



**Air-Conditioning, Heating, and Refrigeration
Institute (AHRI) Low-GWP Alternative Refrigerants
Evaluation Program (Low-GWP AREP)**

TEST REPORT #30

Compressor Calorimeter Test of R- 134a Alternative Refrigerant R-1234yf in Reciprocating Compressors

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List of Tested Refrigerant's Compositions (Mass%)

R-1234yf	R-1234yf (100)
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1. Introduction:

Scope of the work is evaluation of the compressor performance with new low GWP refrigerant R1234yf in compressor NEK6214Z primarily used for R134a refrigerant.

2. Details of Test Setup:

a. Description of Test Refrigerant-Lubricant and Charge

- Pure fluid refrigerant tested
 - R134a by supplier LINDE
 - New refrigerant named R1234yf delivered by Honeywell
- Lubricant
 - Compressor lubricant is POE oil Emkarate RL 22HB by Lubrizol

b. Description of Compressors and test conditions/methodology

The evaluation was done by testing of 2 compressors model NEK6214Z, 269HG92 made by Embraco, type hermetic reciprocating one piston compressor. Compressors are primarily used for R134a refrigerant. First test was done with R134a for purpose of reference values and then they were tested with new refrigerant R1234yf. Average from 2 compressors was considered in the final results.

Model	NEK6214Z	NEK6214Z
BOM	269HG92	269HG92
Application	HBP-HST	HBP-HST
S/N	P12VSP98	P12VSP99
Oil	POE 22	POE 22
Motor	CSIR, monophase	CSIR, monophase
Power supply	115V/60Hz	115V/60Hz
Ambient temperature	35°C	35°C
Subcooling	0°C	0°C
Fan cooling	270 m ³ /h	270 m ³ /h
Temperature determination	Dewpoint	Dewpoint

Table 2-1, Compressor configuration and test description

Thermodynamic properties of R134a determined from Refprop 6.0 (by NIST USA), thermodynamic properties of R1234yf determined from file received from Honeywell.

c. Test facilities

The performance tests were performed on a calorimeter using Calorimetric method A Secondary fluid calorimeter on the suction side, see EN13771. Before the measurements were done, the calorimeter was cleaned from potential residues of previous tests, evacuated and subsequently charged with the correct refrigerant R134a and R1234yf.

Calorimeter charge with R134a: 1.2 kg
 Calorimeter charge with R1234yf: 1.2 kg

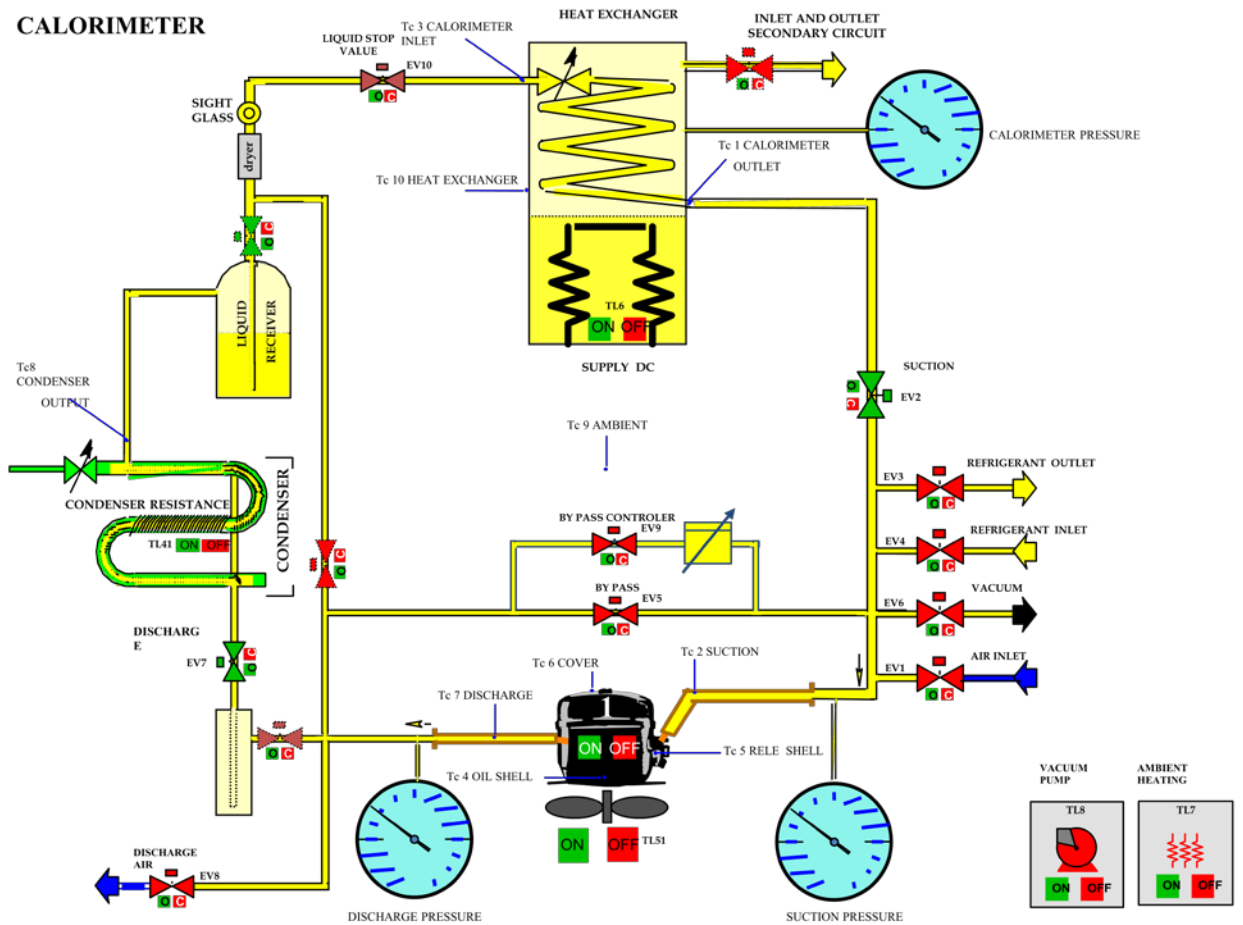


Figure 2-1, Schematic diagram of the calorimeter

Parameter	Instrument	Accuracy
Compressor power input	Yokogawa WT230	± (0.1% of reading + 0.1% of range),
Compressor voltage	Yokogawa WT230	± (0.1% of reading + 0.1% of range), 300 V
Compressor current	Yokogawa WT230	± (0.1% of reading + 0.1% of range), 10 A
Heat exchanger DC power input	Yokogawa WT230	± (0.3% of reading + 0.2% of range)
Heat exchanger DC voltage	Yokogawa WT230	± (0.2% of reading + 0.2% of range), 300 V
Heat exchanger DC current	Yokogawa WT230	± (0.2% of reading + 0.2% of range), 20 A
Suction pressure transducer	BD sensor 10 bar	± 0.1% of range
Discharge pressure transducer	BD sensor 40 bar	± 1% of range
Temperature - Heat exchanger input	TC "T", Agilent 34970A	± 0.5°C
Temperature - Heat exchanger output	TC "T", Agilent 34970A	± 0.5°C
Temperature - Heat exchanger internal	TC "T", Agilent 34970A	± 0.3°C
Temperature - Calorimeter ambient	TC "T", Agilent 34970A	± 0.5°C
Temperature - Compressor shell	TC "T", Agilent 34970A	± 0.5°C
Temperature - Return gas	TC "T", Agilent 34970A	± 0.5°C

Table 2-2, List of instruments with their accuracy

d. Coefficients equation format

Coefficients equation format:

$$X = C1 + C2 \cdot (S) + C3 \cdot D + C4 \cdot (S^2) + C5 \cdot (S \cdot D) + C6 \cdot (D^2) + C7 \cdot (S^3) + C8 \cdot (D \cdot S^2) + C9 \cdot (S \cdot D^2) + C10 \cdot (D^3)$$

where:

C = Equation coefficient, represents compressor performance

S = Suction dew point temperature, [°C]

D = Discharge dew point temperature, [°C]

X = compressor performance (mass flow rate, capacity, power and EER)

e. Uncertainties

Uncertainty for cooling capacity: ± 47.29 BTU/h (valid for all points)

Power input uncertainty: ± 3.46 W (valid for all points)

3. Results

3.1. Return gas temperature 18.3 °C

3.1.1. Reference measurement with R134a

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (BTU/h)	Power input (W)	Current (A)	EER (BTU/Wh)	Mass flow (kg/h)
R134a	30	-10	18.3	28.3	3295.2	503.0	6.45	6.55	19.88
R134a	30	-5	18.3	23.3	4154.0	556.5	6.70	7.46	25.21
R134a	30	0	18.3	18.3	5145.7	620.2	7.08	8.30	31.44
R134a	30	5	18.3	13.3	6249.8	695.0	7.56	8.99	38.44
R134a	30	10	18.3	8.3	7495.3	769.1	8.11	9.75	46.91
R134a	45	-10	18.3	28.3	2746.0	547.9	6.65	5.01	19.02
R134a	45	-5	18.3	23.3	3486.1	610.7	7.01	5.71	24.29
R134a	45	0	18.3	18.3	4345.7	678.4	7.45	6.41	30.54
R134a	45	5	18.3	13.3	5342.4	752.4	7.96	7.10	37.86
R134a	45	10	18.3	8.3	6428.2	834.8	8.58	7.70	45.98
R134a	60	-10	18.3	28.3	2116.0	590.4	6.91	3.58	17.34
R134a	60	-5	18.3	23.3	2733.0	661.1	7.32	4.13	22.60
R134a	60	0	18.3	18.3	3424.1	739.9	7.85	4.63	28.54
R134a	60	5	18.3	13.3	4268.8	827.7	8.51	5.16	35.97
R134a	60	10	18.3	8.3	5177.1	918.1	9.21	5.64	44.06

Table 3-1a, Measured data of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (%)	Power input (%)	Current (%)	EER (%)	Mass flow (%)
R134a	30	-10	18.3	28.3	0.9	1.2	6.2	2.1	0.7
R134a	30	-5	18.3	23.3	0.4	1.1	6.2	1.4	0.4
R134a	30	0	18.3	18.3	0.0	0.9	5.4	0.9	0.1
R134a	30	5	18.3	13.3	0.2	1.2	4.9	1.0	0.0
R134a	30	10	18.3	8.3	0.4	1.3	5.1	0.9	0.9
R134a	45	-10	18.3	28.3	0.5	1.1	5.8	1.6	0.4
R134a	45	-5	18.3	23.3	0.1	0.6	4.9	0.7	0.1
R134a	45	0	18.3	18.3	0.1	0.1	3.8	0.0	0.3
R134a	45	5	18.3	13.3	0.1	0.1	3.1	0.0	0.2
R134a	45	10	18.3	8.3	0.1	0.4	3.1	0.4	0.0
R134a	60	-10	18.3	28.3	0.7	1.4	6.0	2.1	0.9
R134a	60	-5	18.3	23.3	0.5	0.2	4.1	0.6	0.4
R134a	60	0	18.3	18.3	0.6	0.6	3.8	0.0	0.6
R134a	60	5	18.3	13.3	0.4	0.1	2.9	0.4	0.7
R134a	60	10	18.3	8.3	0.4	0.2	2.7	0.2	0.5

Table 3-1b, Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg/h, °C)	Power input (W, °C)
C1	6.402E+03	2.734E+01	5.296E+02
C2	2.443E+02	1.278E+00	1.557E+01
C3	-3.620E+01	3.078E-01	2.580E+00
C4	2.975E+00	1.954E-02	1.560E-01
C5	-7.424E-01	3.198E-03	-1.459E-01
C6	-1.692E-01	-6.782E-03	1.657E-02
C7	-7.199E-03	8.221E-05	-2.867E-03
C8	-1.425E-02	9.560E-06	-3.720E-04
C9	-1.277E-02	-3.909E-05	2.742E-03
C10	-8.469E-04	3.382E-05	-1.545E-05

Table 3-2, Coefficients C1 – C10 for NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

CURVE-FITTED CHARTS

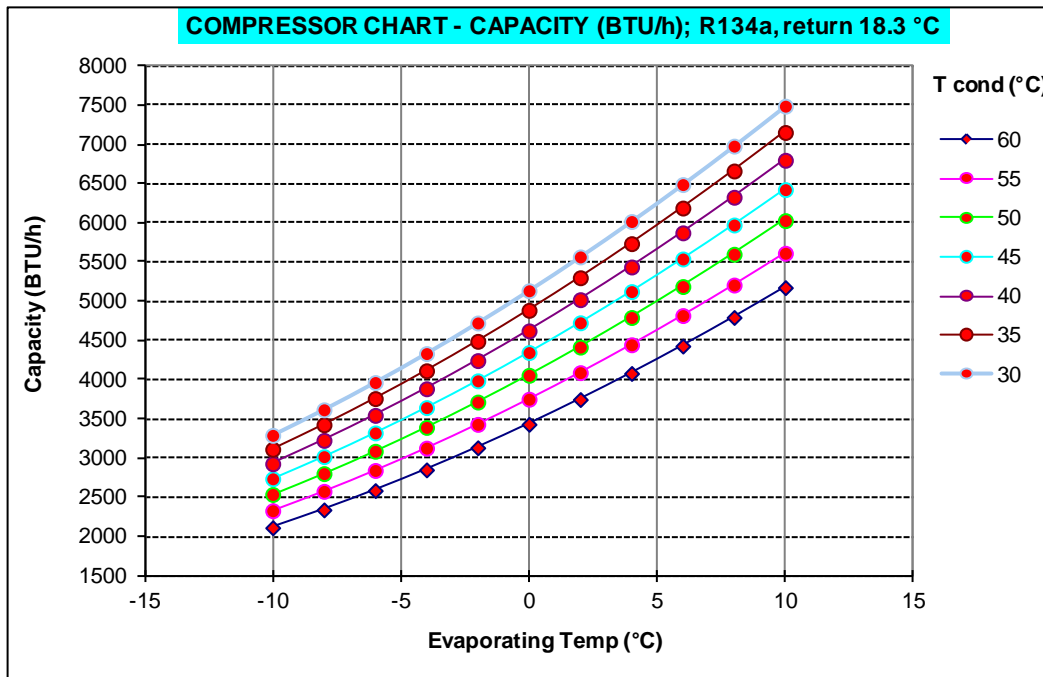


Figure 3-1, Cooling capacity of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

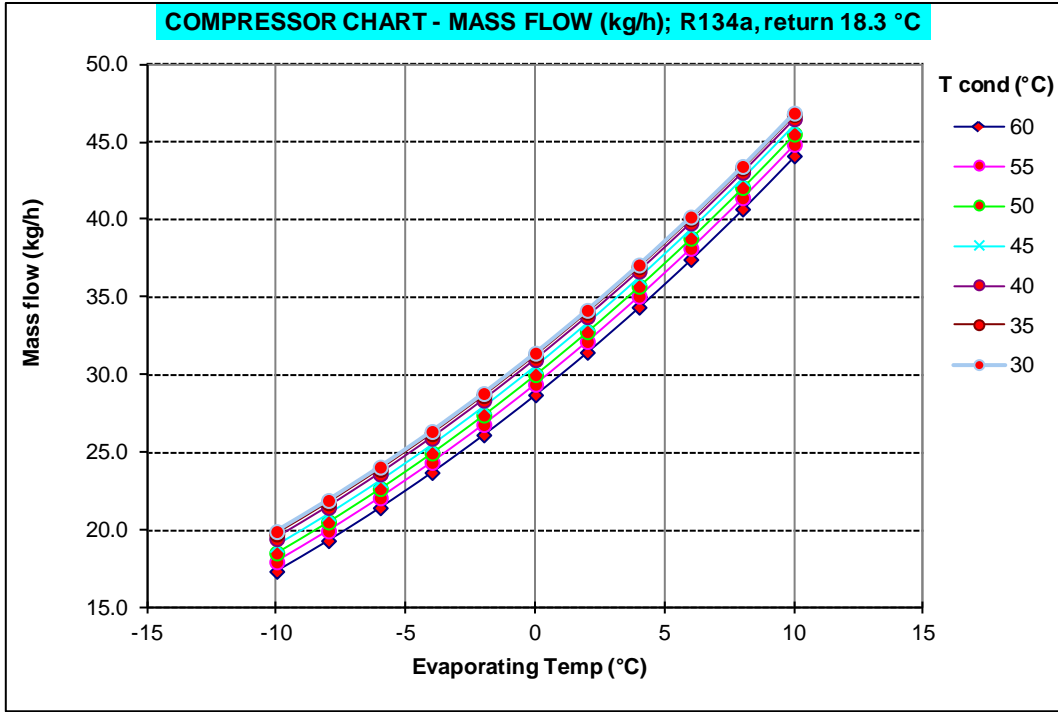


Figure 3-2, Mass flow of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

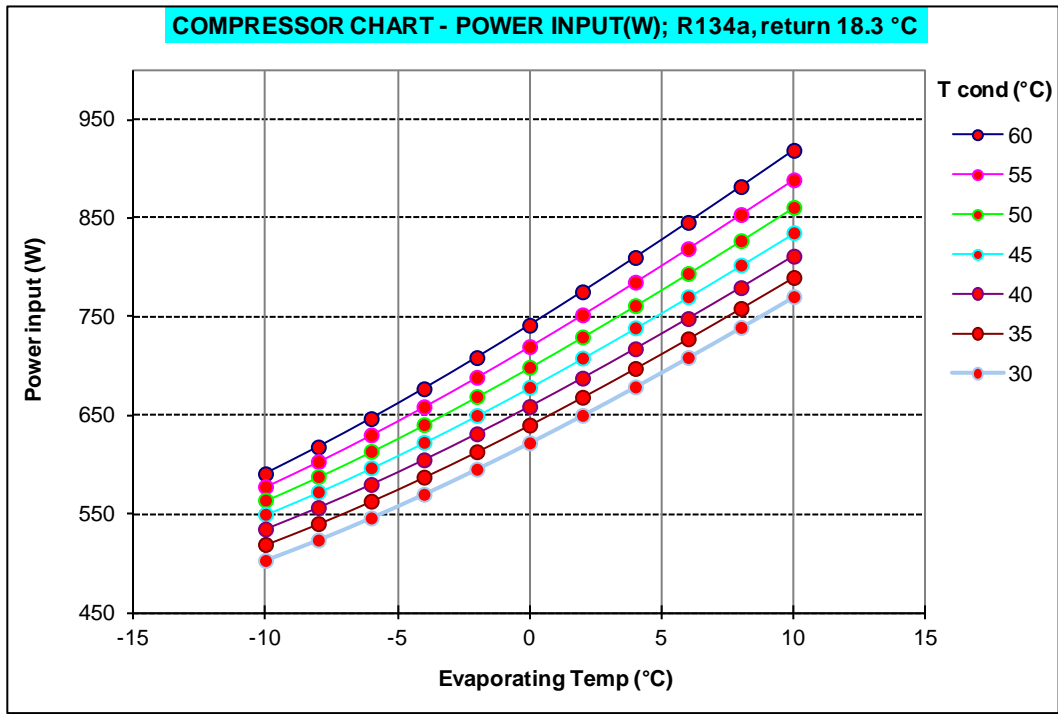


Figure 3-3, Power input of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

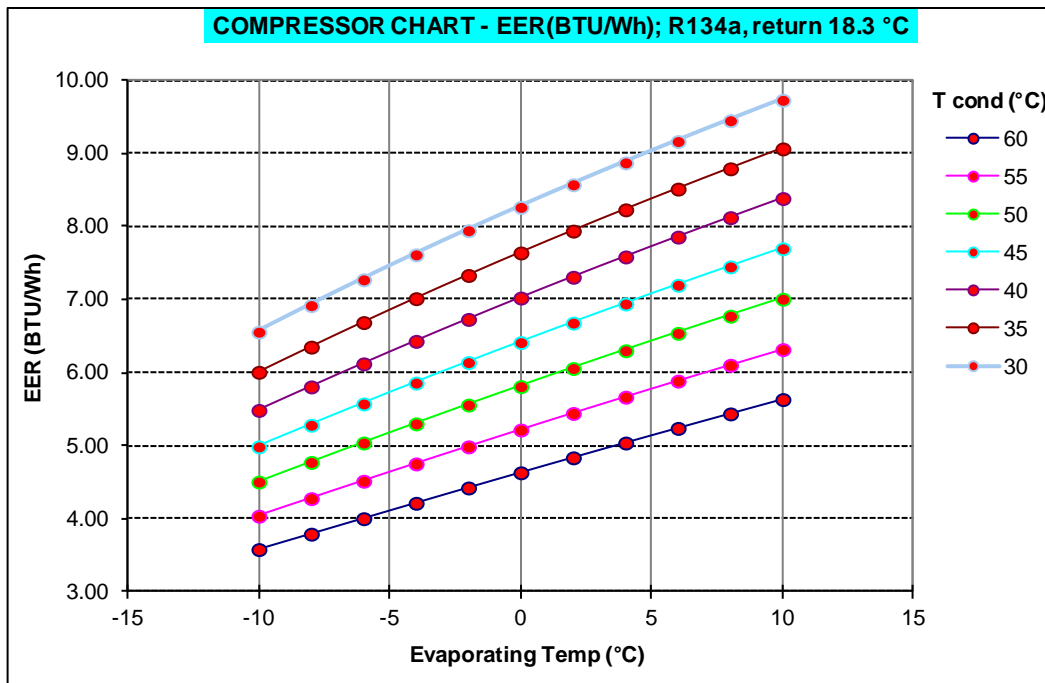


Figure 3-4, EER of NEK6214Z, refrigerant R134a, return gas temperature 18.3 °C

3.1.2. Measurement with new refrigerant R1234yf

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (BTU/h)	Power input (W)	Current (A)	EER (BTU/Wh)	Mass flow (kg/h)
R1234yf	30	-10	18.3	28.3	3442.2	531.1	6.64	6.48	25.66
R1234yf	30	-5	18.3	23.3	4230.9	589.7	6.97	7.18	31.71
R1234yf	30	0	18.3	18.3	5164.6	656.6	7.37	7.87	38.97
R1234yf	30	5	18.3	13.3	5968.3	716.2	7.76	8.33	45.40
R1234yf	30	10	18.3	8.3	6835.1	784.2	8.22	8.72	54.49
R1234yf	45	-10	18.3	28.3	2799.6	570.3	6.81	4.91	24.63
R1234yf	45	-5	18.3	23.3	3476.2	632.2	7.19	5.50	30.81
R1234yf	45	0	18.3	18.3	4255.8	698.8	7.61	6.09	38.05
R1234yf	45	5	18.3	13.3	5113.6	771.8	8.13	6.63	46.11
R1234yf	45	10	18.3	8.3	5881.7	847.6	8.70	6.94	53.73
R1234yf	60	-10	18.3	28.3	2095.5	613.0	7.14	3.42	22.91
R1234yf	60	-5	18.3	23.3	2627.9	678.2	7.50	3.87	28.93
R1234yf	60	0	18.3	18.3	3247.6	752.7	7.99	4.31	36.44
R1234yf	60	5	18.3	13.3	3921.1	830.7	8.56	4.72	44.22
R1234yf	60	10	18.3	8.3	4663.9	912.9	9.19	5.11	53.38

Table 3-3a, Measured data of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

AVERAGE	T cond	T evap	T return gas	T Superheat	Cool. Capacity	Power input	Current	EER	Mass flow
REFRIGERANT	(°C)	(°C)	(°C)	(°C)	%	%	%	%	%
R1234yf	30	-10	18.3	28.3	0.8	0.5	5.0	0.3	0.9
R1234yf	30	-5	18.3	23.3	0.9	0.5	4.9	0.4	1.0
R1234yf	30	0	18.3	18.3	0.6	0.6	4.2	0.0	0.6
R1234yf	30	5	18.3	13.3	1.2	1.1	4.3	0.2	1.2
R1234yf	30	10	18.3	8.3	0.4	1.3	3.7	0.8	1.9
R1234yf	30	-10	18.3	28.3	0.2	0.6	5.0	0.8	0.4
R1234yf	45	-5	18.3	23.3	0.1	0.0	3.7	0.0	0.1
R1234yf	45	0	18.3	18.3	0.3	0.4	3.9	0.1	0.3
R1234yf	45	5	18.3	13.3	0.0	0.3	3.4	0.3	0.2
R1234yf	45	10	18.3	8.3	3.4	0.1	2.7	3.6	3.4
R1234yf	60	-10	18.3	28.3	0.6	0.0	3.3	0.6	0.7
R1234yf	60	-5	18.3	23.3	0.4	0.2	3.8	0.1	0.5
R1234yf	60	0	18.3	18.3	0.5	0.4	3.8	0.1	1.2
R1234yf	60	5	18.3	13.3	0.2	0.3	3.0	0.1	0.3
R1234yf	60	10	18.3	8.3	0.3	0.1	2.6	0.4	0.2

Table 3-3b, Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg/h, °C)	Power input (W, °C)
C1	6.136E+03	3.877E+01	5.024E+02
C2	1.659E+02	1.379E+00	9.733E+00
C3	-1.517E+01	-5.456E-03	7.952E+00
C4	-1.196E+00	9.189E-03	-3.222E-02
C5	1.204E+00	9.342E-04	9.331E-02
C6	-6.868E-01	5.681E-04	-1.094E-01
C7	-6.502E-02	-3.556E-05	-1.533E-03
C8	4.270E-02	1.238E-04	2.477E-03
C9	-2.889E-02	2.577E-05	-1.509E-04
C10	2.267E-03	-1.918E-05	8.888E-04

Table 3-4, Coefficients C1 – C10 for NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

CURVE-FITTED CHARTS

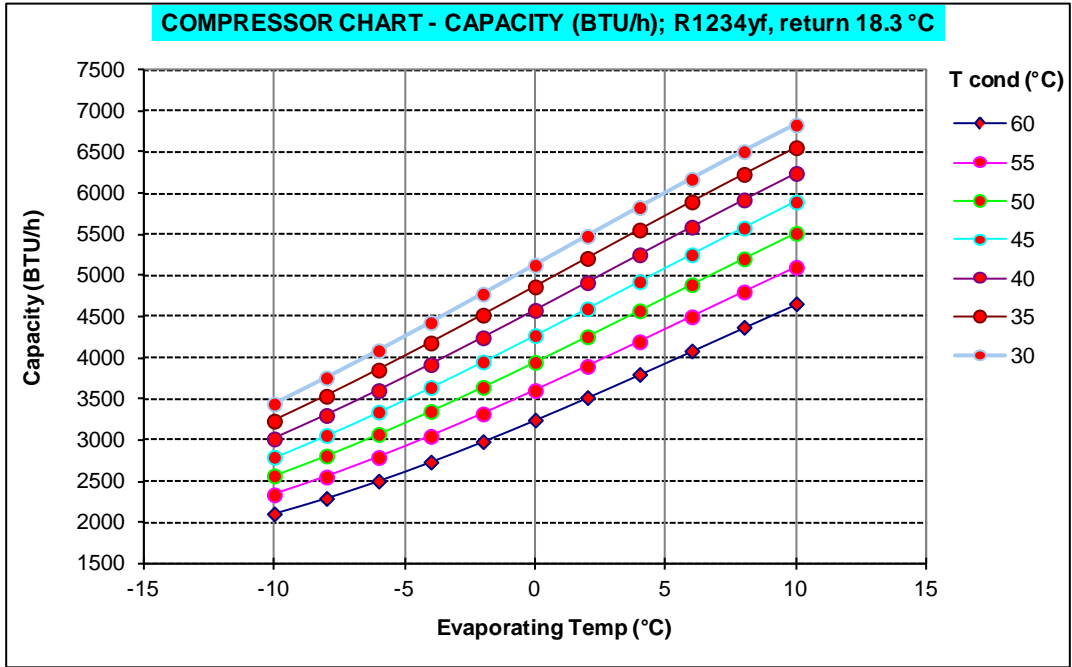


Figure 3-5, Cooling capacity of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

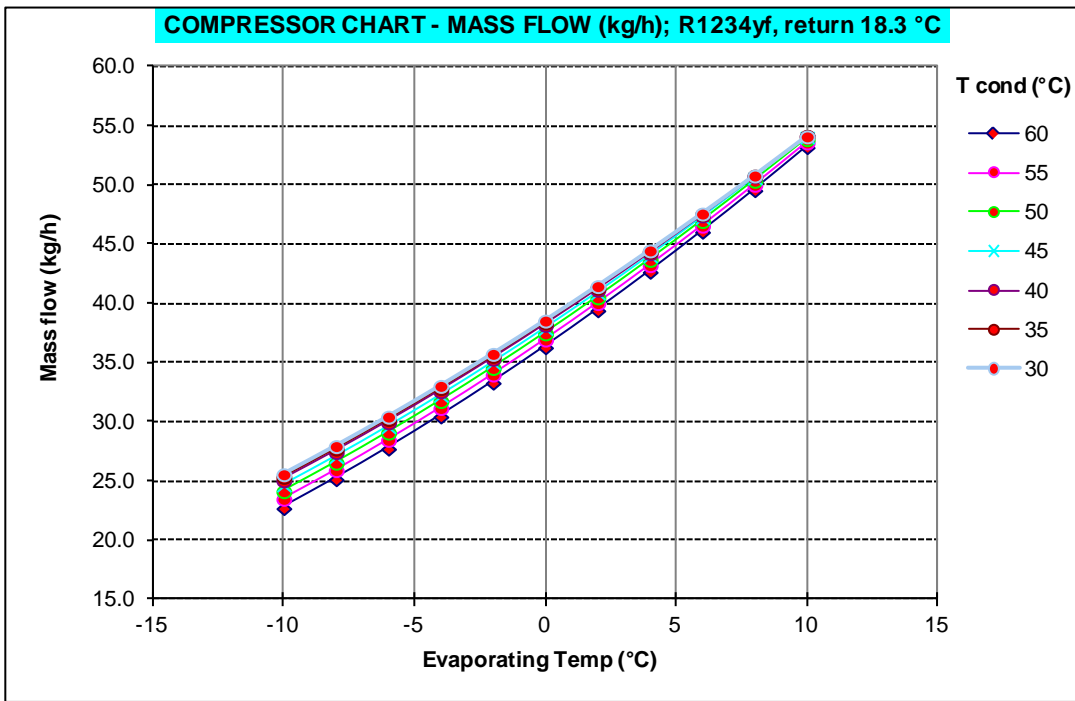


Figure 3-6, Mass flow of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

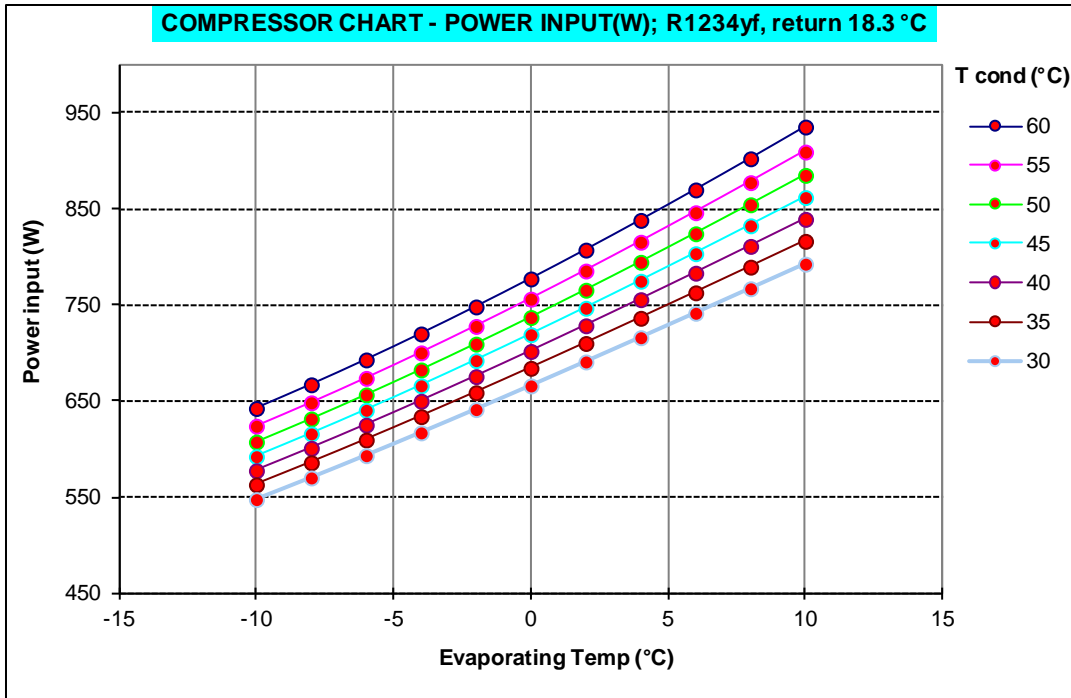


Figure 3-7, Power input of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

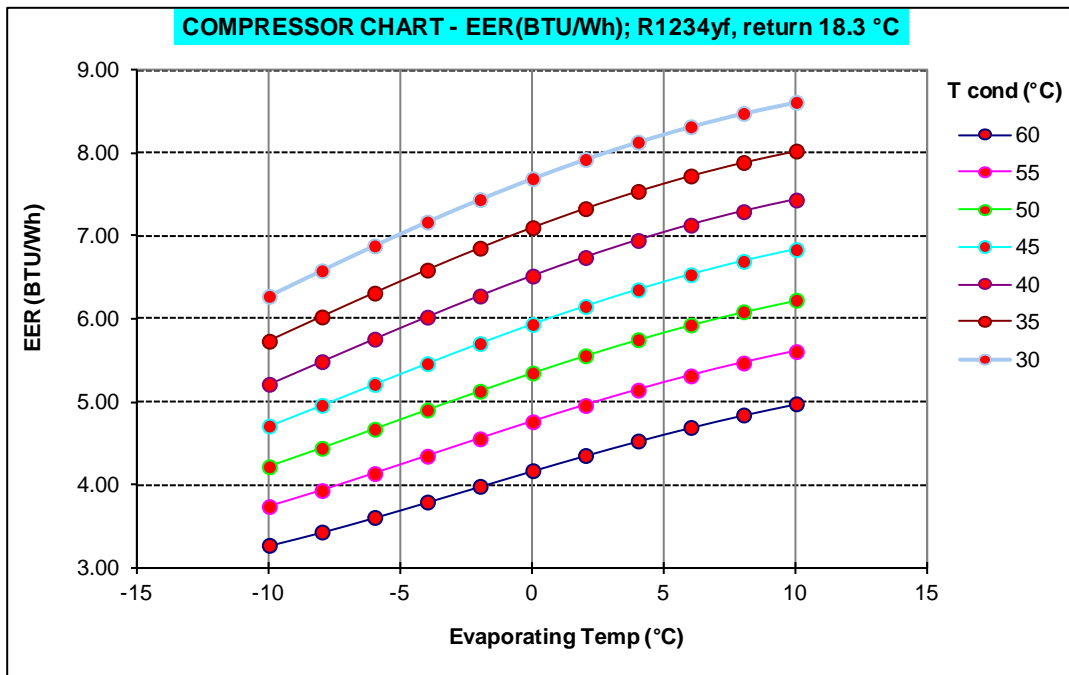


Figure 3-8, EER of NEK6214Z, refrigerant R1234yf, return gas temperature 18.3 °C

3.1.3. Comparison of the results

Capacity (BTU/h) R1234yf								Mass Flow (kg/h) R1234yf							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	2103	2334	2564	2791	3013	3230	3438	-10	22.77	23.55	24.19	24.71	25.11	25.41	25.63
-8	2291	2551	2806	3056	3299	3532	3755	-8	25.21	25.97	26.60	27.11	27.50	27.79	28.00
-6	2501	2788	3068	3340	3601	3850	4085	-6	27.79	28.53	29.14	29.63	30.01	30.29	30.49
-4	2732	3045	3348	3639	3916	4179	4426	-4	30.50	31.22	31.81	32.27	32.63	32.90	33.09
-2	2981	3317	3640	3949	4242	4517	4773	-2	33.36	34.05	34.60	35.04	35.38	35.62	35.79
0	3243	3601	3944	4269	4575	4861	5124	0	36.35	37.00	37.52	37.93	38.23	38.45	38.60
2	3516	3895	4255	4595	4913	5207	5476	2	39.47	40.08	40.56	40.93	41.21	41.39	41.51
4	3797	4194	4570	4923	5251	5552	5825	4	42.72	43.28	43.72	44.05	44.29	44.44	44.53
6	4083	4497	4887	5251	5587	5893	6169	6	46.10	46.61	47.01	47.29	47.48	47.59	47.64
8	4370	4799	5201	5575	5917	6228	6504	8	49.61	50.07	50.41	50.64	50.78	50.85	50.85
10	4656	5099	5511	5892	6240	6552	6827	10	53.25	53.64	53.92	54.10	54.19	54.20	54.16

Capacity (BTU/h) R134a								Mass Flow (kg/h) R134a							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	2119	2336	2544	2743	2935	3119	3297	-10	17.33	17.95	18.52	19.03	19.44	19.74	19.90
-8	2347	2583	2809	3026	3233	3432	3623	-8	19.31	19.94	20.52	21.03	21.45	21.75	21.90
-6	2593	2850	3094	3328	3552	3766	3971	-6	21.43	22.07	22.66	23.18	23.60	23.90	24.05
-4	2857	3134	3399	3651	3891	4121	4340	-4	23.70	24.35	24.96	25.48	25.91	26.20	26.34
-2	3139	3437	3722	3992	4250	4496	4730	-2	26.12	26.79	27.40	27.93	28.36	28.65	28.79
0	3438	3758	4063	4353	4629	4891	5141	0	28.70	29.38	30.00	30.54	30.97	31.26	31.38
2	3754	4096	4422	4732	5027	5306	5572	2	31.44	32.13	32.76	33.31	33.73	34.02	34.14
4	4086	4452	4800	5130	5444	5741	6023	4	34.34	35.05	35.69	36.24	36.66	36.95	37.06
6	4435	4824	5194	5546	5879	6195	6494	6	37.41	38.13	38.78	39.33	39.76	40.04	40.15
8	4800	5213	5606	5979	6332	6667	6984	8	40.66	41.39	42.05	42.60	43.03	43.31	43.41
10	5180	5618	6034	6429	6804	7158	7493	10	44.08	44.83	45.49	46.05	46.47	46.75	46.90

Capacity: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-0.8	-0.1	0.8	1.7	2.7	3.5	4.3
-8	-2.4	-1.3	-0.1	1.0	2.0	2.9	3.6
-6	-3.5	-2.1	-0.8	0.3	1.4	2.2	2.9
-4	-4.4	-2.9	-1.5	-0.3	0.7	1.4	2.0
-2	-5.0	-3.5	-2.2	-1.1	-0.2	0.5	0.9
0	-5.7	-4.2	-2.9	-1.9	-1.2	-0.6	-0.3
2	-6.3	-4.9	-3.8	-2.9	-2.3	-1.9	-1.7
4	-7.1	-5.8	-4.8	-4.0	-3.5	-3.3	-3.3
6	-7.9	-6.8	-5.9	-5.3	-5.0	-4.9	-5.0
8	-9.0	-7.9	-7.2	-6.8	-6.6	-6.6	-6.9
10	-10.1	-9.3	-8.7	-8.4	-8.3	-8.5	-8.9

Mass flow: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	31.3	31.2	30.6	29.9	29.2	28.7	28.8
-8	30.5	30.3	29.7	28.9	28.2	27.8	27.9
-6	29.7	29.3	28.6	27.8	27.1	26.7	26.8
-4	28.7	28.2	27.5	26.7	26.0	25.6	25.6
-2	27.7	27.1	26.3	25.4	24.7	24.3	24.3
0	26.7	25.9	25.1	24.2	23.5	23.0	23.0
2	25.5	24.7	23.8	22.9	22.2	21.7	21.6
4	24.4	23.5	22.5	21.6	20.8	20.3	20.1
6	23.2	22.2	21.2	20.2	19.4	18.9	18.7
8	22.0	21.0	19.9	18.9	18.0	17.4	17.1
10	20.8	19.7	18.5	17.5	16.6	15.9	15.5

Power Input (W) R1234yf

°C	60	55	50	45	40	35	30
-10	643	625	608	593	578	564	548
-8	668	649	632	617	602	587	571
-6	694	674	657	641	626	610	594
-4	721	701	683	667	651	635	618
-2	749	728	710	693	676	659	642
0	778	757	738	720	702	685	666
2	808	786	766	747	729	711	691
4	839	816	795	775	756	737	717
6	870	847	825	804	784	763	742
8	903	878	855	833	812	790	768
10	936	910	885	862	840	817	793

EER (BTU/Wh) R1234yf

°C	60	55	50	45	40	35	30
-10	3.27	3.74	4.22	4.71	5.21	5.73	6.27
-8	3.43	3.93	4.44	4.96	5.48	6.02	6.58
-6	3.61	4.13	4.67	5.21	5.75	6.31	6.88
-4	3.79	4.34	4.90	5.46	6.02	6.59	7.16
-2	3.98	4.55	5.13	5.70	6.27	6.85	7.44
0	4.17	4.76	5.35	5.93	6.51	7.10	7.69
2	4.35	4.96	5.55	6.15	6.74	7.33	7.92
4	4.53	5.14	5.75	6.35	6.94	7.53	8.13
6	4.69	5.31	5.93	6.53	7.13	7.72	8.31
8	4.84	5.47	6.08	6.69	7.29	7.88	8.47
10	4.98	5.60	6.22	6.83	7.43	8.02	8.61

Power Input (W) R134a

°C	60	55	50	45	40	35	30
-10	590	577	563	549	534	519	502
-8	617	603	587	572	556	540	523
-6	646	630	613	596	579	562	545
-4	676	658	640	622	604	587	569
-2	708	688	668	649	631	613	595
0	741	719	698	678	658	640	622
2	775	751	729	708	687	668	649
4	809	784	761	738	717	697	678
6	845	818	793	770	748	727	708
8	881	853	826	802	779	758	739
10	918	888	860	834	811	789	770

EER (BTU/Wh) R134a

°C	60	55	50	45	40	35	30
-10	3.59	4.05	4.51	5.00	5.49	6.02	6.56
-8	3.80	4.29	4.78	5.29	5.82	6.36	6.93
-6	4.01	4.53	5.05	5.58	6.13	6.70	7.28
-4	4.22	4.76	5.31	5.87	6.44	7.02	7.62
-2	4.43	5.00	5.57	6.15	6.74	7.34	7.95
0	4.64	5.23	5.82	6.42	7.03	7.65	8.27
2	4.85	5.45	6.07	6.69	7.32	7.95	8.58
4	5.05	5.68	6.31	6.95	7.59	8.24	8.88
6	5.25	5.90	6.55	7.21	7.86	8.52	9.17
8	5.45	6.11	6.78	7.46	8.13	8.80	9.46
10	5.64	6.33	7.01	7.70	8.39	9.07	9.74

Power input: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	9.0	8.2	7.9	8.0	8.3	8.7	9.2
-8	8.2	7.7	7.6	7.8	8.2	8.7	9.1
-6	7.3	7.1	7.2	7.5	8.0	8.5	8.9
-4	6.5	6.5	6.7	7.2	7.7	8.1	8.5
-2	5.7	5.9	6.2	6.7	7.2	7.7	7.9
0	5.0	5.2	5.7	6.2	6.7	7.1	7.2
2	4.3	4.6	5.1	5.6	6.1	6.4	6.5
4	3.6	4.0	4.5	5.0	5.5	5.7	5.7
6	3.0	3.5	4.0	4.5	4.8	5.0	4.8
8	2.4	2.9	3.4	3.9	4.2	4.3	3.9
10	1.9	2.4	2.9	3.3	3.6	3.5	3.0

EER: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-8.9	-7.7	-6.6	-5.8	-5.2	-4.8	-4.5
-8	-9.8	-8.3	-7.2	-6.3	-5.7	-5.3	-5.0
-6	-10.1	-8.6	-7.5	-6.7	-6.1	-5.8	-5.5
-4	-10.2	-8.8	-7.7	-7.0	-6.5	-6.2	-6.0
-2	-10.2	-8.9	-7.9	-7.3	-6.9	-6.7	-6.5
0	-10.2	-8.9	-8.1	-7.6	-7.3	-7.2	-7.1
2	-10.2	-9.1	-8.5	-8.1	-7.9	-7.8	-7.7
4	-10.3	-9.4	-8.9	-8.7	-8.6	-8.5	-8.5
6	-10.6	-9.9	-9.5	-9.4	-9.4	-9.4	-9.4
8	-11.1	-10.6	-10.3	-10.3	-10.3	-10.4	-10.4
10	-11.8	-11.4	-11.3	-11.3	-11.5	-11.6	-11.6

Table 3-5, Comparison of the results, return gas temperature 18.3 °C

3.2. Superheating 11.1 °C

3.2.1. Reference measurement with R134a

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (BTU/h)	Power input (W)	Current (A)	EER (BTU/Wh)	Mass flow (kg/h)
R134a	30	-10	1.1	11.1	3097.6	505.0	6.46	6.13	20.44
R134a	30	-5	6.1	11.1	3988.5	559.6	6.73	7.13	25.82
R134a	30	0	11.1	11.1	5025.4	622.0	7.09	8.08	31.87
R134a	30	5	16.1	11.1	6178.8	695.2	7.58	8.89	38.51
R134a	30	10	21.1	11.1	7503.5	768.2	8.06	9.77	46.50
R134a	45	-10	1.1	11.1	2534.3	549.3	6.68	4.61	19.49
R134a	45	-5	6.1	11.1	3306.4	612.5	7.05	5.40	24.82
R134a	45	0	11.1	11.1	4217.9	679.7	7.47	6.21	30.94
R134a	45	5	16.1	11.1	5294.8	753.0	7.97	7.03	38.01
R134a	45	10	21.1	11.1	6501.8	833.5	8.56	7.80	45.66
R134a	60	-10	1.1	11.1	1927.1	588.8	6.89	3.27	17.89
R134a	60	-5	6.1	11.1	2544.4	662.0	7.33	3.84	22.98
R134a	60	0	11.1	11.1	3306.1	740.9	7.88	4.46	29.06
R134a	60	5	16.1	11.1	4209.6	827.8	8.51	5.09	36.00
R134a	60	10	21.1	11.1	5249.0	918.7	9.21	5.71	43.77

Table 3-6a, Measured data of NEK6214Z, refrigerant R134a, superheating 11.1°C

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (%)	Power input (%)	Current (%)	EER (%)	Mass flow (%)
R134a	30	-10	1.1	11.1	0.5	1.1	6.4	1.6	0.4
R134a	30	-5	6.1	11.1	1.0	0.7	5.9	1.7	0.9
R134a	30	0	11.1	11.1	0.5	0.9	5.2	0.4	0.3
R134a	30	5	16.1	11.1	0.8	1.0	4.5	1.8	0.6
R134a	30	10	21.1	11.1	0.4	1.3	3.8	0.9	1.0
R134a	45	-10	1.1	11.1	0.1	0.9	5.5	0.8	0.2
R134a	45	-5	6.1	11.1	0.5	0.2	4.3	0.7	0.5
R134a	45	0	11.1	11.1	0.1	0.4	4.2	0.6	0.2
R134a	45	5	16.1	11.1	0.3	0.1	3.3	0.2	0.4
R134a	45	10	21.1	11.1	0.4	0.4	3.2	0.0	0.5
R134a	60	-10	1.1	11.1	0.9	0.4	4.8	1.2	0.7
R134a	60	-5	6.1	11.1	1.0	0.4	4.3	1.4	1.1
R134a	60	0	11.1	11.1	0.5	0.3	3.5	0.9	0.3
R134a	60	5	16.1	11.1	0.0	0.2	3.0	0.2	0.0
R134a	60	10	21.1	11.1	0.6	0.3	2.7	0.4	0.7

Table 3-6b, Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R134a, superheating 11.1 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg/h, °C)	Power input (W, °C)
C1	5.720E+03	2.968E+01	5.239E+02
C2	2.309E+02	1.173E+00	1.567E+01
C3	3.637E+00	1.725E-01	3.165E+00
C4	2.854E+00	1.502E-02	1.434E-01
C5	3.476E-01	5.859E-03	-1.701E-01
C6	-1.075E+00	-3.700E-03	2.501E-03
C7	1.666E-03	6.888E-05	-1.444E-03
C8	1.822E-04	3.906E-05	-3.998E-04
C9	-2.381E-02	-6.532E-05	3.102E-03
C10	5.724E-03	1.095E-05	8.749E-05

Table 3-7, Coefficients C1 – C10 for NEK6214Z, refrigerant R134a, superheating 11.1 °C

CURVE-FITTED CHARTS

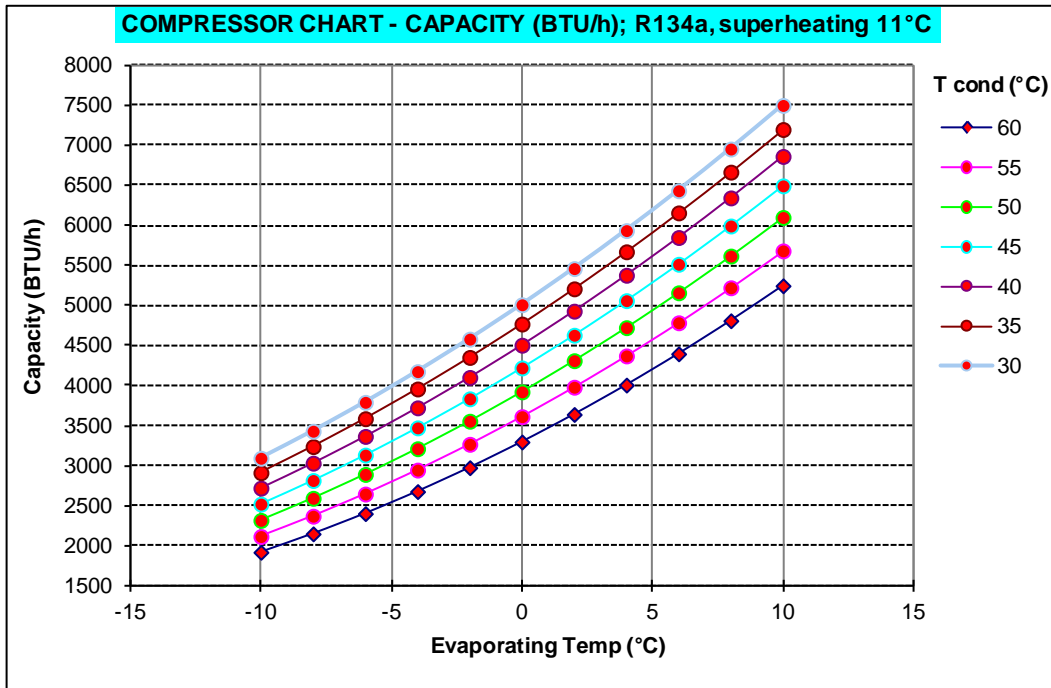


Figure 3-9, Cooling capacity of NEK6214Z, refrigerant R134a, superheating 11.1 °C

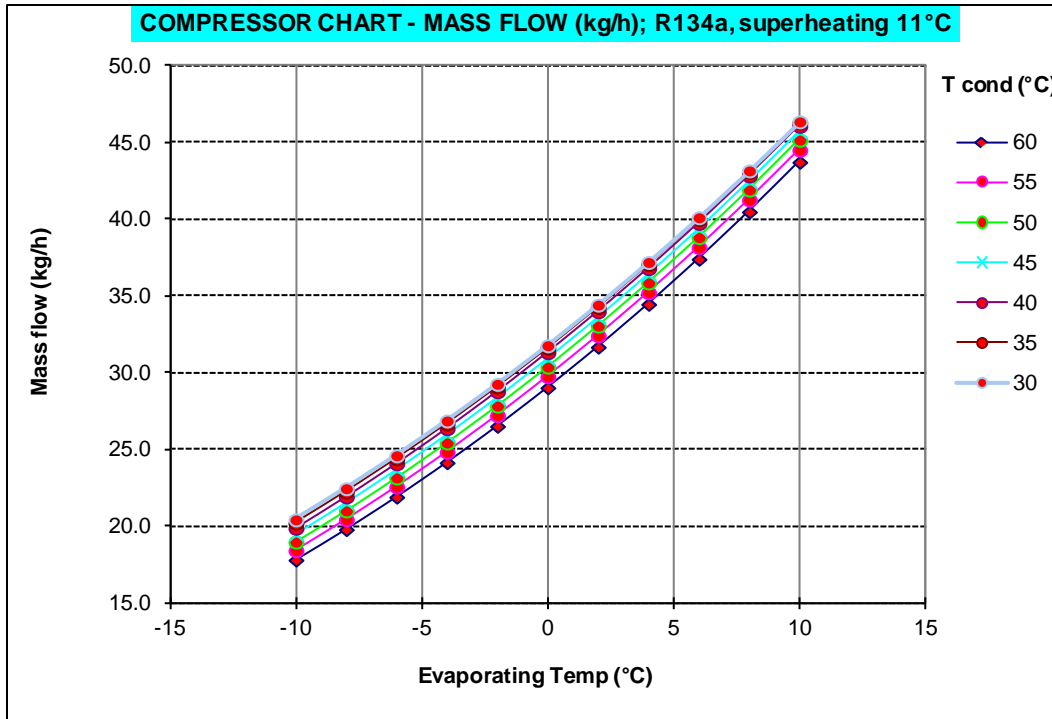


Figure 3-10, Mass flow of NEK6214Z, refrigerant R134a, superheating 11.1 °C

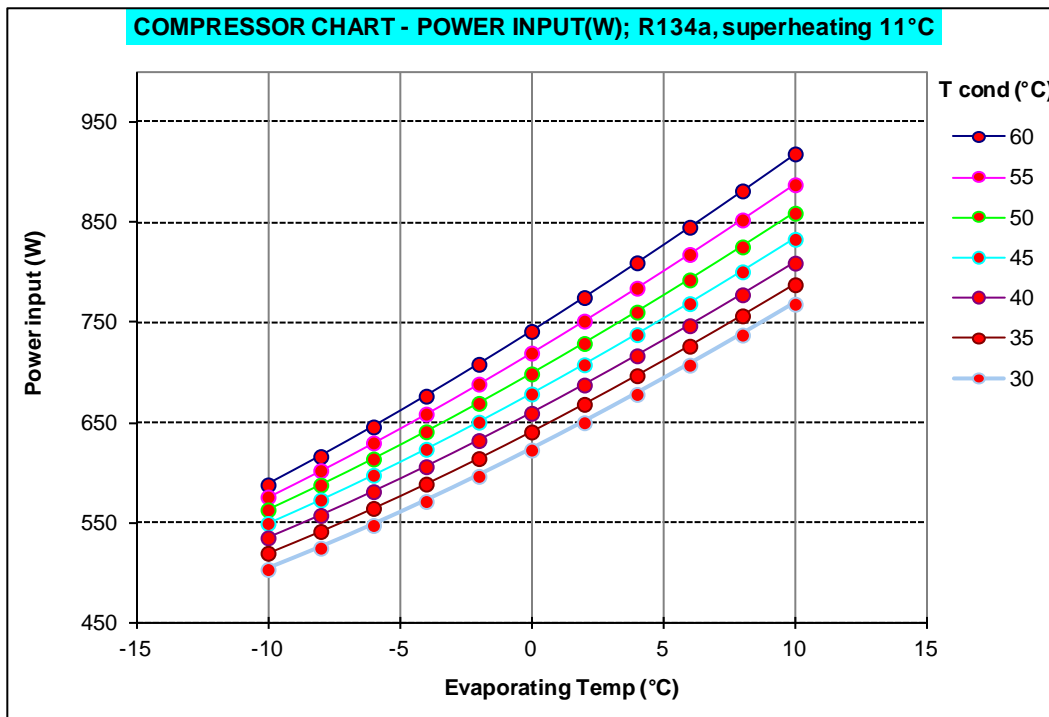


Figure 3-11, Power input of NEK6214Z, refrigerant R134a, superheating 11.1 °C

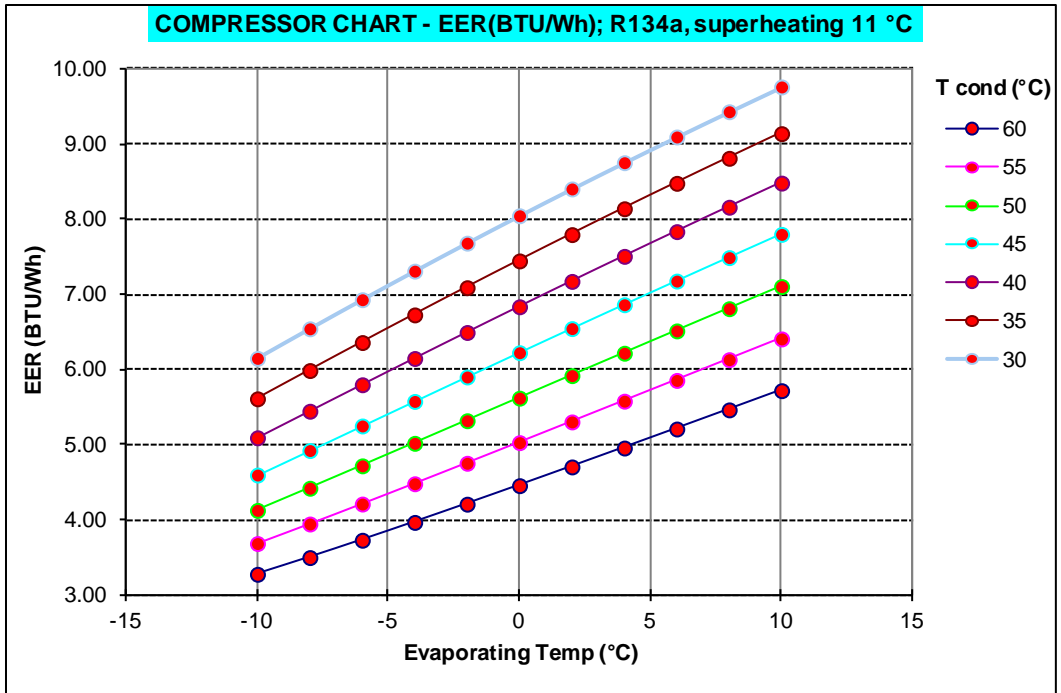


Figure 3-12, EER of NEK6214Z, refrigerant R134a, superheating 11.1 °C

3.2.2. Measurement with new refrigerant R1234yf

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (BTU/h)	Power input (W)	Current (A)	EER (BTU/Wh)	Mass flow (kg/h)
R1234yf	30	-10	1.1	11.1	3151.7	535.4	6.70	5.89	26.38
R1234yf	30	-5	6.1	11.1	3984.4	594.6	7.01	6.70	32.46
R1234yf	30	0	11.1	11.1	4983.3	658.2	7.38	7.57	39.48
R1234yf	30	5	16.1	11.1	5880.1	715.0	7.76	8.22	45.45
R1234yf	30	10	21.1	11.1	6945.3	779.2	8.24	8.91	55.10
R1234yf	45	-10	1.1	11.1	2492.8	571.9	6.85	4.36	25.24
R1234yf	45	-5	6.1	11.1	3218.4	633.1	7.21	5.08	31.49
R1234yf	45	0	11.1	11.1	4063.2	699.6	7.63	5.81	38.55
R1234yf	45	5	16.1	11.1	5031.5	772.2	8.14	6.52	46.26
R1234yf	45	10	21.1	11.1	6033.8	850.9	8.72	7.09	53.89
R1234yf	60	-10	1.1	11.1	1805.0	611.0	7.14	2.95	23.52
R1234yf	60	-5	6.1	11.1	2369.7	677.5	7.51	3.50	29.55
R1234yf	60	0	11.1	11.1	3055.0	753.0	8.01	4.06	36.63
R1234yf	60	5	16.1	11.1	3854.6	829.8	8.56	4.65	44.44
R1234yf	60	10	21.1	11.1	4780.9	914.0	9.20	5.23	53.12

Table 3-8a, Measured data of NEK6214Z, refrigerant R1234yf, superheating 11.1°C

AVERAGE	T cond	T evap	T return gas	T Superheat	Cool. Capacity	Power input	Current	EER	Mass flow
REFRIGERANT	(°C)	(°C)	(°C)	(°C)	%	%	%	%	%
R1234yf	30	-10	1.1	11.1	0.9	0.9	5.9	0.1	0.8
R1234yf	30	-5	6.1	11.1	0.5	0.3	4.9	0.2	0.6
R1234yf	30	0	11.1	11.1	0.1	0.4	4.2	0.3	0.3
R1234yf	30	5	16.1	11.1	0.3	0.6	4.0	0.3	0.2
R1234yf	30	10	21.1	11.1	0.4	1.0	3.5	0.6	0.7
R1234yf	45	-10	1.1	11.1	0.9	0.3	4.4	1.2	0.7
R1234yf	45	-5	6.1	11.1	0.1	0.2	4.2	0.1	0.0
R1234yf	45	0	11.1	11.1	0.5	0.3	3.7	0.1	0.5
R1234yf	45	5	16.1	11.1	0.3	0.1	3.0	0.4	0.3
R1234yf	45	10	21.1	11.1	2.5	0.4	2.9	2.9	2.4
R1234yf	60	-10	1.1	11.1	0.1	0.4	3.0	0.4	0.3
R1234yf	60	-5	6.1	11.1	0.4	0.2	3.9	0.6	0.5
R1234yf	60	0	11.1	11.1	0.0	0.2	3.3	0.1	0.1
R1234yf	60	5	16.1	11.1	0.6	0.3	3.1	0.3	0.5
R1234yf	60	10	21.1	11.1	0.0	0.2	2.6	0.1	0.0

Table 3-8b, Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R1234yf, superheating 11.1 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg/h, °C)	Power input (W, °C)
C1	5.930E+03	4.302E+01	6.166E+02
C2	1.624E+02	1.334E+00	6.881E+00
C3	-1.415E+01	-2.825E-01	-7.345E-01
C4	-2.462E-01	1.505E-02	-6.641E-02
C5	2.118E+00	9.210E-04	2.118E-01
C6	-7.063E-01	7.005E-03	8.476E-02
C7	-1.709E-02	3.711E-04	4.889E-04
C8	4.520E-02	-5.752E-06	3.190E-03
C9	-3.869E-02	1.688E-05	-1.240E-03
C10	2.370E-03	-6.747E-05	-5.874E-04

Table 3-9, Coefficients C1 – C10 for NEK6214Z, refrigerant 1234yf, superheating 11.1°C

CURVE-FITTED CHARTS

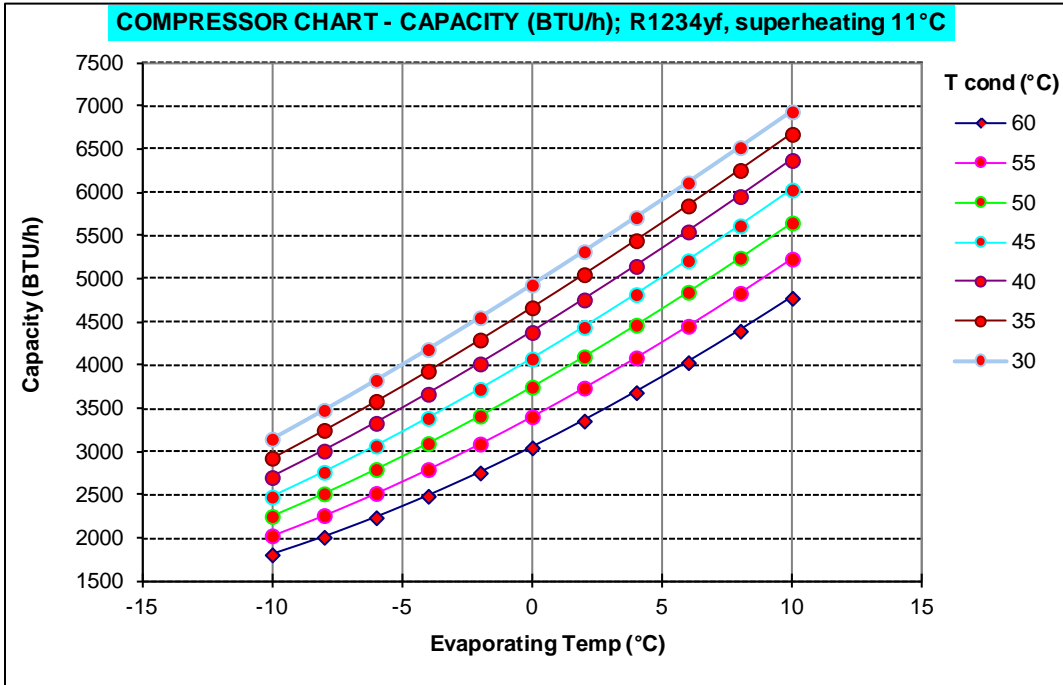


Figure 3-13, Cooling capacity of NEK6214Z, refrigerant R1234yf, superheating 11.1 °C

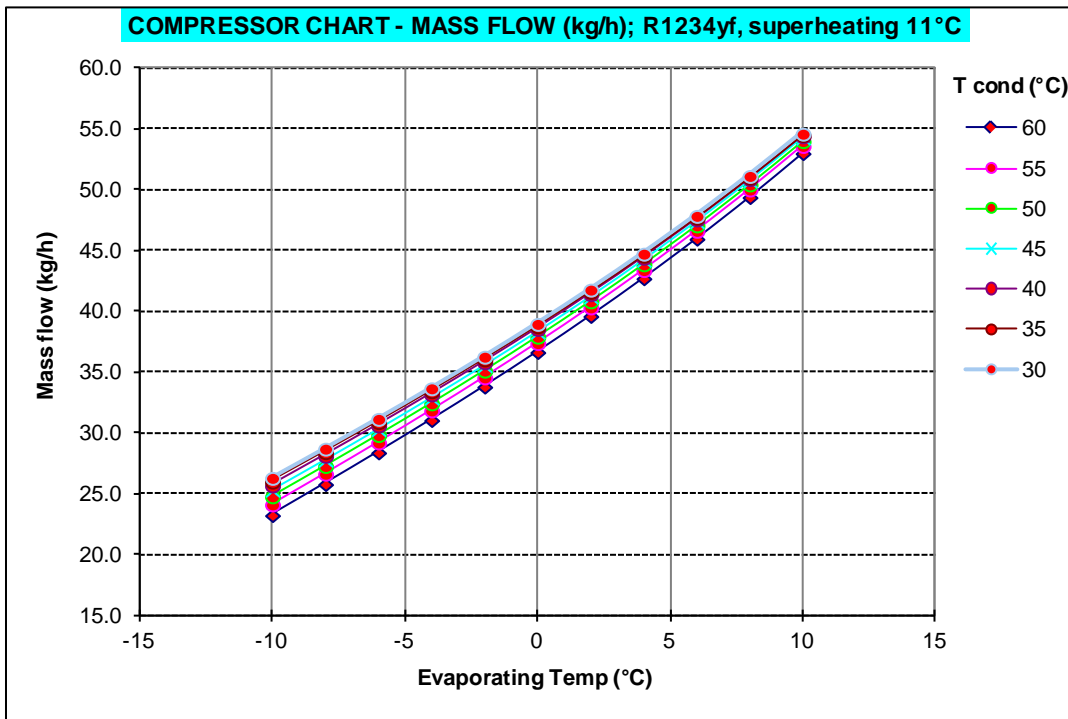


Figure 3-14, Mass flow of NEK6214Z, refrigerant R1234yf, superheating 11.1 °C

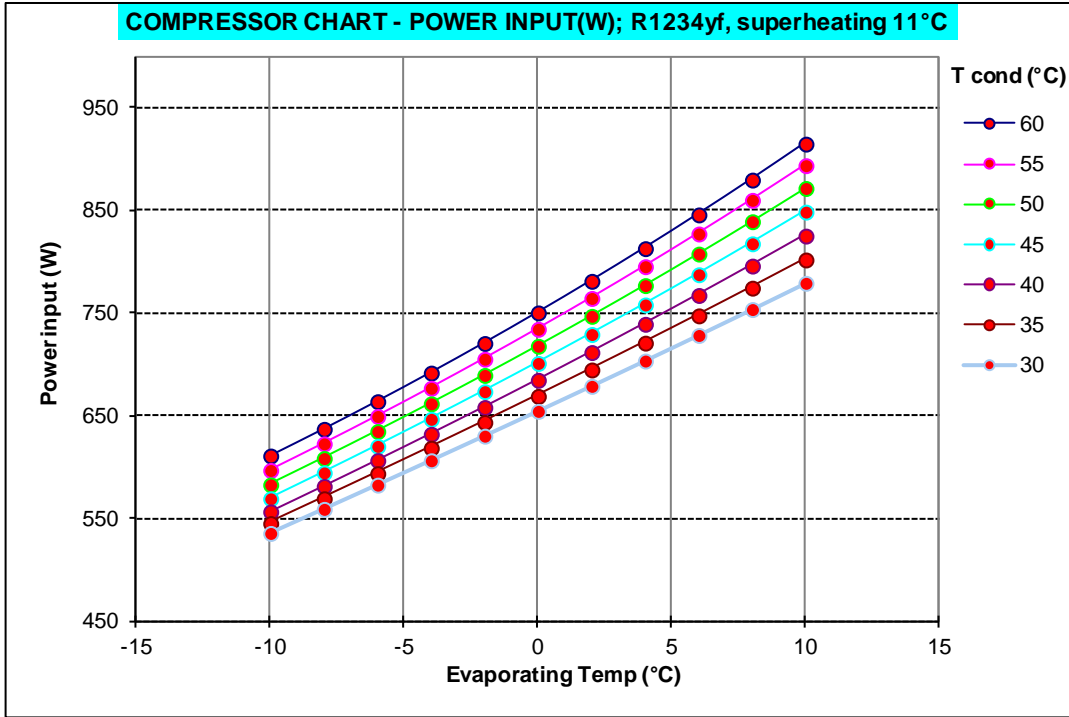


Figure 3-15, Power input of NEK6214Z, refrigerant R1234yf, superheating 11.1 °C

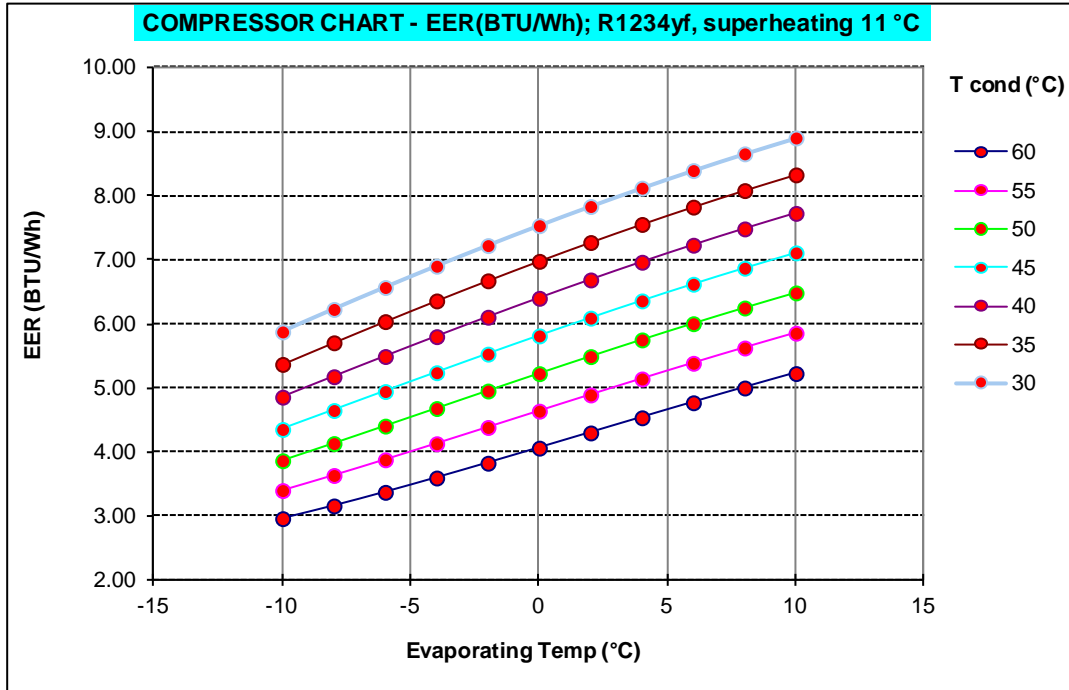


Figure 3-16, EER of NEK6214Z, refrigerant R1234yf, superheating 11.1 °C

3.2.3. Comparison of the results

Capacity (BTU/h) R1234yf								Mass Flow (kg/h) R1234yf							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	1812	2032	2255	2481	2706	2930	3150	-10	23.31	24.19	24.86	25.36	25.74	26.07	26.38
-8	2015	2266	2518	2767	3012	3252	3484	-8	25.87	26.71	27.35	27.82	28.19	28.49	28.78
-6	2241	2522	2799	3070	3334	3588	3830	-6	28.46	29.28	29.89	30.34	30.68	30.95	31.22
-4	2490	2799	3100	3391	3670	3937	4188	-4	31.13	31.92	32.50	32.92	33.23	33.49	33.74
-2	2759	3094	3418	3727	4021	4298	4556	-2	33.87	34.63	35.19	35.58	35.87	36.11	36.33
0	3050	3409	3753	4079	4385	4671	4933	0	36.72	37.45	37.98	38.35	38.61	38.82	39.03
2	3360	3742	4104	4444	4762	5054	5320	2	39.68	40.38	40.88	41.23	41.47	41.66	41.85
4	3689	4091	4470	4823	5150	5448	5715	4	42.78	43.45	43.93	44.25	44.47	44.63	44.80
6	4036	4457	4851	5215	5549	5850	6116	6	46.03	46.68	47.12	47.42	47.61	47.76	47.91
8	4400	4838	5245	5619	5958	6261	6525	8	49.45	50.07	50.49	50.76	50.94	51.06	51.19
10	4781	5234	5653	6034	6376	6679	6938	10	53.06	53.65	54.05	54.30	54.45	54.55	54.66

Capacity (BTU/h) R134a								Mass Flow (kg/h) R134a							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	1928	2125	2326	2529	2729	2921	3101	-10	17.84	18.46	19.02	19.51	19.92	20.24	20.47
-8	2158	2378	2602	2824	3040	3246	3439	-8	19.83	20.47	21.05	21.55	21.96	22.28	22.50
-6	2411	2655	2900	3141	3374	3595	3799	-6	21.94	22.61	23.20	23.71	24.12	24.44	24.64
-4	2686	2954	3220	3480	3730	3966	4182	-4	24.19	24.87	25.48	25.99	26.41	26.72	26.91
-2	2983	3275	3563	3843	4109	4359	4587	-2	26.56	27.27	27.88	28.40	28.82	29.12	29.30
0	3304	3620	3929	4228	4511	4775	5016	0	29.07	29.79	30.42	30.94	31.36	31.65	31.82
2	3648	3987	4318	4636	4936	5215	5467	2	31.72	32.46	33.10	33.62	34.03	34.31	34.46
4	4014	4378	4730	5067	5384	5677	5941	4	34.51	35.26	35.91	36.44	36.84	37.11	37.24
6	4404	4791	5165	5521	5855	6162	6438	6	37.45	38.21	38.86	39.39	39.79	40.05	40.16
8	4817	5228	5623	5999	6349	6671	6959	8	40.54	41.31	41.97	42.49	42.88	43.12	43.21
10	5253	5688	6105	6499	6866	7202	7502	10	43.77	44.56	45.22	45.74	46.12	46.34	46.41

Capacity: R1234yf change relative to R134a (%)								Mass flow: R1234yf change relative to R134a (%)							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	-6.1	-4.4	-3.1	-1.9	-0.8	0.3	1.6	-10	30.7	31.0	30.7	30.0	29.3	28.8	28.9
-8	-6.6	-4.7	-3.2	-2.0	-0.9	0.2	1.3	-8	30.4	30.5	29.9	29.1	28.4	27.9	27.9
-6	-7.0	-5.0	-3.5	-2.2	-1.2	-0.2	0.8	-6	29.7	29.5	28.9	28.0	27.2	26.7	26.7
-4	-7.3	-5.3	-3.7	-2.6	-1.6	-0.7	0.1	-4	28.7	28.3	27.6	26.7	25.9	25.3	25.4
-2	-7.5	-5.5	-4.1	-3.0	-2.1	-1.4	-0.7	-2	27.5	27.0	26.2	25.3	24.5	24.0	24.0
0	-7.7	-5.8	-4.5	-3.5	-2.8	-2.2	-1.6	0	26.3	25.7	24.8	23.9	23.1	22.7	22.7
2	-7.9	-6.2	-5.0	-4.1	-3.5	-3.1	-2.7	2	25.1	24.4	23.5	22.6	21.9	21.4	21.4
4	-8.1	-6.5	-5.5	-4.8	-4.3	-4.0	-3.8	4	23.9	23.2	22.3	21.4	20.7	20.3	20.3
6	-8.4	-7.0	-6.1	-5.5	-5.2	-5.1	-5.0	6	22.9	22.1	21.2	20.4	19.7	19.3	19.3
8	-8.6	-7.5	-6.7	-6.3	-6.2	-6.1	-6.2	8	22.0	21.2	20.3	19.5	18.8	18.4	18.5
10	-9.0	-8.0	-7.4	-7.2	-7.1	-7.3	-7.5	10	21.2	20.4	19.5	18.7	18.1	17.7	17.8

Power Input (W) R1234yf								EER (BTU/Wh) R1234yf							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	612	598	583	570	557	546	536	-10	2.96	3.40	3.87	4.35	4.86	5.37	5.87
-8	638	623	609	595	582	570	560	-8	3.16	3.64	4.13	4.65	5.18	5.71	6.23
-6	664	650	635	621	607	594	583	-6	3.37	3.88	4.41	4.94	5.49	6.04	6.57
-4	692	677	662	647	633	619	607	-4	3.60	4.13	4.68	5.24	5.80	6.36	6.90
-2	721	706	690	674	659	644	631	-2	3.83	4.38	4.95	5.53	6.10	6.67	7.22
0	751	735	718	702	685	670	655	0	4.06	4.64	5.22	5.81	6.40	6.98	7.53
2	782	765	747	730	712	695	679	2	4.30	4.89	5.49	6.09	6.69	7.27	7.83
4	813	796	777	759	740	721	704	4	4.54	5.14	5.75	6.36	6.96	7.55	8.12
6	846	828	808	788	768	748	729	6	4.77	5.39	6.00	6.62	7.23	7.82	8.39
8	880	860	840	818	796	775	754	8	5.00	5.62	6.25	6.87	7.48	8.08	8.65
10	915	894	872	849	826	802	780	10	5.23	5.85	6.48	7.11	7.72	8.32	8.90

Power Input (W) R134a								EER (BTU/Wh) R134a							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	589	577	564	550	536	521	504	-10	3.28	3.68	4.13	4.60	5.09	5.61	6.15
-8	617	603	589	574	558	542	526	-8	3.50	3.94	4.42	4.92	5.45	5.99	6.54
-6	646	631	615	598	582	565	548	-6	3.73	4.21	4.72	5.25	5.80	6.36	6.93
-4	677	659	642	624	607	590	572	-4	3.97	4.48	5.02	5.58	6.15	6.73	7.31
-2	709	689	670	651	633	615	597	-2	4.21	4.75	5.32	5.90	6.49	7.09	7.68
0	742	720	699	679	660	641	623	0	4.45	5.03	5.62	6.22	6.83	7.44	8.05
2	775	752	730	708	688	669	651	2	4.70	5.30	5.92	6.54	7.17	7.79	8.40
4	810	785	761	738	717	698	679	4	4.96	5.58	6.22	6.86	7.51	8.14	8.75
6	845	818	793	769	747	727	708	6	5.21	5.86	6.51	7.18	7.83	8.48	9.09
8	882	853	826	801	778	757	738	8	5.46	6.13	6.81	7.49	8.16	8.81	9.43
10	919	888	859	833	810	788	769	10	5.72	6.41	7.10	7.80	8.48	9.14	9.76

Power input: R1234yf change relative to R134a (%)								EER: R1234yf change relative to R134a (%)							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	3.9	3.6	3.5	3.6	4.0	4.8	6.3	-10	-9.6	-7.7	-6.3	-5.3	-4.6	-4.3	-4.4
-8	3.3	3.4	3.5	3.7	4.2	5.1	6.5	-8	-9.7	-7.8	-6.5	-5.5	-4.9	-4.7	-4.8
-6	2.8	3.1	3.4	3.8	4.3	5.2	6.4	-6	-9.5	-7.8	-6.6	-5.8	-5.3	-5.1	-5.2
-4	2.2	2.8	3.2	3.7	4.3	5.0	6.1	-4	-9.3	-7.8	-6.7	-6.0	-5.6	-5.5	-5.6
-2	1.7	2.4	3.0	3.5	4.1	4.8	5.6	-2	-9.1	-7.7	-6.9	-6.3	-6.0	-5.9	-6.0
0	1.2	2.1	2.7	3.3	3.8	4.4	5.1	0	-8.8	-7.7	-7.0	-6.6	-6.4	-6.3	-6.4
2	0.8	1.7	2.4	3.0	3.5	3.9	4.4	2	-8.6	-7.8	-7.2	-6.9	-6.8	-6.7	-6.8
4	0.4	1.4	2.2	2.7	3.1	3.4	3.7	4	-8.5	-7.8	-7.5	-7.3	-7.2	-7.2	-7.2
6	0.1	1.1	1.9	2.4	2.7	2.9	2.9	6	-8.4	-8.0	-7.8	-7.8	-7.8	-7.7	-7.7
8	-0.2	0.9	1.7	2.1	2.3	2.3	2.2	8	-8.5	-8.3	-8.2	-8.3	-8.3	-8.3	-8.2
10	-0.4	0.7	1.4	1.9	2.0	1.8	1.4	10	-8.6	-8.6	-8.7	-8.8	-8.9	-8.9	-8.8

Table 3-10, Comparison of the results, superheating 11.1 °C

3.3. Superheating 22.2 °C

3.3.1. Reference measurement with R134a

AVERAGE	T cond	T evap	T return gas	T Superheat	Cool. Capacity	Power input	Current	EER	Mass flow
REFRIGERANT	(°C)	(°C)	(°C)	(°C)	BTU/h	W	A	(BTU/Wh)	kg/h
R134a	30	-10	12.2	22.2	3252.7	504.3	6.45	6.45	20.26
R134a	30	-5	17.2	22.2	4138.6	557.6	6.72	7.42	25.26
R134a	30	0	22.2	22.2	5215.1	618.7	7.06	8.43	31.22
R134a	30	5	27.2	22.2	6421.6	691.2	7.53	9.29	37.66
R134a	30	10	32.2	22.2	7855.1	761.1	7.90	10.32	45.82
R134a	45	-10	12.2	22.2	2670.1	548.6	6.67	4.87	19.16
R134a	45	-5	17.2	22.2	3462.8	610.8	7.02	5.67	24.29
R134a	45	0	22.2	22.2	4413.9	677.9	7.44	6.51	30.26
R134a	45	5	27.2	22.2	5535.5	750.5	7.93	7.38	37.15
R134a	45	10	32.2	22.2	6808.0	831.7	8.53	8.19	44.72
R134a	60	-10	12.2	22.2	2066.3	589.4	6.90	3.51	17.69
R134a	60	-5	17.2	22.2	2728.1	661.5	7.33	4.12	22.67
R134a	60	0	22.2	22.2	3522.8	740.5	7.86	4.76	28.54
R134a	60	5	27.2	22.2	4448.9	828.4	8.50	5.37	35.15
R134a	60	10	32.2	22.2	5523.2	922.0	9.21	5.99	42.57

Table 3-11a, Measured data of NEK6214Z, refrigerant R134a, superheating 22.2 °C

AVERAGE	T cond	T evap	T return gas	T Superheat	Cool. Capacity	Power input	Current	EER	Mass flow
REFRIGERANT	(°C)	(°C)	(°C)	(°C)	%	%	%	%	%
R134a	30	-10	12.2	22.2	2.6	0.9	6.3	3.5	2.4
R134a	30	-5	17.2	22.2	0.8	0.9	5.9	1.7	0.8
R134a	30	0	22.2	22.2	0.3	1.0	5.4	1.3	0.3
R134a	30	5	27.2	22.2	0.2	0.5	4.4	0.8	0.4
R134a	30	10	32.2	22.2	0.4	1.2	4.9	0.8	0.5
R134a	45	-10	12.2	22.2	0.2	1.1	5.8	1.3	0.1
R134a	45	-5	17.2	22.2	1.4	0.3	4.7	1.8	1.2
R134a	45	0	22.2	22.2	0.1	0.0	3.6	0.1	0.1
R134a	45	5	27.2	22.2	0.6	0.1	3.3	0.5	0.6
R134a	45	10	32.2	22.2	0.2	0.5	3.2	0.2	0.0
R134a	60	-10	12.2	22.2	0.8	0.5	5.0	1.3	0.9
R134a	60	-5	17.2	22.2	0.6	0.3	4.1	0.4	0.3
R134a	60	0	22.2	22.2	1.0	0.5	3.6	1.4	1.1
R134a	60	5	27.2	22.2	0.1	0.3	3.0	0.3	0.3
R134a	60	10	32.2	22.2	0.3	0.5	2.8	0.8	0.3

Table 3-11b., Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R134a, superheating 22.2 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg, °C)	Power input (W, °C)
C1	5.829E+03	3.633E+01	5.053E+02
C2	2.400E+02	1.110E+00	1.479E+01
C3	9.056E+00	-3.559E-01	4.257E+00
C4	4.306E+00	2.241E-02	1.020E-01
C5	3.960E-01	7.946E-03	-1.467E-01
C6	-1.211E+00	8.318E-03	-2.246E-02
C7	9.822E-03	1.156E-04	-1.756E-03
C8	-2.559E-02	-1.124E-04	6.952E-04
C9	-2.554E-02	-9.777E-05	3.000E-03
C10	6.965E-03	-7.584E-05	2.839E-04

Table 3-12, Coefficients C1 – C10 for NEK6214Z, refrigerant R134a, superheating 22.2 °C

CURVE-FITTED CHARTS

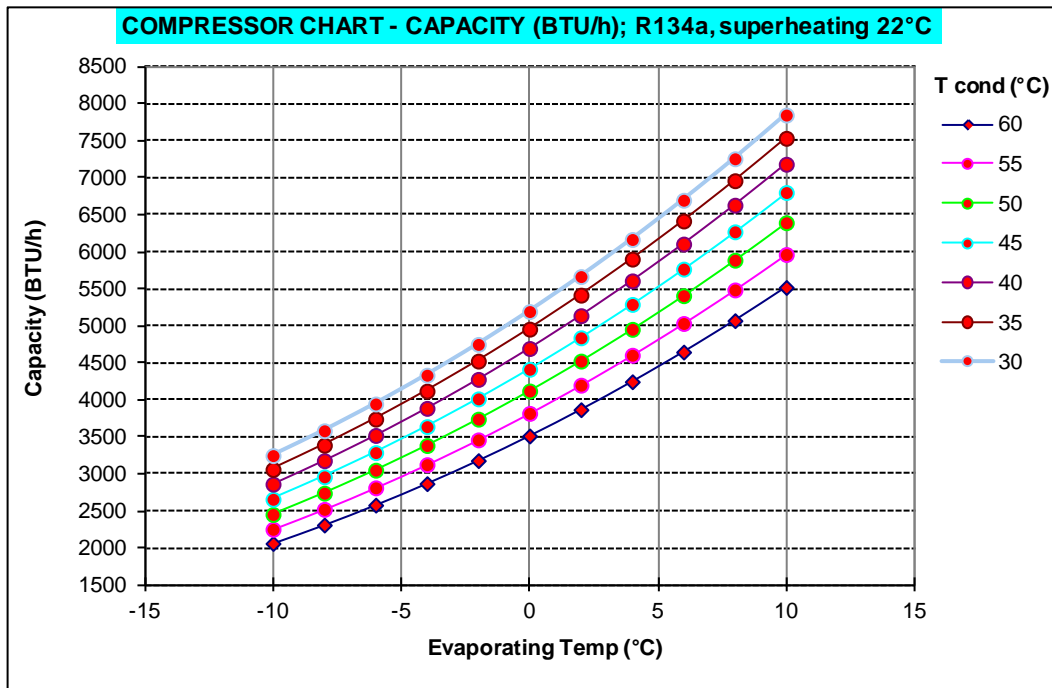


Figure 3-17, Cooling capacity of NEK6214Z, refrigerant R134a, superheating 22.2 °C

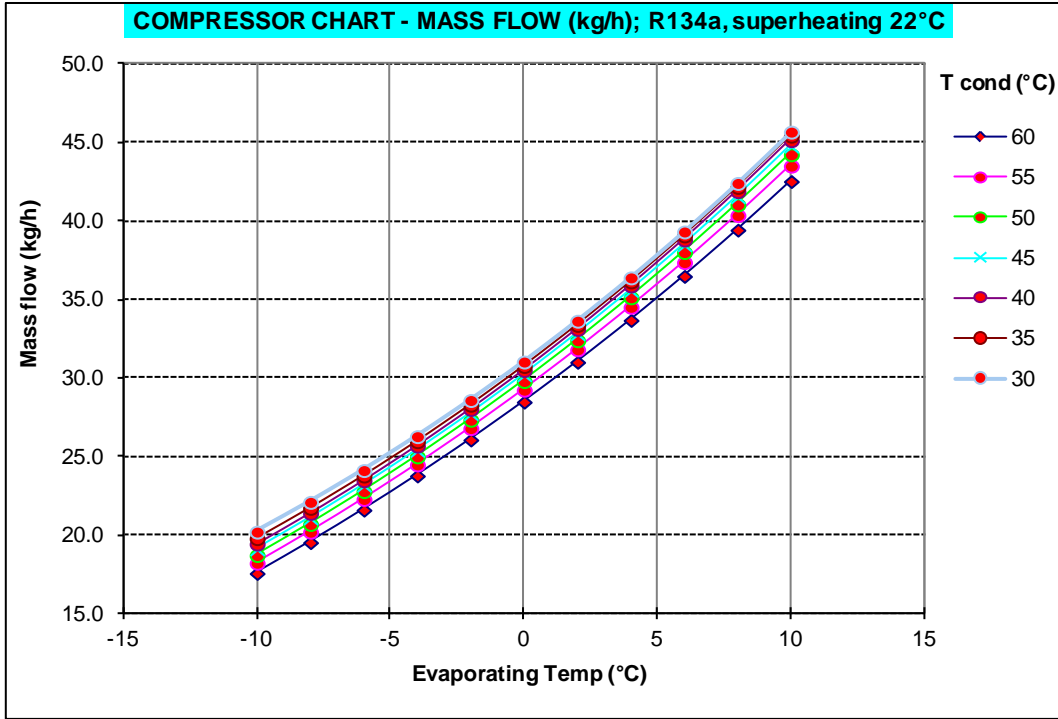


Figure 3-18, Mass flow of NEK6214Z, refrigerant R134a, superheating 22.2 °C

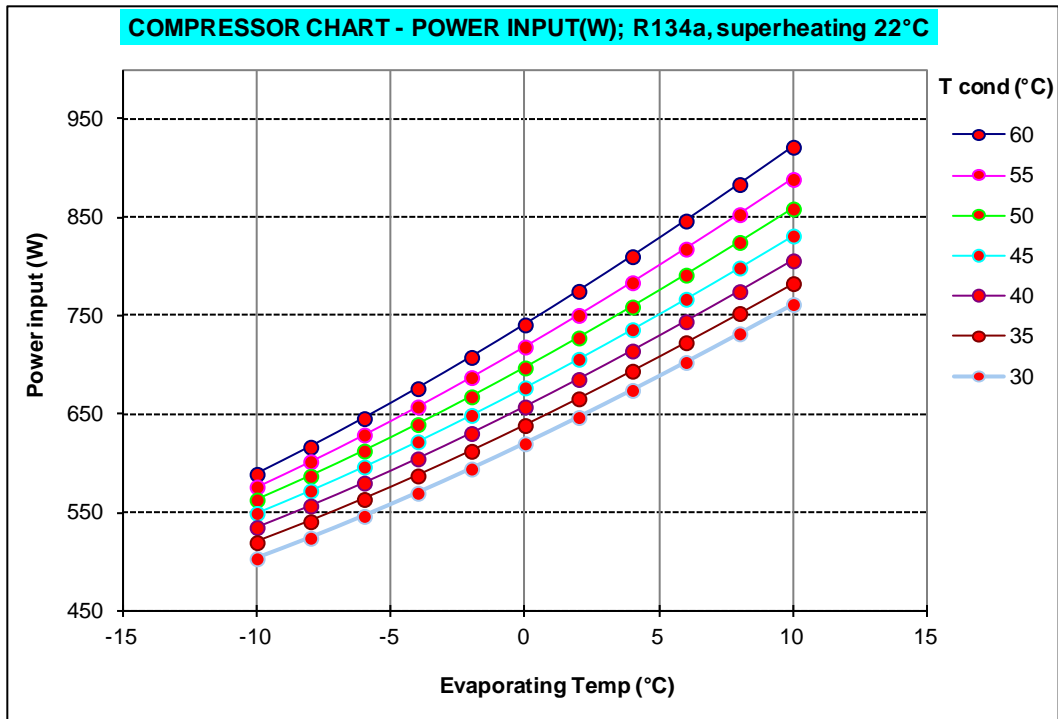


Figure 3-19, Power input of NEK6214Z, refrigerant R134a, superheating 22.2 °C

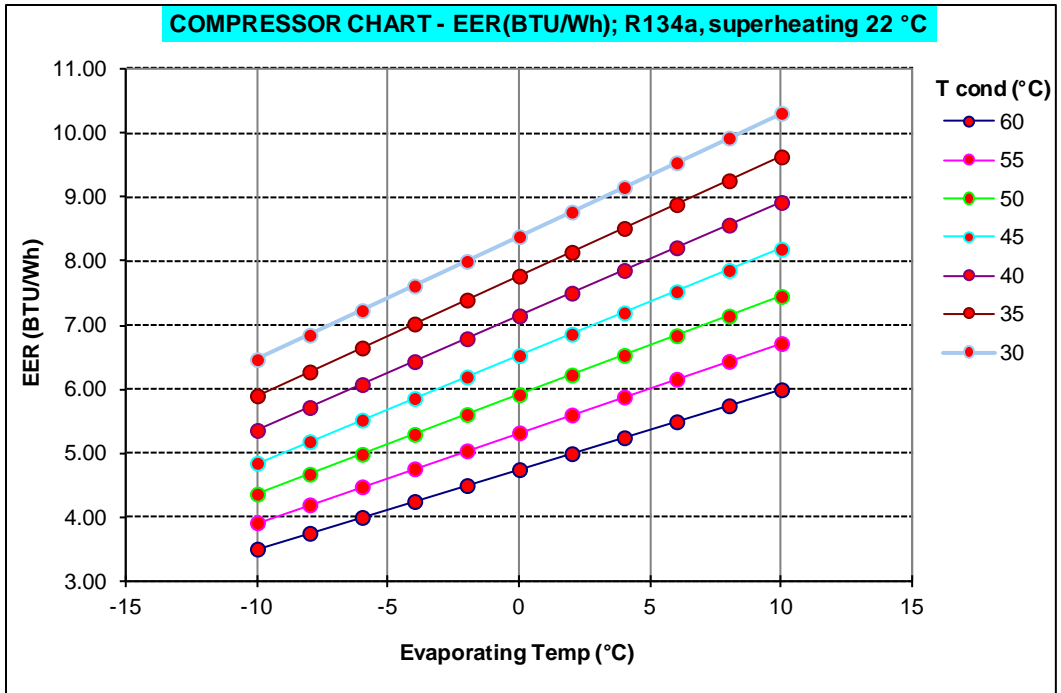


Figure 3-20, EER of NEK6214Z, refrigerant R134a, superheating 22.2 °C

3.3.2. Measurement with new refrigerant R1234yf

AVERAGE REFRIGERANT	T cond (°C)	T evap (°C)	T return gas (°C)	T Superheat (°C)	Cool. Capacity (BTU/h)	Power input (W)	Current (A)	EER (BTU/Wh)	Mass flow (kg/h)
R1234yf	30	-10	12.2	22.2	3340.7	531.6	6.60	6.28	25.91
R1234yf	30	-5	17.2	22.2	4207.4	589.9	6.96	7.13	31.75
R1234yf	30	0	22.2	22.2	5251.6	654.2	7.36	8.03	38.59
R1234yf	30	5	27.2	22.2	6329.3	719.6	7.77	8.80	45.35
R1234yf	30	10	32.2	22.2	7640.1	791.3	8.25	9.66	54.43
R1234yf	45	-10	12.2	22.2	2691.8	571.1	6.83	4.71	24.85
R1234yf	45	-5	17.2	22.2	3447.5	631.9	7.18	5.46	30.84
R1234yf	45	0	22.2	22.2	4348.9	698.3	7.61	6.23	37.72
R1234yf	45	5	27.2	22.2	5386.5	770.8	8.11	6.99	45.36
R1234yf	45	10	32.2	22.2	6571.7	854.9	8.74	7.69	53.62
R1234yf	60	-10	12.2	22.2	1996.7	612.0	7.15	3.26	23.16
R1234yf	60	-5	17.2	22.2	2604.0	677.6	7.50	3.84	29.01
R1234yf	60	0	22.2	22.2	3336.5	753.2	7.97	4.43	35.75
R1234yf	60	5	27.2	22.2	4216.2	832.5	8.56	5.06	43.59
R1234yf	60	10	32.2	22.2	5194.0	918.6	9.22	5.65	51.82

Table 3-13a, Measured data of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

AVERAGE	T cond	T evap	T return gas	T Superheat	Cool. Capacity	Power input	Current	EER	Mass flow
REFRIGERANT	(°C)	(°C)	(°C)	(°C)	%	%	%	%	%
R1234yf	30	-10	12.2	22.2	1.0	0.3	5.3	0.7	1.2
R1234yf	30	-5	17.2	22.2	0.8	0.2	4.8	0.5	0.8
R1234yf	30	0	22.2	22.2	0.5	0.6	4.6	0.1	0.5
R1234yf	30	5	27.2	22.2	0.7	0.7	4.0	0.1	0.8
R1234yf	30	10	32.2	22.2	0.4	1.0	3.6	1.4	0.4
R1234yf	30	-10	12.2	22.2	0.3	0.7	5.3	1.0	0.3
R1234yf	45	-5	17.2	22.2	0.6	0.1	4.0	0.7	0.4
R1234yf	45	0	22.2	22.2	0.3	0.4	3.9	0.1	0.3
R1234yf	45	5	27.2	22.2	0.5	0.2	2.9	0.4	0.6
R1234yf	45	10	32.2	22.2	2.3	0.6	2.2	1.7	2.3
R1234yf	60	-10	12.2	22.2	0.0	0.3	3.2	0.3	0.1
R1234yf	60	-5	17.2	22.2	0.1	0.3	4.1	0.2	0.1
R1234yf	60	0	22.2	22.2	0.8	0.4	4.1	0.4	0.7
R1234yf	60	5	27.2	22.2	1.2	0.4	3.2	0.8	0.8
R1234yf	60	10	32.2	22.2	0.1	0.4	2.8	0.3	0.3

Table 3-13b, Difference (abs %) between 2 measured pieces of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

Coefficients	Capacity (BTU/h, °C)	Mass flow (kg, °C)	Power input (W, °C)
C1	6.750E+03	3.928E+01	5.275E+02
C2	2.145E+02	1.251E+00	1.088E+01
C3	-5.139E+01	-6.888E-02	5.653E+00
C4	2.815E+00	1.904E-02	4.737E-02
C5	8.712E-01	7.160E-03	6.257E-02
C6	1.117E-01	2.289E-03	-6.692E-02
C7	6.757E-03	1.222E-04	6.890E-04
C8	-3.196E-03	-5.142E-05	1.599E-03
C9	-2.978E-02	-7.022E-05	1.863E-04
C10	-3.384E-03	-3.480E-05	5.829E-04

Table 3-14, Coefficients C1 – C10 for NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

CURVE-FITTED CHARTS

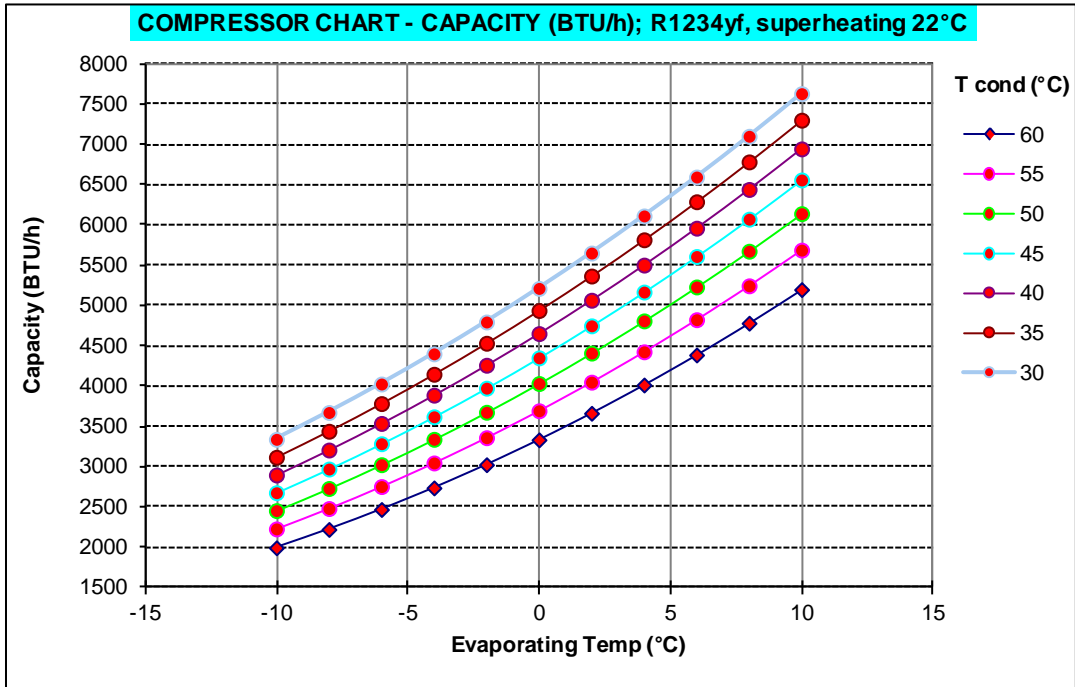


Figure 3-21, Cooling capacity of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

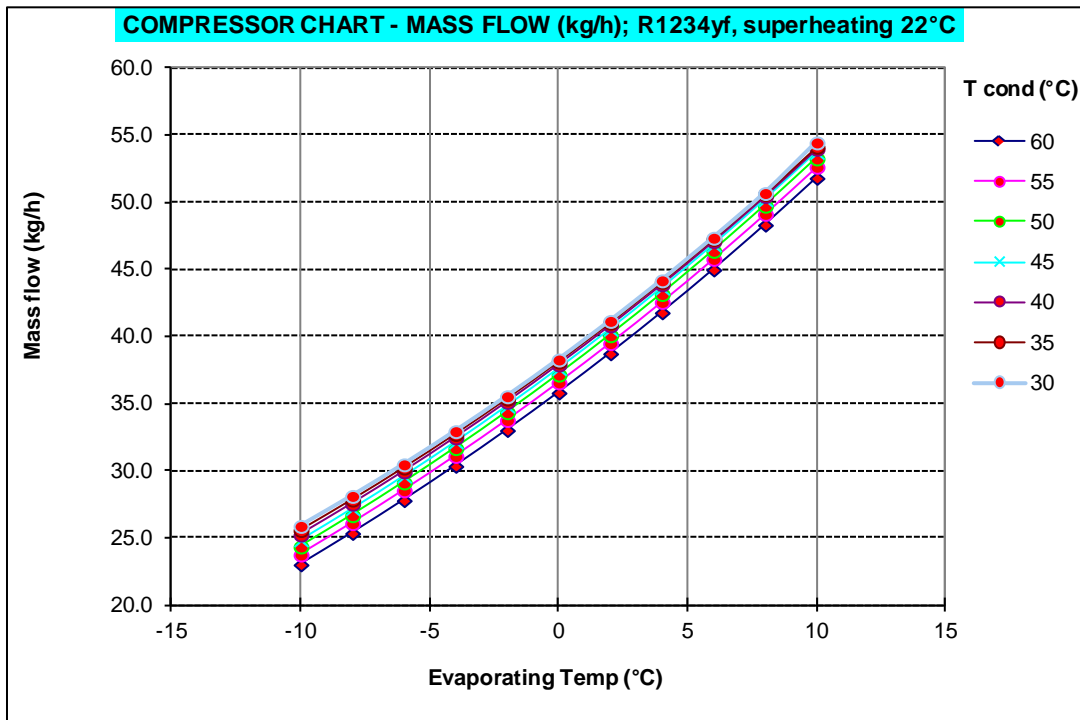


Figure 3-22, Mass flow of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

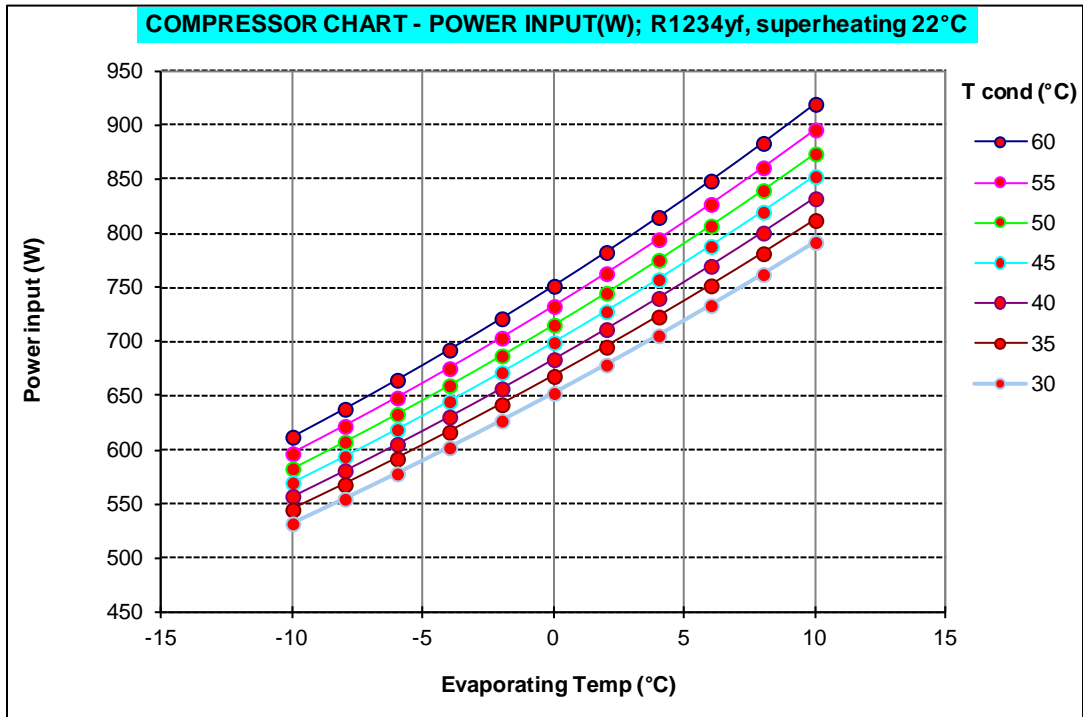


Figure 3-23, Power input of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

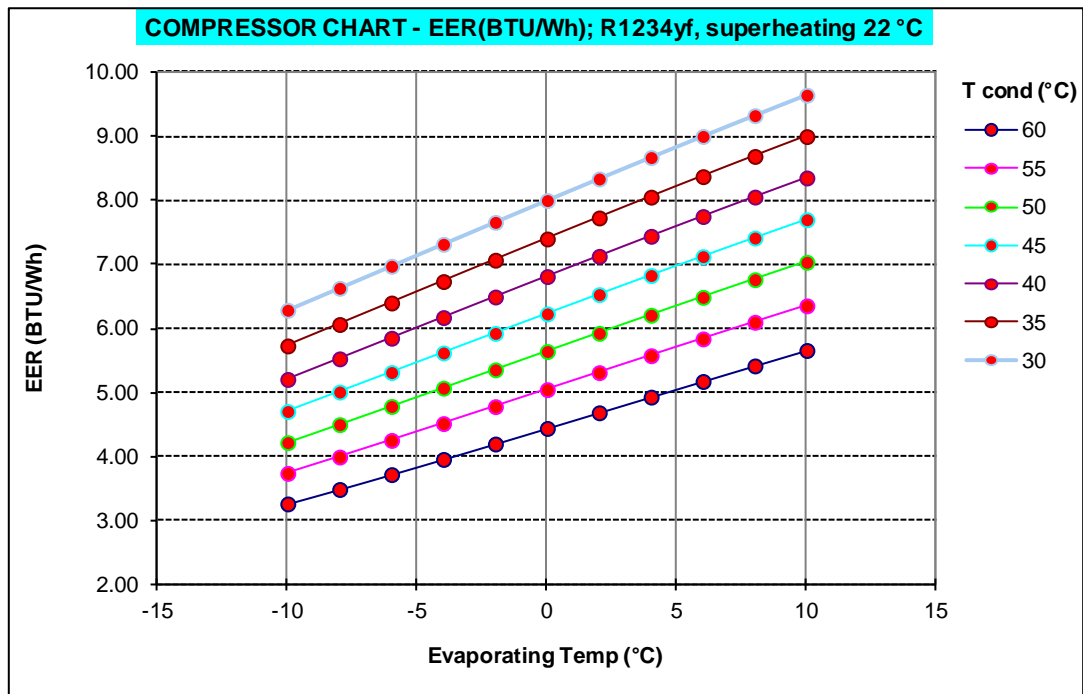


Figure 3-24, EER of NEK6214Z, refrigerant R1234yf, superheating 22.2 °C

3.3.3. Comparison of the results

Capacity (BTU/h) R1234yf

°C	60	55	50	45	40	35	30
-10	1998	2233	2460	2682	2902	3122	3345
-8	2226	2486	2735	2976	3212	3445	3678
-6	2474	2759	3030	3290	3542	3788	4031
-4	2742	3051	3345	3624	3893	4152	4406
-2	3030	3365	3681	3980	4264	4537	4801
0	3338	3699	4037	4356	4657	4943	5218
2	3668	4054	4415	4753	5071	5371	5656
4	4019	4431	4815	5172	5507	5821	6117
6	4392	4829	5236	5614	5965	6293	6600
8	4786	5250	5680	6077	6446	6788	7106
10	5203	5693	6146	6564	6950	7306	7635

Mass Flow (kg/h) R1234yf

°C	60	55	50	45	40	35	30
-10	23.07	23.80	24.40	24.88	25.28	25.63	25.93
-8	25.41	26.14	26.73	27.20	27.58	27.90	28.17
-6	27.85	28.59	29.17	29.63	29.99	30.28	30.52
-4	30.41	31.15	31.73	32.18	32.52	32.78	32.99
-2	33.08	33.82	34.40	34.85	35.17	35.42	35.60
0	35.87	36.62	37.21	37.64	37.96	38.18	38.33
2	38.79	39.55	40.14	40.57	40.88	41.08	41.21
4	41.84	42.62	43.21	43.64	43.94	44.12	44.23
6	45.03	45.83	46.42	46.86	47.14	47.32	47.40
8	48.37	49.18	49.79	50.22	50.51	50.67	50.73
10	51.86	52.69	53.31	53.74	54.03	54.18	54.50

Capacity (BTU/h) R134a

°C	60	55	50	45	40	35	30
-10	2068	2259	2459	2665	2869	3067	3254
-8	2317	2528	2747	2968	3186	3395	3590
-6	2586	2819	3057	3295	3527	3747	3951
-4	2876	3132	3390	3646	3892	4126	4340
-2	3187	3467	3747	4021	4284	4531	4756
0	3519	3824	4127	4420	4701	4962	5200
2	3874	4205	4531	4845	5144	5421	5672
4	4252	4610	4960	5296	5614	5908	6173
6	4652	5038	5414	5773	6111	6423	6703
8	5077	5491	5893	6276	6636	6966	7263
10	5525	5970	6399	6807	7189	7539	7853

Mass Flow (kg/h) R134a

°C	60	55	50	45	40	35	30
-10	17.64	18.29	18.78	19.17	19.51	19.86	20.27
-8	19.60	20.27	20.76	21.14	21.46	21.79	22.17
-6	21.67	22.35	22.85	23.23	23.54	23.84	24.19
-4	23.84	24.55	25.06	25.44	25.74	26.03	26.35
-2	26.13	26.86	27.39	27.78	28.08	28.35	28.65
0	28.54	29.30	29.85	30.25	30.55	30.81	31.09
2	31.07	31.87	32.45	32.86	33.17	33.42	33.69
4	33.74	34.57	35.18	35.61	35.93	36.19	36.45
6	36.54	37.42	38.06	38.52	38.85	39.11	39.37
8	39.48	40.41	41.09	41.58	41.93	42.20	42.45
10	42.57	43.55	44.28	44.80	45.17	45.46	45.72

Capacity: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-3.4	-1.2	0.0	0.7	1.1	1.8	2.8
-8	-3.9	-1.7	-0.5	0.3	0.8	1.5	2.5
-6	-4.3	-2.2	-0.9	-0.2	0.4	1.1	2.0
-4	-4.7	-2.6	-1.3	-0.6	0.0	0.6	1.5
-2	-4.9	-2.9	-1.8	-1.0	-0.5	0.1	0.9
0	-5.1	-3.3	-2.2	-1.5	-0.9	-0.4	0.3
2	-5.3	-3.6	-2.6	-1.9	-1.4	-0.9	-0.3
4	-5.5	-3.9	-2.9	-2.3	-1.9	-1.5	-0.9
6	-5.6	-4.1	-3.3	-2.8	-2.4	-2.0	-1.5
8	-5.7	-4.4	-3.6	-3.2	-2.9	-2.6	-2.2
10	-5.8	-4.6	-4.0	-3.6	-3.3	-3.1	-2.8

Mass flow: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	30.7	30.1	29.9	29.8	29.6	29.0	27.9
-8	29.6	29.0	28.8	28.7	28.5	28.0	27.1
-6	28.5	27.9	27.7	27.6	27.4	27.0	26.2
-4	27.5	26.9	26.6	26.5	26.3	26.0	25.2
-2	26.6	25.9	25.6	25.4	25.3	24.9	24.3
0	25.7	25.0	24.6	24.4	24.2	23.9	23.3
2	24.8	24.1	23.7	23.5	23.2	22.9	22.3
4	24.0	23.3	22.8	22.5	22.3	21.9	21.4
6	23.2	22.5	22.0	21.6	21.4	21.0	20.4
8	22.5	21.7	21.2	20.8	20.5	20.1	19.5
10	21.8	21.0	20.4	20.0	19.6	19.2	19.2

Power Input (W) R1234yf								EER (BTU/Wh) R1234yf							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	612	597	583	570	557	545	532	-10	3.26	3.74	4.22	4.71	5.21	5.73	6.28
-8	638	622	608	594	581	568	555	-8	3.49	4.00	4.50	5.01	5.53	6.06	6.63
-6	665	648	633	619	606	592	578	-6	3.72	4.25	4.78	5.31	5.85	6.40	6.97
-4	693	675	660	645	631	617	602	-4	3.96	4.52	5.07	5.62	6.17	6.73	7.31
-2	722	704	687	672	657	642	627	-2	4.20	4.78	5.36	5.92	6.49	7.07	7.66
0	752	733	716	699	684	668	653	0	4.44	5.05	5.64	6.23	6.81	7.40	8.00
2	783	763	745	728	712	695	679	2	4.69	5.31	5.93	6.53	7.13	7.72	8.33
4	815	795	776	758	740	723	706	4	4.93	5.58	6.21	6.83	7.44	8.05	8.67
6	849	827	807	788	770	752	734	6	5.17	5.84	6.49	7.12	7.75	8.37	9.00
8	884	861	840	820	801	782	762	8	5.42	6.10	6.76	7.41	8.05	8.68	9.32
10	920	896	874	853	832	812	792	10	5.66	6.35	7.03	7.70	8.35	8.99	9.64

Power Input (W) R134a								EER (BTU/Wh) R134a							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	589	576	563	550	535	520	504	-10	3.51	3.92	4.37	4.85	5.36	5.90	6.46
-8	617	602	587	573	557	541	524	-8	3.76	4.20	4.68	5.18	5.72	6.27	6.84
-6	646	629	613	597	580	564	547	-6	4.00	4.48	4.99	5.52	6.08	6.65	7.23
-4	676	658	640	622	605	588	570	-4	4.25	4.76	5.30	5.86	6.43	7.02	7.61
-2	708	688	668	649	631	613	595	-2	4.50	5.04	5.61	6.19	6.79	7.39	8.00
0	741	719	697	677	658	639	620	0	4.75	5.32	5.92	6.53	7.15	7.77	8.38
2	775	751	728	706	686	666	647	2	5.00	5.60	6.22	6.86	7.50	8.14	8.76
4	811	784	759	736	715	694	675	4	5.25	5.88	6.53	7.19	7.86	8.51	9.15
6	847	818	792	767	744	723	703	6	5.49	6.16	6.84	7.52	8.21	8.88	9.53
8	884	853	825	799	775	753	732	8	5.74	6.44	7.14	7.86	8.56	9.25	9.92
10	922	889	859	831	806	783	762	10	5.99	6.72	7.45	8.19	8.92	9.63	10.31

Power input: R1234yf change relative to R134a (%)								EER: R1234yf change relative to R134a (%)							
°C	60	55	50	45	40	35	30	°C	60	55	50	45	40	35	30
-10	3.9	3.5	3.5	3.7	4.1	4.8	5.7	-10	-7.0	-4.5	-3.4	-2.9	-2.9	-2.9	-2.8
-8	3.4	3.3	3.4	3.8	4.3	5.0	5.8	-8	-7.1	-4.8	-3.8	-3.4	-3.3	-3.3	-3.2
-6	2.9	3.0	3.3	3.7	4.3	5.0	5.8	-6	-7.0	-5.0	-4.1	-3.8	-3.7	-3.7	-3.6
-4	2.4	2.7	3.1	3.6	4.3	4.9	5.6	-4	-6.9	-5.1	-4.3	-4.1	-4.1	-4.1	-3.9
-2	1.9	2.3	2.9	3.5	4.1	4.8	5.4	-2	-6.7	-5.2	-4.5	-4.3	-4.4	-4.4	-4.3
0	1.4	2.0	2.6	3.3	4.0	4.6	5.2	0	-6.5	-5.2	-4.7	-4.6	-4.7	-4.8	-4.6
2	1.0	1.6	2.4	3.1	3.8	4.4	4.9	2	-6.2	-5.2	-4.8	-4.8	-5.0	-5.1	-4.9
4	0.6	1.4	2.1	2.9	3.6	4.2	4.6	4	-6.0	-5.2	-5.0	-5.1	-5.3	-5.4	-5.3
6	0.2	1.1	2.0	2.7	3.4	4.0	4.4	6	-5.8	-5.2	-5.1	-5.4	-5.6	-5.8	-5.6
8	0.0	0.9	1.8	2.6	3.3	3.8	4.1	8	-5.7	-5.3	-5.3	-5.6	-6.0	-6.2	-6.0
10	-0.2	0.8	1.7	2.6	3.2	3.7	4.0	10	-5.6	-5.4	-5.6	-6.0	-6.4	-6.6	-6.5

Table 3-15, Comparison of the results, superheating 22.2 °C

4. Summary

Return gas temp 18.3 °C

Capacity: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-0.8	-0.1	0.8	1.7	2.7	3.5	4.3
-8	-2.4	-1.3	-0.1	1.0	2.0	2.9	3.6
-6	-3.5	-2.1	-0.8	0.3	1.4	2.2	2.9
-4	-4.4	-2.9	-1.5	-0.3	0.7	1.4	2.0
-2	-5.0	-3.5	-2.2	-1.1	-0.2	0.5	0.9
0	-5.7	-4.2	-2.9	-1.9	-1.2	-0.6	-0.3
2	-6.3	-4.9	-3.8	-2.9	-2.3	-1.9	-1.7
4	-7.1	-5.8	-4.8	-4.0	-3.5	-3.3	-3.3
6	-7.9	-6.8	-5.9	-5.3	-5.0	-4.9	-5.0
8	-9.0	-7.9	-7.2	-6.8	-6.6	-6.6	-6.9
10	-10.1	-9.3	-8.7	-8.4	-8.3	-8.5	-8.9

EER: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-8.9	-7.7	-6.6	-5.8	-5.2	-4.8	-4.5
-8	-9.8	-8.3	-7.2	-6.3	-5.7	-5.3	-5.0
-6	-10.1	-8.6	-7.5	-6.7	-6.1	-5.8	-5.5
-4	-10.2	-8.8	-7.7	-7.0	-6.5	-6.2	-6.0
-2	-10.2	-8.9	-7.9	-7.3	-6.9	-6.7	-6.5
0	-10.2	-8.9	-8.1	-7.6	-7.3	-7.2	-7.1
2	-10.2	-9.1	-8.5	-8.1	-7.9	-7.8	-7.7
4	-10.3	-9.4	-8.9	-8.7	-8.6	-8.5	-8.5
6	-10.6	-9.9	-9.5	-9.4	-9.4	-9.4	-9.4
8	-11.1	-10.6	-10.3	-10.3	-10.3	-10.4	-10.4
10	-11.8	-11.4	-11.3	-11.3	-11.5	-11.6	-11.6

Superheating 11.1 °C

Capacity: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-6.1	-4.4	-3.1	-1.9	-0.8	0.3	1.6
-8	-6.6	-4.7	-3.2	-2.0	-0.9	0.2	1.3
-6	-7.0	-5.0	-3.5	-2.2	-1.2	-0.2	0.8
-4	-7.3	-5.3	-3.7	-2.6	-1.6	-0.7	0.1
-2	-7.5	-5.5	-4.1	-3.0	-2.1	-1.4	-0.7
0	-7.7	-5.8	-4.5	-3.5	-2.8	-2.2	-1.6
2	-7.9	-6.2	-5.0	-4.1	-3.5	-3.1	-2.7
4	-8.1	-6.5	-5.5	-4.8	-4.3	-4.0	-3.8
6	-8.4	-7.0	-6.1	-5.5	-5.2	-5.1	-5.0
8	-8.6	-7.5	-6.7	-6.3	-6.2	-6.1	-6.2
10	-9.0	-8.0	-7.4	-7.2	-7.1	-7.3	-7.5

EER: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-9.6	-7.7	-6.3	-5.3	-4.6	-4.3	-4.4
-8	-9.7	-7.8	-6.5	-5.5	-4.9	-4.7	-4.8
-6	-9.5	-7.8	-6.6	-5.8	-5.3	-5.1	-5.2
-4	-9.3	-7.8	-6.7	-6.0	-5.6	-5.5	-5.6
-2	-9.1	-7.7	-6.9	-6.3	-6.0	-5.9	-6.0
0	-8.8	-7.7	-7.0	-6.6	-6.4	-6.3	-6.4
2	-8.6	-7.8	-7.2	-6.9	-6.8	-6.7	-6.8
4	-8.5	-7.8	-7.5	-7.3	-7.2	-7.2	-7.2
6	-8.4	-8.0	-7.8	-7.8	-7.8	-7.7	-7.7
8	-8.5	-8.3	-8.2	-8.3	-8.3	-8.3	-8.2
10	-8.6	-8.6	-8.7	-8.8	-8.9	-8.9	-8.8

Superheating 22.2 °C

Capacity: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-3.4	-1.2	0.0	0.7	1.1	1.8	2.8
-8	-3.9	-1.7	-0.5	0.3	0.8	1.5	2.5
-6	-4.3	-2.2	-0.9	-0.2	0.4	1.1	2.0
-4	-4.7	-2.6	-1.3	-0.6	0.0	0.6	1.5
-2	-4.9	-2.9	-1.8	-1.0	-0.5	0.1	0.9
0	-5.1	-3.3	-2.2	-1.5	-0.9	-0.4	0.3
2	-5.3	-3.6	-2.6	-1.9	-1.4	-0.9	-0.3
4	-5.5	-3.9	-2.9	-2.3	-1.9	-1.5	-0.9
6	-5.6	-4.1	-3.3	-2.8	-2.4	-2.0	-1.5
8	-5.7	-4.4	-3.6	-3.2	-2.9	-2.6	-2.2
10	-5.8	-4.6	-4.0	-3.6	-3.3	-3.1	-2.8

EER: R1234yf change relative to R134a (%)

°C	60	55	50	45	40	35	30
-10	-7.0	-4.5	-3.4	-2.9	-2.9	-2.9	-2.8
-8	-7.1	-4.8	-3.8	-3.4	-3.3	-3.3	-3.2
-6	-7.0	-5.0	-4.1	-3.8	-3.7	-3.7	-3.6
-4	-6.9	-5.1	-4.3	-4.1	-4.1	-4.1	-3.9
-2	-6.7	-5.2	-4.5	-4.3	-4.4	-4.4	-4.3
0	-6.5	-5.2	-4.7	-4.6	-4.7	-4.8	-4.6
2	-6.2	-5.2	-4.8	-4.8	-5.0	-5.1	-4.9
4	-6.0	-5.2	-5.0	-5.1	-5.3	-5.4	-5.3
6	-5.8	-5.2	-5.1	-5.4	-5.6	-5.8	-5.6
8	-5.7	-5.3	-5.3	-5.6	-6.0	-6.2	-6.0
10	-5.6	-5.4	-5.6	-6.0	-6.4	-6.6	-6.5