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Test of a heat pump

(2 appendices)

Work requested

Determination of performance of four heat pumps used for space heating at an outdoor temperature of -25°C. This report only includes result from one of the heat pumps. Results and reports for the other heat pumps at -25°C see reports with reference PX25834-1, PX25834-2 and PX25834-3. This last test item was also tested at outdoor air temperature -15°C, -7°C and +2°C see report reference PX25834-5.

Item for testing

Heat pump of type:	Air/air
Manufacturer:	Panasonic
Indoor unit model, serial no:	CS-VE9NKE no. 39054
Production date:	-
Outdoor unit model, serial no:	CU-VE9NKE no. 65201
Production date:	-
Heat source:	Air
Refrigerant, weight:	R410A 1,50 kg

The heat pump was selected by the client. The unit arrived in undamaged condition at SP's test laboratory in August 2012. The unit carried rating plates and labels showing information such as the model name and number, serial numbers, power ratings and CE-marking.

Place and date of testing

The heat pump was installed by a representative from Elektrokyl AB Borås supervised by a client from Panasonic at SP Technical Research Institute of Sweden's Energy Technology Department on the 9th of August 2012. Testing was performed 9th and 10th August 2012.

Test method for performance testing for space heating

The space heating performance of the heat pump was tested in accordance with SP Method 1721 and in some parts EN14511. SP method 1721 is an air enthalpy method, where capacities are determined from measurements of the inlet and outlet dry bulb temperatures of the air and the associated air flow rate. The testing procedure involves measurement and calculation of quantities and functions such as:

- Electrical power supplied to the heat pump, P_E
- Thermal output power from the heat pump, P_H
- The coefficient of performance, COP.

The test methods that were used define how the heat pump is to be installed, the duration of the measurement periods, the maximum uncertainty of measurement, process stability, function requirements etc.

Execution of testing, heat pump installation, setup and evaluation of data

The client supervised the installation of the heat pump made by Elektrokyl AB in consultation with a technical officer from SP. The client was present during a major share of the test procedure. The outdoor unit was mounted on top on wooden blocks in a climate chamber. The indoor unit was mounted with mounting plate from an earlier tested indoor unit on a wall panel of wood. Prefabricated refrigeration pipes with a length of 5,5 m and an electrical cable (3G1.5) was used in the installation. At least half of the length of the connecting pipes was exposed to the outside conditions and the elevation between indoor and outdoor unit was less than 2,5m.

The heat pump was set to operate in heat mode and the temperature setting on the remote control was set in its highest value. Louvers and fan speed was set for the highest air flow by the client. The indoor unit was fitted with a coarse air filter (also referred to as a flat sheet filter) during the test. The heat pump was tested with and without the plenum to secure that the plenum did not influence the heat pumps operation or control device. During the test, the static pressure in the plenum was controlled manually to be zero pressure (tolerance ±3 Pa) corresponding to the actual atmospheric pressure. The inlet temperature to the indoor unit was manually controlled to be as close to 20°C as possible during the given circumstances. The operating time for the heat pump during the test was limited to be at least one cycle including a defrost period. For heat pumps that automatically cycles off the indoor fan during defrost the contribution of the net heating delivered from the indoor unit was assigned the value of zero according to EN14511. If there is a negative heating capacity during the defrost period, this will not be included in the calculation of the heating capacity.

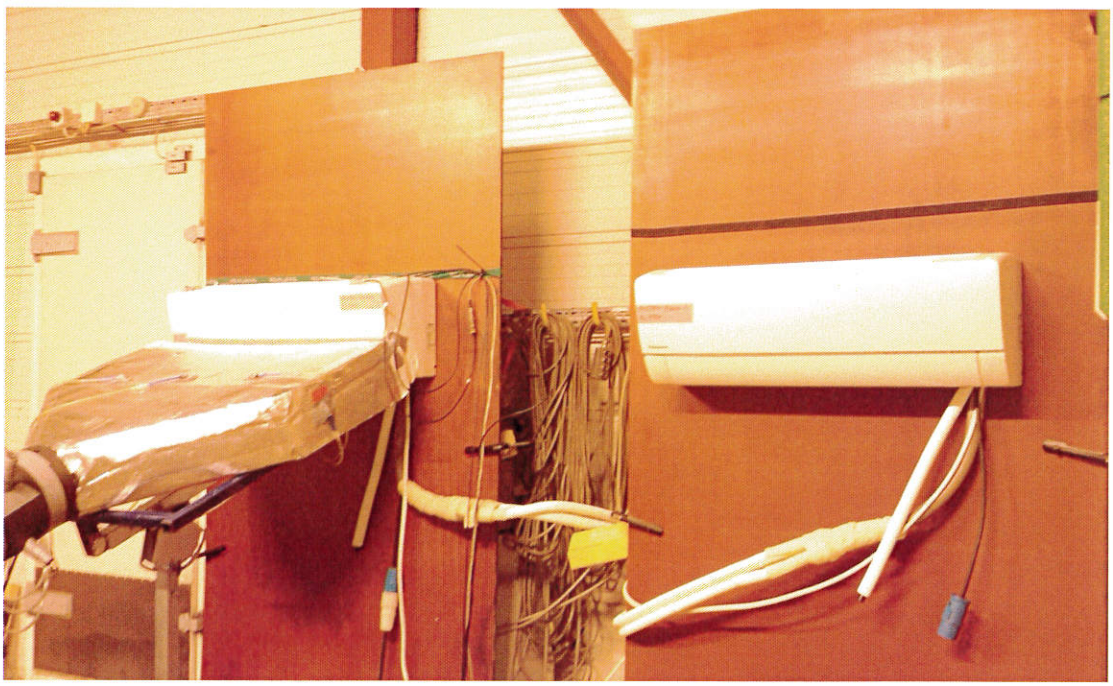

Figure 1. Indoor units mounted on wall panels of wood. The unit to the left is operating and has the plenum attached for measurement of the outlet air temperature and pressure. Downstream the plenum, equipment for airflow and temperature measurement as well as an auxiliary fan was installed

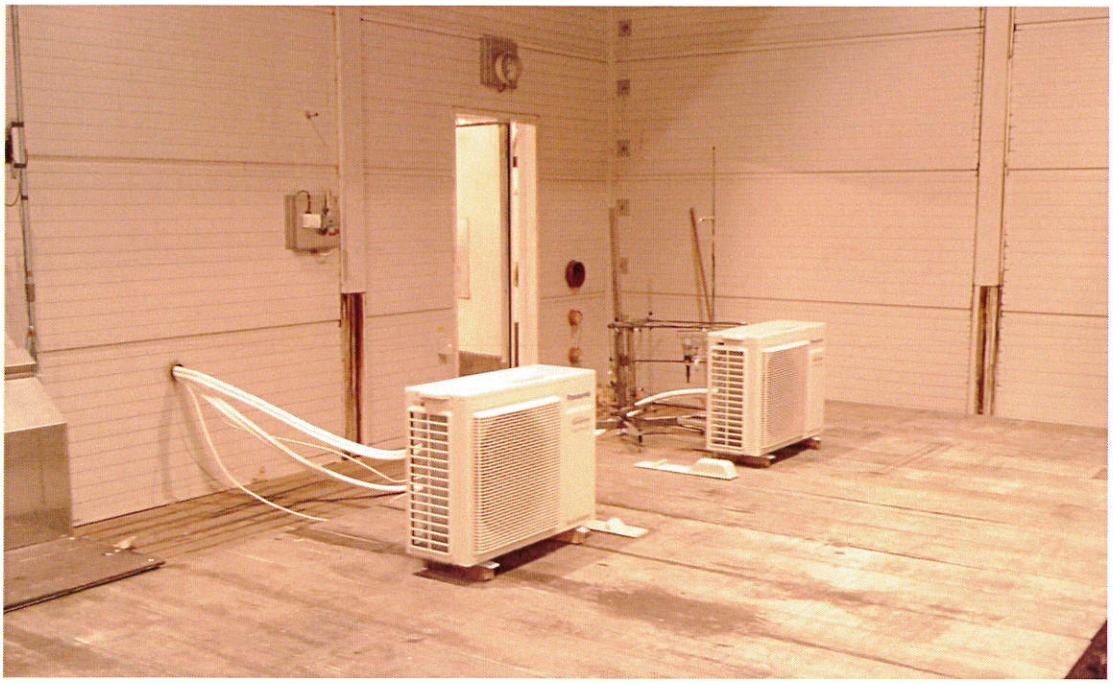

Figure 2. Climate chamber with outdoor units. The outdoor unit to the right has equipment for dry and wet bulb measurement positioned at the air inlet. Air temperature sensors were placed at a maximum distance of 0,25 m from the free air surface.

Test equipment

The following test equipment was used:

Description	Marking
Outdoor climate chamber	ETks-QD CA10
Dew point hygrometer	Inv. No. 200428
Plenum, tripod	LLVP
Gas Flow meter	Inv. No. 201412
Barometer	Inv. No. 202640
Micro manometers	Inv. No. 202626, 200925
Auxiliary fan	Inv. No. 202625
Data logger	Inv. No. 202317
Computer	A300367
Power supply, dew point	Inv. No. 202502
Electrical power	Inv. No. 202643
Air temperatures	Pt 100
Hose, duct, tape	

Results from space heating performance testing

The test results given in this report relate only to the specific item tested and under the specific conditions described, with the specific equipment named and at the specified settings. The total electrical drive power, P_E, and the thermal output power, P_H, were measured and calculated as mean values during the given time period; see table 1 and Figure 3 and comments thereafter.

Table 1. Result mean values during time period

	Unit	Time period
	Minutes	635-705
$t_{a1,\ indoor}$	°C	20,1
$t_{a2,\ indoor}$	°C	39,0
$t_{a1,\ outdoor}$	°C	-24,8
$t_{a1,\ dew\ point,\ outdoor}$	°C	-
q_{vb}	m^3/s	0,0440
P_E	W	2033
P_H	W	3377
COP	-	1,66
Operating cycle	Minutes	-
Defrost period	Minutes	-

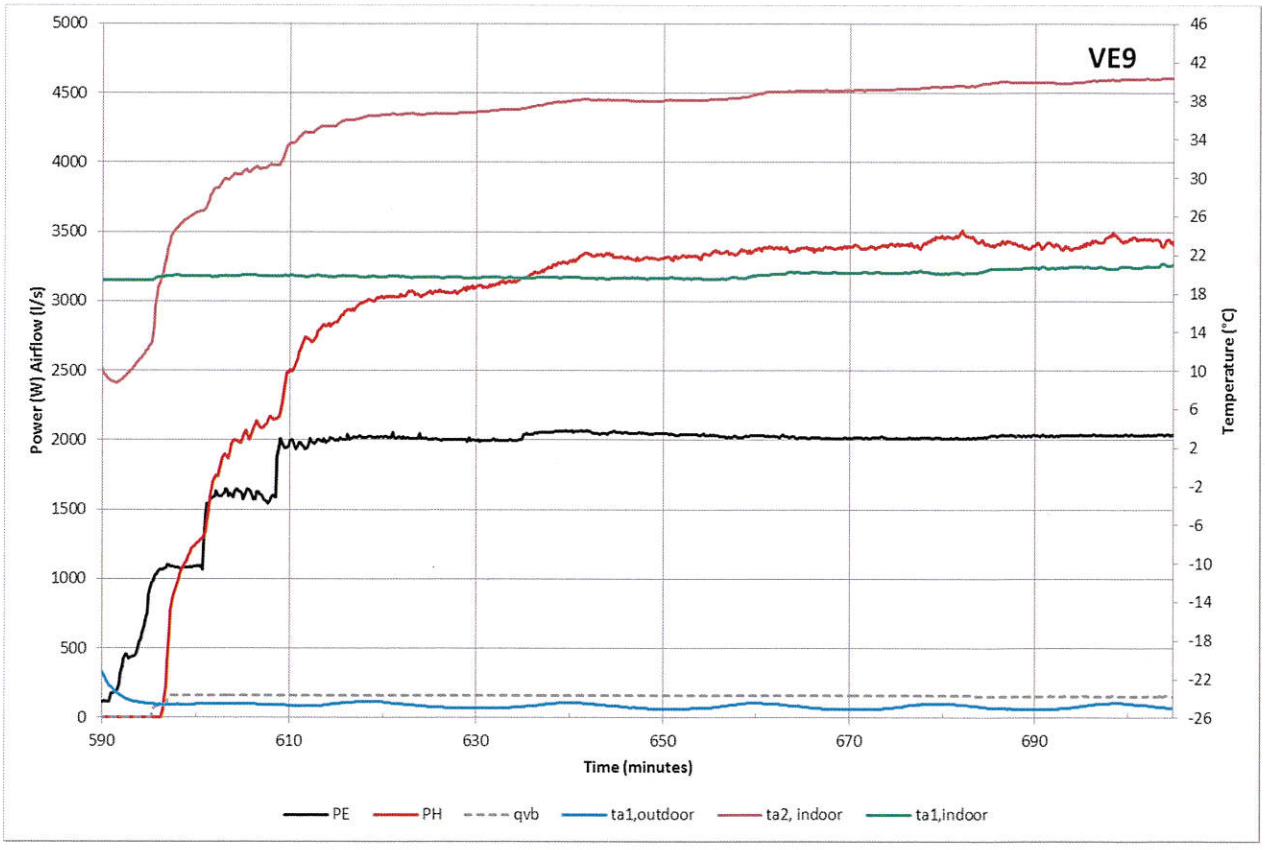

Figure 3. Measured and calculated results from termination of defrost period.

Comments to results

Table 1 shows the mean values during the given time period and the result in this table should be analysed together with Figure 3. A deep understanding of the test method may improve the quality of the conclusions. Therefore, it is recommended that SP takes part in the discussion regarding these time averaged mean values.

Figure 3 shows the plotting each 10 s. From this figure it is possible for a reader that has knowledge of the test method to do some conclusions but it is also recommended that these conclusions could be discussed and confirmed by SP.

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Appendices

1. Uncertainty of measurement
2. Quantities

Appendix 1

Uncertainty of measurement

The results from the test are based partly on measurements and partly on calculations. The total uncertainty of measurement of the results in the report has been calculated in accordance with the following estimates of uncertainties of measurement and calculation. The estimates are based on total uncertainties, including both systematic and random uncertainties. See Appendix 6 for identification of quantities.

Temperatures, measuring points

$t_{a1,indoor}$	± 0,2 K
$t_{a2.indoor}$	± 0,2 K
$t_{a2.indoor} - t_{a1.indoor}$	± 0,05 K
$t_{a1.outdoor}$	± 0,2 K
$t_{dew\ point.\ outdoor}$	± 0,5 K

Other quantities

P_E	± 1,0 %
P_H	± 10 %
COP	± 10 %
q_{vb}	± 5 %
Barometer	± 1 mbar
Pressure difference	± 1 Pa in range 0-200 Pa and ±14 Pa in range 0-2000 Pa
Duration of operation cycle and defrost period	± 1 minute

Appendix 2

Quantities

Where possible, designations of quantities are given in accordance with EN 14511 and SP Method 1721. See Swedish Standard SS 1897 for general designations that are not shown below. The data/values presented for each individual quantity are mean values over the respective measurement period.

COP	Total coefficient of performance (-)
P_E	Total active electrical power supplied (W)
P_H	Total thermal output power delivered
$t_{a1,\ outdoor}$	Temperature, dry bulb, in to the heat pump, evaporator (outdoor air temperature, °C)
$t_{a1,\ dew\ point,\ outdoor}$	Temperature, dew point, in to heat pump, evaporator (outdoor air temperature)
$t_{a1,\ indoor}$	Temperature, dry bulb, in to heat pump, condenser (indoor air temperature)
$t_{a2,\ indoor}$	Temperature, dry bulb, out from heat pump, condenser (indoor air temperature)
q_{vb}	Air flow, (l/s)
Operating cycle	Time for one cycle consisting of a heating period and a defrost period
Defrost period	Time for which the unit is in the defrost mode (minutes)