



Multilateral Fund

for the Implementation of the Montreal Protocol

OBJECTIVE

To build, test, and optimize prototypes of packaged air-conditioning (AC) units based on HFC-32 and R-290 refrigerants; evaluate incremental cost of the conversion and the energy performance of the HFC-32 and R-290-based ACs; and disseminate the findings and results to interested manufacturers in Saudi Arabia and other countries.



DEMONSTRATION OF R-290 AND HFC-32 IN PACKAGED AIR-CONDITIONERS

Project title	Demonstration project at air-conditioning manufacturers to develop window and packaged air-conditioners using lower-GWP refrigerants
Country	Saudi Arabia
Agency	World Bank
Sector	Refrigeration and AC
Subsector/application	Residential and commercial AC
Enterprise/ systems house	Petra Engineering Industries (KSA) Co. Ltd.
Baseline technology	HCFC-22
Alternative technology	R-290 (propane), HFC-32
GWP (alternative technology)	R-290: negligible. HFC-32: 675
Potential safety issues	Flammable
ODS phase-out (mt)	65.27
ODS phase-out (ODP tonnes)	3.59

DESCRIPTION

The project was implemented at Petra Engineering Industries (KSA) Co. Ltd. (with annual capacity of 852 packaged units) to design AC prototypes based on R-290 and HFC-32 refrigerants considering charge size and safety measures; select the main components (i.e., condensers, evaporators, fans and compressors) to achieve similar or better performance than the baseline equipment; and build prototypes taking into consideration the availability of components and suppliers in countries with high-ambient-temperature conditions. Tests to assess the performance of the prototypes were carried out in accordance with international standards. Performance, quantity of charge, and prices were compared to those of R-410A-based equipment.

RESULTS

Petra designed, manufactured, and tested six prototype commercial air-cooled chillers using HFC-32 and R-290 with cooling capacities of 40 kW, 70 kW and 100 kW. The design of the equipment was in accordance with the safety requirements of ISO-5149 and IEC-60335-2-40. Testing was conducted at 35°C, 46°C and 52°C. Results were compared to R-410A, which was tested as a drop-in to HFC-32, rather than in equipment optimized for R-410A. In all cases, both HFC-32 and R-290 units showed similar or better performance (efficiency and cooling capacity) than R-410A, as shown in Figure 1. The substantially higher cost of the R-290 compressor, combined with the higher cost of R-290 refrigerant and of some major components needed for R-290, including a leak detector, resulted in an increase between 37 and 45 per cent in the overall cost of the R-290 equipment, while the overall cost increase was between 11 and 14 per cent in the case of HFC-32.

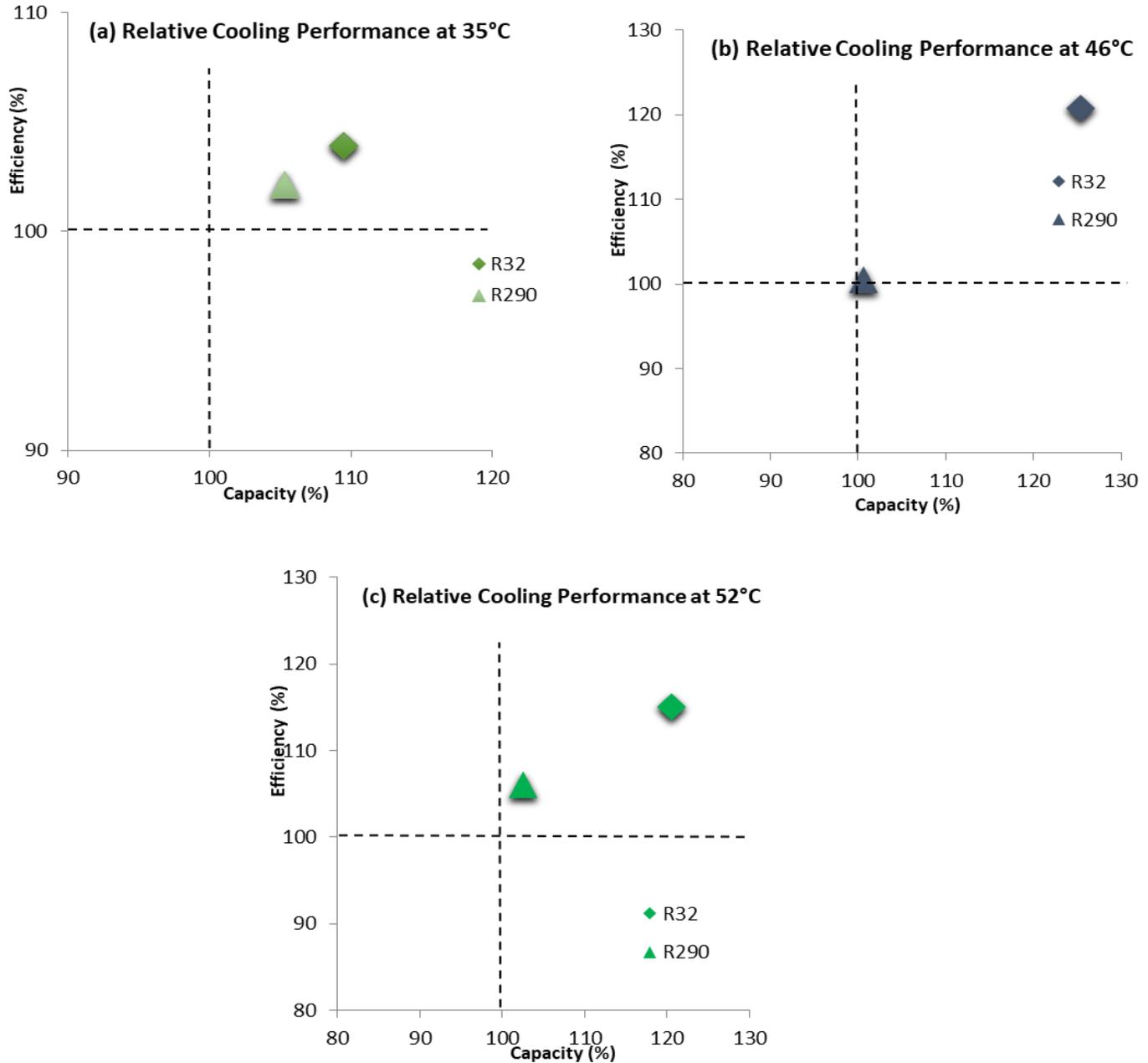


Figure 1. Low-GWP refrigerants' relative performance to R-410A for the 100 kW prototypes at (a) 35°C, (b) 46°C, and (c) 52°C

COST ANALYSIS

Relative to R-410A, the cost of charging the units was 50 to 57 per cent less with HFC-32 and 25 to 44 per cent higher with R-290, given the refrigerant charge, and the prices of HFC-32 (US \$4.44/kg), R-290 (US \$12.25/kg) and R-410A (US \$6.55/kg) in the local market at the time the project was implemented. There was a 11 to 14 per cent increase in the overall cost of major components when transitioning from R-410A to HFC-32, depending on the size of the unit. The difference in cost between HFC-32 and R-290 for most major components was minor, except for the compressor, which was approximately three times more expensive, and resulted in substantial increases in the cost of a unit relative to HFC-32. A leak detector, required for R-290 but apparently not required for HFC-32, also contributed to that difference. ATEX¹ components would further increase the price of a unit, though the need for such components would likely be independent of the refrigerant.

CONCLUSION

Commercial air-cooled chillers can be designed and can operate with HFC-32 and R-290 refrigerants for a variety of cooling capacities and operating conditions, including high ambient temperatures. The requirements of safety standards did not limit the refrigerant charge because of the application and the location of the chillers. However, the use of flammable refrigerants such as R-290 would be restricted by safety standards for most commercial applications, which is not the case for mildly flammable refrigerants like HFC-32. Reductions in refrigerant charge might be achieved through the use of microchannel heat exchangers; however, some enterprises may wish to continue to manufacture their own fin-and-tube heat exchangers in-house.

FINAL REPORT AND SECRETARIAT'S COMMENTS

Additional details on this project are available at the link below:

<http://www.multilateralfund.org/83/English/1/8311.pdf>
(paragraphs 219 to 235 and Annex IV in page 83)

¹ Appareils destinés à être utilisés en ATmosphères EXplosibles (ATEX) *inter alia* specifies equipment allowed in an environment with an explosive atmosphere