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**“Low energy consumption when using R290 as an alternative to R404A in light commercial refrigeration in America”**

*HUAYI COMPRESSOR BARCELONA, S.L.*

# About us

*Huayi Compressor Barcelona, S.L.*

**HUAYI COMPRESSORS GROUP** contributes to a more sustainable world with more than **50 years experience** in designing, manufacturing and selling hermetic compressors and condensing units for the light commercial refrigeration market, operating under the **Cubigel Compressors®** brand worldwide

cubigel® compressors

- **The Green Cooling Range includes:**
  - Natural Gas Refrigerants
  - High Efficiency Compressors + Variable Speed Compressors
- **The advanced design of the Green Cooling Ranges allows:**
  - Efficiency improvement (up to 50% compared to standard versions).
  - Consequently, lower $CO_2$ emissions to the atmosphere.
  - Use of natural refrigerants as R290 with no direct effect on global warming.
  - Additional EER improvement because of moving from HFCs to HCs.

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# GWP & ODP Evolution

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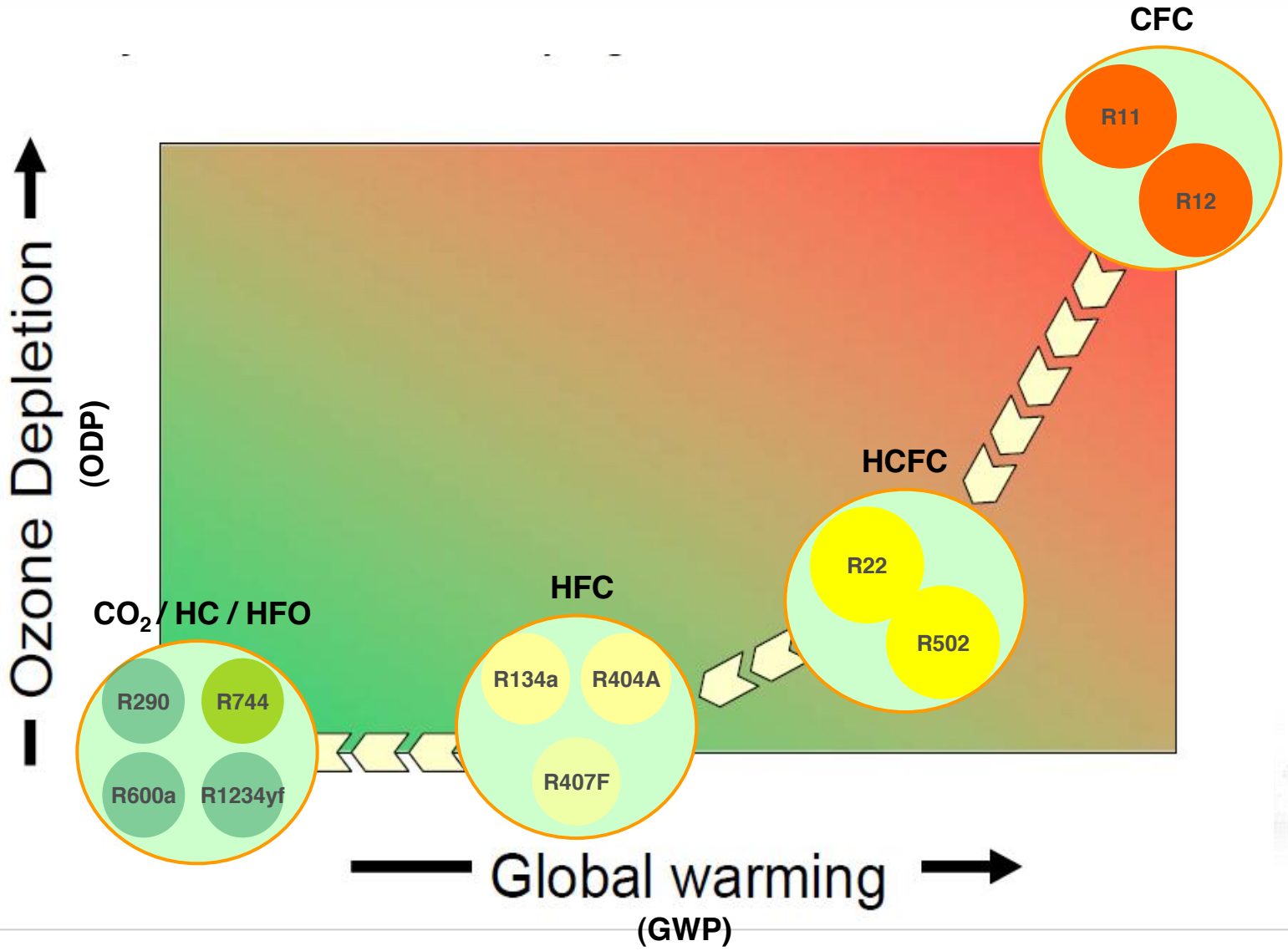

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# Efficiency Evolution

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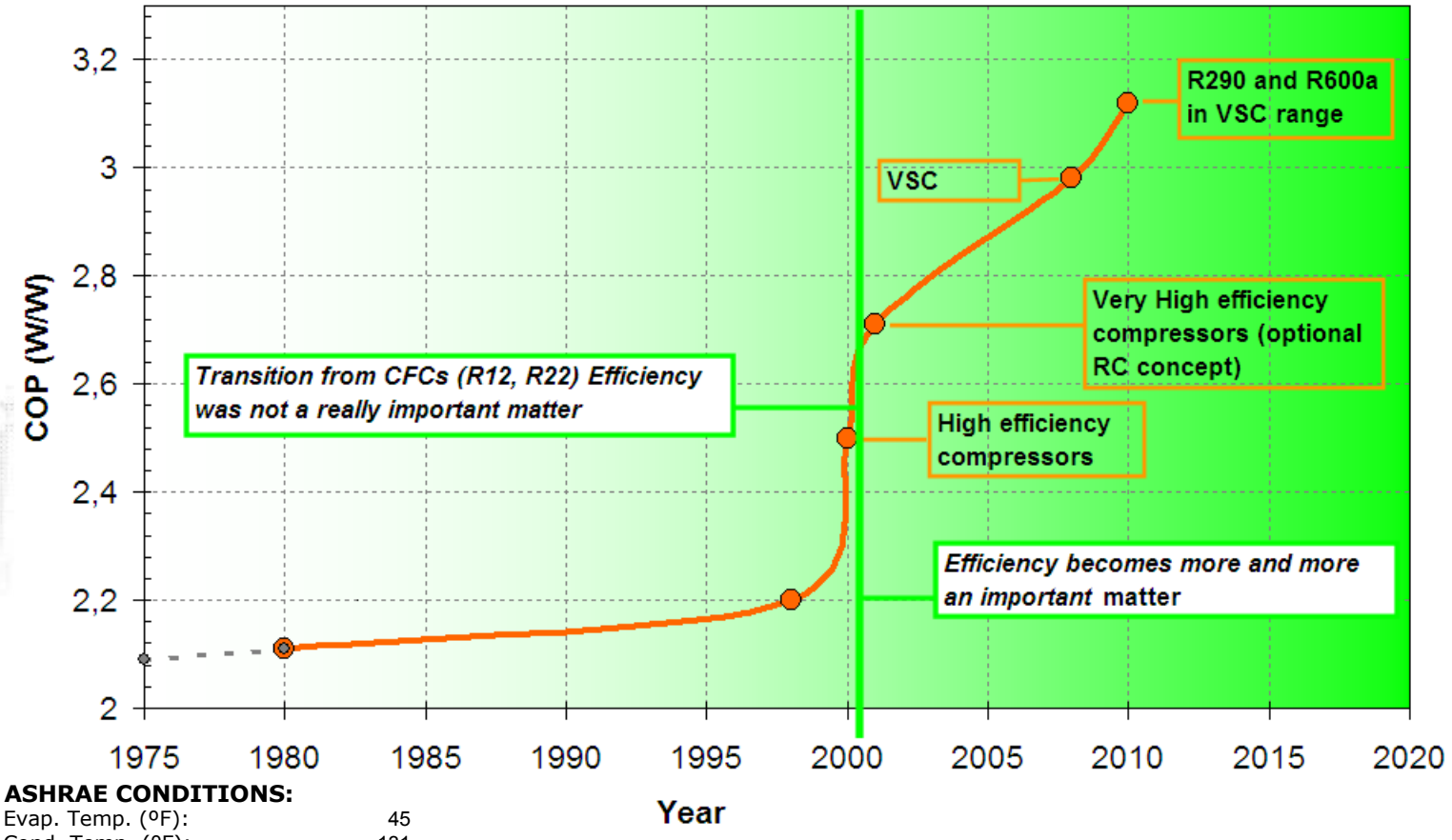
## *EFFICIENCY EVOLUTION FOR LIGHT COMMERCIAL REFRIGERATION*




**ASHRAE CONDITIONS:**

| | |
|---|---|
| Evap. Temp. (ºF): | 45 |
| Cond. Temp. (ºF): | 131 |
| Liquid Temp. (ºF): | 115 |
| Suction Temp. (ºF): | 95 |
| Ambient Temp. (ºF): | 95 |

*"RC": Running capacitor*

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# Refrigerants Comparison

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| Characteristic | R134a | R404A/R507 | R744 | R290 | R1234yf | R407F |
|---|---|---|---|---|---|---|
| Group Name | HFC | HFC | $CO_2$ | HC | HFO | HFC |
| GWP | 1300 | 3260 | 1 | 3 | 4 | 1824 |
| ODP | 0 | 0 | 0 | 0 | 0 | 0 |
| Inherent EER | Medium | Medium | Low | High | Medium | Medium |
| T (14,5 PSI) ºF | -26,1 | -51,7 | -110,2 | -43,78 | -29 | -48,9 |
| T (362,6 PSI) ºF | 77 | 129,2 | 10,4 | 154,4 | 79 | 136,4 |
| P (-31ºF) PSI | 9,72 | 24,08 | 174,77 | 19,73 | 11,46 | 24,66 |
| P (14ºF) PSI | 29,01 | 62,80 | 384,35 | 49,60 | 31,91 | 63,82 |
| P (113ºF) PSI | 168,24 | 296,60 | 1070,81 | 222,05 | 167,37 | 310,38 |
| P (140ºF) PSI | 243,81 | 416,26 | 1070,81 | 307,19 | 238,15 | 427,86 |
| Critical Point | 101ºC 40,67 Bar | 161,6ºF 541,13 PSI | 87,8ºF 1070,81 PSI | 206,6ºF 614,38 PSI | 201,2ºF 490 PSI | 180,68ºF 689,51 PSI |
| Flammable (*) | No | No | No | Yes | Yes | No |
| Oil Type | POE | POE | MINERAL | MINERAL/ POE | POE | POE |
| Status | Current Use | Current Use | Current Use | Current Use | ud | ud |

*(*) If Flammable, there is charge limitation till 150 g per single circuit.*

| Characteristic | R134a | R404A/R507 | R744 | R290 | R1234yf | R407F | Importance |
|---|---|---|---|---|---|---|---|
| GWP | 4 | 2 | 10 | 8 | 7 | 3 | 20% |
| ODP | 10 | 10 | 10 | 10 | 10 | 10 | 10% |
| Inherent COP | 6 | 4 | 6 | 7 | 5 | 4 | 20% |
| Cooling capacity / Size | 5 | 9 | 1 | 8 | 5 | 9 | 20% |
| Pressure level | 5 | 2 | 0 | 4 | 5 | 2 | 10% |
| Requires redesign | 7 | 6 | 0 | 6 | 7 | 6 | 10% |
| Flammability | 10 | 10 | 10 | 0 | 2 | 10 | 10% |
| RANKING | 62 | 58 | 54 | 66 | 58 | 60 | |

**R290 THE BETTER CHOICE FOR LIGHT COMMERCIAL REFRIGERATION**

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# HUAYI - R290 Range for USA

## *Huayi Compressor Barcelona, S.L.*

**R290 HMBP 60 Hz** *Natural Refrigerant*

| Model | Displacement cu.in | Power hp | Application | Cpr cooling | Voltage Frequency | Motor | Refrigeration Capacity \| ºF Condensing Temperature = 131ºF Ashrae Evaporating Temperature = 45ºF Btu/h | EER (Btu/Wh) | COP (W/W) |
|---|---|---|---|---|---|---|---|---|---|
| NLY45RRa | 0,278 | 1/6 | HMBP | F | 115-127V 60Hz ~1 | CSIR | **2463** | **8,64** | **2,53** |
| NLY45RRb | 0,278 | 1/6 | HMBP | F | 115-127V 60Hz ~1 | CSR | **2463** | **9,39** | **2,75** |
| NLY60RRa | 0,365 | 1/5 | HMBP | F | 115-127V 60Hz ~1 | CSIR | **3344** | **8,81** | **2,58** |
| NLY60RRb | 0,365 | 1/5 | HMBP | F | 115-127V 60Hz ~1 | CSR | **3344** | **9,53** | **2,79** |
| NL60TR | 0,365 | 1/4 | HMBP | F | 115-127V 60Hz ~1 | CSIR | **2925** | **7,65** | **2,24** |
| NLY80RRa | 0,494 | 1/4 | HMBP | F | 115-127V 60Hz ~1 | CSIR | **4435** | **8,88** | **2,60** |
| NLY80RRb | 0,494 | 1/4 | HMBP | F | 115-127V 60Hz ~1 | CSR | **4435** | **9,56** | **2,80** |
| NLY90RRa | 0,555 | 1/3 | HMBP | F | 115-127V 60Hz ~1 | CSIR | **5016** | **8,74** | **2,56** |
| NLY90RRb | 0,555 | 1/3 | HMBP | F | 115-127V 60Hz ~1 | CSR | **5016** | **9,43** | **2,76** |

**ASHRAE CONDITIONS:**

| | |
|---|---|
| Evap. Temp. (ºF): | 45 |
| Cond. Temp. (ºF): | 131 |
| Liquid Temp. (ºF): | 115 |
| Suction Temp. (ºF): | 95 |
| Ambient Temp. (ºF): | 95 |

**R290 LBP 60 Hz** *Natural Refrigerant*

| Model | Displacement cu.in | Power hp | Application | Cpr cooling | Voltage Frequency | Motor | Refrigeration Capacity \| ºF Condensing Temperature = 131ºF Ashrae Evaporating Temperature = -10ºF Btu/h | EER (Btu/Wh) | COP (W/W) |
|---|---|---|---|---|---|---|---|---|---|
| NLY45LRa | 0,278 | 1/6 | LBP | F | 115-127V 60Hz ~1 | CSIR | **818** | **4,61** | **1,35** |
| NLY45LRb | 0,278 | 1/6 | LBP | F | 115-127V 60Hz ~1 | CSR | **818** | **4,92** | **1,44** |
| NL45FR | 0,278 | 1/6 | LBP | F | 115-127V 60Hz ~1 | CSIR | **751** | **3,76** | **1,10** |
| NLY60LRa | 0,365 | 1/5 | LBP | F | 115-127V 60Hz ~1 | CSIR | **1186** | **4,85** | **1,42** |
| NLY60LRb | 0,365 | 1/5 | LBP | F | 115-127V 60Hz ~1 | CSR | **1186** | **5,22** | **1,53** |
| NL60FR | 0,365 | 1/5 | LBP | F | 115-127V 60Hz ~1 | CSIR | **929** | **3,89** | **1,14** |
| NLY80LRa | 0,494 | 1/4 | LBP | F | 115-127V 60Hz ~1 | CSIR | **1474** | **4,68** | **1,37** |
| NLY80LRb | 0,494 | 1/4 | LBP | F | 115-127V 60Hz ~1 | CSR | **1474** | **4,99** | **1,46** |
| NLY90LRa | 0,555 | 1/3 | LBP | F | 115-127V 60Hz ~1 | CSIR | **1648** | **4,64** | **1,36** |
| NLY90LRb | 0,555 | 1/3 | LBP | F | 115-127V 60Hz ~1 | CSR | **1648** | **4,92** | **1,44** |
| NPY12LRa | 0,738 | 3/8 | LBP | F | 115-127V 60Hz ~1 | CSIR | **2158** | **4,61** | **1,35** |
| NPY12LRb | 0,738 | 3/8 | LBP | F | 115-127V 60Hz ~1 | CSR | **2158** | **4,92** | **1,44** |

**ASHRAE CONDITIONS:**

| | |
|---|---|
| Evap. Temp. (ºF): | -10 |
| Cond. Temp. (ºF): | 131 |
| Liquid Temp. (ºF): | 90 |
| Suction Temp. (ºF): | 90 |
| Ambient Temp. (ºF): | 90 |

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# Real Case of Study

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| Application Characteristics and Test Conditions | |
|---|---|
| Internal net volume (l) | 340 |
| Power supply (V/Hz) | 115/60 |
| Cabinet load | Empty |
| Ambient temp. / RH (ºF/%) | 77 / 50 |
| Average internal temperature (ºF) | -0,4 |
| Ambient temp / RH in pull down (ºF/%) | 95 / 50 |

| COMPRESSORS DATA | MP12FR | NPY12LRa | NPY12LRb | NPT12FSC |
|---|---|---|---|---|
| Compressor type | R404A Std Effic. | R290 High Effic. | R290 Very HighEffic. | R290 VSC |
| Cooling Capacity (BTU/h) | 2083 | 2158 | 2158 | 2312 |
| EER | 3,93 | 4,61 | 4,92 | 5,36 |
| EER increase vs Std. Effic. (%) | | **17%** | **25%** | **36%** |

**ASHRAE CONDITIONS:**

Evap. Temp. (ºF): -10
Cond. Temp. (ºF): 131
Liquid Temp. (ºF): 90

Suction Temp. (ºF): 90
Ambient Temp. (ºF) 90

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# Real Case Test Results

*Huayi Compressor Barcelona, S.L.*

| DATA | MP12FR | NPY12LRa | NPY12LRb | NPT12FSC |
|---|---|---|---|---|
| **Compressor type** | **R404A Std Effic.** | **R290 High Effic.** | **R290 Very High Effic.** | **R290 VSC** |
| Evaporating temperature (ºF) | -25,78 | -25,24 | -24,88 | -24,7 |
| Condensing temperature (ºF) | 121,1 | 119,84 | 119,12 | 113,18 |
| Duty cycle (% of running time) | 51 | 52 | 52 | 73 |
| Energy consumption (kWh/24h) | 5,22 | 4,49 | 4,05 | 3,31 |
| Energy consumption difference vs cabinet with MP12FR (%) | - | **-14%** | **-22%** | **-37%** |

| Acumulated data in 5 years | MP12FR | NPY12LRa | NPY12LRb | NPT12FSC |
|---|---|---|---|---|
| Total energy consumption (kWh) | 9523 | 8192 | 7391 | 6039 |
| Total energy consumption savings vs MP12FR (kWh) | - | 1331 | 2132 | 3484 |
| Total energy cost savings (US$) (*) | - | 174 | 279 | 456 |
| $CO_2$ emissions (kg $CO_2$) (**) | 4285 | 3687 | 3326 | 2717 |
| $CO_2$ emissions reduction vs std (kg $CO_2$) (**) | - | **-599** | **-960** | **-1568** |

(*) 0,131 $/kWh average energy cost in USA
(**) Supposing 0,45kg $CO_2$ emissions for each kWh of produced energy

# Conclusions

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## R290 advantages vs other alternative gas refrigerants for light commercial Refrigeration in USA:

- R290 one of the best environment friendly alternatives (excellent GWP)
- R290 EPA SNAP approved
- R290 applied in the most efficient appliances produced in Europe from last years with very positive results in million units running
- R290 systems do not requires significant changes vs current HFC's and vs other ecological alternatives ($CO_2$) (Reasonable working pressures)
- R290 allows the use of lower displacement compressors vs R134a and R1234yf to get equivalent cooling capacity
- Weak point of R290 is the limitation of 150 g charge per circuit (which cover most of light commercial appliances charge). Restriction under discusion to extend the maximum charge but estimated to middle term.

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Thank you!