EnergyIdeas Clearinghouse

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Product & Technology Review

Compress Shield®

A polarized refrigerant oil additive designed to reduce friction and increase heat transfer.

Product
Compress Shield

Manufacturer
Energy Savings, L.P.
850 Ridgelake Blvd. Suite 222
Memphis, TN 38120
(901) 842-1001
E-mail: *info@compressshield.com*
Website: *www.compressshield.com*

Distributor
Bobby Cochran
Energy Savings, L.P.
850 Ridgelake Blvd. Suite 222
Memphis, TN 38120
(901) 842-1005
E-mail: *bobbyc@compressshield.com*

Product History
Patent granted in 1990. Marketing under the name of Compress Shield began in earnest in 1992.

Product Function and Application
Compress Shield is what is known as a "polarized refrigerant oil additive" (PROA) and is based on a chlorinated-olefin active ingredient compounded with a chlorine stabilizer. Compress Shield is a refrigerant oil additive that can be added to all the common refrigerant-oil combinations.

According to the manufacturer, the following description explains how it works. The theory is that oil from the compressor gets into the system and attaches to the pipes and coils, which creates an insulating layer on the surfaces, reducing the efficiency of heat transfer (see Figure 1). The PROA displaces this oil that clings to the surfaces and replaces it with a thin film of the additive, which improves the efficiency of heat transfer (see

Figure 1

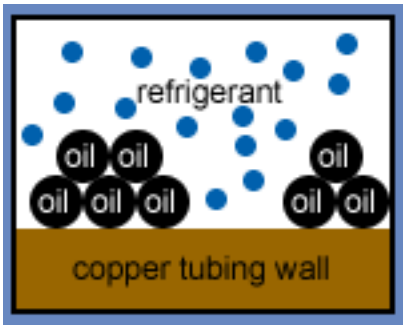
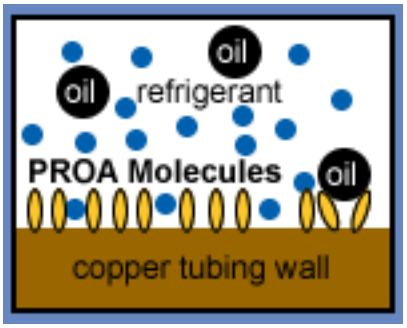


Figure 2



Figures 1 and 2 used with permission from the Compress Shield manufacturer.

Product & Technology Reviews (PTR) are developed for Northwest electric utilities. EnergyIdeas Clearinghouse engineers review published literature for objective, independent test results. No primary testing was conducted by the reviewer for the preparation of this document. PTR factsheets describe the technology, discuss available data, and suggest additional testing needed to verify energy saving claims.
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Figure 2). In addition, it increases the lubricity, or lubrication value, of the refrigerant oil, reducing noise and wear on the compressor.

Energy Savings Claims

The manufacturer claims that properly adding Compress Shield to your refrigeration or air conditioning system will increase its efficiency. Unlike many other brands of refrigerant additive, the manufacturer of Compress Shield does not emphasize their energy savings claims, though they guarantee a 10% increase in efficiency. They stress the benefits to the compressor in terms of reduced noise and maintenance. However, they do suggest in conversation and on their sales sheet that savings might be in the range of 5-20%, averaging about 12.3%, and many of their case studies show savings much higher than this. In addition, the manufacturer's website and some of the distributors suggest 25% or more savings.

Non-Energy Benefits

The manufacturer claims that Compress Shield increases the lubricity of the compressor oil, reducing noise and wear on the compressor, reducing maintenance, and increasing the life of the compressor. They also claim that seals and other synthetic parts will swell less and therefore last longer.

Independent Testing Results

We were unable to locate a well-designed and carefully performed independent laboratory test specifically of Compress Shield, but a few high-quality independent tests of other polarized refrigerant oil additives have been conducted. Since they were not specifically performed on Compress Shield, we have commented on them in the "Alternative Products and Strategies" section below.

Note that the manufacturer of Compress Shield has taken issue with the test procedures in some of these tests, is currently pursuing further independent testing with a reputable testing service, and has told us that they will inform us of those results as soon as they are available.

Cost

Approximately $40-50 per ton of system capacity (installed) for smaller systems, down to $15 per ton for larger systems (according to Tom Dean, National Sales Manager).

Alternative Products and Strategies

The PROA industry has a colorful and interesting history. More than a dozen other companies market or have marketed a polarized refrigerant oil additive, many of which use the formulation from the same patent as Compress Shield. The additives are manufactured by four manufacturers. The energy saving claims are difficult to substantiate, and each manufacturer claims that their product is different from and better than the others.

One of the major differences is that some include chlorine in their formulation. The manufacturers that do have chlorine in their product (including Compress Shield) claim that this adds to the lubricating properties of the additive and increases the affinity to metal surfaces, increasing the oil-displacement characteristic of the additive. Indeed, the phase-out of chlorofluorocarbons (CFCs) and the transition to the newer hydrofluorocarbons (HFCs, such as R-134a and R-404a), has posed new challenges in finding lubricants that are more compatible with HFC refrigerants. The chlorine in the CFCs, not present in the HFCs, added to the lubricity of the oil-refrigerant combination.

The PROA brands without chlorine often claim that the chlorine in the formula is actually detrimental to the performance of the system. They say that the chlorine is hygroscopic – that is, it absorbs water – and has potential to form an acid in the system, promoting corrosion. The manufacturer of Compress Shield counters that their product has been tested according to ASHRAE 97, which is a prescribed method of testing the compatibility of materials with different refrigerant-oil combinations. The manufacturer used this test to show that in a sample of refrigerant and oil with Compress Shield added, no more acid is formed after artificial aging, compared to a sample without

Compress Shield. We have not seen the full report, but the one example the manufacturer gives in its literature is using R-123a with alkyl benzene as the lubricant. In this instance, acid in the Compress Shield-treated sample was actually lower than the one without. The literature gives no indication whether other refrigerant-oil combinations were tested or not. The manufacturers of the non-chlorine-based products also point out that chlorine is hazardous to dispose of and has high ozone-depletion potential.

We know of only five tests of sufficient duration, and with carefully controlled conditions, to help prove or disprove the concept of PROA additives working as claimed. Three of the five tests were using a PROA manufactured under the same patent as Compress Shield, but two of those tests were on a different product, so we cannot say for sure that they were manufactured in exactly the same way. All five tests conclude that there is little or no demonstrable improvement in energy efficiency or performance (0-1.2%) with a PROA installed. Results from four of these tests are in the public domain; these were conducted by Oak Ridge National Laboratory (Levins et al. 1996), Intertek Testing Services (CDH Energy Corp. 2001), the University of Florida (Goswami et al. 1994), and the Florida Solar Energy Center (Cromer 2003). For more detail on these studies, contact the EnergyIdeas Clearinghouse.

When investigating these or any products, be careful to note the source of study results. Two documents that can be found on websites or in the marketing material of many PROA marketers (competitors of Compress Shield, and not Compress Shield itself, as far as we know) are a Federal Energy Management Program (FEMP) Federal Technology Alert (FTA) and a report of a study purported to have been performed by Oak Ridge National Laboratory (ORNL). This FTA has now been retired from the FEMP website because of controversy about the product. Many manufacturers are still circulating this document, sometimes with edits that suggest the product was "tested and approved by FEMP." Note that FEMP does not test products. Most of the information in the FTA was from a manufacturer of a PROA product.

The version we have seen of a study supposedly done by ORNL gives no authors or dates, or any other attribution, and says at the top, simply "OAK RIDGE NATIONAL LABORATORY, Oak Ridge, Tennessee," with the subtitle "Evaluation of "PROATEQ™" Polarized Refrigerant Oil Additive (PROA)." We have not been able to locate anyone at ORNL who can confirm the legitimacy of that study. In fact, ORNL has notified at least one manufacturer to cease and desist in circulating that report. The manufacturer of Compress Shield has not, to our knowledge, falsified or circulated either the FTA or the "ORNL" study documents.

Case Studies

Other than what is found on Compress Shield's website or the websites of other PROA manufacturers, or in their marketing literature, we know of no convincing independent case studies that either confirm or refute their product claims.

A case study worth mentioning because it is prominent in the Compress Shield promotional literature is one that was done by the University of South Florida (USF) on an installation at Universal Studios in Orlando. In that test, which was of short duration, USF researchers ran two identical chillers side-by-side, one with Compress Shield and one without. The test lasted for a total of 15 minutes under one set of conditions. The Florida Energy Conservation Assistance Program (ECAP) report of the study suggests that the efficiency advantage of the unit with Compress Shield was 12.63%, although it does not provide the actual data from the tests. It is worth noting that the report makes no mention of the condition of the two chillers before the Compress Shield was added. That is, even though they were "identical" units operating under the same conditions, we have no confirmation that they measured the performance of the units before the Compress Shield was added to make sure they were actually operating identically. We are trying

to get a copy of a more complete report of this study. In the meantime, for these reasons above, the results of this study should be viewed with caution. Despite these limitations, this test qualified the use of Compress Shield as an Energy Conservation Enhancement for several State of Florida programs and U.S. Department of Energy programs in Florida.

Suggestions for Further Research and Testing

To fully evaluate any product like this would require extensive, carefully designed testing according to Air-Conditioning and Refrigeration Institute (ARI) or other widely accepted standards. Since the lubricant required for each refrigeration application is different, it would have to be tested with a variety of refrigerants and compressor types under various temperature and humidity conditions. We are not aware of any such testing having been done. Before such testing is even contemplated, it would be prudent to at least prove the concept under one set of circumstances, using ARI standards. As mentioned above, the five studies of PROAs we considered show little or no energy benefit of using these products.

Each of Compress Shield's claims will need to be evaluated separately. One of the claims is that Compress Shield will displace oil that builds up on the pipes and coils in the system and thereby improve the heat transfer in the system, effectively increasing the capacity of the system. It would be beneficial in establishing this claim to actually disassemble some older systems to establish that this oil build-up is really there, reassemble the system, install Compress Shield, and compare the difference. Most importantly, the ability to transfer heat should be measured before and after Compress Shield is added. The manufacturer has detailed drawings in some of its promotional literature showing how they think this process works. It would be useful to confirm that this is actually how it works in a real system.

Establishing scientifically that maintenance of the compressors is actually reduced would be difficult, and would take a number of years. However, compressor operating temperature can be measured under controlled conditions, which should give some measure of the wear on the equipment. Sound levels before and after installation could also be measured. Empirical data could be gathered from several dealers of different compressors under similar conditions – some with Compress Shield and some without, and compare their service records over time. It would also be important to control for maintenance procedures and operating conditions. The ideal measure of maintenance reduction would be to find several situations where similar compressors are in operation in one building, and compare the service records over time. Any such study, however, is fraught with complications, uncertainties, and credibility issues.

Additional Reviewer Comments

Matching up the correct lubricant to a given refrigerant and compressor is a very involved science. When CFCs were used as refrigerants, the common lubricant was mineral oil; it mixed well with the refrigerants and had good lubricity. With the introduction of HFCs, the oils used are almost exclusively the synthetic polyol esters, sometimes with special additives. However, until HCFCs (such as R-22) are fully phased out between 2010 and 2030, alkyl benzene and even mineral oil will continue to be common. Each application requires a specific lubricant based on manufacturer specifications. Refrigerant oil manufacturers Anderol and Polar Technology as well as tribology (lubrication) experts are not convinced that there is any single additive that would enhance the performance of all the available lubricant/refrigerant combinations, as is claimed by the manufacturers of Compress Shield and its competitors.

In order to evaluate the value of the manufacturer's claim that the PROA displaces oil in the coils and on the tubes and increases heat transfer, one must first determine if this is a serious problem or not. We believe that the study they are probably basing this claim on is one that was published in ASHRAE Transactions (1993), which found that, indeed, the capacity of an evaporator is reduced (i.e.,

heat transfer is reduced) with increased oil in the system. However, there are a few reasons the results of this study do not establish their point very well:

- The effect of the oil described in the study was somewhat different from what is portrayed in the Compress Shield literature. The ASHRAE-reported study described it as liquid oil creating a boundary layer, rather than a "build-up" of oil. It is not clear how Compress Shield would solve this problem.

- The major effect of oil in the system was with R-12 (a CFC that has been phased out of production as of 1996) and mineral oil. In this case, the capacity was reduced 31.4% at a 5% oil concentration.

- With R-134a and a polyol ester oil (again, a much more common combination these days, and becoming more so) the reduction in capacity with a 5% oil concentration was only 11.3%. This may be because the heat transfer characteristics of polyol ester oils is actually quite good, and probably compares favorably with Compress Shield.

- With an oil separator, as most larger systems would have, the oil concentration is likely to be less than 1%, which would have very little effect on evaporator capacity. For those systems without an oil separator, up to a 5% concentration is reasonable.

- According to studies done at Oak Ridge National Laboratory and the Trane Co., the efficiency of the entire system is surprisingly independent of the heat transfer efficiency. The ORNL study suggests that to improve system efficiency 1% would require about a 10% improvement in the heat transfer coefficient of the condenser coil. Similarly, Trane's simulations suggest that to improve system efficiency 1%, a 25% increase in evaporator efficiency would be required. In short, the efficiency of the entire system would only be affected significantly if the condenser or evaporator is under-sized or under-performing; that is, the system is "capacity-constrained."

The manufacturer claims that the other way that Compress Shield saves energy is by improving the lubrication of the compressor. Copeland Corporation, one of the leading compressor manufacturers, has found that the total losses in a compressor due to friction are about 4% of the total energy. Thus, even if Compress Shield reduced friction losses by 25%, which is unlikely, the improvement in overall efficiency would only be 1%.

Thus, adding together the two mechanisms that Compress Shield says are at work here – improved heat transfer and improved lubricity – the total losses available to improve are in the order of 5-7% (about 4% in friction losses and perhaps 1-3% in heat transfer efficiency losses). Claims of savings anywhere near 7% or higher would require an explanation of an additional mechanism at work. A more likely range of savings is 0-3%.

Another claim the manufacturer makes in its literature is that oils with Compress Shield added will cause less swelling of seals. They conclude that this will increase the life and effectiveness of the seals. Again, compressors are designed for use with a specific refrigerant and oil combination. In the design process, compressor manufacturers take into account the likely degree of swelling of seals. Changing this relationship will not necessarily bring about a positive result. In any event, the test the manufacturer of Compress Shield cites that established this characteristic used a mineral oil lubricant, which, again, is becoming less likely to be used.

The manufacturer of Compress Shield also claims that the compressors will run quieter and have reduced maintenance due to the lubricating qualities of the additive. This kind of claim is very difficult to substantiate or refute. The study at the Florida Solar Energy

Center did in fact measure change in noise levels from the compressor, and actually found a small increase in noise with the additive, though not at a significant level. The ORNL researchers commented in their report that "[t]here was, however, a noticeable, but unquantified, decrease of compressor noise resulting from additive addition."

Though we know of no studies that would verify that maintenance will be reduced on a compressor, neither do we know of any evidence that it is not true. A longitudinal study to establish this one way or the other would be very expensive, and would have to take place over several years. Terry Cohea, Sales Engineer for Energy Savings, L.P. and owner of a compressor remanufacturing business, claims that in his own compressor rebuilding business warranty claims are reduced drastically when Compress Shield is used. Refrigerant oil manufacturers and tribologists (lubrication specialists) are skeptical of this claim, particularly in light of the fact that it is claimed to be effective with all refrigerants and all compressors.

Conclusion

Although this product has been around for 14 years, it has yet to be proven (through credible independent testing) effective for saving energy. The good news is that stories of harm being caused by installing Compress Shield in any system are rare and unconfirmed, so the risk of using the product is small. Most compressor manufacturers should still honor their warranty with the use of Compress Shield, though it would be prudent to verify this. Just in case, Compress Shield offers a warranty that runs concurrently with the manufacturer's warranty, or six months if no warranty is in effect.

We are skeptical about this product being as effective for saving energy as advertised, and particularly about the claim of it being equally effective with all refrigerants and all compressors. The claims that using the product will extend compressor life are very difficult to prove or disprove. If choosing to install it, do so carefully. For instance, if there are several compressors, try it in one first. Only after being convinced beyond a reasonable doubt that it is effective should it be installed in the remaining compressors. In any case, expected savings, if any, will likely be no more than a few percent.

Additional Information

Northwest businesses and electric utilities can contact the EnergyIdeas Clearinghouse for additional information on this or other energy technologies or products. Contact:

Phone: 1-800-872-3568
E-mail: *info@EnergyIdeas.org*
Website: *www.EnergyIdeas.org*

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Reviewer

Jack Zeiger
WSU Extension Energy Program

Note: Product & Technology Reviews are peer reviewed by objective industry professionals prior to publishing.

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