The “Changing State” of Refrigerants

Gary Parker – Refrigerants Product Manager

R-22
R-410A
R-404A
R-22
Refrigerant Suite

The RSD Refrigerant Suite is your central clearing house for all refrigerant related information, Literature - Technical Data, Rules, Regulations, Pending Legislations, Technician Certification, Refrigerant Recovery and more. Refrigerants industry is evolving rapidly and the RSD Refrigerants Suite will keep you "In the Know".

PT Chart  EPA Certifications  Request Training / Info

Home  Refrigerant Training  Literature & Technical Data  Regulations  Refrigerant Recovery  Refrigerant Digests

What's New

California roles out proposal to Reduce HFC Emissions
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➢ Acronyms you may want to know

- CARB – California Air Resources Board
- GWP – Global Warming Potential
- HC – HydroCarbon (R290, R600)
- HCFC – HydroChloroFluoroCarbon (R22)
- HFC – Hydrofluorocarbon (R404a, R407, R410a)
- HFO – HydroFluoroOlefin (R448a, R1234yf)
- SLCP – Short Lived Climate Pollutants
- SNAP - Significant New Alternatives Program
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- Regulation Changes – United States
  - 1990 they Announced ODP Product Phase Out.
  - 1996 CFC Production Ban
  - 2010 R22 AC system Ban
  - 2016 Kigali Amendment began the HFC Phasedown.
  - 2018 New EPA 608 Regulation.
  - 2019 AHRI Supports ASHRAE and UL Safety Standards
  - 2020 R22 (HCFC) Production Ban
  - 20?? R410a AC System Ban
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- U.S. Climate Alliance – Founded in 8-2018

25 States + Puerto Rico
What Is NASRC All About?

The North American Sustainable Refrigeration Council is an action-oriented nonprofit that wants to see natural refrigerants succeed.
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California Presents Low GWP Regulations

**Background:**

In 2015 California began enacting SLCP (Short Lived Climate Pollutant) legislation. The intent was to curb Green House Gas Emissions across all industries. (See Digest 2015-12.1)

In August of 2019, CARB (California Air Resources Board) hosted a workshop to discuss proposed HFC limits for Stationary Refrigeration and Air Conditioning Equipment.

**What they Presented:**

HFC’s are considered the fastest growing of all greenhouse gases and if unchecked are expected to be 10% of the total emissions by 2030.

SB 1383 established a reduction goal of (40% below 2013 levels) by 2030. To achieve this, current HFC emission would need to be cut in half.

**What They are Proposing:**

**Stationary Refrigeration:**

Effective **1-1-2022**: New systems containing > 50lbs must use a refrigerant that is below 150 GWP. This would include remodels and relocation of existing equipment.

**Air Conditioning Equipment:**

Effective: **1-1-2023** New Air Conditioning systems must use a refrigerant with a GWP Below 750. This would be based on Date of Manufacture, allowing for the sale of existing inventory. (Dehumidifiers are also classified as Air Conditioning equipment)

**New Air Chillers:**

Effective: **1-1-2024** New Chiller systems must use a refrigerant with a GWP Below 750. This would be based on Date of Manufacture, allowing sale of existing inventory.

The final rule is expected to be published in Q3-2020
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Regulation Changes – Cal Fire Authority

- Most Current Refrigerants have Global Warming Risk
- Most of the replacements have flammability Risk
- ASHRAE Flammability Categories
  - A1 – No Flame Propagation
  - A2 – Flame Propagation and low flammability
  - A2L – Same as A2 with lower flame velocity
  - A3 – High Flammability (Propane – Isobutane)

- Current A2, A2L, A3 Charge Limit 150g (5.9oz)
- Goal is to safely implement refrigerants < 750 GPW
- Proposed Ban (Per CARB) Effective 1-1-2023
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Regulation Changes – Cal Fire Authority

- A1 Candidate
  - R466A – Honeywell – Material compatibility challenges

- A2L Candidates
  - R32 – Daikin
    - R-32 is used in Europe and Asia now.

- R454B – Chemours and Carrier
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 Regulation Changes – Cal Fire Authority

- Current Standards and Codes
  - ASHRAE 15 (Installation Standard)
    - Published criteria to use A2l’s
  - ASHRAE 15.2 (Installations Standard – Residential)
  - UL 60335-2-40 (Product Safety Standard)
    - Published criteria to use A2l’s

- California Mechanical Code
  - Based on Natl UMC
  - The 2021 code edition has not expanded the use of A2L’s
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Regulation Changes – Cal Fire Authority

- A2L Design Challenges & Priorities > 150g
  - Leak Detection likely required at unit and coil
    ▪ Will we allow equipment within a building or dwelling?
  - Limits on the number of fitting and connections
    ▪ Do all connections need to be monitored?
- Will we require special components
- What happens when there is a loss of power
  ▪ Will detectors need to be battery operated or replaced periodically?
- How do we prevent retrofit to A2L’s?
- First Responder Practices and Safety?
# The “Changing State” of Refrigerants

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Replaces</th>
<th>Manufacture</th>
<th>HFC Fluids</th>
<th>CF3I</th>
<th>HFO Fluids</th>
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- Low Temperature R22 Alternatives

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<tr>
<th>Refrigerant</th>
<th>AKA</th>
<th>Capacity Relative to R22</th>
<th>Mass Flow Relative to R22</th>
<th>Efficacy (cop) rel. to R22</th>
<th>Recommended Lubricant</th>
<th>IPCC Ver 5 GWP</th>
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<td>R-427A</td>
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NIST Reference Fluid Thermodynamic and Transport Properties-REFPROP Version 7.0
(R-22 = 1760)

Low Temperature Conditions -20f SST 105f SDT 10f 95f liquid, 30 deg ent Comp 10f SH

General Rules:
Mass Flow +/- 30% Requires TXV Evaluation
POE, AB, Min Products Have Hydrocarbon components that impact performance & efficiency
System type, Piping Design and use of Oil Separators will impact the actual performance
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**HT/AC R22 Alternatives**

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>AKA</th>
<th>Capacity Relative to R22 @85f</th>
<th>Capacity Relative to R22 @ 105f</th>
<th>Mass Flow Relative to R22</th>
<th>Recommended Lubricant</th>
<th>IPCC Ver 5 GWP</th>
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<td>R-407A</td>
<td>KLEA60</td>
<td>110%</td>
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<td>102%</td>
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<td>POE</td>
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</table>

NIST Reference Fluid Thermodynamic and Transport Properties-REFPROP Version 7.0

**(R22 = 1760)**

High Temperature Conditions +40f SST 105f/125f SDT 10f Subcooling and 10f Superheat

General Rules:

- Mass Flow +/- 30% Requires TXV Evaluation
- POE, AB, Min Products Contain Hydrocarbon components that impact performance and efficiency
Lubricant Choice and the Effect on Performance

- Proper Oil Return is critical for any Refrigeration or AC System. Miscibility between the refrigerant and the oil is essential.
- Some refrigerants claim to be no-oil-change solutions. In most cases, they have a very narrow application window and lower capacity.
- With a non-miscible combination oil logging can occur, which impacts compressor life and performance. Have you ever added oil?
- It is now widely agreed that only percentage of POE is required to ensure proper oil return.
- System design and operating temperature will play a key role in determining that %.
- Additives are now being marketed (Super Change) that improve miscibility, limited to basic close coupled systems.
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Elastomers Seals and Leaks

Myth
• There is a belief that introducing POE oil into a system causes a breakdown of seal material causing leaks

Fact
• When an HVACR system is charged the rubber elastomers seals absorb refrigerant and swell.
• When you remove the HCFC refrigerant the elastomers will shrink to near their original size.
• When you re-charge the system with an HFC, the absence of Chlorine, reduces the absorption rate and the seal will not swell at the same rate.
• The retrofit process must include replacing all elastomers and o-ring
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Schrader Cores and Caps

Open Drive Shaft Seals

RSD
REFRIGERATION SUPPLIES DISTRIBUTOR
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Evaporator Pressure Regulator
Heat Reclaim Valve
Solenoid Valve
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Refrigerant Blend Characteristics

• All Blended (R400 Series) Refrigerants have some measure of glide. Glide is the temperature range in which evaporations or condensing occurs.

• PT Charts reference both Dew and Bubble points
  • Dew is used to measure Superheat
  • Bubble used to measure Subcooling

<table>
<thead>
<tr>
<th>Pressure (psig)</th>
<th>R22 (°F)</th>
<th>R407C Vapor Dew (°F)</th>
<th>R407C Liquid Bubble (°F)</th>
<th>Glide (°F)</th>
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<td>120.4</td>
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Refrigerant Blend Characteristics - Superheat

To determine superheat, use the Dew point value.

Procedure:

- Use gauges to determine the pressure at the coil outlet.
- Use a thermometer to get the temperature at the same point.
- Get the Dew temperature from the Dew column.
- Superheat = Actual Temperature – Dew Temperature.

Example: Find the superheat on an R407C system when the pressure at the evaporator outlet reads 80 psig and your surface thermometer reads 60°F.

- 80 psig yields ~ 50.7°F (Dew point)
- Degree of Superheat = 60°F - 50.7°F = 9.3°F
The “Changing State” of Refrigerants

Refrigerant Blend Characteristics - Subcooling

- To determine subcooling, use the **Bubble point Value**.
- **Procedure:**
  - Use gauges to determine the pressure at the coil outlet.
  - Use a thermometer to get the temperature at the same point.
  - Use the **Bubble** column temperature.
  - Subcooling = Actual Temperature – Bubble Temperature.
- **Example:** Find the subcooling on a system using R407C when the liquid line temperature reads 110°F and the liquid line pressure is 300 psig.
  - **300 psig yields ~ 120.4°F Bubble point**
  - Degree of Subcooling = 120.4°F - 110°F = 10.4°F
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- Refrigerant Characteristics - Evaporator
  - Looking at an R22 Evaporator at 76 lbs
    - Liquid would enter the Evaporator at 45F
    - As long as the refrigerant is at Saturation (liquid & vapor) together, the Evaporator Temp will remain 45f
    - Only in the Superheat phase will the temperature change

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<tr>
<th>Pressure</th>
<th>R22</th>
<th>R407C Vapor Dew</th>
<th>R407C Liquid Bubble</th>
<th>Glide</th>
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<td>45.3</td>
<td>80</td>
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- Refrigerant Blend Characteristics - Evaporator

  - Looking at the Evaporator at 80 lbs
    - Liquid would enter the Evaporator at Bubble Point 39.9°F
    - At Saturation, a combination of Liquid and Vapor will exist until it reaches the Dew Point of 50.7°F
    - Your overall Evaporator Temp will be near the Average 45.3°F
    - Always use the Average value for temperature controlled set points, and equipment selections.

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</table>
The “Changing State” of Refrigerants

Refrigerant Blend Characteristics - Condenser

- Looking at the Condenser at 300 lbs
  - Vapor would enter the Cond. at Dew Point 128.4 F
  - A combination of liquid and Vapor would exist until it reached the Bubble Point of 120.4F
  - Your actual Coil temp will be near of the average 124.4F
  - Always use the Average value for temperature controlled set points, and equipment selection.
The “Changing State” of Refrigerants

- Hydrocarbon Refrigerants R290 – R600
- Odorless Product
- OEM Training Required
- 150 g (5.9oz) Charge Limits
- Requires Unique Tools
  - Leak Detector
  - Vacuum Pump
- Sealed Contact Components
  - Motors
  - Overloads
  - Relays
  - Thermostats
  - ..........
York YZ Series R1233ZD Chiller up to 1200 tons
Industrial Advansor CO2
The “Changing State” of Refrigerants

➢ Low & Med Temperature Transcritical System
The “Changing State” of Refrigerants

- Low/Med Temperature w/Secondary Cooling
The “Changing State” of Refrigerants

- Compact Ammonia
The “Changing State” of Refrigerants

Thank you!

For More information go to:

www.RSD.net/Refrigerant Suite
Or Call
1-800-245-8007 ex 00405