Preliminary Results of the World Bank Low GWP Alternative Demonstration Project in Saudi Arabia

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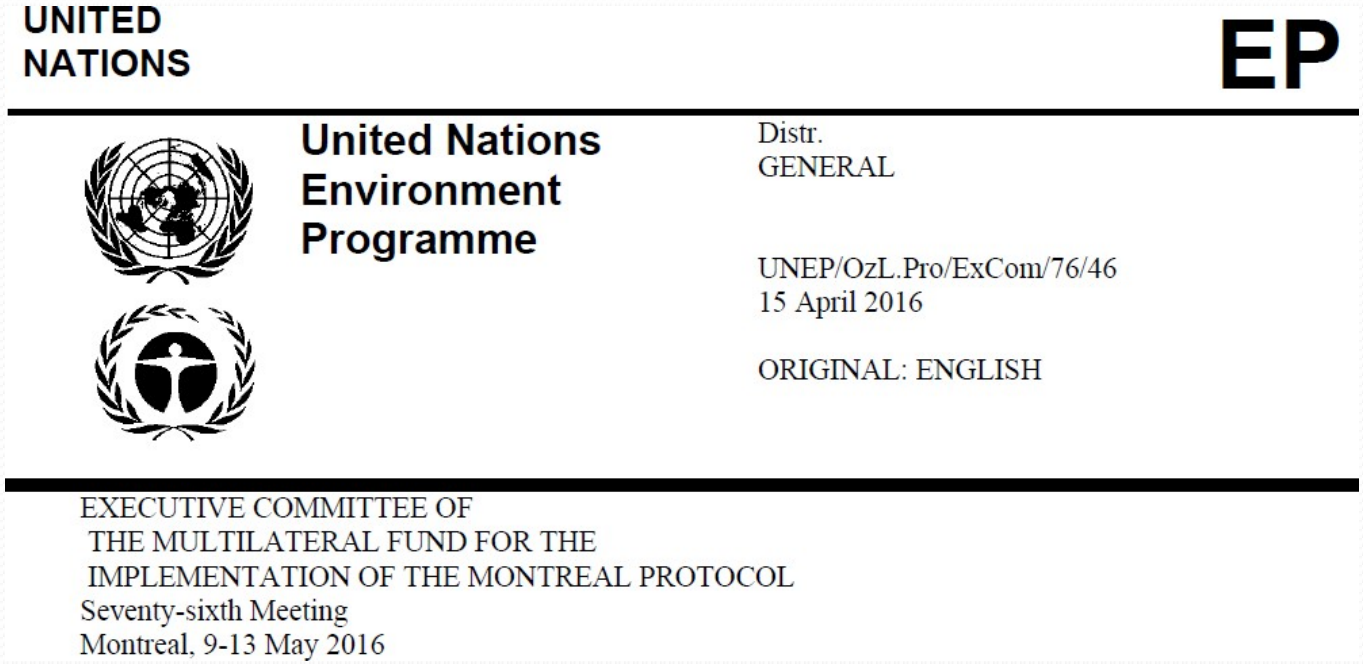
Montreal Protocol ExCom



UNITED NATIONS

EP

United Nations Environment Programme

Distr.
GENERAL

UNEP/OzL.Pro/ExCom/76/46
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ORIGINAL: ENGLISH

EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Seventy-sixth Meeting
Montreal, 9-13 May 2016

United Nation Environment Program

Saudi Arabia: Demonstration project at air conditioning manufacturers to develop window and packaged air conditioners using lower GWP refrigerants (World Bank)
The Executive Committee considered the proposed demonstration project as described in document UNEP/OzL.Pro/ExCom/76/46.

PETRA KSA Facility

Petra's KSA facilities are in the King Abdullah Economic City in Rabigh - Saudi Arabia, with a total area of 45,000 m^2 (485,000 ft^2), employing more than 450 persons in the fields of manufacturing, research and development, management, design, technical support, sales, marketing and after sales services.

Scope of Work

- Petra asked to design, develop, and test air-cooled packaged chillers
  - Alternative Refrigerants
    - HFC-32, GWP= 675, safety classification A2L
    - HC-290 (propane), GWP<4, safety classification A3
  - Baseline refrigerant: R410A, GWP=2088, safety classification A1
  - 3 cooling capacities: 40kW, 70kW, and 100kW
  - Total number of chillers built: 6
  - Total number of chillers tested: 9 (R410A as a drop in)

Refrigerant Safety Classification

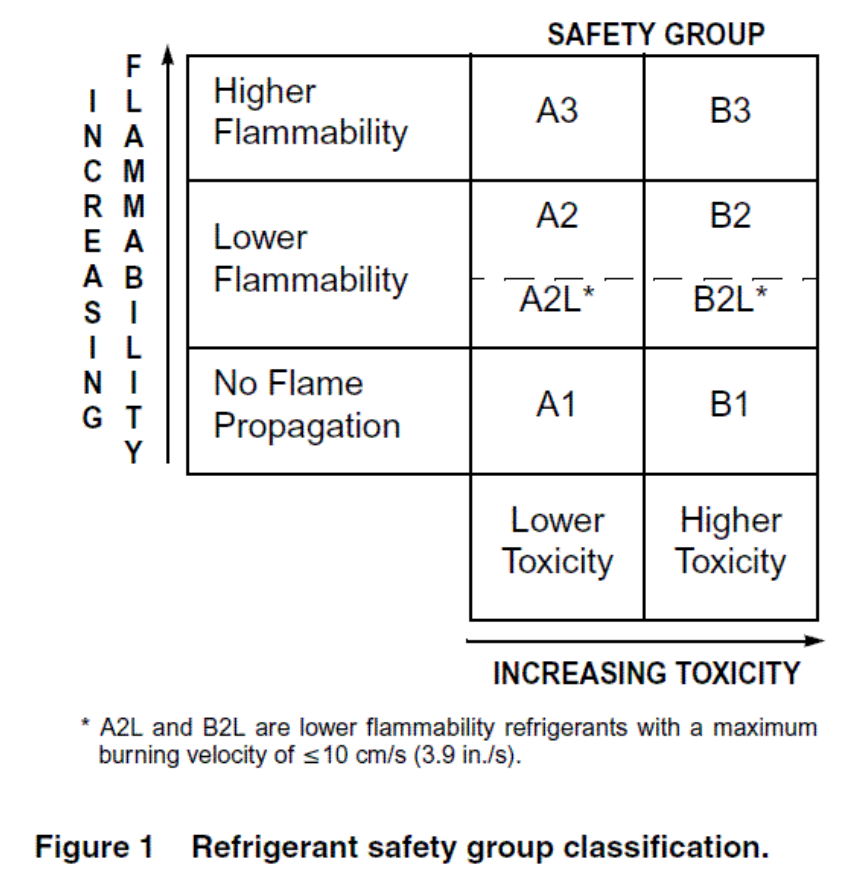

Figure 1 Refrigerant safety group classification.

from: ASHRAE Standard 34-2010

A2L safety group classification used by several refrigerant designation standards:

- ASHRAE Standard 34
- ISO 817

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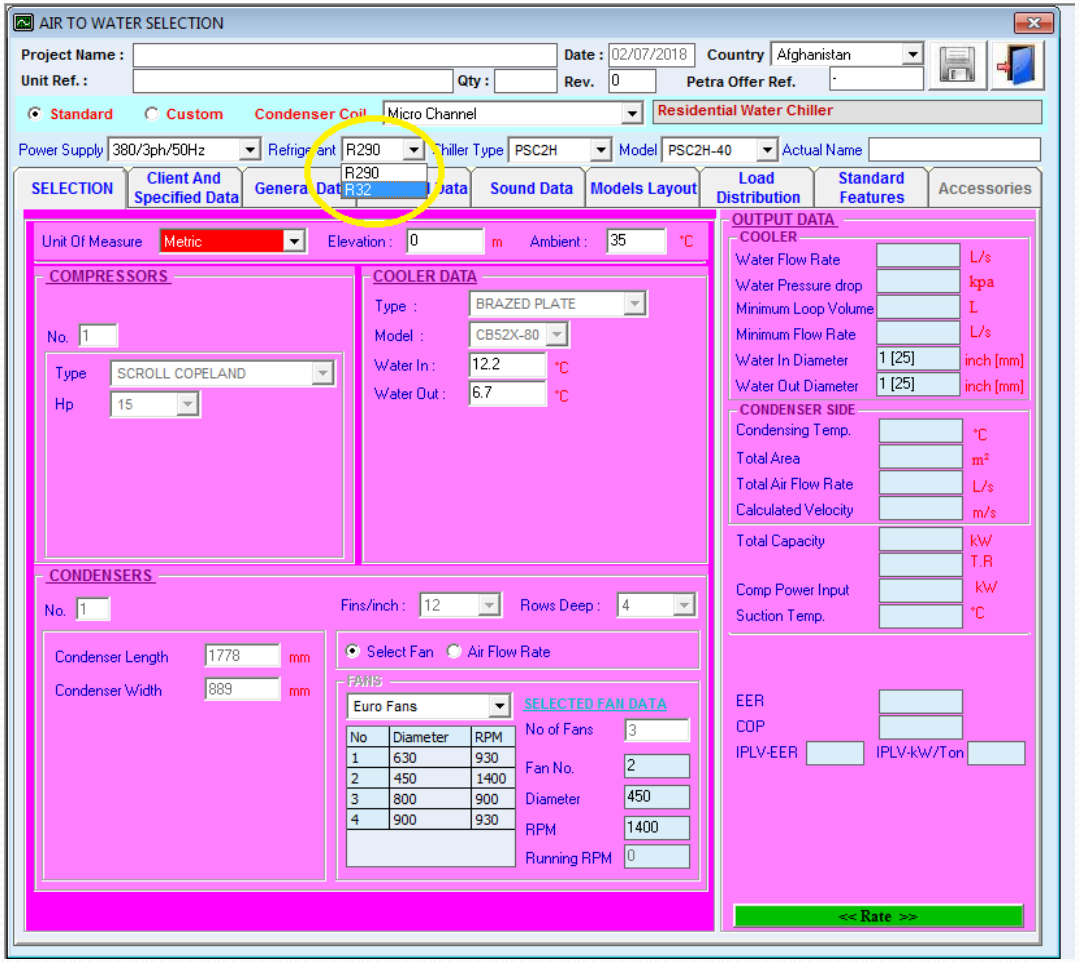
Project Design – Charge Limitation

- Followed procedures outlined in ISO 5149-2014
  - Authorized occupancy “C” (i.e. manufacturing facility)
  - Location classification “III” – Refrigerant containing parts are located outdoor
- Conclusion: No charge restriction for A2L and A3 refrigerants

Project Software Development

- New software was developed to simulate the performance of the units using the R290 and R32



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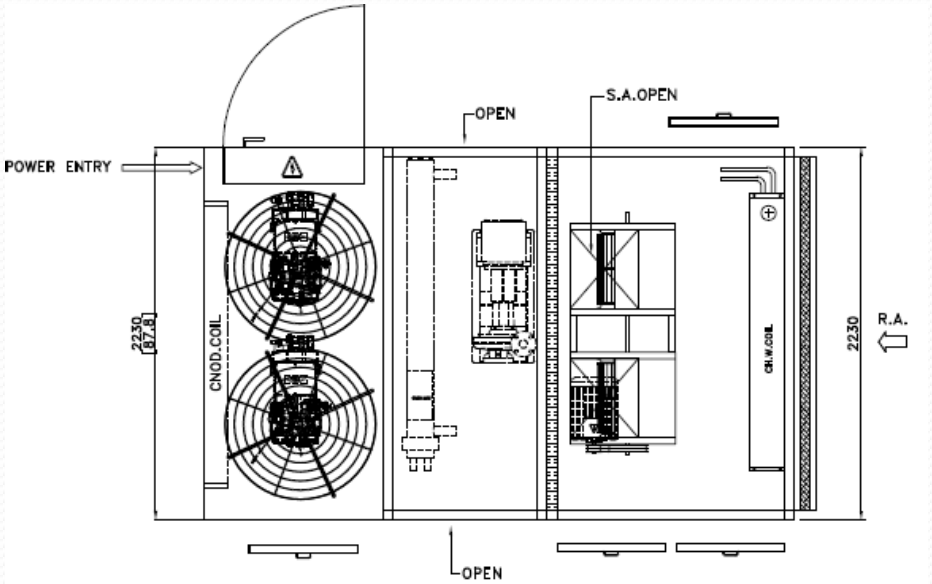
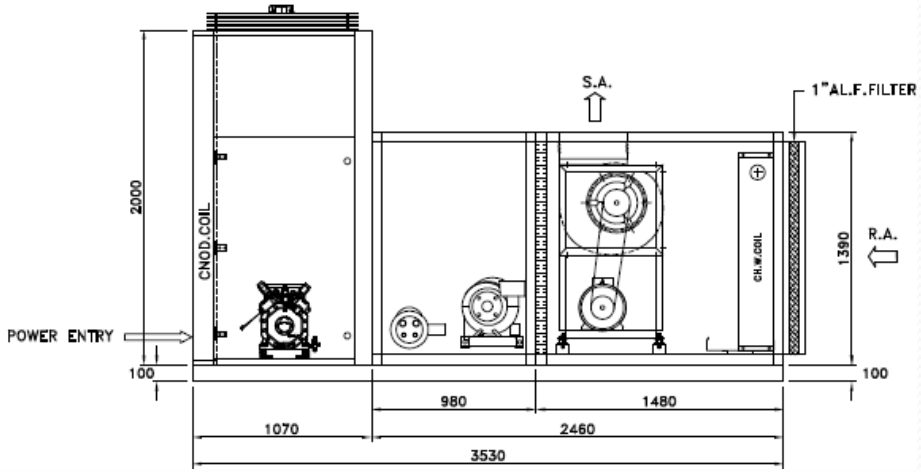
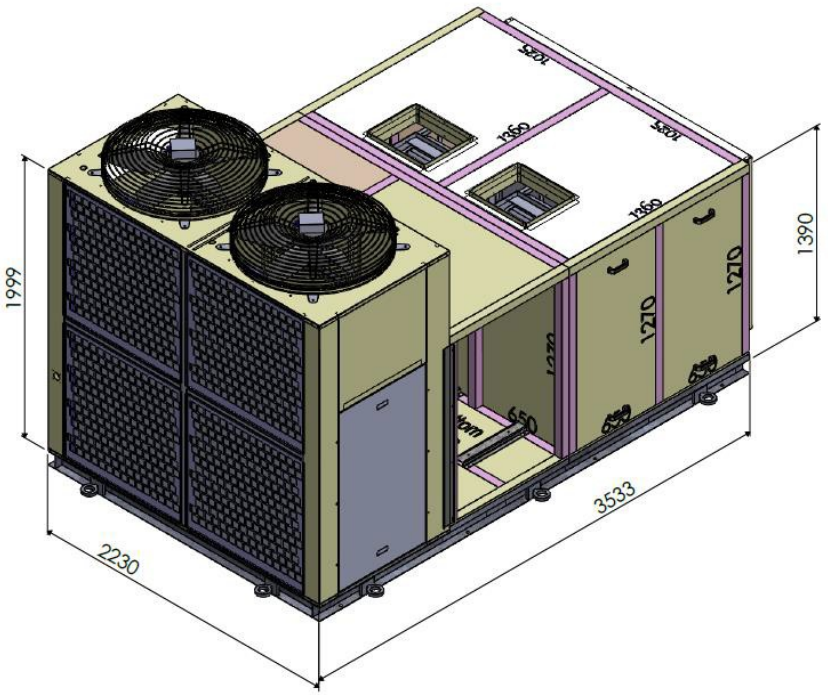
Prototype Unit







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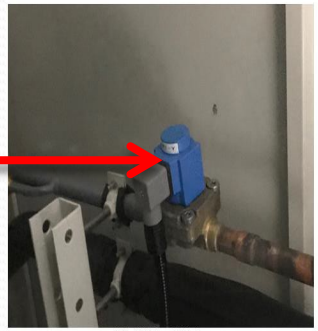
Safety Considerations

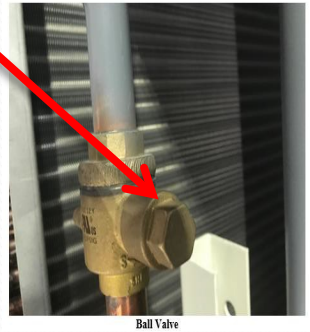
- Eliminate all junction boxes inside the unit
- R290 leak detector beside refrigeration pipes
- Installing electrical enclosure in location far from welding pipes.
- Unit Marking – Compliance with IEC 60335-2-40

Safety Considerations

- Wire mesh added to the condenser coil for hot surfaces protection
- Increased number of isolation valves
- NEMA 4X electrical panel
  - Airflow switch installed to ensure panel is always at positive pressure



Liquid Solenoid Valve



Ball Valve

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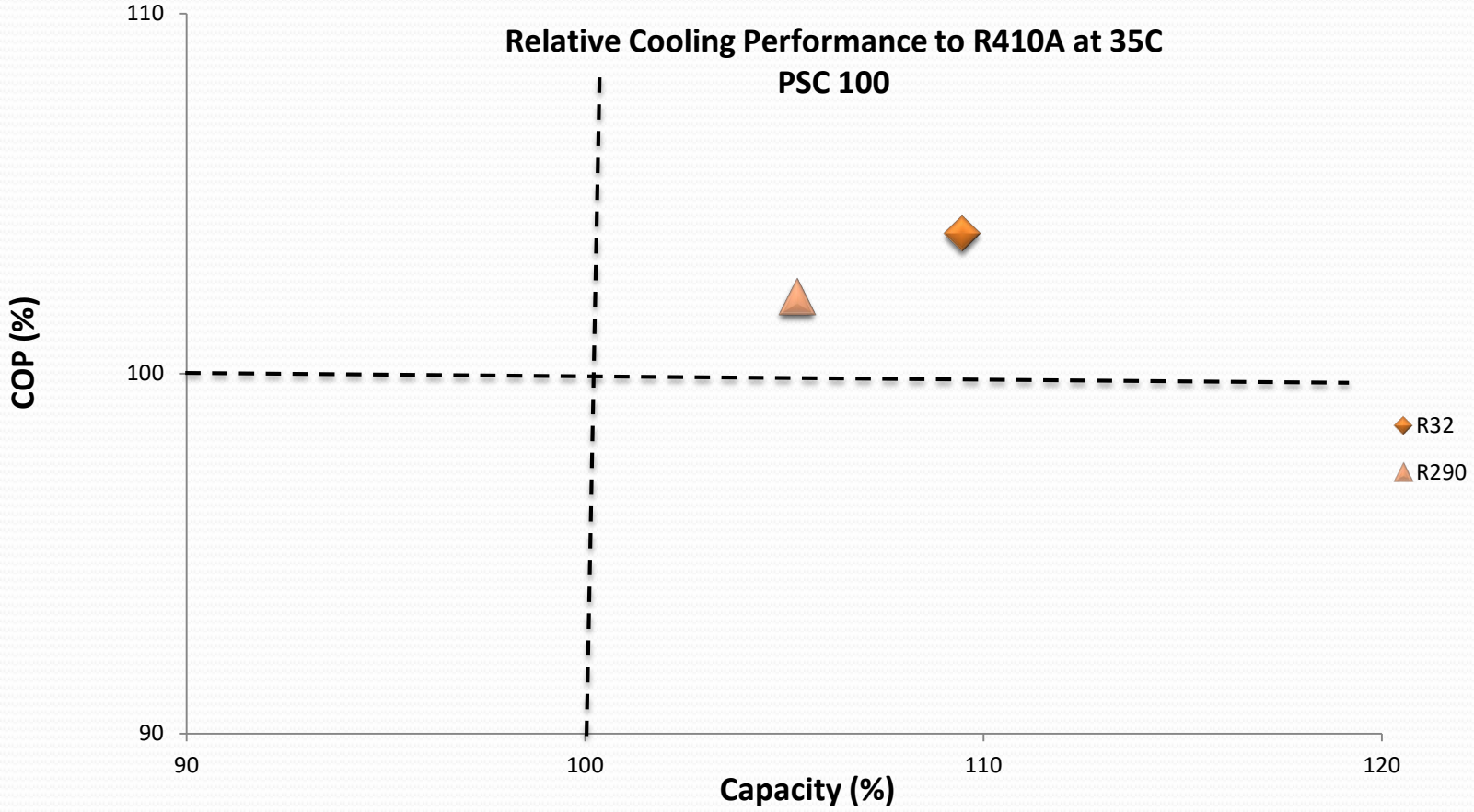
Performance Comparison at Standard Ambient Condition



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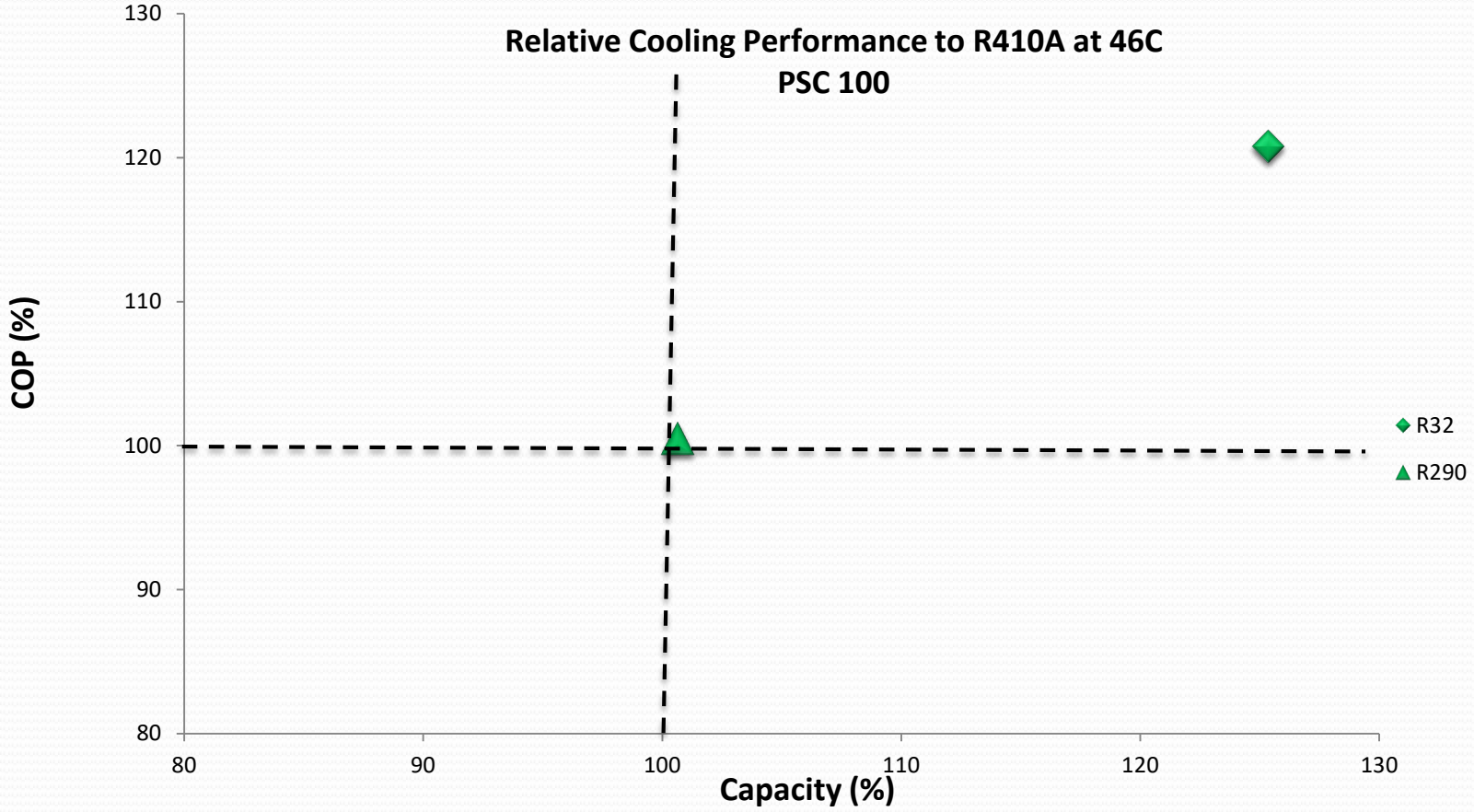
Performance Comparison at High Ambient Condition



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Cost Analysis - Refrigerants

Comparing R290 and R410A

Unit	Refrigerant Charge R410A (KG)	Refrigerant Charge R290 (KG)	Charge Ratio	Cost of refrigerant R410A ($)	Cost of refrigerant R290 ($)	Cost increase (%)
PSC2H-100	16	11	1.45	104.8	134.75	28.6%
PSC2H-70	12	8	1.5	78.6	98	24.7%
PSC2H-40	6.5	5	1.3	42.575	61.25	43.9%

Comparing R32 and R410A

Unit	Refrigerant Charge R410A (KG)	Refrigerant Charge R32 (KG)	Charge Ratio	Cost of refrigerant R410A ($)	Cost of refrigerant R32 ($)	Cost increase (%)
PSC3H-100	16	12	1.33	104.8	225.36	143.66%
PSC3H-70	12	9	1.33	78.6	169.02	115%
PSC3H-40	6.5	5.5	1.18	42.575	103.29	142.6%

Cost Analysis – Major Components

PSC 100 Major Components Cost $	R410A	R32	R290	R290 Unit with ATEX components
Compressor (2)	1821 Hermetic Scroll	1821 Hermetic Scroll	6286 Semi Hermetic Reciprocating	10686 Semi Hermetic Reciprocating
Condenser Coil	2560	2560	2560	2560
Evaporator Heat Exchanger	1829	1829	1829	1829
Expansion valves	123	123	196	196
Electrical Panel and cables	2054	4414	4414	13242
Piping	693	640	693	693
Pressure Relief Valve	275	275	246	246
Filter Drier	275	275	275	275
Solenoid valve	156	156	156	467
TOTAL ($)	**9786**	**12093**	**16655**	**30194**
Percentage	**0%**	**23.6%**	**70.2%**	**208.5%**

Summary

- Air-cooled chillers were successfully built and tested with low GWP refrigerants R32 and R290
- International safety standards were followed and equipment was designed to reduce risk of using flammable refrigerants
- Performance is comparable or better than baseline refrigerant R410A at standard and high ambient testing conditions
- Cost of equipment slightly higher for R32 but significantly higher for R290
- Cost of components are expected to decrease as production increases

Thank you for your attention!