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34 p. tables graphs

21931

Electrostar

Test with the refrigerant R12
Conversion to R134a
Top Mount Refrigerator/Freezer

Final Report

Date: 10.09.97

1. Summary

The tests of the bottom mount refrigerator/freezer by dkk GEP mbH have been performed based on the UNIDO contract No.96/089. The R12 tests should provide the data basis for the design adjustment of the refrigerators from Electrostar to R134a as refrigerant. The tests and design adjustments shall lead to the first prototype according to DIN/EN conditions.The tests carried out with R134a as refrigerant allow to compare the performance of the two refrigerants directly.The converted refrigerator should reach the same performance as the original R12.

Dkk could not select the R134a - compressor, because he has been delivered from Electrostar.

After the second field mission at Electrostar additional tests defined to assure the conversion data with different capillary tubes and compressors with special attention to the pressure dynamic.

The two types of compressors have been compared with the original compressor FN77Q17G for the refrigerant R12.

The results of this test have reconfirmed the set of parameters as already recommended for R134a (see.8.8)

2. View of test program

I. Measuring and Assessment of the design R12

II. Assessment and selection of the components R134, Calculation(2.Interim rep.)

III. Conversion to R134a

IV. Optimization of the cryogenic parameters

V. Measurings according to DIN EN ISO 8187

VI. Calorimeter test

VII. Pull down test

VIII. Noise test

3. Methodology

1. The domestic refrigerator supplied with R12 refrigerant has been inspected to check safety requirements for tests.

2. For the R12 baseline test programme and the R134a adjusted version tests two units of test chambers have been made available.

3. The tests have been carried out following the German standard DIN EN 28187. The test results correspond to German quality standards of measurings.

4. dkk has performed the following tests (both with R12 and the R134a):

   - Continuous running test at ambient temperature of t_a = 32 °C
   - Energy consumption at t_a = 32 °C, $t_{i\ Cool.} \leq 5$ °C
   - Running test at low ambient temperature t_a = 18 °C
   - Running test at high ambient temperature t_a = 43 °C, compartment temperature $t_{i\ Cool.} \leq 5$ °C
   - Freezing capacity test ta = 32 °C
   - Temperature rise test ta = 32 °C

     Tests R12 and R134a according to DIN EN ISO 3743-1, ISO 3740, DIN EN 23741,DIN EN 28960, ISO 8960, DIN 45635 /2

   - Noise test

   Additional tests:

   - Pull down test
   - Calorimeter test

   The tests are made at a voltage of U = 220 V.

4. Type of refrigerator tested

4.1 Technical data indicated

		Electrostar ES 320	
Volume Cool./Fr.	[l]	255/65	
Charging amount of R12	[g]	220	
Type of compressor		FN 77 Q17G	
Energy consumption	[kWh/d]	no specification	

4.2 Visual observations

This type of refrigerator doesn't correspond to european security standards regarding the outside electrical connections (safety cable).

5. R12-Test results

5.1 Continuous Running Test (t_a = 32 °C)

		Electrostar ES 320		required
$t_{i\ Cooler}$	[°C]	-8,2		
$t_{i\ Freezer\ 1)}$	[°C]	-27,5		-
t_{sensor}	[°C]	-30		-
$t_{suction\ pipe}$	[°C]	32		-
P	[W]	124		-

1) measured in air, middle one point

5.2 Energy consumption (t_a = 32 °C)

	R12	Electrostar ES 320/1	Electrostar ES 320/2	required
$t_{i\ Cool.}$	[°C]	1,8	2,5	≥ 0
$t_{i\ Freez.}$	[°C]	-18,6	-18,7	≤ -18
demand $t_{1,2,3\geq 0°C}$		not reached	not reached	$0 \leq t_1, t_2, t_3 \leq +10$
therm.pos.		4.5	4.2	
switch on time	[%]	61,1	63,8	-
energy cons.	[kWh/d]	2,45	2,55	-

ES 320/1 -No. of measuring

5.3 Running test at low ambient temperature (t_a = 18°C, Classification)

		Electrostar ES 320/1	Electrostar ES 320/2	Electrostar ES 320/3	required
$t_{iCool.}$	[°C]	4,5	3,4	-2,8	≥ 0
$t_{i\ Freez.}$	[°C]	-18	-18,3	-24,5	≤ -18
thermost.pos.		2	4	6	-
demand $t_{1,2,3>0°C}$		reached	reached	not reached	$0 \leq t_1, t_2, t_3 \leq +10$

5.4 Running test at high ambient temperature (t_a = 43°C, Classification)

		Electrostar ES 320/1	Electrostar ES 320/2	Electrostar ES 320/3	required
$t_{i\ Cool.}$	[°C]	0	0	8,6	≤ 5
$t_{i\ Freez.}$	[°C]	-18,2	-18,2	-13	≤ -18
thermost.pos.		6 *	4 *	2	-
continuous running		yes	yes	no	
demand $t_{1,2,3\ [°C]}$		not reached	not reached	reached	$0 \leq t_1, t_2, t_3 \leq +10$

*) continuous running

5.5 Freezing Capacity test (t_a = 32°C)

		Electrostar ES 320	required
time (test end)	[h]	31,5	
time (light load)	[h]	22,5	24
$t_{i\ cool.(coldest\ temp.)}$	[°C]	-5,6	$0 \leq t_1, t_2, t_3 \leq +10$
light load	[kg]	4	
thermost.pos.		4.5	
test passed		no	

5.6 Temperature Rise Test (ta = 32°C)

		Electrostar ES 320	required
$t_{i\ Cool.}$	[°C]	1,1	≤ 5
$t_{i\ Freez.}$	[°C]	-18,1	≤ -18
thermost.pos.		4.5	-
time from (-18 to -9) °C	[h]	14,7	

6. Discussion of the R12-results

6.1 Running Test at t_a = 43 °C

The Electrostar ES 320 fulfills not the requirement of the compartment temperatures

1. t_3 < 0°C Cooling compartment or

2. t_i Freez > -18°C by thermostat pos. TW2

6.2 Energy consumption

According to european standard the conditions for energy consumption are set at least in -18°C for freezer and less than 5 °C and more than 0°C for cooling if the delivered model did not reach those conditions the measuring is not comparable.

The refrigerator reached energy consumptions between 2,45 and 2,55 kWh/24h.

The Manufacturer has not declared a value of energy consumption.

6.3 Running test at low temperature (t_a = 18 °)

The refrigerator fulfills the test requirement $t_i \geq 0$ °C and $t_{i\,Freez.} \leq -18$ °C.

6.4 Freezing Capacity test

The refrigerator fulfills not the requirements according to DIN.

The exact conditions see point 5.5

6.5 Temperature Rise Test

The time to reach a temperature could be longer . (22 -24 h)

6.6 Noise Test

The noise test have been performed. s.p.7.7

With the second interim report was hand over a separately report.

7. Design adjustment for the R134a-refrigerant -recommendations

1. Since Electrostar in future wants to cooperate with the compressor producer (Matsushita)dkk has used a compressor which has been selected from Electrostar.
2. The filled quantity of refrigerant has been optimized with a quantity of 165 g.
3. The present capillary tube has been increased to 1,3 m with the same inner diameter to reduce the evaporation temperature in the freezer compartment.
4. The Pull down test shows not negative result of the pressure of the discharge side with larger capillary.
5. The calorimeter test proves the rihgt selection of the compressor with adequate cooling capacity.
6. A new filter drier has been built in vertically.
7. Computer calculation to identify a better energy consumption and a Assessment of the components
8. The oil in the compressor is original from the producer.

8. Test results - Conversion R134a

8.1 Optimization of technical parameters

The optimization of technical parameters have been performed with the compressors have been made ready from electrostar.

In the annex A diagrams are attached from the optimization.

The results could only reached after optimization of the refrigerant quantity and capillary tube adjustment with the original design of ES320.

During the conversion the cooling capacity at lower evaporation temperature is a disadvantage of the refrigerant.

At the conversion without change of the design (cooling system) the temperature in the freezer compartment is to high.

A optimization with the smaller compressor QA77C17GAX5 for the ES320 climate class T according to DIN EN ISO 8187 is not possible because the low cooling capacity.

Additional have been performed the Pull down test with different designs.

8.2 Continuous Running Test (t_a = 32 °C)

		Electrostar ES 320 compressor QA91...	Electrostar ES 320 compressor QA77...
$t_{i\ Cooler}$	[°C]	-7,7	-2,9
$t_{i\ Freezer\ 1)}$	[°C]	-26,7	-23,7
t_{sensor}	[°C]	-30	-27
$t_{suction\ pipe}$	[°C]	28,0	37,0
P	[W]	134	127

1) measured in air, middle one point

8.3 Energy consumption (t_a = 32 °C)

		Electrostar ES 320/1	Electrostar ES 320/2	required
$t_{iCool.}$	[°C]	5,2	5,3	≤ 5
$t_{i\ Freezer}$	[°C]	- 18,5 *	- 19,0 *	≤ -18
demand $t_{1,2,3>0°C}$		reached	reached	$0 \leq t_1,t_2, t_3 \leq +10$
switch on time	[%]	68,8	68	-
thermostat pos.		1.5	1.0	-
energy cons.	[kWh/d]	2,65	2,56	-

* warmest parcel

Measuring 32°C repeated, without Energy cons.

		Electrostar ES 320/3	Electrostar ES 320/4	required
$t_{iCool.}$	[°C]	5,2	5,3	≤ 5
$t_{i\ Freezer}$	[°C]	- 16,8 *	- 19,0 *	≤ -18
demand $t_{1,2,3>0°C}$		not reached	not reached	$0 \leq t_1,t_2, t_3 \leq +10$
thermostat pos.		4	5	-

8.4 Running test at low temperature (t_a = 18 °)

		Electrostar ES 320/1	Electrostar ES 320/2	Electrostar ES 320/3	required
$t_{iCool.}$	[°C]	4,5	2,9	-2,5	≥ 0
$t_{i\ Freez.}$	[°C]	-19,5	-19,7	-21,2	≤ -18
thermost.pos.		2	4	6	-
demand $t_{1,2,3>0°C}$		reached	reached	not reached	$0 \leq t_1,t_2, t_3 \leq +10$

8.5 Running test at high ambient temperature (t_a = 43°C, Classification)

		Electrostar ES 320/1 QA91C22	Electrostar ES 320/2 QA91C22	Electrostar ES 320/3 QA91C22	required
t_i Cool.	[°C]	1,8	1,8	7,3	≤ 5
t_i Freez.	[°C]	-18,2	-18,2	-16,5	≤ -18
thermost.pos.		6 *	4 *	1	-
continuous running		yes	yes	no	
demand $t_{1,2,3>0°C}$		yes	yes	yes	$0 \leq t_1, t_2, t_3 \leq +10$

*) continuous running

		Electrostar ES 320/4 QA77C17
t_i Cool.	[°C]	4,8
t_i Freez.	[°C]	-14,3
thermost.pos.		4 *
continuous running		yes
demand $t_{1,2,3>0°C}$		yes

8.6 Freezing Capacity test

		Electrostar ES 320	required
time (test end)	[h]	28,5	24
time (light load)	[h]	22,3	
t_i cool.(coldest temp.)	[°C]	-3,2	$0 \leq t_1, t_2, t_3 \leq +10$
light load	[kg]	4	
thermost.pos.	[°C]	1.5	
test passed		no	

8.7 Calorimeter Test

The Compressor QA 77 C17 GAX5 (QA 91 C22 GAX5,after last Refrigerator tests measure,only one sample) will be tested according to DIN 8977 with refrigerant R134a at the Calorimeter.

Following data will be measured:

- Cooling Capacity Qo according to CECOMAF and ASHRAE

- Input Power P_1 according to CECOMAF and ASHRAE

- COP according to CECOMAF and ASHRAE

- Start test : * Start cold

* Start warm

Compressor tests - Calorimeter

Type / Parameter		FN77Q17G 1)	QA77C17GAX5	QA91C22GAX5
Evaporation temp.	[°C]	LBP -23,3	LBP -25 2) -23,3	LBP -25 -23,3
Refrigerant		R12	R134a	R134a
Qo				
CECOMAF	[W]		116,7	135
ASHRAE	[W]	191	154,2	187,1
ASHRAE	[kcal/h]	165	132,6	161
P_1				
CECOMAF	[W]		144,1	166,4
ASHRAE	[W]	180	148,4	171,4
COP				
CECOMAF	[W/W]		0,81	0,81
ASHRAE	[W/W]	1,06	1,04	1,09
Start test				
cold tw = 32 °C		-	o.k	o.k
warm tw = 100 °C		-	o.k	o.k

1) Leaflet data, original compressor

2) average two compressors, measuring

8.8 Pull down test

	ES 320 R134a ta= 43°C			ES320 R12 ta= 43°C
Compressor Type	QA91C22 orig.capillary +1,3 m	QA91C22 orig.capillary	QA77C17 original capillary	FN77Q17G original appliances
start pressure [bar] discharge side	5,2	5,2	5,1	5,5
start pressure [bar] suction side	5,0	5,0	5,0	5,3
Max. pressure discharge side[bar]	21,5	22,1	22,2	22,2
pressure [bar] in three ours	15,0	15,5	15,8	14,0

9. Noise test

The noise test have been performed from 17.12.-20.12.96 by SLG test laboratory. The results have been summarized in a separately report.

10. Discussion of the results R134a

10.1 Energy consumption (t_a = 32 °C)

The reached value of energy consumption in the performance with R134a is the same like R12 at the measurings ES 320/2 in points 4.2 and 7.3. The conditions according to DIN ISO 8187 have been reached.The reason for the unsignificant different between R12 and R134a is the Input power of the compressor.

After the first results the thermostat have been adjusted to minimum.

-changing thermostat

We used a thermostat with a other charakteristik. This measuring shows not better results. Therefore was changed the thermostat again and the original used. Afterwards the thermostat position could not adjusted again to the old position. The reason could be the fastening of the thermostat.

The conditions for the measuring energy consumption with the compressor QA77C17 are not adjustable.

10.2 Running test at low temperature (t_a = 18 °C)

The ES 320 fulfills the requirements according to DIN at continuous running.

10.3 Running test at high ambient temperature (43°C)

The ES 320 fulfills the requirements according to DIN at continuous running with the compressor QA91C22GAX5.

The ES 320 fulfills not the requirements according to DIN at continuous running with the compressor QA77C17GAX5. The cooling capacity is to low and Climate class T will not reached.

10.4 Freezing Capacity test

The demand of the temperatures $t_{1,2,3}$ have not been reached in the cooling compartment. The coldest temperatures by R134a is about 2 °C warmer as R12.

10.5 Calorimeter Test

The comparison of the cooling capacities R12 FN77 and R134a QA77C17 in the table (8.7) shows the decrease with R134a at the rated point about 37 W. This compressor(QA77C17) is not suitable for climate class T in the appliances ES320. The leaflet data deviate considerably from the measuring.

The compressor QA91C22 fulfills the demands on cooling capacity and the use in the refrigerator ES320. s. Annex 3 to 7

10.6 Pull down test

The modification of the capillary tube (larger) hasn't negative effects on the pressure in the condenser with the right refrigerant quantity. The pressure rise to 22-23 bar is not critical for the compressor by a short time at ambient temperature 43 °C.

The Pull down test R12 has been performed additional. s. Annex 8 to 10A

If the pressures with the original design from the appliances ES320 / R12 are not a problem than Electrostar has not to expect problems with R134a.

10.5 Noise test

The comparison between R12 and R134a shows that noise level different is about 2 dB(A). This is a good value for R134a. The appliances ES 320 was equipped with the compressor QA91C22. (separately report ,2. Interrim rep.)

11. Safety Requirements

Safty insspection was positive with one exemption :

- the existing safty cable is not connected to the plug

12. Conclusion

The results of the tests show, that with the adjustment and conversion with the refrigerant R134a it is possible to reach the same values compared to R12, if the recommendations described in chapter 7 will be implemented. A normal operation according to EN/DIN is only possible at determined thermostat positions. It is impossible at energy consumption test, running test 43°C and freezing test with R12.

The DIN-tests with the ES 320 R134a have been performed with the compressor QA91C22 and extended capillary tube. This compressor is suitable for the use in the appliances ES320 with R134a.

The conditions have been not reached to the execution the DIN-tests with the compressor QA77C17.

The pressures are in a normal range by the refrigerant R134a and the ambient temperature 43 °C. The Pull down test with the compressor QA77C17 shows not better results as the compressor QA91C22.

Annex

Annex 1 - Optimized quantity of refrigerant for ES 320

Annex 2 - Diagram log p-h R134a

Annex 3 - Calorimeter measuring FN77Q17G Leaflet R12

Annex 4 - Calorimeter measuring QA77C17GAX5

Annex 5 - Calorimeter measuring QA91C22GAX5

Annex 6 - Calorimeter measuring test sheet QA77C17GAX5

Annex 7 - Calorimeter measuring test sheet QA91C22GAX5

Annex 8 - Pull down test QA91C22GAX5 test sheet / diagram

Annex 9 - Pull down test QA91C22GAX5 test sheet / diagram

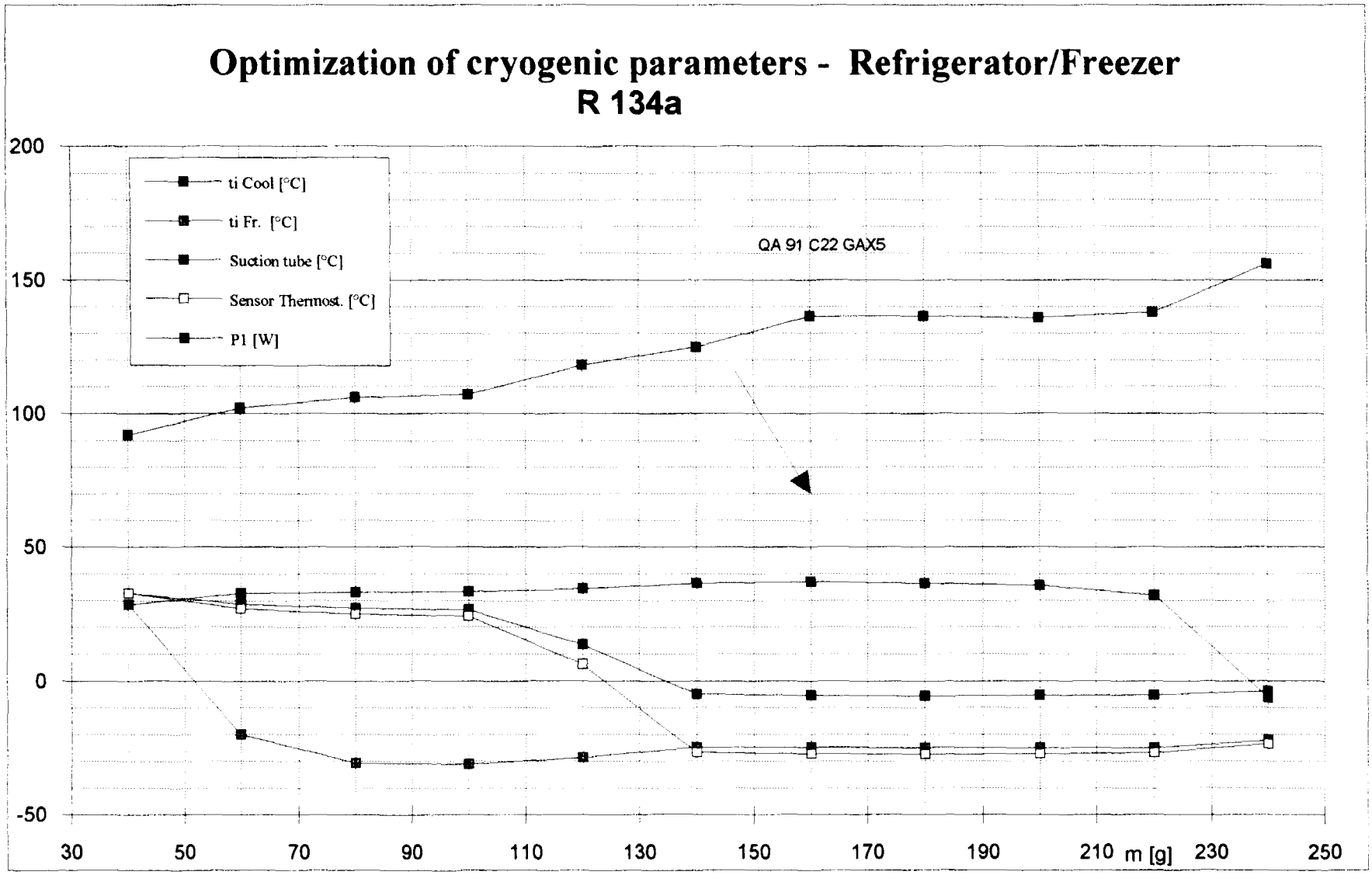
Annex 10 - Pull down test QA77C17GAX5 test sheet / diagram

Annex 10A - Pull down test FN77Q17 test sheet / diagram

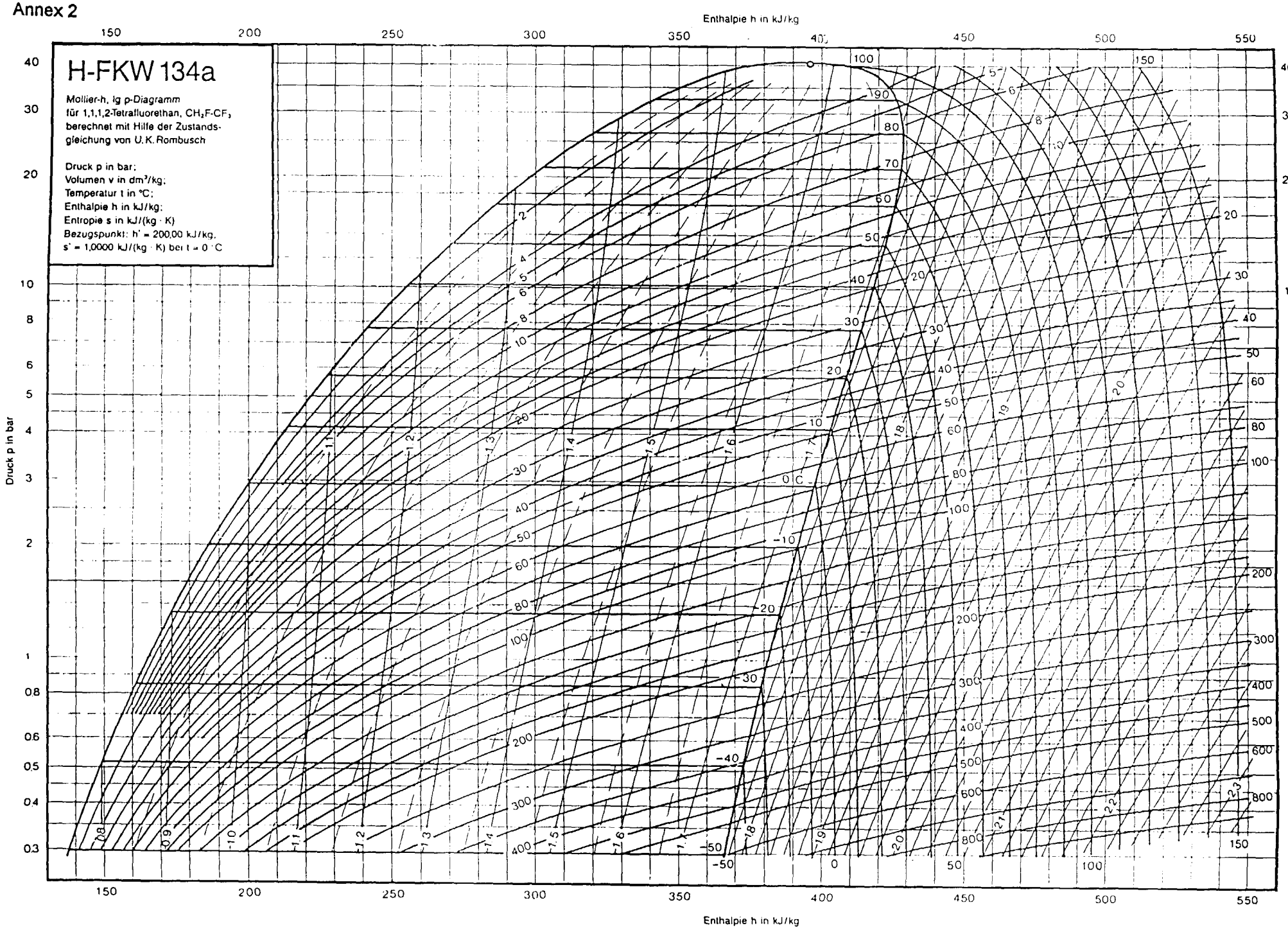
Annex 11 - Parameter of Influence to Optimization

Annex 12 - List of abbreviations

Annex 1


Optimization of cryogenic parameters - Refrigerator/Freezer
R 134a
ti Cool [°C]
ti Fr. [°C]
Suction tube [°C]
Sensor Thermost. [°C]
P1 [W]
QA 91 C22 GAX5
200
150
100
50
0
-50
30
50
70
90
110
130
150
170
190
210
230
250
m [g]

Annex 2


H-FKW 134a
Mollier-h, lg p-Diagramm
für 1,1,1,2-Tetrafluorethan, CH_2F-CF_3,
berechnet mit Hilfe der Zustands-
gleichung von U.K. Rombusch
Druck p in bar;
Volumen v in dm³/kg;
Temperatur t in °C;
Enthalpie h in kJ/kg;
Entropie s in kJ/(kg · K)
Bezugspunkt: h' = 200,00 kJ/kg,
s' = 1,0000 kJ/(kg · K) bei t = 0 °C
Enthalpie h in kJ/kg
Druck p in bar
0 °C

Annex 3

SPECIFICATIONS OF MATSUSHITA COMPRESSOR

Model: FN77Q17G 220V-50Hz No. : QC206SP1AOA

Application:
Low back pressure
Refrigerant:
R12 (CCl_2F_2)
Design type:
Reciprocating connecting rod
Compressor cooling:
Static cooling

Evaporating temp. range:
-35 to -5℃ -31 to 23℉
Refrigerant control:
Capillary tube
Motor type:
RSIR
Voltage range:
165to250V,50Hz

	50 Hz	
Capacity *	191	W
	165	kcal/h
	655	Btu/h
Motor input *	180	W
Current *	1.20	A
C.O.P. *	1.06	
E.E.R. *	3.64	Btu/Wh
Displacement	7.69	cm^3
	0.469	in^3
Oil charge	250	cm^3
	15.3	in^3
Net weight	9.0	kg
	19.9	lbs
Rated current	1.36	A
Starting current	8.14	A
Winding resistance M	8.59	Ω
(T: 20℃ 68℉) S	30.5	Ω
High potential test	1650	V/s.
Residual moisture	150	mg
Impurities	15	mg

* Test conditions

Evaporating temp.:
-23.3℃ -10℉
Condensing temp.:
54.4℃ 130℉
Ambient temp.:
32.2℃ 90℉
Gas superheated to:
32.2℃ 90℉
Liquid subcooled to:
32.2℃ 90℉
Compressor shell temp.:
76℃ 170℉
Power source:
220V-50Hz
Oil:
FREOL S22
SUNISO 3GSD

Motor protector model	MM3-26GCA	
Opening temperature	120	℃
	248	℉
Closing temperature	61	℃
	142	℉
Trip current (T: 70℃ 158℉)	2.60	A
Trip current (T: 25℃ 77℉, t: 18 s.max)	7.0	A
PTC relay model	330M355	
Resistance (T: 25℃ 77℉)	33	Ω
Power consumption	3.5	W max.
Operating time	0.45 to 1.35	s.
Recovery time	65	s.max.
Starting capacitor	- μF,	- V
Running capacitor	- μF,	- V

Approved oils:

FREOL S22
SUNISO 3GSD

NOTES:

Annex 4

Calorimeter Measuring

date: 15.05.97

		TYPE:	QA 77 C17GAX5										Ashrae/ leaflet		
		Design:	R134a				Conditions:		220 V 50 Hz				rated value		
		Refr.:	R134a						to = -25 °C				Q0	176	>=158,4[W]
		Recording:	qa77c17 03/97 R134a Matsush./Electrostar						tf=tf1= 55 °C				P1	161	<=177,1[W]
		Beginning:	4/97						ta=tg1= 32 °C				COP	1,09	>=0,981[W/W]

Compr.No.	to °C	Ventilation	Qo W	P1 W	COP W/W	Uk V	I1 A	Qvol W/cm³	tw °C	tg3 °C	tsch °C	tko °C	tku °C	n l/s	special features
50186	-23,3	static	154,2	148,4	1,04	113	1,25	16,3	105,8	81,7	99,0	87,5	86,5	49,0	**ASHRAE**
Ø			154,2	148,4	1,04	113	1,25	16,3	105,8	81,7	99,0	87,5	86,5	49,0	
50186	-25	static	112,3	141,7	0,793	110	1,25	14,6	105,1	78,3	98,0	86,5	87,0	48,9	
64232	-25	static	121,0	146,5	0,826	113	1,25	15,7	105,1	80,0	100,0	83,0	85,0	49,0	
Ø			116,7	144,1	0,81	111,5	1,25	15,15	105,1	79,2	99,0	84,8	86,0	49,0	

Leaflet data deviate from the measuring

Cooling Capacity - ≈22 W No.50186, ≈15 W No. 64232

Input Power - ≈13 W No. 50186, ~7 W No. 64232 (calculated)

Annex 5

Calorimeter Measuring

date: 13.05.97

TYPE:	QA 91 C22 GAX5
Design:	Series Matsushita
Refr.:	R134a
Recording:	qa91c22gax 0597 electrostar
Beginning:	4/97
Conditions:	220 V 50 Hz
	to = -25 °C
	tf=tf1= 55 °C
	ta=tg1= 32 °C

	Ashrae /leaflet	
	rated value	demand
Q0	207	>=186,3[W]
P1	178	<=195,8[W]
COP	1,16	>=1,04[W/W]

Compr.No.	to °C	Ventilation	Qo W	P1 W	COP W/W	Uk V	I1 A	Qvol W/cm³	tw °C	tg3 °C	tsch °C	tko °C	tku °C	n l/s	special features
597	-15	static	247,7	225,0	1,101	130	1,58	27,1	102,6	100,5	99,0	87,0	87,0	48,5	
Ø			247,7	225,0	1,101	130	1,58	27,1	102,6	100,5	99,0	87,0	87,0	48,5	
597	-23,3	static	187,1	171,4	1,092	113	1,41	16,6	103,9	89,4	97,0	85,0	86,0	49,0	**ASHRAE**
Ø			187,1	171,4	1,092	113	1,41	16,6	103,9	89,4	97,0	85,0	86,0	49,0	
597	-25	static	135,3	166,4	0,813	112	1,4	14,8	105,2	86,8	97,5	84,0	86,0	48,9	
Ø			135,3	166,4	0,813	112	1,4	14,8	105,2	86,8	97,5	84,0	86,0	48,9	
597	-35	static	66,3	123,2	0,538	85	1,35	7,2	106,5	69,0	93,0	82,5	84,0	49,3	
Ø			66,3	123,2	0,538	85	1,35	7,2	106,5	69,0	93,0	82,5	84,0	49,3	

Leaflet data deviate from the measuring
Cooling Capacity - ≈ 20 W
Input power - ≈ 7 W

Annex 6

Compressor data collected on 10.03.97

Compressor type	: QA77C17GAX5	Compressor No. :	50186
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: compressor N. 5D186 in 50186		

Recording : qa77c17 03/97 R134a Matsushita/Electrostar

Calorimeter Data				Displacement	[cm³]	7,69
Conditions				Measuring date	06.03.1997	
				Worker	we	
Operating Current	[V]	:	220,0	Ventilation	static	
Condensing temperature	[°C]	:	55,0	Frequency	[Hz]	: 50
Ambient temperature	[°C]	:	32,0	Liquid subcooled to	[°C]	: 55
tg2 Outlet calorimeter	[°C]	:	32,0	tg1 Suction pipe	[°C]	: 32
				tf2 on valve	[°C]	: 32
1. Evaporating temperature	[°C]	:	-25,0	R cold	[Ohm]	: 9,5
Cooling capacity	[W]	:	112,3	R warm	[Ohm]	: 12,1
Input power	[W]	:	141,7	Constant heating V	[V]	: 0
COP	[W/W]	:	0,8	Constant heating C	[A]	: 0
Sweep voltage	[V]	:	110	Constant heating P	[W]	: 60
Current	[A]	:	1,25	Switch heating start	[time]	: 11 .13
Vol. Cooling Capacity	[W/cm³]	:	14,6	Switch heating end	[time]	: 12 .25
Winding temperature	[°C]	:	105,1	Switch heating duration	[s]	: 4345
Discharge pipe temperature	[°C]	:	78,3	Real power counter start	[KWh]	: 3,188
Temperature behind elec. casing	[°C]	:	98,0	Real power counter end	[KWh]	: 3,2825
Temperatur casing top	[°C]	:	86,5	Energy consumption	[KWh]	: 0,0945
Temperature casing bottom	[°C]	:	87,0	Energy consumption	[Ws]	: 340200
Revolution per minute	[1/s]	:	48,9	Heating power	[W]	: 78,297
Heating power total	[W]	:	138,3	factor	[-]	: 0,8122
Heating power total	[kcal/h]	:	118,94	Viscosity	[cSt]	: -

Compressor data

Compressor type	: QA77C17GAX5	Compressor No. :	50186
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: compressor N. 5D186 in 50186		

Recording : qa77c17 03/97 R134a Matsushita/Electrstar

Calorimeter Data				Displacement	[cm³]	7,69
Conditions like above listed				Measuring date	06.03.1997	
				Worker	we	
2. Evaporating temperature	[°C]	:	-23,3	R cold	[Ohm]	: 9,51
Cooling capacity	[W]	:	125,2	R warm	[Ohm]	: 12,14
Input power	[W]	:	148,4	Constant heating V	[V]	: 0
COP	[W/W]	:	0,84	Constant heating C	[A]	: 0
Sweep voltage	[V]	:	113	Constant heating P	[W]	: 75
Current	[A]	:	1,25	Switch heating start	[time]	: 13 .16
Vol. Cooling Capacity	[W/cm³]	:	16,3	Switch heating end	[time]	: 14 .27
Winding temperature	[°C]	:	105,8	Switch heating duration	[s]	: 4293
Discharge pipe temperature	[°C]	:	81,7	Real power counter start	[KWh]	: 3,3496
Temperature behind elec. casing	[°C]	:	99,0	Real power counter end	[KWh]	: 3,444
Temperatur casing top	[°C]	:	87,5	Energy consumption	[KWh]	: 0,0944
Temperature casing bottom	[°C]	:	86,5	Energy consumption	[Ws]	: 339840
Revolution per minute	[1/s]	:	49,0	Heating power	[W]	: 79,161
Heating power total	[W]	:	154,16	factor	[-]	: 0,8122
Heating power total	[kcal/h]	:	132,58	Viscosity	[cSt]	: -

Annex 6/1

Compressor data collected on 10.03.97

Compressor type	: QA77C17GAX5	Compressor No. :	64232
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	:		

Recording : qa77c17 03/97 R134a Matsushita/Electrostar

Calorimeter Data						
Conditions				Displacement	[cm³]	7,69
				Measuring date	06.03.1997	
				Worker	we	
Operating Current	[V]	:	220,0	Ventilation	static	
Condensing temperature	[°C]	:	55,0	Frequency	[Hz]	: 50
Ambient temperature	[°C]	:	32,0	Liquid subcooled to	[°C]	: 55
tg2 Outlet calorimeter	[°C]	:	32,0	tg1 Suction pipe	[°C]	: 32
				tf2 on valve	[°C]	: 32
1. Evaporating temperature	[°C]	:	-25,0	R cold	[Ohm]	: 9,64
Cooling capacity	[W]	:	121,0	R warm	[Ohm]	: 12,28
Input power	[W]	:	146,5	Constant heating V	[V]	: 0
COP	[W/W]	:	0,83	Constant heating C	[A]	: 0
Sweep voltage	[V]	:	113	Constant heating P	[W]	: 60
Current	[A]	:	1,25	Switch heating start	[time]	: 15.20
Vol. Cooling Capacity	[W/cm³]	:	15,7	Switch heating end	[time]	: 16.29
Winding temperature	[°C]	:	105,1	Switch heating duration	[s]	: 4143
Discharge pipe temperature	[°C]	:	80	Real power counter start	[KWh]	: 5,5002
Temperature behind elec. casing	[°C]	:	100,0	Real power counter end	[KWh]	: 3,6026
Temperatur casing top	[°C]	:	83,0	Energy consumption	[KWh]	: 0,1024
Temperature casing bottom	[°C]	:	85,0	Energy consumption	[Ws]	: 368640
Revolution per minute	[1/s]	:	49	Heating power	[W]	: 88,979
Heating power total	[W]	:	148,98	factor	[-]	: 0,8122
Heating power total	[kcal/h]	:	128,12	Viscosity	[cSt]	: -

Annex 7

Compressor data collected on 12.05.97

Compressor type	: QA91C22GAX5	Compressor No. :	597
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: choosed and delivered by Electrostar		

Recording : qa91c22 05/97 R134a Matsushita/Electrostar

Calorimeter Data				Displacement	[cm³]		9,1
Conditions				Measuring date	07.05.1997		
				Worker	we		
Operating Current	[V]	:	220,0	Ventilation	static		
Condensing temperature	[°C]	:	55,0	Frequency	[Hz]	:	50
Ambient temperature	[°C]	:	32,0	Liquid subcooled to	[°C]	:	55
tg2 Outlet calorimeter	[°C]	:	32,0	tg1 Suction pipe	[°C]	:	32
				tf2 on valve	[°C]	:	32
1. Evaporating temperature	[°C]	:	-15,0	R cold	[Ohm]	:	8,24
Cooling capacity	[W]	:	247,7	R warm	[Ohm]	:	10,42
Input power	[W]	:	225,0	Constant heating V	[V]	:	0
COP	[W/W]	:	1,1	Constant heating C	[A]	:	0
Sweep voltage	[V]	:	130	Constant heating P	[W]	:	230
Current	[A]	:	1,58	Switch heating start	[time]	:	10. 25
Vol. Cooling Capacity	[W/cm³]	:	27,1	Switch heating end	[time]	:	11. 51
Winding temperature	[°C]	:	102,6	Switch heating duration	[s]	:	5174
Discharge pipe temperature	[°C]	:	100,5	Real power counter start	[KWh]	:	6,8881
Temperature behind elec. casing	[°C]	:	99,0	Real power counter end	[KWh]	:	6,9965
Temperatur casing top	[°C]	:	87,0	Energy consumption	[KWh]	:	0,1084
Temperature casing bottom	[°C]	:	87,0	Energy consumption	[Ws]	:	390240
Revolution per minute	[1/s]	:	48,5	Heating power	[W]	:	75,423
Heating power total	[W]	:	305,42	factor	[-]	:	0,811
Heating power total	[kcal/h]	:	262,66	Viscosity	[cSt]	:	-

Compressor data

Compressor type	: QA91C22GAX5	Compressor No. :	597
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: choosed and delivered by Electrostar		

Recording : qa91c22 05/97 R134a Matsushita/Electrostar

Calorimeter Data				Displacement	[cm³]		9,1
Conditions like above listed				Measuring date	06.05.1997		
				Worker	we		
2. Evaporating temperature	[°C]	:	-23,3	R cold	[Ohm]	:	8,24
Cooling capacity	[W]	:	151,9	R warm	[Ohm]	:	10,46
Input power	[W]	:	171,4	Constant heating V	[V]	:	0
COP	[W/W]	:	0,89	Constant heating C	[A]	:	0
Sweep voltage	[V]	:	113	Constant heating P	[W]	:	105
Current	[A]	:	1,41	Switch heating start	[time]	:	10 .32
Vol. Cooling Capacity	[W/cm³]	:	16,6	Switch heating end	[time]	:	12 .00
Winding temperature	[°C]	:	103,9	Switch heating duration	[s]	:	5286
Discharge pipe temperature	[°C]	:	89,4	Real power counter start	[KWh]	:	6,1679
Temperature behind elec. casing	[°C]	:	97,0	Real power counter end	[KWh]	:	6,2884
Temperatur casing top	[°C]	:	85,0	Energy consumption	[KWh]	:	0,1205
Temperature casing bottom	[°C]	:	86,0	Energy consumption	[Ws]	:	433800
Revolution per minute	[1/s]	:	49,0	Heating power	[W]	:	82,066
Heating power total	[W]	:	187,07	factor	[-]	:	0,812
Heating power total	[kcal/h]	:	160,88	Viscosity	[cSt]	:	-

Annex 7/1

Compressor data collected on 12.05.97

Compressor type	: QA91C22GAX5	Compressor No. :	597
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: choosed and delivered by Electrostar		

Recording : qa91c22 05/97 R134a Matsushita/Electrostar

Calorimeter Data				Displacement	[cm³]		9,1
Conditions				Measuring date	30.04.1997		
				Worker	we		
Operating Current	[V]	:	220,0	Ventilation	static		
Condensing temperature	[°C]	:	55,0	Frequency	[Hz]	:	50
Ambient temperature	[°C]	:	32,0	Liquid subcooled to	[°C]	:	55
tg2 Outlet calorimeter	[°C]	:	32,0	tg1 Suction pipe	[°C]	:	32
				tf2 on valve	[°C]	:	32
3. Evaporating temperature	[°C]	:	-25,0	R cold	[Ohm]	:	8,24
Cooling capacity	[W]	:	135,3	R warm	[Ohm]	:	10,5
Input power	[W]	:	166,4	Constant heating V	[V]	:	0
COP	[W/W]	:	0,8	Constant heating C	[A]	:	0
Sweep voltage	[V]	:	112	Constant heating P	[W]	:	95
Current	[A]	:	1,4	Switch heating start	[time]	:	14.44
Vol. Cooling Capacity	[W/cm³]	:	14,8	Switch heating end	[time]	:	15.48
Winding temperature	[°C]	:	105,2	Switch heating duration	[s]	:	3857
Discharge pipe temperature	[°C]	:	86,8	Real power counter start	[KWh]	:	58186
Temperature behind elec. casing	[°C]	:	97,5	Real power counter end	[KWh]	:	58953
Temperatur casing top	[°C]	:	84,0	Energy consumption	[KWh]	:	0,0767
Temperature casing bottom	[°C]	:	86,0	Energy consumption	[Ws]	:	276120
Revolution per minute	[1/s]	:	48,9	Heating power	[W]	:	71,589
Heating power total	[W]	:	166,59	factor	[-]	:	0,8122
Heating power total	[kcal/h]	:	143,27	Viscosity	[cSt]	:	-

Compressor data

Compressor type	: QA91C22GAX5	Compressor No. :	597
Variant	: Electrostar Conversion		
Design	: R134a		
Remarks	: choosed and delivered by Electrostar		

Recording : qa91c22 05/97 R134a Matsushita/Electrostar

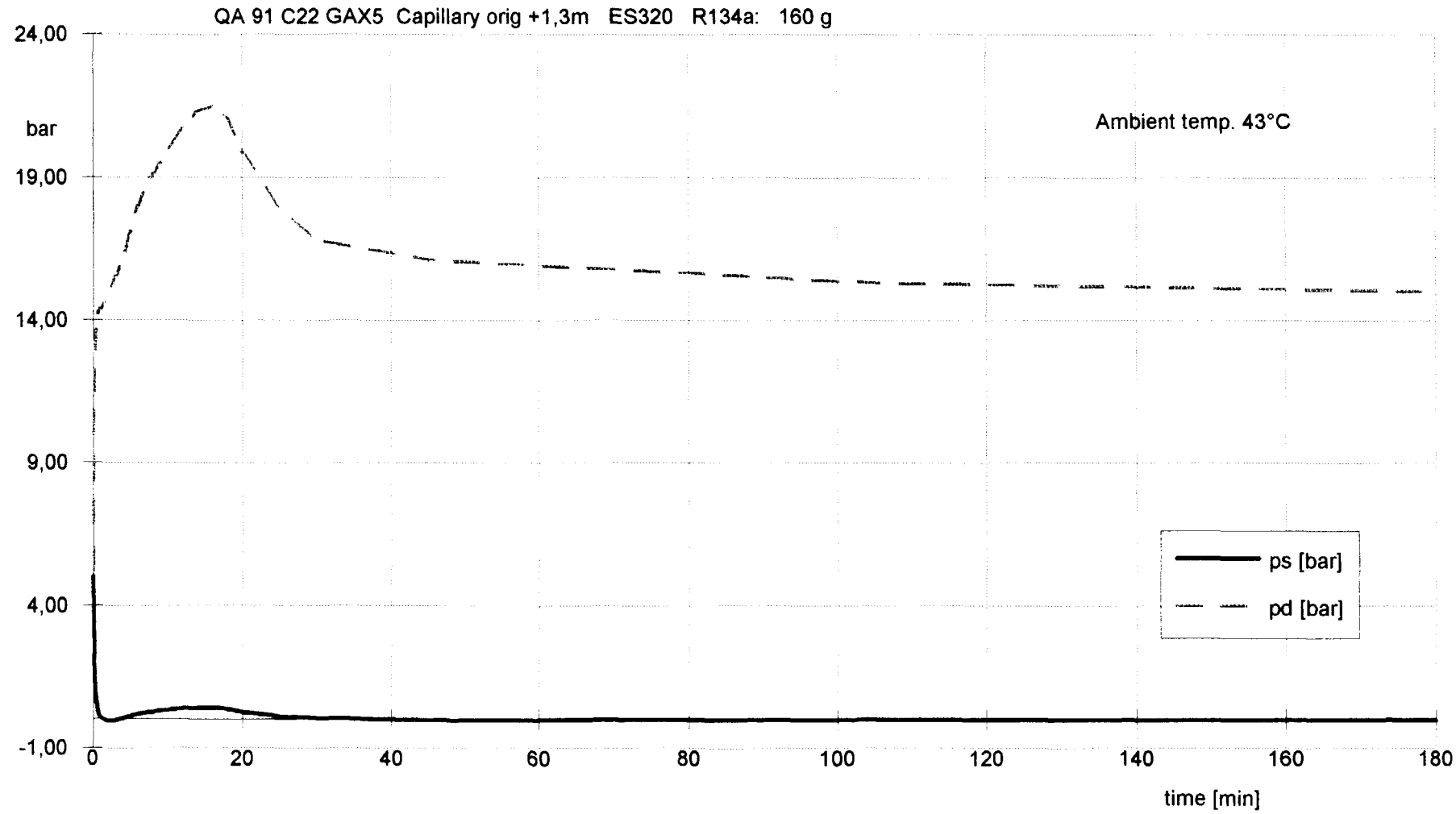
Calorimeter Data				Displacement	[cm³]		9,1
Conditions like above listed				Measuring date	30.04.1997		
				Worker	we		
4. Evaporating temperature	[°C]	:	-35,0	R cold	[Ohm]	:	8,24
Cooling capacity	[W]	:	66,3	R warm	[Ohm]	:	10,54
Input power	[W]	:	123,2	Constant heating V	[V]	:	0
COP	[W/W]	:	0,54	Constant heating C	[A]	:	0
Sweep voltage	[V]	:	85	Constant heating P	[W]	:	0
Current	[A]	:	1,35	Switch heating start	[time]	:	14. 31
Vol. Cooling Capacity	[W/cm³]	:	7,2	Switch heating end	[time]	:	16. 03
Winding temperature	[°C]	:	106,5	Switch heating duration	[s]	:	5519
Discharge pipe temperature	[°C]	:	69	Real power counter start	[KWh]	:	6,4711
Temperature behind elec. casing	[°C]	:	93,0	Real power counter end	[KWh]	:	6,5962
Temperatur casing top	[°C]	:	82,5	Energy consumption	[KWh]	:	0,1251
Temperature casing bottom	[°C]	:	84,0	Energy consumption	[Ws]	:	450360
Revolution per minute	[1/s]	:	49,3	Heating power	[W]	:	81,602
Heating power total	[W]	:	81,6	factor	[-]	:	0,813
Heating power total	[kcal/h]	:	70,18	Viscosity	[cSt]	:	-

Annex 8

		Pull down - Test		R134a		10.03.1997
		ta = 43 °C		start pressure: ps = 5,0 bar		
		Appliances: ES 320 Electrostar			pd = 5,2 bar	
time	Pressure		Pressure			R134a 160g
s / min	suction side		discharge side		Compressor : QA 91 C22 GAX5	
	[bar]		[bar]		Capillary : orig. +1,3m	
10"	2,16		11,50			
20"	1,01		13,20			
30"	0,59		14,00			
40"	0,29		14,20			
50"	0,15		14,30			
1	0,06		14,40			
2	-0,06		14,80			
3	-0,05		15,50			
4	0,02		16,20			
5	0,10		17,10			
6	0,17		18,00			
7	0,21		18,60			
8	0,25		19,10			
9	0,29		19,50			
10	0,31		20,00			
12	0,36		10,70			
14	0,39		21,50			
16	0,41		21,30			
18	0,35		21,00			
20	0,25		19,90			
25	0,10		18,00			
30	0,04		16,80			
45	-0,05		16,10			
100	-0,14		15,30			
180	-0,17		15,00			

Annex 8/1

Pull down test

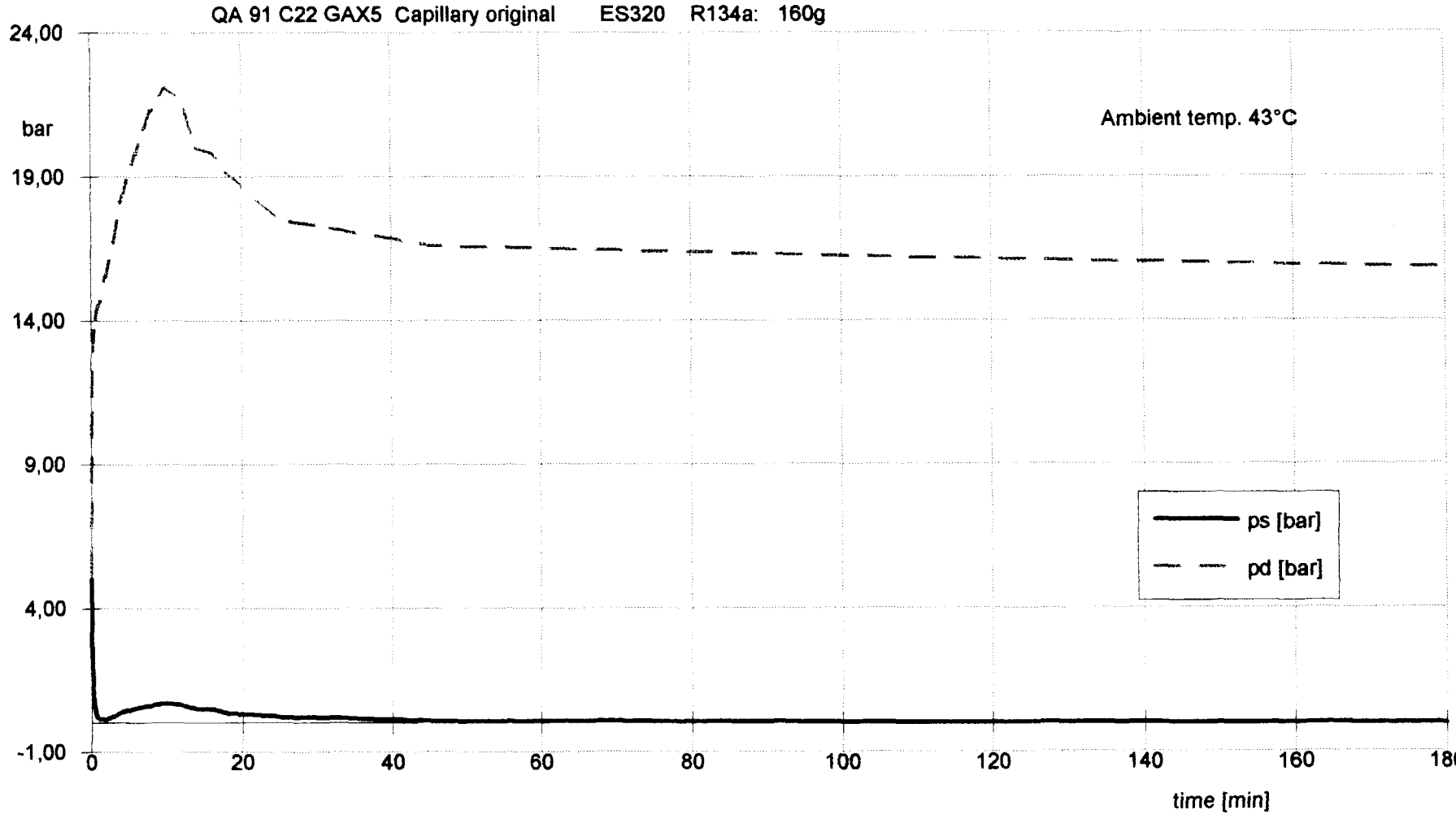


Annex 9

		Pull down - Test		R134a		04.04.1997
		ta = 43 °C		start pressure: ps = 5,0 bar		R134a 160 g
		Appliances: ES 320 Electrostar		pd = 5,2 bar		
time	Pressure		Pressure			
s / min	suction side		discharge side		Compressor : QA 91 C22 GAX5	
	[bar]		[bar]		Capillary : original	
10"	1,86		11,00			
20"	0,94		13,20			
30"	0,53		13,90			
40"	0,31		14,10			
50"	0,20		14,30			
1	0,15		14,50			
2	0,13		15,50			
3	0,24		16,70			
4	0,36		18,10			
5	0,45		19,00			
6	0,51		19,80			
7	0,58		20,60			
8	0,62		21,30			
9	0,66		21,80			
10	0,69		22,10			
12	0,61		21,70			
14	0,49		20,10			
16	0,48		19,80			
18	0,33		19,20			
20	0,29		18,70			
25	0,21		17,50			
30	0,19		17,30			
60	0,06		16,60			
100	0,00		16,20			
180	-0,05		15,50			

Annex 9/1

Pull down test

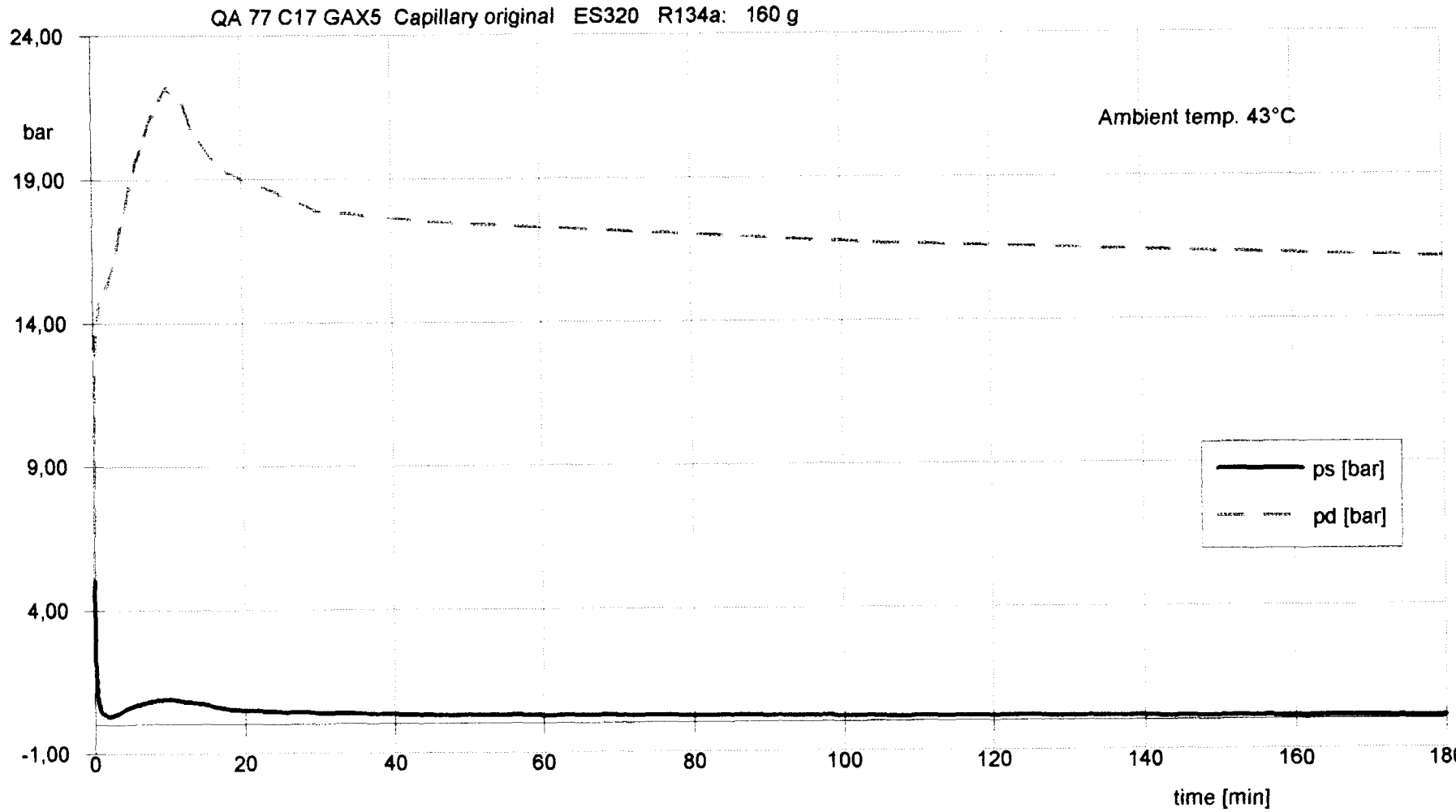


Annex 10

		Pull down - Test		R134a		22.04.1997
		ta = 43 °C		start pressure:	ps = 5,0 bar	R134a 160 g
		Appliances: ES 320 Electrostar			pd = 5,1 bar	
time	Pressure		Pressure			
s / min	suction side		discharge side		Compressor : QA 77 C17 GAX5	
	[bar]		[bar]		Capillary : original	
10"	2,29		11,00			
20"	1,35		13,00			
30"	0,88		13,80			
40"	0,66		14,20			
50"	0,49		14,50			
1	0,41		14,70			
2	0,27		15,30			
3	0,35		16,20			
4	0,52		17,60			
5	0,63		18,70			
6	0,70		19,70			
7	0,77		20,50			
8	0,82		21,20			
9	0,86		21,80			
10	0,88		22,20			
12	0,78		21,70			
14	0,73		20,40			
16	0,61		19,80			
18	0,52		19,30			
20	0,49		19,00			
25	0,43		18,50			
30	0,39		17,90			
60	0,29		17,50			
100	0,20		16,70			
180	0,10		15,80			

Annex 10/1

Pull down test

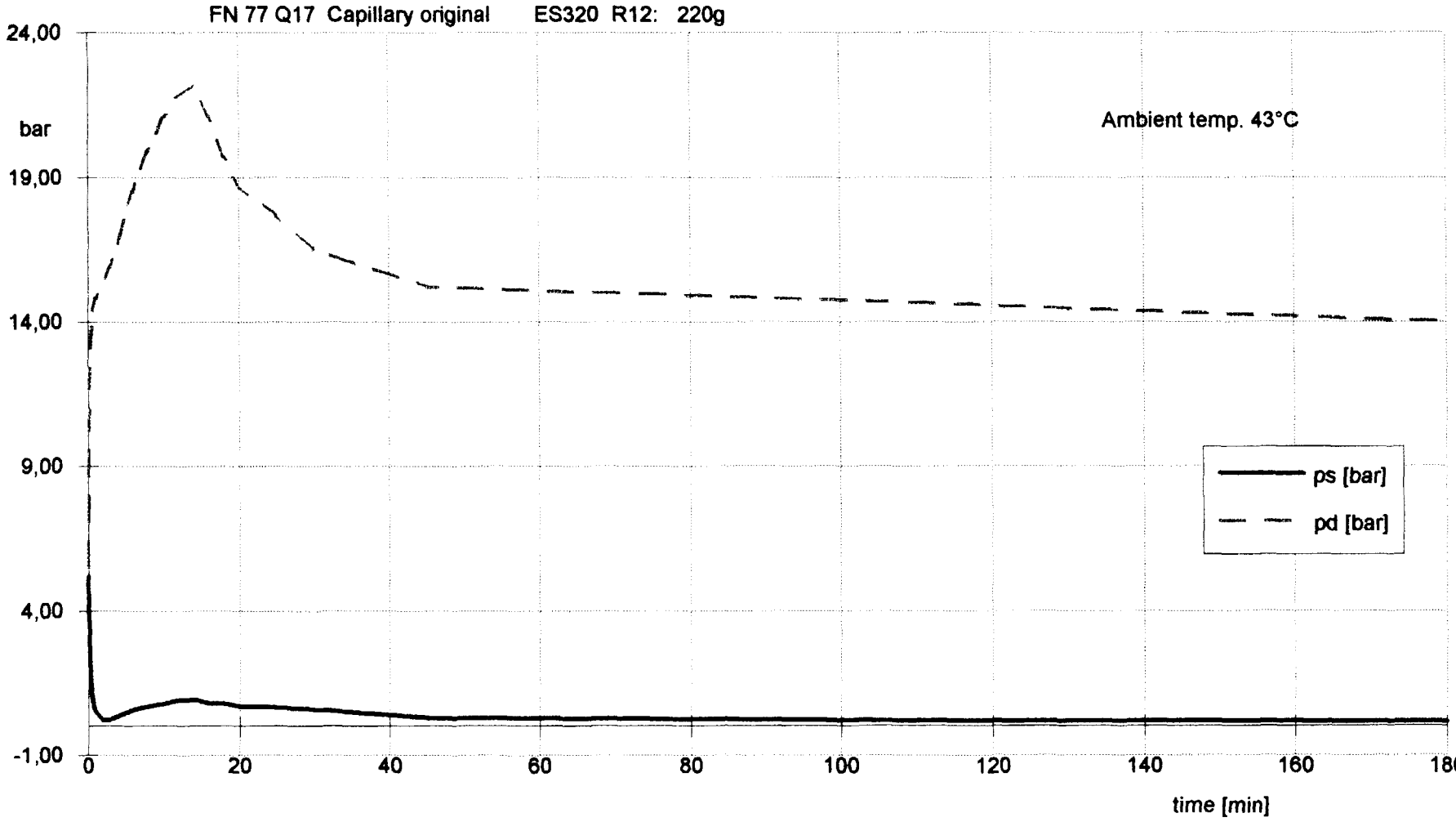


Annex 10A

		Pull down - Test		R12		29.05.1997
		ta = 43 °C		start pressure: ps = 5,3 bar		R12 220 g
		Appliances: ES 320 Electrostar			pd = 5,5 bar	
time	Pressure		Pressure			.
s / min	suction side		discharge side		Compressor : FN 77 Q17	
	[bar]		[bar]		Capillary : original	
10"	3,14		10,40			
20"	1,72		12,40			
30"	1,18		13,60			
40"	0,87		14,20			
50"	0,69		14,60			
1	0,52		14,80			
2	0,21		15,30			
3	0,24		15,90			
4	0,33		16,70			
5	0,47		17,70			
6	0,55		18,50			
7	0,63		19,30			
8	0,69		19,90			
9	0,74		20,50			
10	0,77		21,10			
12	0,89		21,80			
14	0,91		22,20			
16	0,76		21,10			
18	0,76		19,70			
20	0,69		18,70			
25	0,64		17,70			
30	0,58		16,50			
60	0,27		15,50			
100	0,20		14,70			
180	0,15		14,00			

Annex 10/A1

Pull down test



Annex 12

List of abbreviations
Verzeichnis der Abkürzungen

Data Calorimeter

to	Verdampfungstemperatur	Evaporating temperature
Qo	Kälteleistung	Cooling Capacity
P1	Leistungsaufnahme	Input Power
COP	Leistungszahl	Coefficient of Performance
Uk	Kippspannung	Sweep Voltage
I1	Betriebsstrom	Operating Current
Qvol	volumetrische Kälteleistung	vol. Cooling Capacity
tw	Wicklungstemperatur	winding temperature
tg3	Druckstutzentemperatur	Discharge pipe temperature
tsch	Temperatur unter Schutzkappe	Temperature behind elec.casing
tko	Temp. Kapsel oben	Temperature Casing top
tku	Temp. Kapsel unten	Temperature Casing bottom
n	Drehzahl	Revolution per minute
tf	Verflüssigungstemperatur	Condensing temperature
tfl	Unterkühlungstemperatur	Temperature of subcooled liquid
ta	Umgebungstemperatur	Ambient temperature
tg1	Sauggastemperatur	Suction gas temperature
R	Widerstand motor	Resistance motor

General Data

R12	Kältemittel Dichlordifluormrthan	Refrigerant
R134a	Kältemittel Tetrafluoräthan	Refrigerant
ti	Innentemperatur	Temperature inside
$t_{i\,Cool.}$	Durchschnittstemperatur $t_{1,2,3}$ Kühlfach	Temperature averrage $t_{1,2,3}$ cooling compartment
$t_{i\,Freez.}$	wärmste Temp. des wärmsten Paketes	warmest temp. of the warmest parcel
t_1	Innentemperatur Kühlfach oben	Temperature cooling compartment top
t_2	Innentemperatur Kühlfach mitte	Temperature cooling compartment middle
t_3	Innentemperatur Kühlfach unten	Temperature cooling compartment bottom
$t_{1,2,3}$	positon according to DIN EN 28 187 Annex 11b 6a)	

U	Betriebsspannung	Operating voltage
P	Leistungsaufnahme des Gerätes	Input Power of the appliances