAKING THE SWITCH TO AFTERMARKET OIL

Across the refrigeration industry today, a growing significance is being placed on the value of using original equipment manufacturer (OEM) refrigeration oil.

The trend is being driven largely by two issues.

First, modern compressors have advanced well beyond those of previous generations and are today designed to achieve impressive levels of efficiency and longevity. These improvements, however, put greater demands on compressor oil to protect equipment against premature wear and excessive oil carryover, while allowing longer oil life without frequent changes.

Second, in plants with non-ammonia refrigerants, the recent introduction of new refrigerant gasses adds a layer of complexity to the process of selecting the most compatible, reliable, high-performing compressor oil for any given piece of equipment or operating condition.

These two issues combine to create a challenge for today's facility and operations teams who are responsible for protecting the investments they've made in refrigeration equipment: Oil formulation is more critical than ever to maintaining uptime, productivity and equipment life. Aftermarket oil may not be up to the task.

This white paper explores five factors to consider before making the switch from OEM to aftermarket oil.

Consideration 1: It's not as simple as putting substitute oil in your car.

Some car and truck owners wouldn't think twice about switching from a manufacturer's 'genuine' motor oil to a comparable, often less expensive aftermarket oil - especially after the warranty period has ended. But there's a big difference between substituting motor oil in an automobile engine and substituting compressor oil in a refrigeration system.

Automotive engine oils never leave the car engine, while compressor oils touch every part of the refrigeration system. Oils tested only for compatibility with the compressor may cause plugging of evaporator orifices, fouling of heat transfer surfaces or reactions with normal system chemistry not anticipated by a third-party lubricant supplier.

Also, automobile manufacturers often test their engines with a number of different third-party oils and, based on those tests (and a rating system established by the Society of Automotive Engineers), may approve a handful of brands for recommended use. In those cases, the vehicle owner can choose from a number of options and feel confident that the oil will perform as expected.

There are no standardized formulations, industry-approved rating systems or established best practices for third-party testing of oils used in refrigeration systems. In fact, the development and testing of refrigeration oil is today more specialized and complex than it has ever been.

In other words, one size does not fit all.



AS SYSTEMS BECOME INCREASINGLY SOPHISTICATED AND REFRIGERANT CHEMISTRIES CONTINUE TO EVOLVE, OIL FORMULATIONS ARE BEING ENGINEERED TO ENSURE THE BEST COMPATIBILITY AND PERFORMANCE FOR EACH COMPONENT IN THE REFRIGERATION SYSTEM.

Consideration 2: The industry landscape has changed.

In recent years, three trends have combined to create increased risk when using aftermarket oil.

NEW REGULATIONS

As Chlorofluorocarbons (CFCs) were phased out, the old rules of thumb about the interactions between refrigerants and oil ceased to apply. For many of the newer refrigerant gasses, lubricant suppliers have conducted significant 'wear testing' and testing of miscibility characteristics, but validation within working refrigeration systems falls on OEMs. For now, the OEMs are understandably focused on identifying refrigerant/oil combinations they know will be compatible with the specific products they build, sell and stand behind.

EQUIPMENT ADVANCES

Over the past few decades, the refrigeration industry has transitioned from reciprocating compressors to rotary screws in most applications. Screw compressors used on ammonia maintain much lower discharge temperatures than reciprocating compressors, and don't oxidize oil in the same way. With proper filtration, modern refrigeration oils can last much longer without requiring replacement, but it is critical that lubricants be able to maintain lubricity, viscosity, oil carryover levels and key additives over much longer periods of time than when oil was routinely changed every year or so. Quality, proven oils and proper oil analysis are keys to long oil and equipment life.

The industry has also witnessed the introduction of a wide array of more complex, engineered synthetic or semi-synthetic lubricants. Synthetic oils, in some cases, offer advantages in lower pour points to simplify oil return and prevent waxing of evaporators or suction filters. They can also reduce oil carryover, due to lower or nonexistent aromatic content, and can provide more consistent viscosity over varying temperatures, which can be essential for a compressor operating with a variable frequency drive (VFD). However, they can complicate swelling or shrinking of O-rings or gaskets, and should only be substituted into existing machines with full knowledge of system chemistry.

TIGHTER BUDGETS

Because many operations and facilities teams continue to feel capital budget pressure, it's understandable that some would consider substituting aftermarket compressor oil, which can be less expensive. But with lower first cost comes the added risk of problems somewhere in the compressor or other parts of the refrigeration system. While aftermarket oil manufacturers may stand by their oil, they are not likely to stand by a compressor or system that fails or leaks because the oil is not compatible.

Consideration 3: Formulating the right oil for the right equipment and application is a complex task.

Original equipment manufacturers put a great deal of effort into making sure oil is formulated to meet the specifications of each individual type of equipment, and is tested under real-world conditions - both in the lab and in the field. This includes consideration of characteristics such as:

- **Miscibility:** The performance of a hydrofluorocarbon (HFC) or carbon dioxide (CO₂) system is optimized when the lubricant and refrigerant mix to form a single, clear phase (that is, they are miscible). Miscibility lowers the viscosity of the lubricant carried through the system, so the lubricant can more efficiently return to the compressor. In ammonia systems, the oil return systems are designed to function with minimal miscibility, but oil carryover is often reduced with low miscibility oils.
- **Viscosity:** Viscosity is affected by two things: the amount of refrigerant that's dissolved in the oil, and temperature. Compressor oil that is too thick may cause compressor shaft seals to leak. Compressor oil that is too thin cannot provide enough of an oil film to support the loading of the bearings, reducing bearing life. That's why it's beneficial to align oil viscosity to a specific application. The use of VFDs with compressor drivers can place additional viscosity requirements on the lubricants at lower speeds. Manufacturers are aware of these limits and will specify lubricants to cover speed ranges appropriately.

- **Dilution and solubility:** The conditions under which the compressor operates should dictate the percentage of refrigerant dissolved in the oil. If a system is designed to handle 10 percent refrigerant in the oil, it may be overwhelmed by oil that is diluted to 20 percent, causing damage to bearings and, potentially, compressor failure.
- **Viscosity index:** A lubricant with a better viscosity index allows operation over a wider temperature range without excess reduction in viscosity. Modern anti-friction bearing equipped compressors are capable of operating at much higher temperatures than the sleeve bearing equipped compressors of the past. Higher oil temperatures can allow heat recovery for underfloor glycol warming systems or reduce penalties associated with liquid injection oil cooling, but only if the lubricants are designed to operate at the higher temperatures while maintaining proper viscosity.
- **Quality base stocks with low carryover potential:** Lubricants designed to keep oil carryover low are important to keep the compressor oils in the compressors, not spread all over the system where they can foul heat exchangers and require oil draining. Some aftermarket oils are blends of different

chemistry that, in some cases, will separate in operation with the lighter molecules ending up in the system, changing the base viscosity of the lubricant.

- **Minimal, and only well-proven additives:** Improper additive chemistry is probably the single biggest problem encountered with aftermarket lubricants. Unanticipated chemical reactions with ammonia, or other common system contaminants such as water, have led to many compressor failures when unproven oils are added to refrigeration compressors.





OEM oil is formulated and then put through extensive, targeted reliability testing. Are the compressor bearings running at the right temperature? Does the friction horsepower or bearing loss align with what was expected for this compressor at this temperature and for this application? This level of testing gives OEM manufacturers the confidence to stand behind their oil, because they fully understand how the oil will behave in the application for which it is being developed.

By contrast, aftermarket oil is developed for a mass market. While it may be marketed as 'equivalent' to an OEM product, there is no way to guarantee that substitute oil will be compatible with any given piece of equipment and under any given set of operating conditions. Bottom line: You won't know what you're getting.



Consideration 4: The risks are significant.

One of the greatest risks of using oil that hasn't been tested in a particular type of equipment or environment is that it can result in unintended, but costly, chemical reactions that shorten compressor life.

CASE IN POINT: The following images illustrate the impact on seal faces tested using OEM oil and aftermarket oil. The OEM oil test (on top) showed virtually no wear after 400 hours. The aftermarket oil (on bottom), which included untested additives, resulted in compressor failure.	LAB TEST: Ammonia Refrigeration Plant with OEM Oil RESULT: No significant wear on the seal face	
	LAB TEST: Ammonia Refrigeration Plant with Aftermarket Oil RESULT: Abrasive, dark deposits that led to compressor failure	
CASE IN POINT: The following images illustrate the impact on bearings tested using OEM oil and aftermarket oil. The OEM oil (on top) showed virtually no wear on the bearings. The incompatible aftermarket oil (shown at right) caused bearing failure that led to compressor failure.	FIELD TEST: Natural Gas Plant with OEM Oil RESULT: No significant wear on the bearings	
	FIELD TEST: Natural Gas Plant with Substitute Oil RESULT: Bearing failure that led to compressor failure	

In both examples, unproven additives were found to be present in the aftermarket oil. Often, these additives are marketed to provide benefits such as preventing oxidation, reducing friction, preventing wear under high-pressure metal-to-metal contact or improving the efficiency of the compressor. Across the industry, many of these claims go unsubstantiated. But one thing is certain: Unproven additives have the potential to cause catastrophic equipment damage.

Consideration 5: Calculate the true cost.

Because it is specially formulated, OEM oil may cost more than substitute oil. But initial cost savings can be easily outweighed by the cost of recovering from compressor damage or failure caused by incompatible or inferior oil.

- **Compressor repair or replacement.** If equipment failure is linked to the use of aftermarket oil, the compressor manufacturer will likely void the warranty, leaving the end user to absorb the full cost to repair or replace the unit - which can range from thousands to tens of thousands of dollars.

As a hypothetical example, what follows is a cost comparison between OEM and aftermarket oil, along with the potential costs caused by the use of incorrect oil.

- **Downtime.** When an overhaul or new system is needed, the refrigeration system may also be offline for weeks or months, which can have a significant impact on production or operations - even if the compressor is one of many units on site.

Maintenance Item	Operating Cost Comparison			Comments
	OEM Oil	Aftermarket Oil & Compressor Repair	Aftermarket Oil & Compressor Replacement	
Oil Change	\$1,500	\$1,200	\$1,200	Based on 2 drums of oil
Shaft Seal Replacement	\$0	\$2,500	\$0	Shaft seal cost varies between \$2.5k and \$5k
Bearing Replacement	\$0	\$5,000	\$0	Average bearing set
Misc. Compressor Component	\$0	\$2,000	\$0	Other misc. small parts
New Compressor	\$0	\$0	\$40,000	Compressor replacement (mat'l) is between \$40k and \$50k
Labor	\$1,248	\$4,992	\$4,992	1 day to change oil vs. 3 days to either replace or repair compressor
TOTAL COSTS	\$2,748	\$15,692	\$46,492	

Notes:

- *Estimated industrial refrigeration compressor lifecycle is 10-15 years, before a major overhaul is needed.*
- *A replacement industrial refrigeration compressor could cost, on average, between \$40,000 and \$60,000. The lesser amount was used in this hypothetical calculation.*
- *The above calculation does not include additional costs such as rigging, quick ship cycle premiums to expedite a new compressor or the cost of temporary cooling service.*

CONCLUSION

Choosing the right compressor oil for any given piece of equipment and application is a decision that deserves careful consideration. Creating the perfect match between equipment, application and oil composition is both complex and essential. Aftermarket oil, developed for a mass market, may not be up to the task.

Still, some specifying engineers, operations and facility managers continue to be enticed by first-time cost savings offered by the manufacturers of aftermarket oil. And as this paper has shown, it can be a risky decision. Industry professionals must ask themselves, "How much would I be willing to pay for the peace of mind in knowing the investments I've made in refrigeration equipment are protected against damage or catastrophic loss?"

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