ORNL/TM-2019/1082

Low-GWP Refrigerant Evaluation in AC Systems for High Ambient Temperature Applications - Acquire Nortek Residential AC/HP Units for Evaluation and Model the Units Using HPDM – FY19 1st Quarter Milestone Report

Bo Shen
12/31/2018

Approved for public release.
Distribution is unlimited.

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE US DEPARTMENT OF ENERGY

ORNL/TM-2019/1082

BTO Project 3.2.2.19
FY19 1st Quarter Milestone Report

Low-GWP Refrigerant Evaluation in AC Systems for High Ambient Temperature Applications – Acquire Nortek residential AC/HP units for evaluation and model the units using HPDM

Author
Bo Shen

Date: 12/31/2018

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6283
managed by
UT-BATTELLE, LLC
for the
US DEPARTMENT OF ENERGY
under contract DE-AC05-00OR22725

Acquire Nortek residential AC/HP units for evaluation and model the units using HPDM (Regular Milestone)

Executive Summary

For the upcoming refrigerant transition from HFCs to minorly flammable HFO refrigerants (A2L), refrigerant charge reduction is important to mitigate the fire hazard. Microchannel heat exchangers (MHXs) are a mature technology, which is effective in reducing system charge while maintaining similar heat transfer performance. MHXs will be applied more widely when the new refrigerants are used. Prior studies of the A2L HFO blends were mostly focused on fin-and-tube coils (FTC). An in-depth study for an air conditioner (AC)/heat pump (HP) system using all microchannel heat exchangers is still lacking.

In FY19, a side-to-side comparison will be conducted between two residential split heat pumps, one using all FTCs and the other using all MHXs for drop-in investigation, to identify potential issues for future design. The two heat pumps have similar rated capacity, SEER, HSPF levels, similar fan, blower and compressor, but differ in heat exchangers. Both the HPs use two-stage compressors to facilitate investigating different refrigerant flow rates. We will drop-in HFO refrigerants (replacements for R-410A, e.g. R452B, R447B, R32, etc.). The experiments will reveal the potential of MHXs for charge reduction, and how the two systems using A2L refrigerants operate under standard SEER and HSPF rating conditions.

The two units were donated by our partner, i.e. Nortek Global HVAC, an industry leader in making heat pumps using all MHXs as well as FTCs. The units were shipped to ORNL this week, and the product design data were also shared for modeling the two units using HPDM.

TABLE OF CONTENTS

List of Figures

LIST OF TABLES

1. Unit Information

Unit information of the two 5-ton split heat pumps are illustrated in Table 1. They have similar rating values.

Table 1: Unit Information of Two 5-Ton Nortek Split Heat Pumps

Units	5-ton Split HP with All Microchannel Heat Exchangers	5-ton Split HP with All Fin-and-Tube Coils
Outdoor Unit Model No	FSH1BF4M2SX60K	ET4BF-060KA
Indoor Unit Model No	B6VMMX60K-C	B6VMAX60K-C
Rated Cooling Capacity [Btu/hr], High Speed	55000	55000
Rated Cooling Capacity [Btu/hr], Low Speed	41000	41000
Rated Cooling EER [Btu/hr/W], High Speed	11.7	12.5
SEER [Btu/hr/W]	16.0	16.0
Rated Heating COP [W], High Speed	3.32	3.52
HSPF [Btu/hr/W]	8.5	8.5
Rated Heating Capacity [Btu/hr], High Speed	52500	52500
Rated Heating Capacity [Btu/hr], Low Speed	37000	37000
High Indoor Air Flow [SCFM]	1835	1800
Low Indoor Air Flow [SCFM]	1280	1200

2. Comparison of Performance Varying with Ambient Temperature

Although the two units have similiar rating performance, minor differences exist when changing with the ambient temperature. Figures 1 and 2 present the total capacities and cooling EERs as a function of the ambient temperature, respectively. When running the high compressor speed, the HP with all FTCs has slightly higher capacities, and thus, better EERs at low ambient temperatures. On the other hand, the performance results are identical when running the low compressor speed.

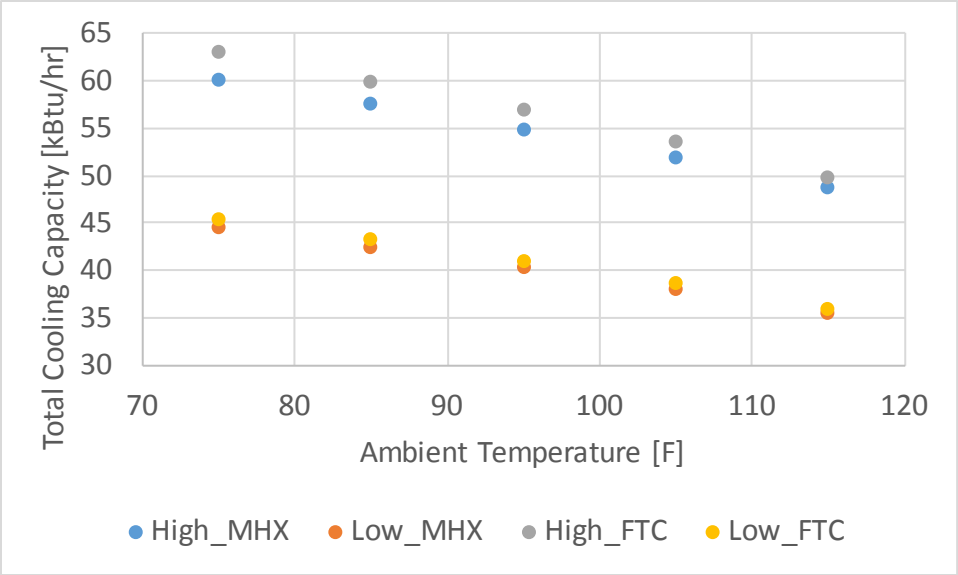

Figure 1: Total Cooling Capacies Varying with Ambient Temeperature for the Units with All MHXs and All FTCs at High and Low Compressor Speeds

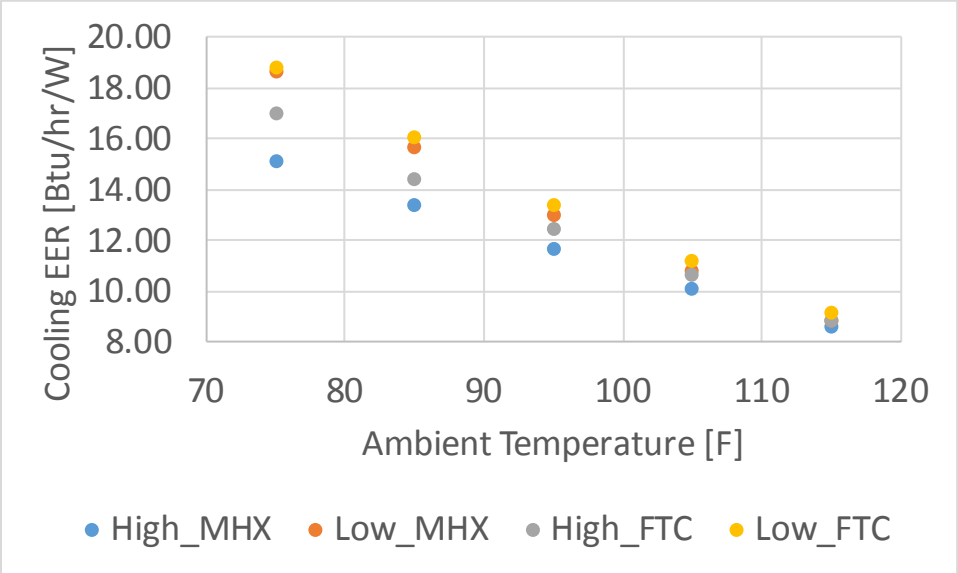

Figure 2: Cooling EERs Varying with Ambient Temeperature for the Units with All MHXs and All FTCs at High and Low Compressor Speeds

Figures 3 and 4 present the total heating capacities and COPs as a function of the ambient temperature, respectively. When running the high compressor speed, the HP with all MHXs deliver larger capacities but lower COPs at high ambient temperatures. when running the low compressor speed, the COP of the HP with all FTCs degrades faster than that using all MHXs at low ambient temperatures.

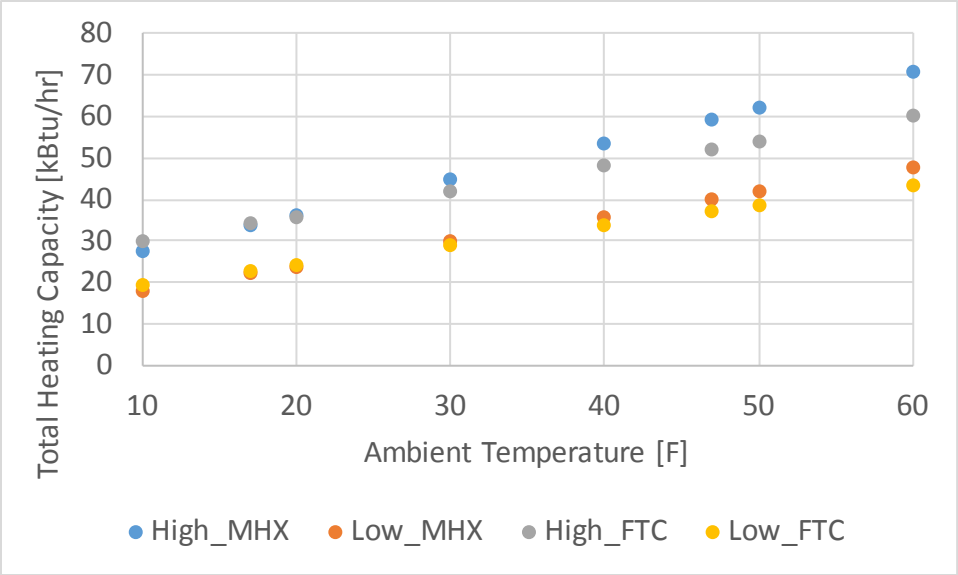

Figure 3: Total Heating Capacities Varying with Ambient Temeperature for the Units with All MHXs and All FTCs at High and Low Compressor Speeds

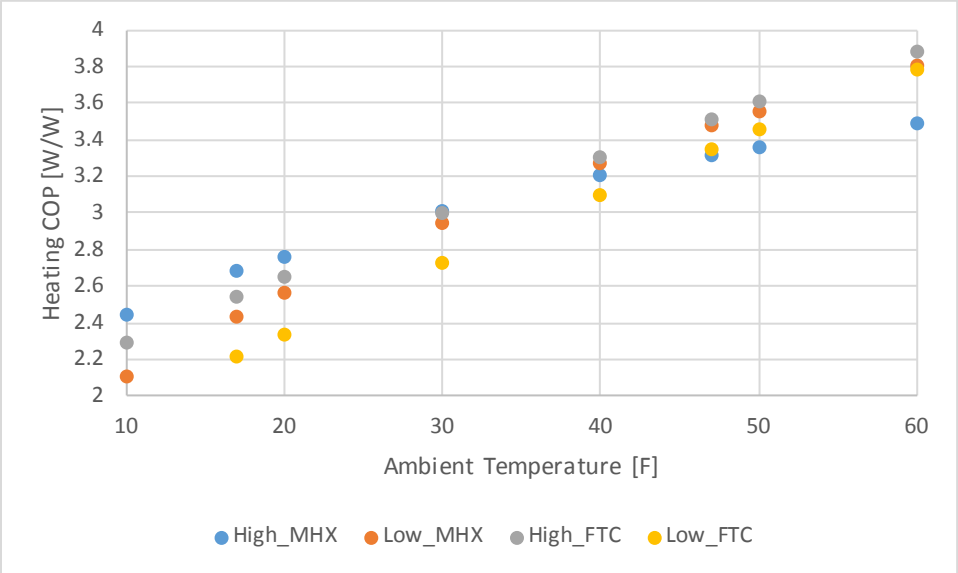

Figure 4: Heating COPs Varying with Ambient Temeperature for the Units with All MHXs and All FTCs at High and Low Compressor Speeds