DuPont™ ISCEON®

REFRIGERANTS

Technical Information

Retrofit Guidelines for DuPont™ ISCEON® M099™ (R-438A) Refrigerant

The miracles of science™

Retrofit Guidelines for
DuPont™ ISCEON® MO99™ Series Refrigerant

Table of Contents

Introduction

DuPont™ ISCEON® refrigerants have proven to be reliable and cost-effective non-ozone-depleting retrofit refrigerants. In many cases, systems retrofitted with these refrigerants are operating with the same mineral oil or alkylbenzene lubricant that was used with the previous CFC or HCFC refrigerant, and have been shown to provide similar system performance as when operating with the previous refrigerant. Using these retrofit guidelines, direct expansion (DX), residential and commercial air conditioning (AC), and medium and low temperature refrigeration systems containing R-22 can be easily and economically retrofitted to ISCEON® MO99™. This allows existing equipment to continue operating safely and effectively for the remainder of its useful life.

Retrofit Choice for R-22 Direct Expansions in Medium and Low Temperature Refrigeration Systems Direct Expansion Chiller Systems, Residential and Commercial Air Conditioning

ISCEON® MO99™ is a non-ozone-depleting HFC Refrigerant designed to replace R-22 in existing direct expansion (DX) residential and commercial air conditioning (AC) and medium- and low-temperature refrigeration systems. **ISCEON® MO99™ is compatible with traditional and new lubricants; in most cases no change of lubricant type during retrofit is required.**

Oil return is determined by a number of operating and design conditions – in some systems with complex piping configurations, POE may need to be added. Minor equipment modifications (e.g., seal replacement) or expansion device adjustments may be required in some applications.

Field experience has shown that ISCEON® MO99™ provides performance that meets customer requirements in most properly retrofitted systems. ISCEON® MO99™ provides similar cooling capacity and energy efficiency to R-22 in most systems, while operating at lower compressor discharge temperature. Actual performance depends on system design and operating conditions.

Systems using ISCEON® MO99™ are easy to service. For most systems. ISCEON® MO99™ can be topped off during service without the need to remove the entire refrigerant charge. The cause of any refrigerant loss should be investigated and corrected as soon as is possible.

Note: When servicing <u>critically charged</u> systems, all of the refrigerant charge should be removed. This is the same practice recommended for HCFC-22.

Easy Steps to Retrofit

The following provides a summary of the basic retrofit steps for ISCEON® MO99™. (Detailed discussion of each step is provided in this bulletin.)

1. Establish baseline performance with existing refrigerant. (See retrofit checklist (attached).)
2. Remove all the old (R-22 or other) refrigerant from the system into a recovery cylinder. Weigh the amount removed.
3. Replace the filter drier and elastomeric seals/gaskets*.
4. Evacuate system and check for leaks.
5. Charge with ISCEON® MO99™.
   - Remove liquid only from charging cylinder.
   - The initial charge amount should be approximately 90% of the standard charge for R-22. The final charge amount will be approximately 95%.
6. Start up system, monitor, adjust TXV and/or charge size to achieve optimum superheat.
7. Monitor oil levels in compressor. Add oil as required to maintain proper levels
8. Label system for the refrigerant and lubricant used.

Retrofit Complete

**Critical Seals are those components that are difficult to isolate and/or service while operating or require removal of the entire refrigerant charge, i.e. liquid receiver level gauge.*

Important Safety Information

Like CFCs and HCFCs, ISCEON® refrigerants are safe to use when handled properly. However, any refrigerant can cause injury or even death when mishandled. Please review the following guidelines and consult the product MSDS, including proper personal protective equipment recommendations, before using any refrigerant. At a minimum, appropriate hand (gloves) and eye (safety glasses) protection should be used.

- Do not work in high concentrations of refrigerant vapors. Always maintain adequate ventilation in the work area. Do not breathe vapors. Do not breathe lubricant mists from leaking systems. Ventilate the area well after any leak before attempting to repair equipment.
- Do not use handheld leak detectors to check for breathable air in enclosed working spaces. These detectors are not designed to determine if the air is safe to breathe. Use oxygen monitors to ensure adequate oxygen is available to sustain life.
- Do not use flames or halide torches to search for leaks. Open flames (e.g. Halide detection torches, or brazing torches) can release large quantities of acidic compounds in the presence of all refrigerants, and these compounds can be hazardous. Halide torches are not effective as leak detectors for HFC refrigerants; they detect the presence of Chlorine, which is not present in ISCEON® MO99™, and consequently, these detectors will not detect the presence of this refrigerant. Use an electronic leak detector designed to find the refrigerants you are using.

If you detect a visible change in the size or color of a flame when using brazing torches to repair equipment, stop work immediately and leave the area. Ventilate the work area well and stop any refrigerant leaks before resuming work. These flame effects may be an indication of very high refrigerant concentrations, and continuing to work without adequate ventilation may result in injury or death.

Note: Any refrigerant can be hazardous if used improperly. Hazards include liquid or vapor under pressure, and frostbite from the escaping liquid.

Overexposure to high concentrations of refrigerant vapor can cause asphyxiation and cardiac arrest. Please read all safety information before handling any refrigerant.

Refer to the ISCEON® MO99™ Material Safety Data Sheet (MSDS) for more specific safety information. DuPont Safety Bulletin AS-1 also gives additional information for safe handling of refrigerants.

Flammability

ISCEON® MO99™ is non-flammable in air under normal conditions. However, this product when mixed with high concentrations of air or oxygen under elevated pressure can become combustible in the presence of an ignition source. This product should not be mixed with air to check for system leaks.

Lubricant and Filter Drier Information

Lubricants

Lubricant selection is based on many factors, including compressor wear characteristics, material compatibility, and lubricant/refrigerant solubility (which can affect oil return to the compressor). ISCEON® MO99™ is compatible with traditional and new lubricants – in most retrofit situations with direct expansion systems no change of oil type is required.

Field experience has shown that ISCEON® MO99™ will work successfully with the existing mineral (or Alkylbenzene) oil in most systems. In systems where oil return is a potential concern, such as flooded evaporators or in systems where the suction line accumulator acts as a low pressure receiver, replacement of all, or part (10-25%) of the compressor oil charge with OEM approved polyol ester is recommended.

Filter Drier

Change the filter drier during the retrofit. This is a routine system maintenance practice. There are two types of filter driers commonly used, solid core and loose filled. Replace the drier with the same type currently in use in the system. The drier label will show which refrigerants can be used with that drier. Select a drier specified to work with HFC refrigerants. (Many driers sold today are "universal" – they will work with most fluorocarbon refrigerants.) Check with your DuPont Distributor for the correct drier to use in your system.

Elastomeric Seals

R-22, and to a lesser extend R-22 containing refrigerant blends, interact relatively strongly with many elastomers causing significant swelling and often, over time, a measurable increase in hardness, etc. ISCEON® MO99™ does not have such a strong effect on those elastomers commonly used as seals in refrigeration systems. A consequence of this is that, when replacing R-22 (and, to a lesser extent, R-22 containing blends) with ISCEON® MO99™ in a system retrofit, it is possible for leaks to occur at elastomeric seals that are exposed to the refrigerant. (This is not a problem attributable to the use of ISCEON® MO99™. Such seal leaks have been reported when replacing R-22 with other HFC refrigerants such as R-407C or R-404A.) Components commonly affected are Schrader core seals, liquid level receiver gaskets, solenoid valves, ball valves and flange seals. Leaks do not occur in every system retrofitted and, in practice, it is difficult to predict whether such leaks will occur. (As a rule of thumb the older the system, the higher the probability that leaks will be observed after a retrofit.)

As a consequence, it is recommended to change any system-critical seals (those which would require removal of the refrigerant charge to allow seal replacement e.g., liquid receiver, refrigerant high-pressure side, etc.) as a matter of course during the retrofit and to have spare seals for other components available during restart of the system. A rigorous leak check regime pre- and post-retrofit will minimize any refrigerant losses. Obviously any seals found to be leaking before the retrofit takes place should be replaced during the retrofit.

General Retrofit Information

System Modifications

The composition of the ISCEON® MO99™ refrigerant has been selected to provide performance comparable to R-22 in terms of both capacity and energy efficiency. As a result, minimal system modifications are anticipated with retrofitting.

ISCEON® MO99™ is a near-azeotrope. The vapor composition in the refrigerant cylinder is different from the liquid composition. For this reason, ISCEON® MO99™ should be transferred from the container in the liquid phase during system charging (or when transferring from one container to another).

In general, ISCEON® MO99™ refrigerant is not recommended for use in centrifugal compressor systems or for chillers with flooded evaporators. Direct expansion systems with low pressure receivers may be retrofitted using ISCEON® MO99™ but a single oil change to a POE oil of the same viscosity as the original oil type is required to ensure adequate oil management for this system configuration.

Retrofits of R-22 systems with non-ozone-depleting alternative refrigerants such as R-407C will require multiple oil changes and possibly more extensive modifications to the existing equipment. For some systems, the cost of conversion may be large. ISCEON® MO99™ provides the service contractor and equipment owner with a cost-effective way to retrofit an existing system without oil changes.

Note: ISCEON® MO99™ should not be mixed with other refrigerants or additives that have not been clearly specified by DuPont or the system equipment manufacturer. Mixing this refrigerant with CFC or HCFC refrigerants, or mixing two different alternative refrigerants, may have an adverse effect on system performance. "Topping off" a CFC or HCFC refrigerant with any Suva® or ISCEON® refrigerant is strictly not recommended.

System Superheat

Desired system performance after a retrofit with DuPont™ ISCEON® MO99™ may require adjustment of the system superheat. This is discussed in the detailed retrofit procedures given below.

System Oil Management

In some poorly designed, maintained, or operated R-22 systems, or ones with extremely complex piping and component arrangements, the oil may not consistently return to the compressor. If oil return issues existed with R-22 operation, it is recommended corrective actions be taken prior to converting to ISCEON® MO99™. In many situations, systems retrofitted with MO99™ have operated routinely using the mineral oil or Alkyl benzene that was used with the original HCFC refrigerant. With complex systems, in a small number of cases, the oil may not return consistently to the compressor.

It is important that oil levels in the compressors be monitored during initial operation with the ISCEON® MO99™. If the oil level falls below the minimum allowed, top up the oil to the minimum level with the existing oil type. Do not fill to maximum as the level may rise again.

Should the oil level fall continuously, or suffer large oscillations during an operating cycle, addition of POE lubricant has proven effective in restoring adequate oil return rates. POE lubricant should be progressively added to the system. An initial addition of 10-20% (of the total oil charge) should be made. This should be followed by further small increments until the oil level returns to normal.

It is important to ensure that, when adding POE oil to the system, the oil level (immediately after addition) is kept below the system mid-point (e.g. mid-sight glass) oil level.

It is also important to keep accurate records of how much oil is added to avoid over-filling.

<u>Systems with Liquid Receivers</u>

When converting a refrigeration or AC system with a liquid receiver from R-22 to MO99™, there is a possibility of trapping oil in the receiver by formation of a separate layer if the oil discharge rate of the compressor is high, for example, when there is no oil separator system. Since it is impossible to know at any given time what the oil discharge rate of any compressor is, and it may change over time, it is recommended for systems with liquid receivers and no oil separators, that a single oil change (or at least 20% of total oil) from mineral oil to an appropriate POE be made during the conversion. The addition of the POE will assist in maintaining adequate oil solubility in the receiver in the event of a high discharge of oil from the compressor. There is no need to perform multiple system flushes or remove all of the mineral oil when converting to MO99™.

Systems that have oil separators, such as supermarket parallel racks, when converted to MO99™, have typically maintained lower oil circulation rates and have not required the addition of POE to maintain solubility in liquid receivers.

<u>Enhanced Surface Tubing</u>

In systems containing enhanced tube surfaces in heat exchangers, large amounts of oil in circulation could potentially inhibit heat transfer and negatively impact system performance. If a specific system with enhanced heat transfer tubes is suspected or known to have high oil circulation rates, a partial change of mineral oil to POE will provide increased solubility of the lubricant in the refrigerant.

Liquid Refrigerant Control

The potential problems that poor liquid refrigerant control can cause in a refrigeration or air conditioning system can be severe and are difficult to predict with certainty. Where flooding, slugging, and refrigerant migration can occur, corrective action should be taken. The proper course of action is normally dependent on the compressor type, system design, type of problem, and the refrigerant/lubricant combination. Compressor or equipment manufacturers should be consulted for detailed guidance on liquid control for a specific system.

While undesirable for reasons previously described and often dependent on system design, management of liquid refrigerant in general may be accomplished by a variety of equipment or control strategies:

1. **<u>Minimize Refrigerant Charge</u>** - charge system with minimum amount of refrigerant required for proper operation. Keep the tubes in condensers, evaporators, and connecting lines to smallest practical size.

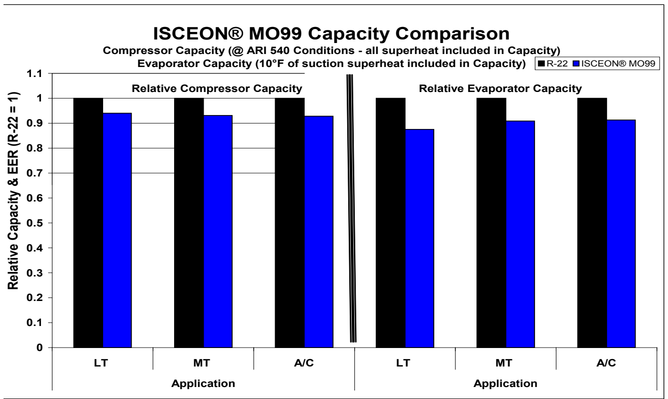
2. **<u>Pumpdown Cycle (Continuous or One-Time)</u>** - isolates the refrigerant when compressor is not in operation, preventing refrigerant migration (see for example, Copeland Application Engineering Bulletin AE-1182-R24).

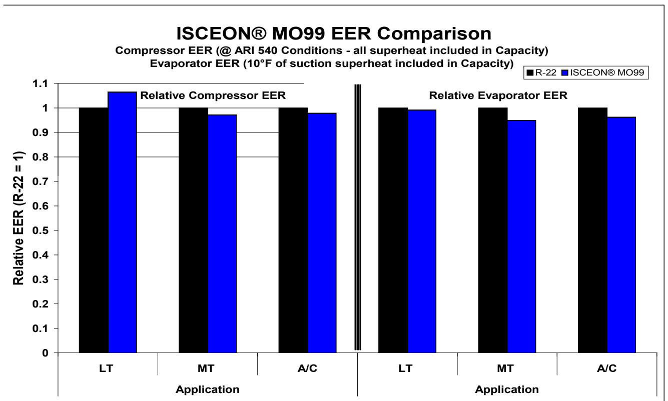
3. **<u>Crank Case Heaters</u>** - maintains oil in the compressor at a temperature higher than coldest part of the system, driving refrigerant out of compressor.

4. **<u>Suction Line Accumulators</u>** - provides a temporary storage vessel to trap liquid refrigerant which has flooded back. Especially important for heat pump systems.

Liquid Control Issues during Refrigerant Conversions (Retrofits)

When systems designed for a particular refrigerant gas need to be converted to operate on another refrigerant, there are a few liquid control issues that require specific attention as detailed below.





Low Temperature (LT): -25°F Evaporator, Seasonal Average Condenser (70% @ 80°F/30% @ 105°F), 10°F subcool liquid, 65°F return gas
Medium Temperature (MT): 20°F Evaporator, Seasonal Average Condenser (70% @ 80°F/30% @ 120°F), 10°F subcool liquid, 65°F return gas
Air Conditioning (A/C):45°F Evaporator, 115°F Condenser, 15°F subcool liquid, 65°F return gas

Flood back, Superheat, and Temperatuare Glide

Flood back (incomplete evaporation of liquid refrigerant in the evaporator) due to inadequate superheat may be caused by an incorrect TXV or improperly adjusted TXV and can lead to slugging and/or bearing washout.

For air conditioning or refrigeration systems being converted from R-22 to ISCEON® MO99™ refrigerant, the mass flow rates are fairly similar such that a TXV (valve body, power-head, or nozzle/orifice) properly sized and operating well for R-22 should not need replacement when switching to MO99™.

However, it may be necessary to slightly adjust the TXV due to the temperature glide effect of the new refrigerant. The need for adjustment will depend on current valve set-points and amount of superheat desired. Since the mass flow rates and pressure-temperature curves for R-22 and MO99™ are very close, only minor adjustments should be required for properly sized components. Conversion kits are available to convert some older non-adjustable TXVs into adjustable type without replacing the valve if need be.

Detailed guidelines on setting superheat for ISCEON® MO99™ can be found in the retrofit guidelines published at www.isceon.com.

For refrigerants other than ISCEON® MO99™, please consult your valve or refrigerant manufacturer for guidance.

Refrigerant Migration and Oil Miscibility

Refrigerant migration, the movement of refrigerant (vapor and/or liquid) to the compressor during off-cycles, usually occurs when the compressor becomes colder than the rest of the system, creating a driving force. This typically happens during cold weather, however, refrigerant migration can occur under other conditions.

Systems operating with highly miscible refrigerant oil pairs (R-22/mineral oil or R-404A/POE), can disssolve a large amount of refrigerant into the oil due to refrigerant migration during off-cycles. Upon start-up, the dissolved refrigerant will rapidly flash from the oil, resulting in foaming, a drop in oil pressure, reduced lubricity, and/or potential slugging of the compressor.

Concerns over refrigeration migration issues extend as well to converted systems with limited miscibility refrigerant/oil combinations such as ISCEON®/mineral oil, since in these cases the potential exists to form separate oil and refrigerant phases in the compressor. The impact of refrigerant migration and recommendations for converting systems from R-22 to ISCEON® are very equipment-specific. Consult the OEM or contact DuPont for specific questions.

Refrigerant Recovery Information

Most recovery or recycle equipment used for R-22 can be used for ISCEON® MO99™. Use standard procedures to avoid cross contamination when switching from one refrigerant to another. Most recovery or recycle machines can use the same compressor oil that was used for the HCFC refrigerant. However, some modifications may be necessary, such as a different kind of drier or a different moisture indicator. Consult the equipment manufacturer for specific recommendations.

In the United States, DuPont will take back (for reclaim) ISCEON® MO99™ refrigerant discussed in this bulletin. In other regions contact your DuPont refrigerant distributor for details of the refrigerant reclaim program.

Expected Performance After Retrofit

Operational Set-Points

ISCEON® MO99™ has been designed to closely match the pressure, temperature, enthalpy, and mass flow properties of R-22. Therefore, in most cases, the operational set-points currently used for evaporator pressures, thermal expansion valves, condenser head pressure control, etc. will be adequate for MO99™. It is recommended that after replacing the R-22 with MO99™, the system be started up and operation allowed to stabilize using these R-22 set-points. If desired, after the system has stabilized, operating controls can be fine tuned to optimize system performance. Detailed instructions for measuring and setting suction pressure, superheat, and subcooling are contained in the Appendix.

Table 1 shows approximate system performance changes following a retrofit and are general guidelines for system behavior. These values are based on field experience, calorimeter testing and thermodynamic property data; and assume equal compressor efficiency.

Cooling capacity and energy efficiency depend greatly on system design, operating conditions and the actual condition of the equipment. ISCEON® MO99™ provides similar cooling capacity and energy efficiency to R-22 in most systems. Actual performance depends on system design and operating conditions.

Table 1

ISCEON® MO99™ Compressor Calorimeter Performance Compared to R-22 in Refrigeration and Air Conditioning Systems

Performance with subcooling based on thermocycle calculations from calorimeter data and do not include heat transfer effects

	Low Temperature* -25°F evaporator 105°F condenser 65°F return gas with 10°F sub-cooling	**Medium Temperature** 20°F evaporator 120°F condenser 65°F return gas with 10°F sub-cooling	**A/C & High Temperature** 45°F evaporator 115°F condenser 65°F return gas with 15°F sub-cooling
Discharge Temperature, °F	-22	-45	-31
Discharge Pressure, psi	+3	+6	+5

+ is increase and - is decrease for ISCEON® MO99™ vs R-22

*R-22 assumes demand cooling with low temp discharge temperature of 275°F.

Detailed Retrofit Procedure for R-22 in Direct Expansion Medium and Low Temperature Refrigeration Systems, Residential and Commercial Air Conditioning

(Refer to the retrofit checklist at the back of this bulletin)

1. **Establish baseline performance with current refrigerant.** Collect system performance data while the old refrigerant is in the system. Check for correct refrigerant charge and operating conditions. The baseline data of temperatures and pressures at various points in the system (evaporator, condenser, compressor suction and discharge, superheat and subcool) at normal operating conditions will be useful when optimizing operation of the system with the ISCEON® MO99™. A System Data Sheet is included at the back of this bulletin to record baseline data.
2. **Remove refrigerant from the system into a recovery cylinder.** The existing charge should be removed from the system and collected in a recovery cylinder using a recovery device capable of pulling 10–15 in Hg vacuum (50–67 kPa absolute). If the recommended charge size for the system is not known, weigh the amount of refrigerant removed. The initial quantity of ISCEON® MO99™ to charge to the system can be estimated from this amount. (See step 5). Ensure that any residual refrigerant dissolved in the compressor oil is removed by holding the system under vacuum. Break the vacuum with dry nitrogen.
3. **Replace the filter drier/elastomeric seals/gaskets.** It is routine practice to replace the filter drier during system maintenance. Replacement filter driers are available that are compatible with ISCEON® MO99™. While the system is empty, check and replace any elastomeric seals that may be near the end of their serviceable life. Even if they were not previously leaking, the change of swell characteristics when changing to any new refrigerant (e.g., R-22 to any HFC refrigerant) and the general disturbance to the system may cause worn seals to leak after retrofit. Although, in general, the same seal materials can be used with ISCEON® MO99™ (refer to Compatibility Tables in the DuPont PUSH bulletin #K-10927) it has been observed (as with other HFC based refrigerants) that shrinkage of the original seal may occur after conversion causing refrigerant leakage. Components commonly affected are Schrader core seals, liquid level receiver gaskets, solenoid valves, ball valves and flange seals, but all external seals in contact with the refrigerant should be viewed as a potential leak source post retrofit. Field experience has shown that the older the system, the greater the likelihood of seal and gasket leaks. It is recommended to change any system critical seals (e.g., those which require removal of the refrigerant charge to allow seal replacement e.g., liquid receiver, condenser system) as a matter of course and to have spare seals for other components available during the retrofit should any seal failure occur. Non-critical seals are those in sections of the system which can be isolated using shut-off valves from the main refrigerant charge, such as those on compressors, individual evaporators, etc. Shrader valves can generally be changed in-situ, under pressure, using a special tool, and thus are not considered to be system critical. A rigorous leak check regime pre- and post-retrofit will minimize any refrigerant losses.
4. **Evacuate system and check for leaks. Use normal service practices.** To remove air or other non-condensable gases and any residual moisture from the system, evacuate the system to near full vacuum (29.9 in Hg vacuum [500 microns] or less than 10 kPa), isolate the vacuum pump from the system and observe the vacuum reading. If the system does not maintain vacuum it is an indication that there might be a leak. Pressurize the system with nitrogen, taking care not to exceed the system design maximum pressure and check for leaks. Do not use mixtures of air and refrigerant under pressure, to check for leaks; these mixtures can be combustible. After leak checking with Nitrogen remove residual Nitrogen using a vacuum pump.
5. **Charge with ISCEON® MO99™.** Remove liquid only from charging cylinder. (If the cylinder does not have a valve with a diptube, invert the cylinder so that the valve is underneath the cylinder). The proper cylinder position for liquid removal is often indicated by arrows on the cylinder and cylinder box. Once liquid is removed from the cylinder, the refrigerant can be allowed to enter the refrigeration system as liquid or vapor as desired. Use the manifold gauges or a throttling valve to flash the liquid to vapor if required.

WARNING: Do not charge liquid refrigerant into the compressor. This will cause serious irreversible damage.

In general, refrigeration systems will require about the same weight of ISCEON® MO99™.refrigerant as the original R-22 charge, although some may require slightly more and some slightly less. The optimum charge will vary depending on the system design and operating conditions. The initial charge should be approximately 90% of the standard charge for R-22. After start-up and adjustment, the final charge amount will usually be similar to the R-22 charge. Consult the system OEM guidelines for specific directions.

Note: For systems with a liquid refrigerant receiver, charge the system to the normal refrigerant level in the receiver. These values apply provided no changes to mechanical components of the system (which could significantly affect the system's internal volumetric capacity) will be made during the retrofit.

6. **Start up system, adjust charge size** (for systems without a liquid receiver). Start the system and let conditions stabilize. If the system is undercharged (as indicated by the level of superheat at the evaporator exit, or by the amount of sub-cool at the condenser exit) add more ISCEON® MO99™ in small amounts (still by transferring as liquid from the charging cylinder) until the system conditions reach the desired level. See the pressure-temperature charts in this bulletin to compare pressures and temperatures in order to calculate superheat or sub-cooling for the refrigerant you are using. Sight glasses in the liquid line can be used in most cases as a guide to system charge, but correct system charge must be determined by measuring system operating conditions (discharge and suction pressures, suction line temperature, compressor motor amps, superheat, etc.). Attempting to charge until the sight glass is "full" may result in overcharging the refrigerant. Please read "How to Determine Suction Pressure, Superheat and Subcool."

   Ensuring that the correct compressor suction superheat is set is very important for reliable system operation with ISCEON® MO99™. Experience has shown that superheat (at the compressor inlet) for ISCEON® MO99™ should be the same as for the refrigerant being replaced.

WARNING: Liquid refrigerant entering the compressor at any time during system operation can lead to compressor oil level problems and rapid compressor failure.

7. **Monitor oil levels.** During initial operation of the system it is very important to monitor the level of oil in the compressor (or compressor oil management system) to verify that oil is returning to the compressor in an adequate manner.
   - If the oil level falls below the minimum allowed level, top up to the minimum level with the existing oil type. Do not fill to the maximum level as the level may rise again.
   - Should the oil return appear to be erratic as evidenced by large swings in oil level during the refrigeration system cycle it is recommended that some of the oil be removed from the system and replaced with POE oil. Replacement of up to 30% of the oil with POE will help to restore oil return stability. The exact amount of oil to be changed will depend on the system itself (evaporating temperatures, physical geometry, etc.)
   - POE lubricant should be progressively added to the system. An initial addition of 10-25% (of the total oil charge) should be made. This should be followed by small increments until the oil level returns to normal consistently throughout the refrigeration system operating cycle.
   - It is important to ensure that, when adding POE oil to the system, the oil level (immediately after addition) is kept below the system mid-point (e.g. mid-sight glass) oil level.

8. **Thoroughly leak check the system.** As mentioned in step 3 it is possible that refrigerant leakage can occur during or immediately after a retrofit. Experience has shown that some leaks will not appear until after the new refrigerant has been charged to the system. Pay particular attention to Schrader valve core seals, solenoid valves and ball valve stems on the liquid high pressure side.

9. **Label the system** to clearly and permanently show the refrigerant in the system and any oil(s) present in the system.

Pressure/Temperature Charts (Appendix B)

How to Read the Pressure/Temperature Chart

The following pages contain pressure/temperature charts for the refrigerants discussed in this bulletin. Two temperatures are shown for MO99™ at a given pressure:

- Saturated Liquid Temperature (Bubble Point)—In the condenser, this is the point at which the last bit of vapor has condensed. This temperature/pressure should be used when determining the system subcooling as well as the temperature/pressure value of product stored in a refrigerant cylinder.
- Saturated Vapor Temperature (Dew Point)—In the evaporator, this is the temperature at which the last drop of liquid has just boiled. Above this temperature, the refrigerant will be superheated vapor. This pressure/temperature should be used in determining the system superheat.

How to Determine Suction Pressure, Superheat, and Subcool

Suction Pressure

In many cases, the evaporator pressure setting used for R-22 will provide adequate performance when using MO99™. However, if it is determined some adjustment is needed, refer to Appendix A (Average Evaporator (**Table 5**) and Average Condenser Set Points (**Table 4**)) and proceed as follows. Determine the expected average evaporator temperature using R-22 (from the baseline data you collected prior to the retrofit). Find the same expected evaporator temperature in the Saturated Vapor (Dew Point) column for ISCEON® MO99™. Note the corresponding pressure for this temperature. This is the approximate suction pressure at which the system should operate.

Superheat

In many cases, the superheat settings used for R-22 will provide adequate performance when using MO99™. However, if it is determined an adjustment is needed, refer to the P-T chart (Appendix B) - **Table 6** and proceed as follows. First, measure the suction pressure, and using the saturated vapor pressure (dew point) table for ISCEON® MO99™, determine the saturated vapor temperature corresponding to that measured suction pressure. Next, measure the suction temperature at the compressor inlet (suction) and subtract the previously determined dew point temperature for ISCEON® MO99™, to give the amount of vapor superheat. Adjust TXV if necessary to increase or decrease superheat. In general, the superheat for MO99™ operation should be similar to that used previously during R-22 operation.

Subcool

Using the saturated liquid pressure (bubble point) tables in P-T Chart Appendix B **Table 6** for ISCEON® MO99™, determine the saturated liquid temperature for the measured condensing pressure (usually the high-side pressure). Measure the refrigerant liquid line temperature and subtract it from the previously determined bubble point temperature for ISCEON® MO99™ to give the amount of liquid subcool.

Retrofit Checklist for Converting CFC or HCFC Systems to DuPont™ ISCEON® MO99™

__________ 1. Establish baseline performance with existing refrigerant.

- Use the System Data sheet given below.
- Note the oil type in use and system operating data (if system is operating properly).
- Check for existing leaks and repair.

__________ 2. Remove existing refrigerant charge from system. (Need 10–15 in Hg vacuum [50–67 kPa absolute] to remove charge.)

- Use recovery cylinder (DO NOT vent to atmosphere).
- Weigh amount removed (if possible): ________________.
- Break the vacuum with dry nitrogen.

__________ 3. Replace the filter drier and elastomeric seals/gaskets.

- Check and replace elastomeric seals and gaskets that cannot be replaced w/out removal of refrigerant
  - Components commonly affected are Schrader core seals, liquid level receiver gaskets, solenoid valves, ball valves and flange seals but all external seals in contact with the refrigerant should be viewed as a potential leak source post retrofit.
- Check that oil is in good condition; replace if necessary.

__________ 4. Evacuate system and check for leaks.

- Does the system hold a vacuum?
- Break vacuum with dry nitrogen, pressurize to below the system design pressure.
- Does the system hold pressure?
- Check for any leaks.

__________ 5. Charge system with ISCEON® MO99™ refrigerant.

- Remove liquid only from cylinder.
- The initial charge amount should be approximately 85% of the standard charge for R-22. The final charge amount will be approximately 95%.

Note: Do not charge liquid refrigerant into the compressor. This will cause serious irreversible damage.

__________ 6. Adjust TXV and/or refrigerant charge to achieve the same superheat as the original system. If adjustment is not adequate, replace TXV orifice.

__________ 7. Monitor oil levels in compressor. If necessary add original oil to attain normal operating level (mid-sight glass).

- If a sudden surge in oil level occurs (e.g., during/just after defrost) remove a small (approximately 10%) quantity of the mineral oil and replace with POE oil. Repeat if necessary.
- If the oil levels falls below the minimum, top-up to the minimum level with the existing oil type.
- If the oil level continuously falls or large oscillations occur during operation, add a sufficient amount of an equivalent POE until oil return becomes normal.

__________ 8. Label system clearly. Ensure System Data sheet is completed and filed securely.

Retrofit is complete!

System Data Sheet

Type of System/Location: ______________________________

Equipment Mfg.: ______________________

Model No.: ______________________

Serial No.: ______________________

Date of Manufacture: ______________________

Original Charge Size: ______________________

Lubricant Charge Size: ______________________

Drier Type (check one):

Model No.: ______________________

____

Compressor Mfg.: ______________________

Model No.: ______________________

Serial No.: ______________________

Date of Manufacture: ______________________

Lubricant Type: ______________________

Drier Mfg: ______________________

Loose Fill: ______________________

Solid Core: ______________________

Condenser Cooling Medium (air/water): ______________________

Expansion Device (check one): Capillary Tube: ______________________

Expansion Valve: ______________________

If Expansion valve:

Manufacturer: ______________________

Model No.: ______________________

Control/Set Point: ______________________

Location of Sensor: ______________________

Other System Controls (ex.: head press control), Describe: ______________________

____

(circle units used where applicable)				
Date/Time				
Refrigerant				
Charge Size (lb)				
Ambient Temp. (°F)				
Compressor:				
Suction T (°F)				
Suction P (psi)				
Discharge T (°F)				
Discharge P (psi)				
Evaporator:				
Coil Air/H_2O In T (°F)				
Coil Air/H_2O Out T (°F)				
Operating Service Temperature (°F)				
Condenser:				
Coil Air/H_2O In T (°F)				
Coil Air/H_2O Out T (°F)				
Superheat and Subcool (derived values)				
Refrigerant T at Superheat Ctl. Pt (°F)				
Calculated Superheat (°F)				
Exp. Device Inlet T (°F)				
Calculated sub-cool (°F)				
Motor Amps (if pack: total)				
Comments: ______________________				

Table 2
Physical Properties of DuPont™ ISCEON® MO99™

Physical Property	Unit	ISCEON® MO99™	R–22
Boiling Point (1 atm.)	°F	–45.4	–41.8
Vapor Pressure at 77°F)	psia	161.3	151.2
Liquid Density at 77°F	lb/cu ft	71.13	74.6
Density, Satd. Vapor at 77°F	lb/cu ft	2.97	2.72
Ozone Depletion Potential	CFC–11 = 1.0	0	0.05
Global Warming Potential, SAR values	CO_2 = 1	1890	1500
AR4 values		2264	1810

Table 3
Composition of ISCEON® MO99™ (Wt. %)

	HFC–32	HFC-125	HFC–134a	n-butane	i-pentane
ISCEON® MO99™	8.5	45	44.2	1.7	0.6

Appendix A

Table 4
Condenser Pressure Set Points

Based on 20F° Evapporator, 10F° Subcooling		
R-22, psig	Avg Condenser Temp, F°	MO99™ psig
143.4	80	143.9
145.7	81	146.3
148.0	82	148.7
150.4	83	151.1
152.8	84	153.6
155.3	85	156.1
157.8	86	158.6
160.3	87	161.2
162.8	88	163.8
165.4	89	166.4
168.0	90	169.1
170.6	91	171.8
173.2	92	174.6
175.9	93	177.3
178.7	94	180.1
181.4	95	183.0
184.2	96	185.8
187.0	97	188.7
189.8	98	191.7
192.7	99	194.6
195.6	100	197.6
198.6	101	200.6
201.5	102	203.7
204.5	103	206.8
207.5	104	209.9
210.6	105	213.1
213.7	106	216.3
216.8	107	219.5
220.0	108	222.8
223.2	109	226.1
226.4	110	229.4
229.6	111	232.7
232.9	112	236.1
236.2	113	239.5
239.5	114	243.0
242.9	115	246.5
246.3	116	250.0
249.7	117	253.6
253.2	118	257.1
256.7	119	260.8
260.2	120	264.4
263.7	121	268.1
267.3	122	271.8
270.9	123	275.5
274.6	124	279.3
278.3	125	283.1
282.0	126	287.0
285.7	127	290.9
289.5	128	294.8

Based on 20F° Evapporator, 10F° Subcooling		
R-22, psig	Avg Condenser Temp, F°	MO99™ psig
293.3	129	298.7
297.1	130	302.7
300.9	131	306.7
304.8	132	310.7
308.8	133	314.8
312.7	134	318.9
316.7	135	323.0
320.7	136	327.2
324.8	137	331.4
328.8	138	335.7
332.9	139	339.9
337.1	140	344.2

In general, the condensing pressure of R-22 and MO99™ are very close and will require minimal adjustment to control set-points. After converting from R-22 to MO99™ the condensing pressure can be determined by locating the desired average condenser temperature (or R-22 pressure setting) on this chart and determining the new set point required for equivalent operation with MO99™.

Table 5
Evaporator Suction Pressure Set Points

Based on 105F° Condenser, 95F° Subcooling		
R-22, psig	Avg Evaporator Temp, F°	MO99™ psig
7.6	-25	5.2
8.1	-24	5.7
8.6	-23	6.1
9.1	-22	6.6
9.6	-21	7.1
10.1	-20	7.6
10.7	-19	8.1
11.2	-18	8.6
11.8	-17	9.2
12.4	-16	9.7
13.0	-15	10.3
13.6	-14	10.9
14.2	-13	11.5
14.9	-12	12.1
15.5	-11	12.8
16.2	-10	13.4
16.9	-9	14.1
17.6	-8	14.8
18.3	-7	15.5
19.1	-6	16.2
19.8	-5	16.9
20.6	-4	17.7
21.4	-3	18.4
22.2	-2	19.2
23.0	-1	20.0
23.8	0	20.8
24.6	1	21.6
25.5	2	22.5
26.4	3	23.3
27.2	4	24.2
28.1	5	25.1
29.0	6	26.0
30.0	7	26.9
30.9	8	27.8
31.9	9	28.7
32.8	10	29.7
33.8	11	30.7
34.8	12	31.7
35.8	13	32.7
36.9	14	33.7
37.9	15	34.7
39.0	16	35.8
40.0	17	36.9
41.1	18	37.9
42.2	19	39.0
43.3	20	40.2
44.5	21	41.3
45.6	22	42.4
46.8	23	43.6

Based on 105F° Condenser, 95F° Subcooling		
R-22, psig	Avg Evaporator Temp, F°	MO99™ psig
47.9	24	44.8
49.1	25	46.0
50.3	26	47.2
51.5	27	48.4
52.8	28	49.6
54.0	29	50.9
55.3	30	52.2
56.6	31	53.4
57.9	32	54.7
59.2	33	56.1
60.5	34	57.4
61.8	35	58.7
63.2	36	60.1
64.5	37	61.5
65.9	38	62.9
67.3	39	64.3
68.7	40	65.7
70.1	41	67.1
71.6	42	68.9
73.0	43	70.0
74.5	44	71.5
76.0	45	73.0

After converting from R-22 to MO99™, the evaporator temperature can be set by locating the desired average evaporator temperature or (R-22 evaporator pressure) on this chart and determining the new set point required for MO99™ in order to achieve an equivalent average evaporator temperature.

Appendix B

Table 6
Temperature—Pressure Chart ISCEON® MO99™

Pressure (psig)	R-22	ISCEON® MO99™	
	Saturated Temperature (°F)	Saturated Liquid (Bubble Point) Temperature (°F)	Saturated Vapor (Dew Point) Temperature (°F)
-6	-60.5	-63.0	-51.5
-5	-56.7	-59.3	-47.8
-4	-53.3	-55.8	-44.5
-3	-50.0	-52.6	-41.3
-2	-47.0	-49.6	-38.4
-1	-44.1	-46.8	-35.6
0	-41.4	-44.2	-33.0
1	-38.9	-41.7	-30.6
2	-36.5	-39.3	-28.2
3	-34.2	-37.0	-26.0
4	-32.0	-34.8	-23.9
5	-29.8	-32.7	-21.8
6	-27.8	-30.7	-19.8
7	-25.8	-28.8	-18.0
8	-24.0	-26.9	-16.1
9	-22.1	-25.1	-14.4
10	-20.4	-23.4	-12.6
12	-17.0	-20.1	-9.4
14	-13.8	-16.9	-6.3
16	-10.8	-13.9	-3.4
18	-7.9	-11.1	-0.6
20	-5.2	-8.4	2.0
22	-2.5	-5.8	4.6
24	0.0	-3.4	7.0
26	2.4	-1.0	9.3
28	4.7	1.3	11.6
30	6.9	3.5	13.7
32	9.1	5.7	15.8
34	11.2	7.7	17.8
36	13.2	9.7	19.8
38	15.2	11.7	21.7
40	17.1	13.6	23.5
42	19.0	15.4	25.3
44	20.8	17.2	27.1
46	22.6	18.9	28.8
48	24.3	20.6	30.4
50	26.0	22.3	32.1
52	27.6	23.9	33.7
54	29.2	25.5	35.2
56	30.8	27.0	36.7
58	32.4	28.6	38.2
60	33.9	30.1	39.6
62	35.3	31.5	41.1
64	36.8	32.9	42.5
66	38.2	34.3	43.8
68	39.6	35.7	45.2
70	41.0	37.1	46.5
75	44.3	40.3	49.7
80	47.5	43.5	52.7
85	50.6	46.5	55.7
90	53.5	49.4	58.5
95	56.4	52.2	61.2
100	59.1	54.9	63.9
105	61.8	57.5	66.4
110	64.4	60.1	68.9
115	66.9	62.6	71.3
120	69.3	65.0	73.6
125	71.7	67.3	75.9
130	74.0	69.6	78.1
135	76.2	71.8	80.3
140	78.4	73.9	82.4
145	80.6	76.0	84.4
150	82.7	78.1	86.4
155	84.7	80.1	88.4
160	86.7	82.1	90.3
165	88.7	84.0	92.1
170	90.6	85.9	94.0
175	92.5	87.8	95.8
180	94.3	89.6	97.5
185	96.2	91.4	99.2
190	97.9	93.1	100.9
195	99.7	94.8	102.6
200	101.4	96.5	104.2
205	103.1	98.2	105.8
210	104.8	99.8	107.4
215	106.4	101.4	108.9
220	108.0	103.0	110.5
225	109.6	104.6	112.0
230	111.1	106.1	113.4
235	112.7	107.6	114.9
240	114.2	109.1	116.3
245	115.7	110.5	117.7
250	117.1	112.0	119.1
255	118.6	113.4	120.5
260	120.0	114.8	121.8
265	121.4	116.2	123.1
270	122.8	117.6	124.4
275	124.2	118.9	125.7
280	125.5	120.3	127.0
285	126.9	121.6	128.3
290	128.2	122.9	129.5
295	129.5	124.2	130.7
300	130.8	125.4	131.9
310	133.3	127.9	134.3
320	135.8	130.4	136.6
330	138.2	132.7	138.9
340	140.6	135.1	141.1
350	142.9	137.4	143.3
360	145.2	139.6	145.4
370	147.5	141.8	147.5
380	149.6	143.9	149.5
390	151.8	146.1	151.5
400	153.9	148.1	153.4

For Further Information: (877) 683-3566

www.isceon.com

DuPont Fluorochemicals
Wilmington, DE 19880-0711

Europe, Middle East, and Africa

DuPont de Nemours
International S.A.
2 Chemin du Pavillon
P.O. Box 50
CH-1218 Le Grand-Saconnex
Geneva, Switzerland
41-22-717-5111

Canada

DuPont Canada, Inc.
P.O. Box 2200, Streetsville
Mississauga, Ontario
Canada
L5M 2H3
(905) 821-3300

DuPont México, S.A. de C.V.

Homero 206
Col. Chapultepec Morales
C.P. 11570 México, D.F.
52-55-57 22 11 00

South America

DuPont do Brasil S.A.
Alameda Itapecuru, 506
Alphaville 06454-080 Barueri
São Paulo, Brazil
55-11-4166-8263

DuPont Argentina S.A.

Casilla Correo 1888
Correo Central
1000 Buenos Aires, Argentina
0 800 33 38766

Asia Pacific

Philippines
DuPont Fareast Inc Philippines
19th floor Gt Tower International
6815 Ayala Avcorner Hv Costast
Makati City
Philippines
1227
63-2-8189911
63-2-8189659

Thailand
DuPont (Thailand) Co.,Ltd
6-7th Floor, M. Thai Tower, All Seasons Place,
87 Wireless Road, Lumpini, Phatumwan
Bangkok
Thailand
10330
66-2-6594000
66-2-6594001-2

Malaysia
DuPont Malaysia Sdn Bhd
6th Floor, Bangunan Samudera,
No.1 Jalan Kontraktor U1/14
Sek U1, Hicom-Glenmarie Industrial Park
Shah Alam
Selangor
40150
60-3-55693006
60-3-55693001

Singapore
DuPont Company (Singapore) Pte Ltd
1 HarbourFront Place #11-01
HarbourFront Tower One
Singapore
098633
65-65863688
65-62727494

Indonesia
PT DuPont Indonesia
Menara Mulia 5th Floor
Jl Jend. Gatot Subroto Kav. 9-11
Jakarta
Indonesia
12930
62-21-5222555
62-21-5222565

Taiwan
DuPont Taiwan Ltd.
13Fl., No. 167, Tun Hwa N. Rd.,
Taipei
Taiwan, R. O. C.
105
886-2-27191999
886-2-25457098

India
E I DuPont India Private Ltd
DLF Cyber Greens, Tower "C" 7th Floor
Sector 25A, DLF City
Phase III
Gurgaon 122002
INDIA
91-124-2540900
91-124-2540891

Korea
DuPont (Korea) Inc.
4th Floor, Asia Tower
#726, Yeoksam-dong, Kangnam-Ku
Seoul, Korea
135-719
82-2-22225207
82-2-22225483

Hong Kong
DuPont China Limited
26/F., Tower 6, Gateway
Canton Road
Tsimsha tsui
Hong Kong
852-27345345
852-23683516

Australia/New Zealand
DuPont (Australia) Ltd
168 Walker Street North Sydney
PO Box 930 North Sydney
Sydney
NSW
2060
61-2-99236111
61-2-99236135

China
DuPont China Holding Co.,Ltd.
15th Floor, Shui On Plaza,
333 Huai Hai Road (Central)
Shanghai
200021
86-21-63866366
86-21-63853542

The information set forth herein is furnished free of charge and is based on technical data that DuPont believes to be reliable. It is intended for use by persons having technical skill, at their own discretion and risk. The handling precaution information contained herein is given with the understanding that those using it will satisfy themselves that their particular conditions of use present no health or safety hazards. Because conditions of product use are outside our control, we make no warranties, express or implied, and assume no liability in connection with any use of this information. As with any material, evaluation of any compound under end-use conditions prior to specification is essential. Nothing herein is to be taken as a license to operate under or a recommendation to infringe any patents.

K-22217-1 09/11

The miracles of science™