Low GWP Alternate Refrigerants for HVAC Systems

R32

As the U.S. HVAC industry transitions to low Global Warming Potential (GWP) refrigerants, there are three leading replacement options for R-410A today: R-32, R-454B, and R-466A. Here is how they compare:

	R-410A Benchmark	R-32	R-454B	R-466A
Global Warming Potential (GWP) [1]	2,088	675	466	733
Composition	R-32 50% R-125 50%	R-32 100%	R-32 68.9% R-1234yf 31.1%	R-32 49% R-125 11.5% R-1311 39.5%
Blend	Yes	No	Yes	Yes
Longevity in U.S.	Since 1996	Since 2016	Not in use yet	Not in use yet
Proprietary	No	No	Yes	Yes
Global System Install Base	Universal	>160 million [2]	No Data	No Data
Can be charged in both liquid and gas phase?	No	Yes	No	No
Is drop-in to existing R-410A units allowed?	-	No	No	No
Refrigerant Safety Classification [3]	A1	A2L	A2L	A1
Flame Propagation [3]	No	Yes - Lower flammability	Yes - Lower flammability	No
Anticipated to meet CARB/AIM Act Regulation (<750 GWP)	No	Yes	Yes	Yes
Lower Flammability Limit, LFL (g/m^3) [3]	-	306	352.6 (296) [4]	-
Refrigerant Concentration Limit, RCL (g/m^3) [3]	420	77	49 (74) [4]	99
Temperature Glide [5]	Yes	No	Yes	Yes
Temperature Glide amount (K) [5]	<0.1	0	1.0 to 1.3	1.5 [6]
Critical Temperature, T_c (°C) [5]	71.3	78.1	78.1	76.5 [6]
System Capacity *,*	100%	>110% [7]	>97% [8]	>95% [9]
System Efficiency *,*	100%	>107% [7]	>102% [8]	>100% [9]
Refrigerant Charge Size *	-	Up to 40% smaller [10]	Up to 10% smaller [11]	Up to 26% larger [12]
Refrigerant Cost ($/kg [$/lb.]) [13]	$11.07 [$5.03]	$9.04 [$4.11]	$28.36 [$12.89]	No Data
Direct Emissions (kg CO_2-eq.) [14]	1,879	496 (73.6% lower)	346 (81.6% lower)	660 (64.8% lower)
Indirect Emissions (kg CO_2-eq.) [14]	15,384	14,419 (6.3% lower)	14,662 (4.7% lower)	15,117 (1.7% lower)
Total Emissions (kg CO_2-eq.) [14]	17,263	14,916 (13.6% lower)	15,008 (13.1% lower)	15,776 (8.6% lower)

* When compared to a R-410A system with similar specifications.

* While R-32 products are widely available, there are no products readily available with other low GWP blends. Consequently, the comparative analysis was performed using calculations and simulation models and publicly available refrigerant data.

[1] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

[2] https://www.daikin.com/csr/information/influence/hfc32

[3] ASHRAE Standard 34-2019, ISSN 1041-2336, with published errata and addenda (as of January 2022) ASHRAE, Atlanta, GA.

[4] Based on updated calculations from errata for ASHRAE 34-2019, the RCL may be closer to 74 g/m^3. Daikin suggests that RCL values for R-454B, if needed, should be obtained from the refrigerant manufacturers.

[5] Lemmon, E.W., Bell, I.H., Huber, M.L., McLinden, M.O. NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018. doi: https://doi.org/10.18434/T4/1502528

[6] https://sustainability.honeywell.com/us/en/products/refrigerants/hfo-blends/solstice-n41-r-466a

[7] Guo, Weihua; Ji, GaoFeng; Zhan, Honghong; and Wang, Dan, "R32 Compressor for Air conditioning and Refrigeration applications in China" (2012). International Compressor Engineering Conference. Paper 2098.

[8] https://www.opteon.com/en/products/refrigerants/xl41

[9] https://prod-edam.honeywell.com/content/dam/honeywell-edam/pmt/am/en-us/sustainability/refrigerants/documents/pmt-am-solsticen41-safety-compliance-brochure.pdf

[10] Based on Daikin's internal calculations: https://www.daikinapplied.com/news/news/R-32

[11] ACHR hosted Podcast - Refrigerants Transition from R-410A – Light commercial and Residential AC markets (participants: Chemours, Carrier, Danfoss, Emerson)

[12] ASHRAE Chapter Conference Paper 2020 (https://mnashrae.starchapter.com/images/Kujak_Minnesota_Chapter_Feb2020_Performance_of_R466A.pdf)

[13] Typical cost as described in EPA Affordability AIM Act Subsection i Factors October 2021 (https://www.regulations.gov/document/EPA-HQ-OAR-2021-0643-0032)

[14] Comparison is made using the Life Cycle Climate Performance (LCCP) metric, measured in kg-CO_2.eq. LCCP analysis was performed using a high efficiency HP (24+ SEER), using performance gains claimed by respective refrigerant manufacturer, for a residential sized (9000 Btu/h cooling capacity), installed in Houston, TX climate zone, with an assumed annual leakage rate of 4% and end of life refrigerant leakage of 15% with a 15 year lifetime. The heating COP and SEER were adjusted based on refrigerant characteristics and performance. The physical system size, trim charge requirements and capacity were kept consistent to ensure a like-to-like comparison.