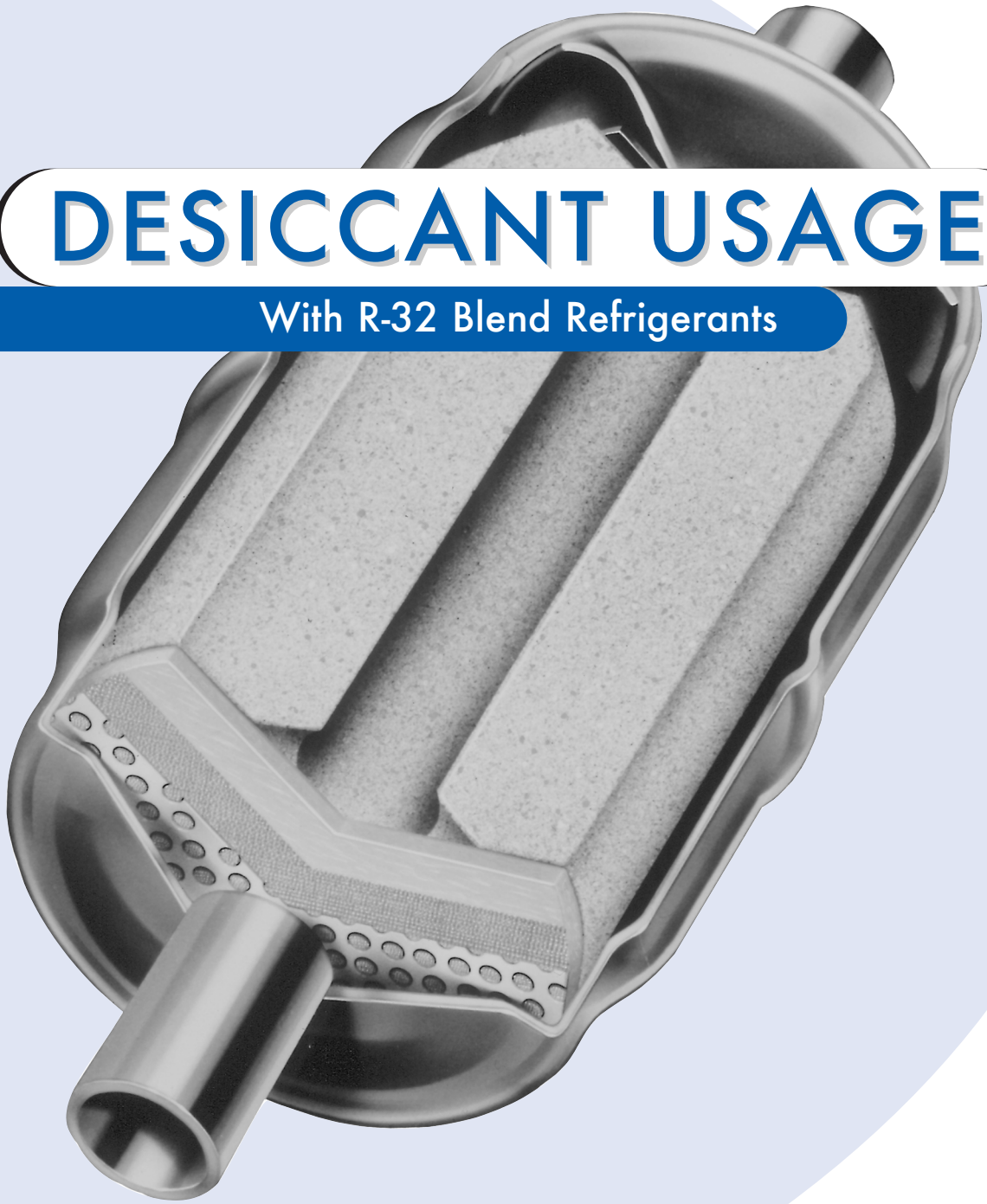
July 2000 / **FORM 40-139**

DESICCANT USAGE

With R-32 Blend Refrigerants



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The industry continues to adapt to HFC refrigerants and POE lubricants. In recent years much has been learned from evaluating alternative refrigerants and lubricants with desiccants. Many of these issues were addressed in Sporlan Forms 40-130 and 40-133. However, little has been published on desiccant compatibility with refrigerant blends containing R-32 (e.g., R-407C, R-410A). Refrigerants such as R-407C and R-410A are in use and scheduled to replace R-22, an HCFC refrigerant. The focus of this publication is to review features, purpose, compatibility and performance of a Catch-All Filter-Drier when installed in these systems.

REQUIREMENTS

For any system, the primary functions of a filter-drier are filtration and the removal of moisture and acid. Molecular sieve is a desiccant used for the primary purpose of removing moisture. Water removal is necessary since moisture can play a role in the formation of acids and corrosion within a system. The primary purpose of activated alumina in a filter-drier is to remove acid. Acids not removed from a system will react with other materials that could adversely affect system components. Experience has shown a mixture of these desiccants to be ideal in the removal of the many types of contaminants which are possible in any system.

Molecular sieve and activated alumina compatibility must be reviewed with refrigerants such as R-407C and R-410A. These refrigerants have R-32 and R-125 in the blend, with R-407C having a percentage of R-134a. To ensure compatibility, Sporlan in conjunction with other parties, has extensively evaluated the materials used in the Catch-All Filter-Drier.

MOLECULAR SIEVE

Compatibility — R-32 is a small polar molecule that can be co-adsorbed by molecular sieve. However, this interaction does not affect compatibility and water removal performance (which will be discussed later) in an actual system.

A specific molecular sieve has been designed to exclude the R-32 refrigerant molecules from inside its structure. With this exclusion, the material is touted to have superior compatibility and water capacity. To evaluate how the molecular sieve used in a Catch-All compares to the compatibility of R-32 excluding molecular sieve, testing was performed by an independent testing laboratory.

The test set-up used vessels containing 100 grams of a particular molecular sieve, 100 grams of polyolester (POE) lubricant, and 900 grams of R-410A. The vessels were aged at 160°F for 14 days. Although the aging temperature is unrealistic for liquid or suction line applications, the temperature was elevated to promote chemical reactions if incompatibility existed. The refrigerant was analyzed for refrigerant breakdown by-products by gas chromatography (G.C.) and by gas chromatography-mass spectrometry (G.C.-M.S.). The fluorine ion; an indication of refrigerant breakdown, was measured by ion chromatography. In addition, the POE lubricant was analyzed for water content, viscosity, acid content, and chemical breakdown by infrared (I.R.) spectrometry before and after the test.

Chromatography and spectrometry analyses indicated no incompatibility between the fluids and the molecular sieve used in the Catch-All or the R-32 excluding molecular sieve. Table 1 shows the results of the other analyses.

Table 1

Material/Fluid	Refrigerant Fluoride Content (ppm)	Lubricant Water Content (ppm)	POE Viscosity (mm^2/s) at 105°F	POE Acid Number
Virgin R-410A	< 0.2	—	—	—
R-32 excluding molecular sieve	< 0.2	27	32.6	< 0.1
Molecular sieve in Catch-All	< 0.2	30	32.5	< 0.1
Virgin POE lubricant	—	49	32.5	< 0.1

Results show both the molecular sieve used in the Catch-All and the R-32 excluding molecular sieve are compatible with commercially available R-32 blend refrigerants and POE lubricant.

Performance — The molecular sieve used in the Catch-All Filter-Drier does co-adsorb R-32 refrigerant molecules. Extensive water capacity testing by Sporlan has shown with R-32 adsorbed on the molecular sieve surface, the water capacity is not adversely affected.

A separate test program with an independent testing laboratory evaluated the molecular sieve used in the Catch-All and compared it to the R-32 excluding molecular sieve. The scope of the test was to examine the dynamic drying behavior of the currently used molec-

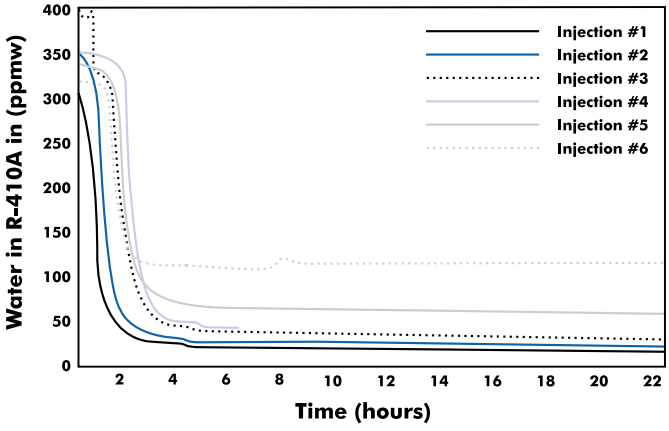
ular sieve and the R-32 excluding molecular sieve. Testing the dry-down performance characteristics of both materials is critical in understanding the interaction of the R-32 and water molecules in an actual system. Described below is the set-up and results of the testing performed by the independent laboratory.

Special R-410A loops were developed for the study. Water detection sensors were added to each system. The systems were operated under identical conditions. A vessel containing the molecular sieve to be tested was added to the system. The vessel was installed in a bypass line of the liquid line, with a valve on both sides of the vessel so the container could be isolated. At system start-up, the by-pass line was shut-off and refrigerant flow went through a separate line.

With the system in operation a quantitative water injection of 2.0cc was added to the system and allowed to distribute throughout the system for 30 minutes. After 30 minutes, the valves to the by-pass line were opened and the valve to the main liquid line was shut off, thereby forcing full liquid flow through the vessel containing the molecular sieve.

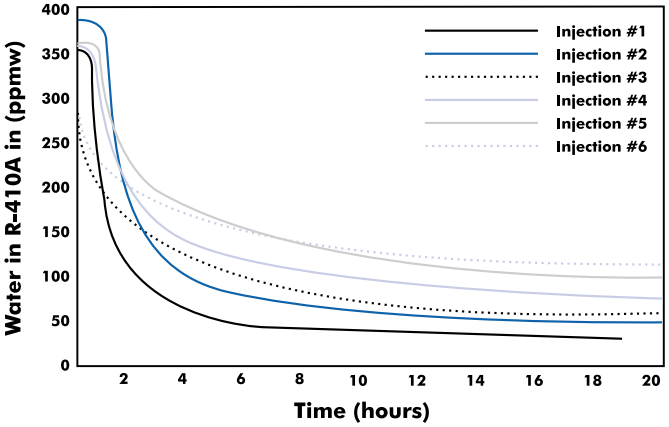
Figures 1 & 2 show the dynamic drying behavior of each molecular sieve sample. Each water injection was allowed to equilibrate for approximately 20+ hours before another injection of water was added. Injections were added to the system until the molecular sieve could not remove enough water to reach a 60 ppm equilibrium point dryness (E.P.D.) with R-410A. A sample not able to remove water down to a specified E.P.D. indicates the molecular sieve has nearly reached its water capacity under those conditions.

Figure 1 Dry-down Rate for Molecular Sieve Used in the Catch-All in Liquid R-410A



The results in Figure 1 prove the molecular sieve used in the Catch-All Filter-Drier prefers the smaller and more polar water molecules over the R-32 refrigerant molecules. When water is present, the R-32 molecule is released and the water molecule is adsorbed. The results demonstrate the excellent dry-down behavior of the molecular sieve used in the Catch-All when compared to the dry-down behavior of the R-32 excluding molecular sieve shown in Figure 2.

Figure 2 Dry-down Rate for R-32 Excluding Molecular Sieve in Liquid R-410A



ACTIVATED ALUMINA

Some manufacturers are promoting the use of 100% molecular sieve filter-driers for HFC-POE lubricant systems. Although it is logical to have increased moisture removal capabilities, these filter-driers do not adequately remove acids formed from lubricant and refrigerant decomposition. A blend of molecular sieve and activated alumina is necessary in a filter-drier since type and quantity of contaminants introduced or generated in a system is unpredictable.

Alumina compatibility with R-32 blend refrigerants has been evaluated in laboratory and system testing. Laboratory testing evaluated the interaction of activated alumina with R-407C and POE lubricant at 200°F in glass sealed tubes. Although 200°F is an unrealistic liquid or suction line temperature, the elevated temperature was intended to amplify a potential incompatibility between the fluids and material. The test results showed activated alumina is compatible with R-407C and POE lubricant.

The compatibility of activated alumina with POE lubricant formulations has been addressed in Forms 40-130 and 40-133. Repeated test results have demonstrated compatibility and addressed concerns that existed about the behavior of activated alumina in an HFC-POE lubricant system.

SYSTEM TESTING

In addition to years of experience, recent HFC-POE lubricant system testing has further reinforced the need for acid removal ability in a filter-drier. Results show acid can be generated in an HFC-POE lubricant system. In sufficient concentration, acid will detrimentally react with various materials within the system. Testing has shown solid contaminants are generated over time within an HFC system without a

filter-drier. The amount of solid contaminant generated (solids from wear or reaction) was dependent on the refrigerant and operating condition. These particles caused control problems at the metering device on certain systems, and led to adverse compressor wear and failure.

To demonstrate the effectiveness of a Catch-All Filter-Drier, identical systems were built with Catch-Alls installed in the liquid line. The systems were operated at the same conditions as the systems without filter-driers. With a Catch-All installed, results showed a negligible amount of solid contaminants existed in the system. Less particles in circulation allowed the metering device to control properly for the duration of the test. The compressor components were examined and showed virtually no wear. The generated acid(s) were removed by the Catch-All before the acid reacted with other materials and system longevity was extended.

In another test, R-410A units were designed and operated at conditions typical of an air conditioning application. The systems were frequently monitored over the course of six months to investigate the interaction of desiccants in a system using R-410A and POE lubricant. Results verified the molecular sieve and alumina used in the Catch-All are compatible in an R-410A-POE lubricant system. When compared to virgin R-410A, testing showed no difference in fractionation of the refrigerant blend when exposed to the desiccants in the test. The desiccants adsorb a negligible amount of R-32 when compared to the amount of R-32 molecules in the refrigerant blend.

CONCLUSION

Extensive testing of the raw materials and molded core in the Catch-All Filter-Drier demonstrates its compatibility and effectiveness in systems using R-32 blend refrigerants (R-410A, R-407C, etc.). A properly designed filter-drier requires a blend of molecular sieve and activated alumina for proper system protection.

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