# DuPont™ ISCEON® 9 Series

REFRIGERANTS

Technical Information
ART-46

# Retrofit Guidelines for DuPont™ ISCEON® M029 (R-422D) Refrigerant

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# Retrofit Guidelines for DuPont™ ISCEON® 9 Series Refrigerants

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## Introduction

DuPont™ ISCEON® 9 Series refrigerants have proven to be easy-to-use, 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) water chiller systems, residential and commercial air conditioning (AC), and medium temperature refrigeration systems (can also be used in low temperature) containing R-22 can be easily and economically retrofitted to ISCEON® MO29. This allows existing equipment to continue operating safely and effectively for the remainder of its useful life.

### *Retrofit Choice for R-22 in Medium (and Low) Temperature Refrigeration Systems, Direct Expansion Water Chiller Systems, Residential and Commercial Air-Conditioning*

ISCEON® MO29 is an easy-to-use, non-ozone-depleting HFC Refrigerant originally designed to replace R-22 in existing direct expansion (DX) water chiller systems. It can also be used in residential and commercial air conditioning (AC) and medium-temperature (and low) refrigeration systems. **ISCEON® MO29 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® MO29 provides performance that meets customer requirements in most properly retrofitted systems. ISCEON® MO29 provides similar cooling capacity and energy efficiency to R-22 in most systems, while operating at significantly lower compressor discharge temperature. Actual performance depends on system design and operating conditions.

**ISCEON® MO29 can be topped off during service without removing the entire refrigerant charge.**

**Note:** When servicing critically charged 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® MO29.

1. Establish baseline performance with existing refrigerant.
2. Remove all refrigerant from the system into a recovery cylinder. Weigh the amount removed.
3. Replace the filter drier and elastomeric seals/gaskets that are exposed to refrigerant.

   **Note:** Some systems may require expansion valve adjustments. 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 refrofit.
4. Evacuate system and check for leaks.
5. Charge with ISCEON® MO29.
   - Remove liquid only from charging cylinder.
   - The initial charge amount should be approximately 85% of the standard charge for R-22. The final charge amount will be approximately 95%.
6. Start up system, 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***

## Important Safety Information

Like CFCs and HCFCs, ISCEON® 9 Series refrigerants are safe to use when handled properly. However, any refrigerant can cause injury or even death when mishandled. Please review the following guidelines before using any refrigerant.

- **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 (eg. 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® MO29, 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 appropriate Material Safety Data Sheet (MSDS) for more safety information about each refrigerant. DuPont Safety Bulletin AS-1 also gives additional information for safe handling of refrigerants.

### *Flammability*

ISCEON® MO29 is non-flammable in air under normal conditions. However, mixtures of this product with high concentrations of air or oxygen at elevated pressure and/or temperature can become combustible in the presence of an ignition source. This product should not be mixed with air to check for 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® MO29 is compatible with traditional and new lubricants – in most retrofit situations no change of oil type is required.

**Field experience has shown that ISCEON® MO29 will work successfully with the existing mineral 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 (~25%) of the compressor oil charge with an 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*

While the system is empty, check and replace all 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® MO29 (refer to Compatibility Tables in 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 (refer to HFC Compatibility with Elastomeric Seals #K-17335). 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) as a matter of course and to have spare seals for other components available during the retrofit should any seal failure occur. A rigorous leak check regime pre and post retrofit will minimize any refrigerant losses.

## General Retrofit Information

### *System Modifications*

The compositions of the ISCEON® 9 Series refrigerants have been selected to provide performance comparable to the refrigerants they are replacing in terms of both capacity and energy efficiency. As a result, minimal system modifications are anticipated with retrofitting. The ISCEON® 9 Series refrigerant discussed in this bulletin is a near-azeotrope, therefore the vapor composition in the refrigerant cylinder is different from the liquid composition. For this reason, ISCEON® 9 Series refrigerants should be transferred from the container from the liquid phase during system charging (or when transferring from one container to another).

In general, ISCEON® MO29 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® MO29 but a single oil change to a POE oil of the same viscosity as the original oil type is required.

Retrofits of R-22 systems with non-ozone-depleting alternative refrigerants such as R-404A or 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® MO29 provides the service contractor and equipment owner with a cost effective way to retrofit an existing system.

**Note:** ISCEON® MO29 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® 9 Series refrigerant is strictly not recommended.

### *System Superheat*

Desired system performance after a retrofit with DuPont™ ISCEON® MO29 requires correct setting of the system superheat. This is discussed in the detailed retrofit procedures given below.

### *System Oil Management*

In many situations, systems retrofitted with ISCEON® MO29 have operated routinely using the mineral oil or Alkylbenzene 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® MO29.* 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% (of the total oil charge) should be made. This should be followed by 5% 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.

### *Refrigerant Recovery Information*

Most recovery or recycle equipment used for R-22, can be used for ISCEON® MO29. 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® MO29 refrigerant. In other regions contact your DuPont refrigerant distributor for details of the refrigerant reclaim program.

### *Expected Performance After Retrofit*

**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® MO29 provides similar cooling capacity and energy efficiency to R-22 in most systems while operating at significantly lower compressor discharge temperature. Actual performance depends on system design and operating conditions.

## Table 1
## ISCEON® MO29 Performance Compared to R-22 in Refrigeration Systems

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

| | Low Temperature<br>–25°F (–32°C) evaporator<br>105°F ( 41°C) condenser<br>65°F ( 18°C) return gas<br>with 10°F (6°C) subcooling | Med Temperature<br>20°F (–7°C) evaporator<br>120°F (49°C) condenser<br>65°F (18°C) return gas<br>with 10°F (6°C) subcooling |
|---|---|---|
| Discharge Temperature, °F (°C) | –33 (–18) | –64 (–36) |
| Discharge Pressure, psi (kPa) | +10 (+69) | +10 (+69) |
| Refrigeration Cooling Capacity, % | +8 | –5 |
| Energy Efficiency, % | +14 | Same |

+ is increase and – is decrease for ISCEON® MO29 vs. R-22

R-22 assumes demand cooling with discharge temperature of 275°F (135°C)

### Retrofit Choice for R-22 in Medium (and Low) Temperature Refrigeration Systems, Direct Expansion Water Chiller Systems, Residential and Commercial Air-Conditoning

***(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, etc.) at normal operating conditions will be useful when optimizing operation of the system with the ISCEON® MO29. 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® MO29 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® MO29. See page 2 of this manual for additional information on driers. While the system is empty, check and replace any seals which 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 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® MO29 (refer to 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 (refer to HFC Compatibility with Elastomeric Seals #K-17335). 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 refrofit. It is recommended to change any system critical seals (i.e., those which require removal of the refrigerant charge to allow seal replacement e.g., liquid receiver) as a matter of course and to have spare seals for other components available during the retrofit should any seal failure occur. A rigorous leak check regime pre and post retrofit will minimize any refrigerant losses. Field experience has shown that the older the system, the greater the likelihood of seal and gasket leaks.
4. **Evacuate system and check for leaks.** Use normal service practices. To remove air or other noncondensables and any residual moisture from the system, evacuate the system to near full vacuum (29.9 in Hg vacuum [500 microns] or less than 0.1 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.

5. **Charge with ISCEON® MO29. Remove liquid only from charging cylinder.** The proper cylinder position for liquid removal is indicated by arrows on the cylinder and cylinder box. Once liquid is removed from the cylinder, the refrigerant can be charged to the 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, the refrigeration system will require less weight of the ISCEON® MO29 than of the original R-22 charge, although some will require slightly more. The optimum charge will vary depending on the system design and operating conditions. The initial charge amount should be approximately 85% of the standard charge for R-22. The final charge amount will be approximately 95%.

**Note:** 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.** 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® MO29 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 "clear" 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® MO29. Experience has shown that superheat (at the compressor inlet) for ISCEON® MO29 should be the same as for the refrigerant being replaced.

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 25% 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% (of the total oil charge) should be made. This should be followed by 5% 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.

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

## Pressure/Temperature Charts

### *How to Read the Pressure/Temperature Chart*

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

- **Saturated Liquid Temperature (Bubble Point)**—In the condenser, this is the temperature at which the last bit of vapor has condensed. Below this temperature, the refrigerant will be subcooled liquid. This temperature should also be used when determining the pressure/temperature value of product 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.
- Average Coil Temperature (for ISCEON® MO29)—The evaporator and condenser will perform like it is operating at this constant temperature. It is an average of the bubble and dew point temperatures determined from either the suction or condenser pressure. Use this average temperature to compare coil temperatures with the refrigerant you are replacing. **Note:** this is an approximation of the average temperature for low glide refrigerants.

### *How to Determine Suction Pressure, Superheat, and Subcool*

#### Suction Pressure

Determine the expected evaporator temperature using the R-22 (from the baseline data you collected prior to the retrofit). Find the same expected evaporator temperature in the Average Coil Temperature column for ISCEON® MO29. Note the corresponding pressure for this temperature. This is the suction pressure at which the system should operate.

#### Superheat

Using the saturated vapor pressure tables for ISCEON® MO29, determine the saturated vapor temperature (dew point) for the measured suction pressure. Measure the suction temperature and subtract the previously determined dew point temperature for ISCEON MO29 to give the amount of vapor superheat.

#### Subcool

Using the saturated liquid pressure tables for ISCEON® MO29, determine the saturated liquid temperature (bubble point) for the measured discharge temperature. Measure the refrigerant liquid line temperature and subtract it from the previously determined bubble point temperature for ISCEON® MO29 to give the amount of liquid subcool.

## Retrofit Checklist for Converting CFC or HCFC Systems to DuPont™ ISCEON® MO29

_____ 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
  - 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® MO29 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.:_____ Compressor Mfg.:_____

Model No.:_____ Model No.:_____

Serial No.:_____ Serial No.:_____

Original Charge Size:_____ Lubricant Type:_____

_____ Lubricant Charge Size:_____

Drier Mfg.:_____ Drier Type (check one):

Model No.:_____ 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, oz/g) | | | | |
| Ambient Temp. (°F/°C) | | | | |
| Relative Humidity | | | | |
| Compressor: | | | | |
| Suction T (°F/°C) | | | | |
| Suction P (psi/kPa/bar) | | | | |
| Discharge T (°F/°C) | | | | |
| Discharge P (psi/kPa/bar) | | | | |
| Box/FixtureT (°F/°C) | | | | |
| Evaporator: | | | | |
| Refrigerant Inlet T (°F/°C) | | | | |
| Refrigerant Outlet T (°F/°C) | | | | |
| Coil Air/$H_2O$ In T (°F/°C) | | | | |
| Coil Air/$H_2O$ Out T (°F/°C) | | | | |
| Refrigerant T at Superheat Ctl. Pt. (°F/°C) | | | | |
| Condenser: | | | | |
| Refrigerant Inlet T (°F/°C) | | | | |
| Refrigerant Outlet T (°F/°C) | | | | |
| Coil Air/$H_2O$ In T (°F/°C) | | | | |
| Coil Air/$H_2O$ Out T (°F/°C) | | | | |
| Exp. Device Inlet T (°F/°C) | | | | |
| Motor Amps | | | | |
| Run/Cycle Time | | | | |
| Comments: _____ | | | | |
| _____ | | | | |
| | | | | |

## Table 2
## Physical Properties of DuPont™ ISCEON® MO29

| Physical Property | Unit | ISCEON® MO29 | R–22 |
|---|---|---|---|
| Boiling Point (1 atm.) | °C<br>°F | –43<br>–46 | –41<br>–41 |
| Vapor Pressure at 25°C (77°F) | kPa absolute<br>psia | 1130<br>164 | 1041<br>151 |
| Liquid Density at 25°C (77°F) | $kg/m^3$<br>$lb/ft^3$ | 1144<br>71.4 | 1193<br>74.5 |
| Density, Satd. Vapor at 25°C (77°F) | $kg/m^3$<br>$lb/ft^3$ | 59.3<br>3.7 | 44.9<br>2.8 |
| Ozone Depletion Potential | CFC–11 = 1.0 | 0 | 0.05 |
| Global Warming Potential | $CO_2$ = 1 | 2230 | 1700 |

## Table 3
## Composition of ISCEON® MO29 (Wt. %)

| | HFC–125 | HFC–134a | isobutane |
|---|---|---|---|
| ISCEON MO29 | 65.1 | 31.5 | 3.4 |

# Appendix

## Table 4
## Pressure – Temperature Chart (ENG Units): R–22 and ISCEON® MO29

| Pressure psig | R-22 Sat. Temp °F | ISCEON® MO29 Sat. Liquid Temp °F | ISCEON® MO29 Sat. Vapor Temp °F | ISCEON® MO29 Avg. Coil Temp °F |
|---|---|---|---|---|
| 20* | –79 | –83 | –73 | –78 |
| 15* | –66 | –70 | –61 | –66 |
| 10* | –56 | –60 | –51 | –56 |
| 5* | –48 | –52 | –44 | –48 |
| 0 | –41 | –45 | –36 | –41 |
| 2 | –36 | –40 | –32 | –36 |
| 4 | –31 | –36 | –27 | –31 |
| 6 | –27 | –32 | –23 | –27 |
| 8 | –23 | –28 | –20 | –24 |
| 10 | –20 | –24 | –16 | –20 |
| 12 | –16 | –21 | –13 | –17 |
| 14 | –13 | –18 | –10 | –14 |
| 16 | –10 | –15 | –7 | –11 |
| 18 | –7 | –12 | –4 | –8 |
| 20 | –5 | –9 | –2 | –6 |
| 22 | –2 | –7 | 1 | –3 |
| 24 | 0 | –4 | 3 | –1 |
| 26 | 3 | –2 | 6 | 2 |
| 28 | 5 | 0 | 8 | 4 |
| 30 | 7 | 3 | 10 | 6 |
| 32 | 9 | 5 | 12 | 8 |
| 34 | 12 | 7 | 14 | 10 |
| 36 | 14 | 9 | 16 | 12 |
| 38 | 16 | 11 | 18 | 14 |
| 40 | 17 | 13 | 20 | 16 |
| 42 | 19 | 15 | 21 | 18 |
| 44 | 21 | 16 | 23 | 20 |
| 46 | 23 | 18 | 25 | 21 |
| 48 | 25 | 20 | 27 | 23 |
| 50 | 26 | 21 | 28 | 25 |
| 55 | 30 | 25 | 32 | 29 |
| 60 | 34 | 29 | 36 | 33 |
| 65 | 38 | 33 | 39 | 36 |
| 70 | 41 | 36 | 43 | 39 |
| 75 | 45 | 40 | 46 | 43 |
| 80 | 48 | 43 | 49 | 46 |
| 85 | 51 | 46 | 52 | 49 |
| 90 | 54 | 49 | 55 | 52 |
| 95 | 57 | 52 | 57 | 54 |
| 100 | 59 | 54 | 60 | 57 |
| 105 | 62 | 57 | 63 | 60 |
| 110 | 65 | 59 | 65 | 62 |
| 115 | 67 | 62 | 67 | 65 |
| 120 | 69 | 64 | 70 | 67 |
| 125 | 72 | 67 | 72 | 69 |
| 130 | 74 | 69 | 74 | 72 |
| 135 | 76 | 71 | 76 | 74 |
| 140 | 79 | 73 | 79 | 76 |
| 145 | 81 | 76 | 81 | 78 |
| 150 | 83 | 78 | 83 | 80 |
| 155 | 85 | 80 | 85 | 82 |
| 160 | 87 | 82 | 87 | 84 |
| 165 | 89 | 84 | 88 | 86 |
| 170 | 91 | 85 | 90 | 88 |
| 175 | 93 | 87 | 92 | 90 |
| 180 | 94 | 89 | 94 | 91 |
| 185 | 96 | 91 | 96 | 93 |
| 190 | 98 | 93 | 97 | 95 |
| 195 | 100 | 94 | 99 | 97 |
| 200 | 102 | 96 | 101 | 98 |
| 205 | 103 | 98 | 102 | 100 |
| 210 | 105 | 99 | 104 | 102 |
| 215 | 106 | 101 | 105 | 103 |
| 220 | 108 | 103 | 107 | 105 |
| 225 | 110 | 104 | 108 | 106 |
| 230 | 111 | 106 | 110 | 108 |
| 235 | 113 | 107 | 111 | 109 |
| 240 | 114 | 109 | 113 | 111 |
| 245 | 116 | 110 | 114 | 112 |
| 250 | 117 | 112 | 116 | 114 |
| 255 | 119 | 113 | 117 | 115 |
| 260 | 120 | 114 | 118 | 116 |
| 265 | 122 | 116 | 120 | 118 |
| 270 | 123 | 117 | 121 | 119 |
| 275 | 124 | 119 | 122 | 120 |
| 280 | 126 | 120 | 124 | 122 |
| 285 | 127 | 121 | 125 | 123 |
| 290 | 128 | 123 | 126 | 124 |
| 295 | 130 | 124 | 127 | 126 |
| 300 | 131 | 125 | 129 | 127 |
| 310 | 133 | 128 | 131 | 129 |
| 320 | 136 | 130 | 133 | 132 |
| 330 | 138 | 132 | 136 | 134 |
| 340 | 141 | 135 | 138 | 136 |
| 350 | 143 | 137 | 140 | 139 |
| 360 | 145 | 139 | 142 | 141 |
| 370 | 148 | 141 | 144 | 143 |
| 380 | 150 | 144 | 146 | 145 |
| 390 | 152 | 146 | 148 | 147 |
| 400 | 154 | 148 | 150 | 149 |

**Note:** Saturated Liquid Temperature = Bubble Point
Saturated Vapor Temperature = Dew Point

* Inches Hg, vacuum

## Table 5
## Pressure – Temperature Chart (SI Units): R–22 and ISCEON® MO29

| Pressure Bar (g) | R-22 Sat. Temp °C | ISCEON® MO29 Sat. Liquid Temp °C | ISCEON® MO29 Sat. Vapor Temp °C | ISCEON® MO29 Avg. Coil Temp °C |
|---|---|---|---|---|
| –0.7 | –64 | –66 | –60 | –63 |
| –0.6 | –59 | –61 | –56 | –58 |
| –0.5 | –55 | –57 | –52 | –54 |
| –0.4 | –51 | –54 | –49 | –51 |
| –0.3 | –48 | –51 | –46 | –48 |
| –0.2 | –46 | –48 | –43 | –46 |
| –0.1 | –43 | –46 | –41 | –43 |
| 0 | –41 | –43 | –39 | –41 |
| 0.1 | –39 | –41 | –37 | –39 |
| 0.2 | –37 | –40 | –35 | –37 |
| 0.3 | –35 | –38 | –33 | –35 |
| 0.4 | –34 | –36 | –31 | –34 |
| 0.5 | –32 | –35 | –30 | –32 |
| 0.6 | –31 | –33 | –28 | –31 |
| 0.7 | –29 | –32 | –27 | –29 |
| 0.8 | –28 | –30 | –26 | –28 |
| 0.9 | –26 | –29 | –25 | –27 |
| 1 | –25 | –28 | –23 | –25 |
| 1.1 | –24 | –26 | –22 | –24 |
| 1.2 | –23 | –25 | –21 | –23 |
| 1.3 | –22 | –24 | –20 | –22 |
| 1.4 | –21 | –23 | –19 | –21 |
| 1.5 | –20 | –22 | –18 | –20 |
| 1.6 | –18 | –21 | –17 | –19 |
| 1.7 | –17 | –20 | –16 | –18 |
| 1.8 | –17 | –19 | –15 | –17 |
| 1.9 | –16 | –18 | –14 | –16 |
| 2 | –15 | –17 | –13 | –15 |
| 2.1 | –14 | –16 | –12 | –14 |
| 2.2 | –13 | –15 | –11 | –13 |
| 2.3 | –12 | –15 | –11 | –13 |
| 2.4 | –11 | –14 | –10 | –12 |
| 2.5 | –10 | –13 | –9 | –11 |
| 2.6 | –10 | –12 | –8 | –10 |
| 2.7 | –9 | –11 | –8 | –9 |
| 2.8 | –8 | –11 | –7 | –9 |
| 2.9 | –7 | –10 | –6 | –8 |
| 3 | –7 | –9 | –5 | –7 |
| 3.1 | –6 | –8 | –5 | –7 |
| 3.2 | –5 | –8 | –4 | –6 |
| 3.3 | –4 | –7 | –3 | –5 |
| 3.4 | –4 | –6 | –3 | –5 |
| 3.5 | –3 | –6 | –2 | –4 |
| 3.6 | –2 | –5 | –1 | –3 |
| 3.7 | –2 | –4 | –1 | –3 |
| 3.8 | –1 | –4 | 0 | –2 |
| 3.9 | 0 | –3 | 0 | –1 |
| 4 | 0 | –3 | 1 | –1 |
| 4.2 | 1 | –1 | 2 | 0 |
| 4.4 | 3 | 0 | 3 | 2 |
| 4.6 | 4 | 1 | 4 | 3 |
| 4.8 | 5 | 2 | 6 | 4 |
| 5 | 6 | 3 | 7 | 5 |
| 5.2 | 7 | 4 | 8 | 6 |
| 5.4 | 8 | 5 | 9 | 7 |
| 5.6 | 9 | 6 | 10 | 8 |
| 5.8 | 10 | 7 | 11 | 9 |
| 6 | 11 | 8 | 11 | 10 |
| 6.2 | 12 | 9 | 12 | 11 |
| 6.4 | 13 | 10 | 13 | 12 |
| 6.6 | 14 | 11 | 14 | 13 |
| 6.8 | 15 | 12 | 15 | 13 |
| 7 | 15 | 13 | 16 | 14 |
| 7.2 | 16 | 14 | 17 | 15 |
| 7.4 | 17 | 14 | 18 | 16 |
| 7.6 | 18 | 15 | 18 | 17 |
| 7.8 | 19 | 16 | 19 | 18 |
| 8 | 20 | 17 | 20 | 18 |
| 8.2 | 20 | 18 | 21 | 19 |
| 8.4 | 21 | 18 | 21 | 20 |
| 8.6 | 22 | 19 | 22 | 21 |
| 8.8 | 23 | 20 | 23 | 21 |
| 9 | 23 | 21 | 24 | 22 |
| 9.5 | 25 | 22 | 25 | 24 |
| 10 | 27 | 24 | 27 | 25 |
| 10.5 | 29 | 26 | 29 | 27 |
| 11 | 30 | 27 | 30 | 29 |
| 11.5 | 32 | 29 | 32 | 30 |
| 12 | 33 | 30 | 33 | 32 |
| 12.5 | 35 | 32 | 35 | 33 |
| 13 | 36 | 33 | 36 | 35 |
| 13.5 | 38 | 35 | 37 | 36 |
| 14 | 39 | 36 | 39 | 37 |
| 14.5 | 40 | 37 | 40 | 39 |
| 15 | 42 | 39 | 41 | 40 |
| 15.5 | 43 | 40 | 42 | 41 |
| 16 | 44 | 41 | 44 | 42 |
| 16.5 | 46 | 42 | 45 | 44 |
| 17 | 47 | 44 | 46 | 45 |
| 17.5 | 48 | 45 | 47 | 46 |
| 18 | 49 | 46 | 48 | 47 |
| 18.5 | 50 | 47 | 49 | 48 |
| 19 | 51 | 48 | 50 | 49 |
| 19.5 | 52 | 49 | 51 | 50 |
| 20 | 53 | 50 | 52 | 51 |
| 20.5 | 54 | 51 | 53 | 52 |
| 21 | 56 | 52 | 54 | 53 |
| 21.5 | 57 | 53 | 55 | 54 |
| 22 | 58 | 54 | 56 | 55 |
| 22.5 | 59 | 55 | 57 | 56 |
| 23 | 59 | 56 | 58 | 57 |
| 23.5 | 60 | 57 | 59 | 58 |
| 24 | 61 | 58 | 60 | 59 |
| 24.5 | 62 | 59 | 61 | 60 |
| 25 | 63 | 60 | 62 | 61 |
| 25.5 | 64 | 61 | 62 | 62 |
| 26 | 65 | 62 | 63 | 62 |
| 26.5 | 66 | 62 | 64 | 63 |
| 27 | 67 | 63 | 65 | 64 |
| 27.5 | 68 | 64 | 66 | 65 |
| 28 | 68 | 65 | 66 | 66 |
| 28.5 | 69 | 66 | 67 | 66 |
| 29 | 70 | 67 | 68 | 67 |
| 29.5 | 71 | 67 | 69 | 68 |
| 30 | 72 | 68 | 69 | 69 |
| 30.5 | 72 | 69 | 70 | 70 |
| 31 | 73 | 70 | 71 | 70 |
| 31.5 | 74 | 70 | 72 | 71 |
| 32 | 75 | 71 | 72 | 72 |
| 32.5 | 75 | 72 | 73 | 72 |
| 33 | 76 | 73 | 74 | 73 |
| 33.5 | 77 | 73 | 74 | 74 |
| 34 | 78 | 74 | 75 | 74 |
| 34.5 | 78 | 75 | 76 | 75 |
| 35 | 79 | | | |

**Note:** Saturated Liquid Temperature = Bubble Point
Saturated Vapor Temperature = Dew Point

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