Annex 41

Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

Cold Climate Heat Pumps (CCHP)

Improving low ambient temperature performance of air-source heat pumps

Air source heat pumps have been proven to have the feasibility to achieve high heating efficiency also in cold and very cold locations. Energy savings of 40 % in comparison to a conventional air source heat pump have been demonstrated in field tests.

Key Findings

1 **A prototype two-compressor CCHP system** was field tested in Ohio, U.S. **and demonstrated a measured seasonal heating COP of ~3.0 over two winters. Heating capacity was sufficient** to meet the house load at -25°C **without need for backup heat.**

2 CanmetENERGY (Canada) is investigating a **novel solar assisted heat pump (SAHP)** with potential to **reduce the energy use for space and domestic water heating** in high performance homes between 61 % and 66 % at lower cost than ground source heat pumps (GSHP).

3 An **oil-flooded compression cycle approach** was investigated at Purdue University's Herrick Labs. Lab prototype results confirm that high oil circulation rates lead to **improvements in heating capacity** ranging up to 19 % at the lowest ambient temperature tested (about -18°C).

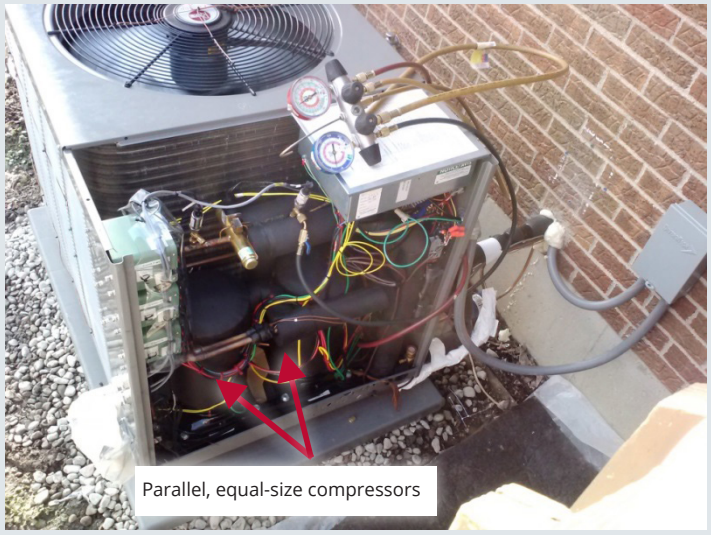

Figure 1. Two compressor field test CCHP prototype.

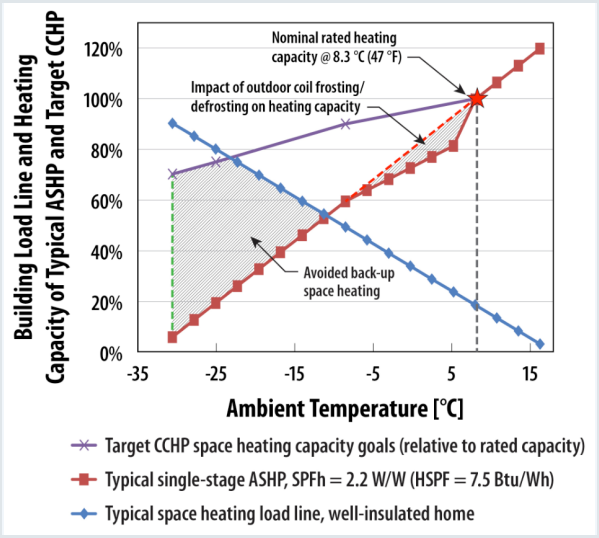

Figure 2. Space heating capacity for target CCHP vs. typical single-stage ASHP.

Background

Electric driven air-source heat pumps (ASHP) generally have the lowest installation cost of all heat pump alternatives, but also the greatest performance challenges at cold outdoor temperatures. One of these is loss of heating capacity at low outdoor temperatures. The other major issue is the loss of capacity due to frosting and defrosting of the outdoor heat exchanger (OHX).

Traditional ASHPs must use low-efficiency backup heat at lower temperatures and suffer loss of performance at moderate outdoor temperatures, as noted in Figure 2.

Annex 41 has focused on two primary areas: advanced Cold Climate Heat Pumps (CCHP) with low-temperature capacity-enhancement approaches have been analytically and experimentally investigated. Secondly, detailed investigations on OHX frosting have been conducted, primarily by Japanese and Austrian researchers.

Objectives

The aims of the Annex 41 were to:

- ... identify and evaluate technology solutions to improve performance of heat pumps for cold climate locations, with primary focus on electrically driven air-source heat pumps (ASHP) but also novel ground-source heat pump (GSHP) and solar assisted heat pump (SAHP) approaches.
- ... produce and share technical data/results for use by designers & manufacturers in producing ASHPs with significantly improved cold climate heating performance.
- ... achieve ASHP solutions with heating capacity at -25°C that is ≥75% of nominal rated capacity at 8.3°C.
- ... prototype cold climate ASHPs "in field" measured heating SPF > 2.63 W/W.

Further information

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Participating countries:	Austria, Canada, Japan, and the USA
Publications:	Final reports of Annex 41 and Executive Summary of Annex 41, available at www.heatpumpingtechnologies.org
Internet:	www.heatpumpingtechnologies.org/annex41