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Lessons Learned from Japan and A5 Countries

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Low GWP Refrigerant Market Penetration (RA)

DAIKIN

- R32 is dominant in the split market
- Daikin has sold approximately 17 million units in more than 60 countries & regions by the end of 2018
- Global total approximately 68 million R32 RA units has been sold (Daikin estimation)
- Approx. 100 million tons of CO₂ could be reduced (Daikin estimation)





Higher Efficiency and Higher Capacity

Performance Relative to Baseline at AHRI A Conditions 35°C [95°F] Outdoor and 27°C [80°F] Indoor



Source: Omar Abhelaziz et al. ORNL "Alternative refrigerant Evaluation for High-Ambient-Temperature Environments: R22 and R410A Alternative for mini split air conditioners"



Low Direct Impact

R32 has the benefits of lower GWP and reduced charge size





LCCP Comparison

Unit: kg CO_{2e}

Emission Category	HFC-410A	HFC-32	L-41b	DR-5
Total Direct Emissions	8,658.00	3,037.50	2,223.00	2,205.00
Annual Refrigerant Leakage	6,926.40	2,430.00	1,778.40	1,764.00
EOL Refrigerant Leakage	1,731.60	607.50	444.60	441.00
Adp. GWP	-	-	-	-
Total Indirect Emissions	76,438.29	71,150.29	74,134.52	74,893.98
Energy Consumption	75,920.40	70,681.89	73,642.79	74,401.99
Equipment Manufacturing	408.71	408.71	408.71	408.71
Equipment EOL	6.46	6.46	6.46	6.46
Refrigerant Manufacturing	102.72	53.22	76.55	76.81
Total Emissions	85,096.29	74,187.79	76,357.52	77,098.98







Actual Data in Brazil

Demo Test | Air conditioning demonstrative project in Brazil

Final results from field tests

Energy consumption comparison between Non-inverter R-410A vs Inverter R-32



*Indirect analysis

Discharge Temperature Control

One concern regarding R32 is potentially higher compressor discharge temperature than R410A.

- For variable speed unit, discharge temperature is not an issue and can be well controlled by EEV and compressor speed control.
- For fixed speed unit, discharge temperature is investigated.
 - In the case of fixed orifice as expansion device, although R32 has higher discharge temperature than R410A, even high ambient condition did not generate discharge temperature exceeds compressor limit.
 - The reason is orifice normally is sized at rating condition. At high pressure differential condition, refrigerant mass flow becomes higher and effectively lower suction super heat, that in turn lowers discharge temperature.
 - For high SEER unit that equipped with TXV, simulation and testing show discharge temperature are within compressor limit too.

Testing unit: SEER 14, 25ft piping Test condition:

- C-5: outdoor=125F, indoor =95F
- C-3: outdoor=125F, indoor=65F





Down Sizing

- R32 can help reduce unit size and refrigerant charge quantity
 - Reduce charge quantity due to higher volumetric capacity
 - Reduce heat exchanger size due to higher efficiency. That in turn could reduce charge further.

Impact on charge and heat exchanger size by simulation and testing.

	EER	SEER	HEX size	Refrigerant charge
R410A	100%	100%	100%	100%
R32 drop-in, capacity matched	107%	105%	100%	85%
R32 Capacity and efficiency matched	102%	100%	80-85%	77%

Assumption: Same air flow rate, with14SEER single speed unitary unit, capacity matched compressor.



Conclusions

R32 was naturally chosen as the next gen refirgerant for split system and module chillers due to:

- Low environmental footprint
- Low energy cost
- Low system cost
- Safety can be managed (ZERO incident in last 7 years with millions of unit shipped)

Thank You For Your Attention!