Form 40-130
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DESICCANT COMPATIBILITY

The refrigeration and air conditioning industry is adjusting to the unique features of new refrigerants and lubricants that are evolving as a result of the phasing out of CFC and HCFC refrigerants. The new long term refrigerant replacements to date consist of pure components and blends of HFC's. The HFC's are not miscible with the commonly used mineral oils thus leading to the introduction of polyolester lubricants to refrigeration and air conditioning systems. The HFC refrigerants and polyolester oils require special considerations with regard to filter-drier material compatibility.

Regardless of the refrigerant and lubricant type, the primary qualities desired in a filter-drier are: filtration, removal of moisture, and removal of acid. Molecular sieve is a desiccant that has been used for the primary purpose of removing moisture, and activated alumina primarily for the purpose of removing acid. It follows, therefore, that these two desiccants be tested for compatibility with HFC refrigerants and polyolester oils. Compatibility is measured by degree of refrigerant decomposition and it must be noted that all commonly used CFC's and HCFC's (i.e., R-12, R-22, and R-502) decompose to a certain extent in the presence of these desiccants. Extensive laboratory testing and many years of positive field experience have proven the decomposition of the CFC's and HCFC's in refrig eration systems to be insignificant. Sealed tube tests have shown decomposition in the presence of desiccants is highest with R-22; therefore, its compatibility test results can be considered acceptable and used as a comparison in the analysis of a new HFC.

Desiccants are presented in a filter-drier in two basic formats: a molded core and as loose beads. The molded core consists of activated alumina and molecular sieve (and possibly activated carbon) in a granular form bound together in a solid core. Loose fill type filter-driers consist of the same desiccants in the form of larger beads but which are not bound together. The compatibility or stability of a given desiccant is different in a molded core than it is in a loose bead format.

A mixture of activated alumina and molecular sieve has proven through the years to be the most effective way of keeping contamination to a minimum. Compatibility of these desiccants with refrigerants is determined using a sealed tube test. The refrigerant is analyzed for decomposition. The degree of decomposition determines if the desiccant is compatible with the refrigerant. However, as previously stated, all chlorinated and fluorinated carbons (CFC's, HCFC's, HFC's) decompose to a certain degree in the sealed tube test, so the decision must be based on comparisons -not absolutes. In sealed tube tests HFC refrigerants have been shown to be much more stable than CFC's and HCFC's.

Polyolester lubricants are very hygroscopic, meaning they have a strong attraction to water. Polyolester oil that is contaminated with water can hydrolyze (react with water) to form a carboxylic acid. Carboxylic acids are organic acids which can damage a system if they are not removed.

Extensive testing has been performed by Sporlan Valve Company and an independent testing laboratory to determine the compatibilities of molecular sieve and activated alumina with the HFC refrigerants and the polyolester lubricants. Sporlan has also been involved in many field trials with HFC refrigerants to determine the performance of the Catch-All on actual systems.

Compatibility testing of desiccant materials is done using the ANSI/ASHRAE Standard Sealed Tube Method 97-1989. The sealed tube test is an accepted method to determine compatibility of materials in a refrigeration system. The test consists of copper, aluminum, and steel coupons, 1.0 cc of refrigerant, 1.0 cc of the appropriate oil, and .50g of the subject desiccant or core materials combined in a sealed glass tube. The tubes are aged for 30 days at an elevated temperature of 300°F. At the end of the test period the tubes are tested for Cl^-(chloride) and F^-(fluoride) ion content, which indicates the degree of refrigerant decomposition.

The following chart summarizes the results of the sealed tube tests. The tests were performed with R-22 to establish an acceptable decomposition percentage and to determine a baseline. The results are compared to those with R- 134a. The 3A molecular sieve and 4A molecular sieve results are averaged values from three separate manufacturers' molecular sieves.

Figure 1
SEALED TUBE TEST RESULTS
R-22 and R-134a With Various Desiccants

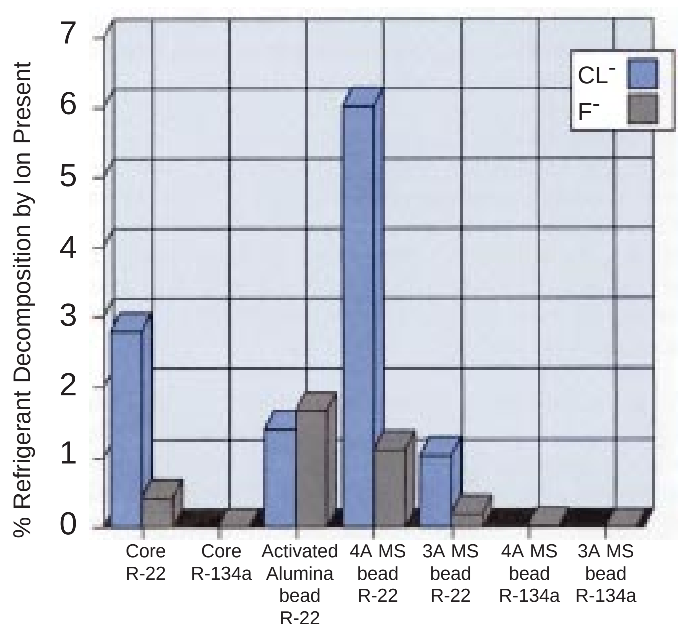
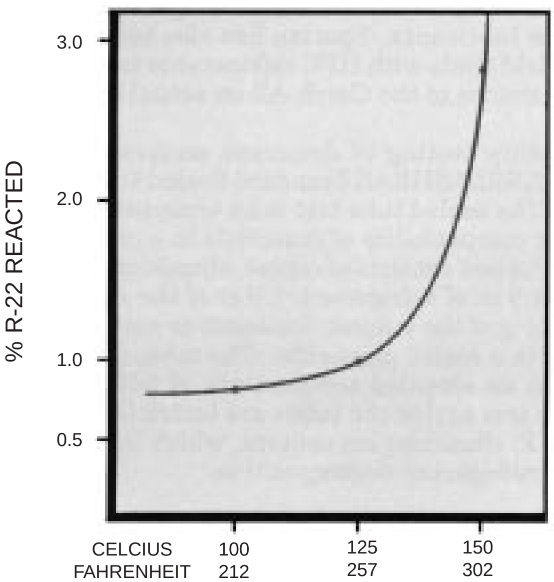


Figure 1 indicates that sealed tube test results in the range of 6% to 7% refrigerant decomposition are entirely acceptable and present no problem in actual systems. It must be understood that the sealed tube test is an extremely severe test and is a comparison test only. The tubes are exposed to very high temperatures in order to accelerate the reactions. The degree to which the decomposition reactions are accelerated with temperature increase is illustrated in Figure 2.

Figure 2
EFFECT OF TEMPERATURE ON SEALED TUBE TEST
Molded Core/R-22/Mineral oil/Cu-AI-Fe



The drastic increase in the decomposition rate as the temperature increases shows the severity of the sealed tube test. At the temperatures typically seen by a filter-drier in a system the decomposition rate is greatly reduced.

The results for the individual beaded desiccants used in loose fill type filter-driers are given in Figures 3 and 4. Molecular sieve was tested from three separate manufacturers using both 3 angstrom (3A) and 4 angstrom (4A) molecular sieves.

The terms 3A and 4A refer to the size of the pore opening of the molecular sieve. 3A and 4A molecular sieve have the same basic crystal structure. The actual size of the opening is determined by the cation used in the crystal. In a 4A sieve the cation is sodium and in a 3A sieve it is potassium. The binders used in the manufacturing of the molecular sieves affect the sieve's compatibility and water capacity.

These results show the greater stability of R-134a over R-22 and the insignificant difference with R-134a between using 3A and 4A molecular sieve. R-22 gives decomposition rates in the range of 6% to 7% with 4A sieve and 1% with 3A sieve. R-134a gives decomposition rates in the range of.01% with 4A sieve and .005% with 3A sieve.

Figure 3
SEALED TUBE TEST RESULTS
Beaded Molecular Sieves
R-22/Mineral oil/Desiccant/Cu-AI-Fe

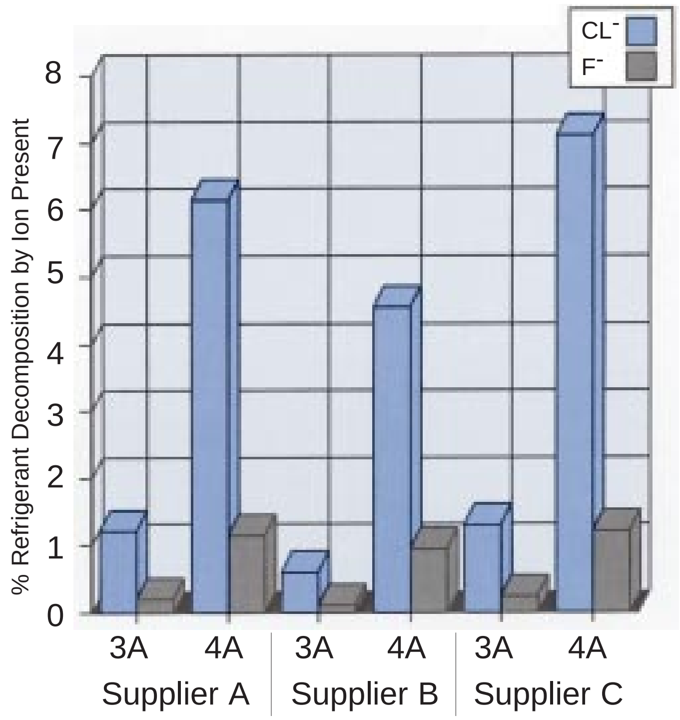
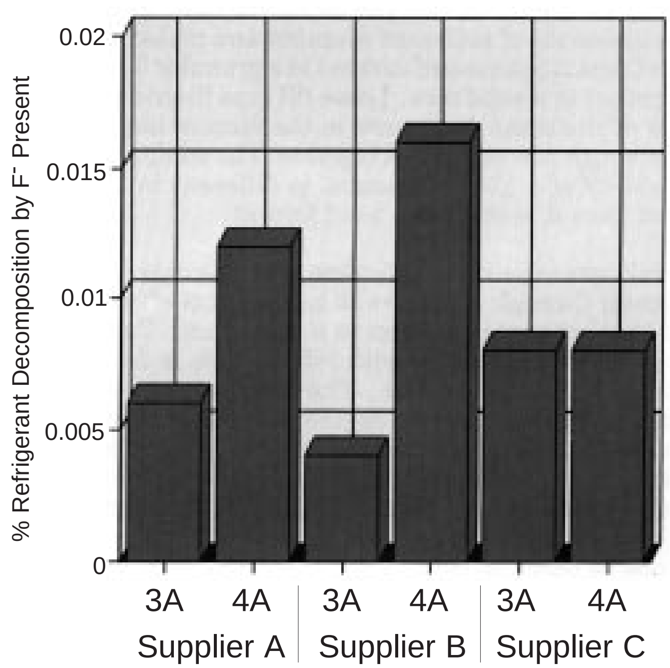


Figure 4
SEALED TUBE TEST RESULTS
Beaded Molecular Sieves
R-134a/Polyolester oil/Desiccant/Cu-AI-Fe



ACTUAL FIELD TEST RESULTS

In order to prove the effectiveness of the Catch-All in HFC/polyolester lubricant systems, Sporlan has participated in several field trials. One widely documented trial was sponsored by the New York State Energy Research and Development Authority and the Empire State Electric Energy Research Corporation. The trial featured the Hannaford Brothers Shop 'n Save supermarket in Glens Falls, New York. At this store R-134a and polyolester lubricant have been used in medium temperature and air conditioning systems. Sporlan Catch-Alls were used throughout and the contaminant levels were closely monitored.

Figure 5 plots the moisture content and Figure 6 the acid number of the polyolester oil versus time on the medium temperature refrigeration system. Both plots show a general decrease in moisture content and acid number of the oil. The final values after 50 weeks show a moisture content of 45 ppm and an acid number of 0.04. The air conditioning system showed similar trends with final results of 70 ppm water and an acid number of 0.03.

The results of the oil analysis led to the conclusion by Aspen Systems, Inc. (an engineering research firm) that Sporlan Catch-Alls can maintain moisture levels below 50 ppm on the R-134a and polyolester system. Wear analysis of two compressors found wear patterns similar to those found on compressors running with traditional refrigerants and lubricants. During the test period there were no moisture or lubricant related problems.

Figure 5
GLENS FALLS SHOP 'N SAVE
DEMONSTRATION RESULTS
Oil Analysis for Med-Temp Rack With POE Oil

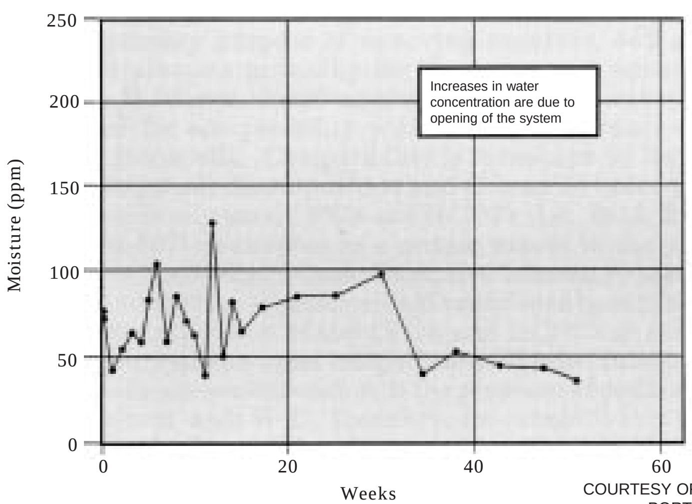
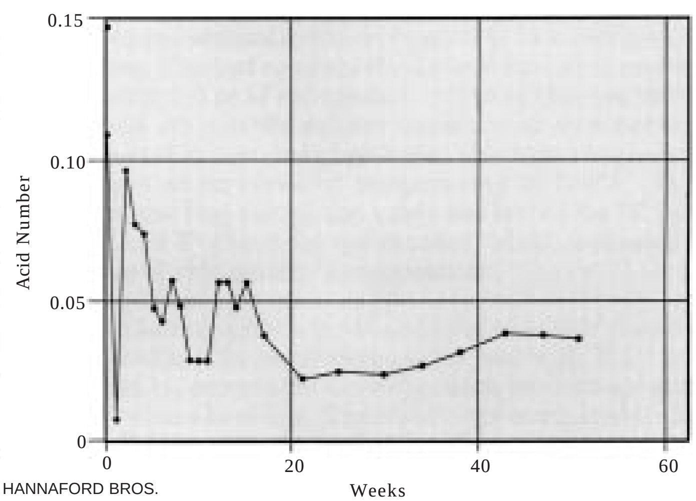


Figure 6
GLENS FALLS SHOP 'N SAVE
DEMONSTRATION RESULTS
Oil Analysis for Med-Temp Rack With POE Oil



COURTESY OF HANNAFORD BROS.
PORTLAND, MAINE
RESEARCH CONDUCTED BY ASPEN SYSTEMS
MARLBOROUGH, MASS.

CONCLUSION

While the testing discussed to this point was performed with R-134a, many other alternative refrigerants have been tested for compatibility with Sporlan molded cores. The sealed tube tests and field trials have shown similar results. Sealed tube test results for several alternative refrigerants are shown in Figure 7.

The conclusion to be drawn from the test results and field tests is that the Sporlan Catch-All, which has proven superior performance for many years, continues to be the proper choice for alternative refrigerants.

Figure 7
SEALED TUBE TEST RESULTS OF THE
CATCH-ALL WITH ALTERNATIVE REFRIGERANTS