



Multilateral Fund

for the Implementation of the Montreal Protocol

OBJECTIVE

To convert a HCFC-22-based production line of split room AC to R-290 technology, in order to validate the use of R-290 as a refrigerant in the manufacture of room ACs; and to obtain and disseminate experience on redesign, safe conversion, refrigerant storage and handling, transportation and installation



DEMONSTRATION PROJECT FOR CONVERSION FROM HCFC-22 TO R-290 IN ROOM AIR-CONDITIONING MANUFACTURING

Project title	Demonstration sub-project for conversion from HCFC-22 to propane at Midea (room air conditioner manufacturing enterprise)
Country	China
Agency	UNIDO
Sector	Refrigeration and air-conditioning (AC)
Subsector/application	Room AC
Enterprise/ systems house	Midea Refrigeration Equipment Co. Ltd.
Baseline technology	HCFC-22
Alternative technology	Propane (R-290)
GWP (alternative technology)	Negligible
Potential safety issues	Flammable
ODS phase-out (mt)	240
ODS phase-out (ODP tonnes)	13.2

DESCRIPTION

Midea produces 20 million room AC units per year (2008) in 75 production lines. Production includes split and window units, cabinets and portable units. The project converted one production line manufacturing 200,000 units (i.e., outdoor units, including variable frequency (VF), for split AC of 1.5HP and below, portable AC, window AC and dehumidifiers).

The conversion of the production line to operate with R-290 required significant equipment modification or replacement, mainly related to safety requirements. A series of safety devices were installed in areas where refrigerant is handled. Modifications included: the assembly line (relocation of equipment to new site, modification of production process, explosion-proof modifications and antistatic measurements; test system; vacuum inspection system, refrigerant supply line, vacuum pump, vacuum chamber helium detector, refrigerant charging equipment (including pressure booster and safety system); leak testing in two stages; ventilation systems; alarm system; sealing machine and tools and fixtures.

In the converted product, the refrigerant charge was significantly reduced from around 1,200 g to 300 g per unit, which required major changes in the configuration of the product components, including heat exchanger and compressor.

Modifications to the compressor were done through the *Demonstration sub-project for conversion of room AC compressor manufacturing from HCFC-22 to propane at Guangdong Meizhi Co.*, implemented together with this project.

In the heat-exchanger manufacturing, modifications were necessary for a number of stages in the process, among them the high-speed fin presses and hairpin tube bending machines. The equipment purchased included leak detectors, safety systems including ventilation, performance test equipment and life test units.

RESULTS

As a result of the conversion, two types of R-290 room AC units (split/VF and portable AC) and six different models are available for mass production.

Compared to the HCFC-22 based units, the use of R-290 in the new AC unit leads to a reduction in energy consumption of between 5% and 12%. The performance of the portable models is 15-19% higher than R-410A units, and the performance of the split-unit models is comparable to HFC-410A units. In order to achieve the best performance, 450g of refrigerant would be required for a 3,500W capacity (COP = 3.0) split unit, however, the standards allow a maximum of 350g, with which the capacity is less than 3,400W (COP of 2.8). Further efficiency improvement, both in compressors and AC units, could be achieved if the charge sizes specified in international standards were relaxed. Until then, efficiency improvement is mainly dependent on further research and development.

The conversion of production lines and the manufacturing of new appliances can be handled safely, despite the flammability of R-290, if appropriate measures are implemented and appropriate tools and equipment are used.

The experiments show that the possibility of fire and explosion for a wall-mounted R-290 air conditioner is only 10^{-8} - 10^{-9} per year under household use conditions in China. Nevertheless, the next stages of the phase-out programme should focus on risks in the servicing and installation processes, risks at different charges, and secondary risks from a fire.

Based on the outcomes of the demonstration project, other room AC manufacturers have started research and development, and conversion activities using R-290 technology.

Performance information for R-290 based air-conditioners*

Type	Model	Capacity (w)	R-290		R-410A		Minimum requirements	Certification
			Charge (g)	COP (w/w)	Charge (g)	COP (w/w)	COP (w/w)	
Split/VF	KFR-26GW/BP3DN7Y	2600	270	4.77(APF)	980(R-410A)	4.75(APF)	3.5	CCC
Split/VF	KFR-35GW/BP3DN7Y	3500	360	4.73(APF)	1130(R-410A)	4.75(APF)	3.5	CCC
Split/VF	MS11M-09HRFN7-QRC4	2600	310	4.0(SCOP)	1030(R-410A)	4.0(SCOP)	3.3(GWP<150)	CB/CE
Split/VF	MS11M-12HRFN7-QRC4	3500	350	4.0(SCOP)	1300	4.0(SCOP)	3.3(GWP<150)	CB/CE
Portable A/C	MPPD-09ERN7-B6G1	2600	210	3.1	430(R-410A)	2.6(R-410A)	2.6	CB/CE
Portable A/C	MPPD-11ERN7-B6G1	3200	230	3.0	520(R-410A)	2.6(R-410A)	2.6	CB/CE

* The R-290 products were developed based on R-410A models, thus, there are no comparison data with R-22. In addition, R-290's RAC efficiency is normally 5-12% higher than R-22. Charge mass is only 45% of R-22.

COST ANALYSIS

Incremental capital costs were incurred in the following components: heat exchanger process equipment (62.08%); equipment for assembly line conversion including R-290 storage and supply, leakage detection and testing, vacuum machine, ventilation and other safety measures for the working area (29.74%); and operating performance testing equipment (8.18%). The incremental operating cost (IOC) was US \$41.95 per unit for the manufacture of an R-290-based split unit. The IOC included the incremental cost for installation (US \$21.31 per unit), which is not part of the production cost. Excluding the installation cost, the IOC was US \$20.64 per unit. The high IOC, associated with product initiation, is expected to decrease in future.

CONCLUSION

R-290 is considered one of the ideal replacements for HCFC-22 in the room AC manufacturing sector. The converted manufacturing line has maintained the quality and performance of the room AC units produced. Their performance is consistent with national (CCC) and international standards (IEC/CB and CE). Significant co-financing efforts from Midea contributed to reaching this performance.

In terms of market introduction, the following lessons can be learned:

- 1) Modification of the existing Chinese standards as well as the establishment of new standards will be a key factor for the adoption of alternative technologies
- 2) New policy/financial measures should be considered to help market sales of R-290 air conditioners
- 3) Training in the servicing and installation of room ACs containing flammable refrigerants is a prerequisite for the market introduction and safe use of the R-290 air conditioners.

FINAL REPORT AND SECRETARIAT'S COMMENTS

<http://www.multilateralfund.org/73/English/1/7317a1.pdf>
(paragraphs 15 to 31 and Annex in page 33)