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IRAN POUYA CO. « EX. GENERAL STEEL »
(Public Joint Stock Co.)
The Leading Manufacturer of Refrigerator, Freezer
and Aluminium Profile

176 p
table
graphs
diagrams

Our Ref.
Date

21473

CONVERSION OF DOMESTIC REFRIGERATOR PRODUCTION FACILITIES TO PHASE OUT CFC 11 AND CFC 12

IRAN POUYA COMPANY

FINAL REPORT

PROJECT NO. MP/IRA/94/403

UNIDO CONTRACT 94/095

PREPARED BY E. GHAFFARI

FACTORY, 4th Km. Old Karaj Rd.
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FIRST PROGRASSIVE REPORT

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CONVERSION OF DOMESTIC REFRIGERATOR PRODUCTION

FACILITIES TO PHASE OUT

CFC 12 AT IRAN POUYA CO.

PROJECT NO. MP / IRA / 94 /403

FIRST PROGRESS REPORT

PREPARED BY E. GHAFARI

P & D MANAGER

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SYNOPSIS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION IS CARRYING OUT A PROJECT TO HELP REDUCING OZONE DEPLETATION OF ATMOSPHERE BY ELIMINATION OF CFC GASES. THE PURPOSE OF THIS PROJECT IS TO PHASE OUT THE USE OF CFC 12 IN IRAN POUYA PRODUCTION FACILITIES.

THE AIM OF THE PROJECT IS TO DESIGN, CALCULATE FOR REIGERATOR MODEL REDEFINITION PROTOTYPING, AND TESTING PROTOTYPES FOR FUNCTIONALITY AND PERFORMANCE OF THEY DIFFERENT MODELS OF REFRIGERATOR AND FREEZER.

THE ALTERNATIVE GAS WHICH IS OZONE FRIENDLY IS REFRIGERANT CALLED HFC 134A, IT WILL BE USED IN PLACE OF CFC12.

THIS REPORT CONSISTS OF MODIFICATIONS, IN THE PHYSICAL DIMENSION OF COMPONENTE AND COOLING UNITS OF BOTH MODELS SO THAT THEY COULD RUN ON REFRIGERANT HFC 134A, WITH ACCEPTABLE PERFORMANCE.

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INTRODUCTION

IRAN POUYA MANUFACTURIN COMPANY PRODUCES ONE MODEL REFRIGERATOR, AND ONE MODEL FREZEER USING CFC12 AS A REFRIGERANT AT THE MOMENT.

IN THE FIRST PART OF THE REPORT ALL OF THE COMPONENTS OF PRESENT PRODUCT WILL BE UNDER CONSIDERATION, INCLUDING THE DIMENSLONAL SPECIFICATION, INSULATION AND PERFORMENCE DETAILS.

IN THE SECOND PART OF THIS REPORT, IS THE CLACULATION AND REDESIGN OF THE COMPONENTS AND ADAPTION FOR USING HFC 134A AS A REFRIGERENT. IN THE LAST PART IS THE SELECTION OF NEW COMPOMENTS AND SPECIFYING NECESSARY CHANGES IN THE CAPILLARY, EVAPORATOR AND CONDENSER. FINALLY THE PLAN PROCEDURE FOR DIFFERENT TESTS TO BE PERFORMED, IS GIVEN IN DETAIL.

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NUMBER OF MODELS

THE PRODUCTION OF IRAN POUYA CO. IS AS FOLLOWS AND THE SUBJECT OF THIS REPORT.

1- ONE DOOR REFRIGERATOR MODEL FRI1

2- UP RIGHT FREEZER MODEL FRF9

THE MAIN PRODUCTION IS REFRIGERATOR WITH 320 LITRE INSIDE VOLUME.

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PERFORMANCE STANDARDS

PERFORMAINCE TESTS AND DESIGN, CALCULATION OF REFRIGERATOR AND FREEZER ARE DONE UNDER THE FALLOWING INTERNATIONAL STANDARDS.

1- DEUTCH STANDARDS DIN 8950 FOR REFRIGERATOR

2- INSTITUTE OF STANDARDS AND INDUSTRIAL RESEARCH OF IRAN ISIRI 254FOR HOUSEHOLE REFRIGERATORS.

3- INTERNATIONAL STANDARD ORGNISATION ISO 8187 FOR HOUSEHOLD REFRIGERATING APPLIANCES.

4- ISIRI 2482 FOR HOUSEHOLD FREEZER AND FROZEN FOOD STORAGE CABINET.

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STANDARD TEST

THE NUMBER OF STANDARD TEST WHICH WILL BE CARRIED OUT ON REFRIGERATOR AND FREEZER ARE AS FOLLOWS.

1- DETERMINATION OF CABINET CONSTANT.

2- CONTINEOUS RUN TEST.

3- CYCLING TEST FOR CALASSIFICATION.

4- ENERGY CONSUMPTION TEST.

5- ICE FREEZE TEST.

THE AMBIENT CLIMET CONDITION OF TESTS WILL BE 43°C FOR THE TROPICAL DESIGN.

FOR ENERGY CONSUMPTION TEST THE AMBIENT TEMPERATURE WILL BE 32OC ACCORDING TO STANDARD.

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ONE DOOR REFRIGERATOR MODEL RIIF

A) DIMENTIONAL SPECIFICATIONS

1- OVERALL DIMENTIONS (L.W.D)	*1450X 660X 530 MM*
2- TOTAL GROSS VOLUME	*320 LIT.*
3- NET VOLUME	*282 LIT.*
4- FREEZING VOLUME	*29 LIT.*

B) INSULATION SPECIFICATIONS

1- TYPE OF INSULATION	*POLYURETHANE FOAM*
2- THICKNESS	*40 MM*
3- MOLLD DENSITY	*32 KG/M³*
4- FREE RISE DENSITY	*22 KG/M³*
5- WEIGHT PER UNIT	*3.5 KG*
6- K.FACTOR	*0.018 W/MK*

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C) REFRIGERATING UNIT COMPONENT DETAILS

1- COMPRESSOR:

COMPRESSOR TYPE	*HERMETIC*
MOTOR SIZE	*1/6 HP*
COOLING CARACITY (ASHRAE)	*106-110K CAL/H*
APPLICATION	*L.B.P*
WORKWG VOLTAGE	*220 V/50HZ*
CURRENT CONSUMPTION	*1 A*
COOLING SYSTEM	*STATIC*
VOLTAG RANGE	*164 - 240 V*
MOTOR TYPE	*RSIR*

2- CONDENSER:

CONDENSER TYPE	*WIRE ON TUBE*
TUBE SIZE	*3/16 "*
TUBE LENGTH	*1200 MM*
OVERALL SIZE(L.H.W)	*1019X 520 MM*
TUBE TYPE	*BUNDY*

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3- ***EVAPORATOR:***

EVAPORATOR TYPE	*ROLL BOUND*
EVAPORATOR NET VALUME	*370 CC*
EVAPORATOR TUBE LENGTH	*15760 MM*
EVAPORATOR SHEET THICKNESS	*1.4 MM*

4- ***CAPILLARY TUBE:***

LENGTH OF TUBE	*3000MM*
OUTSIDE DIAMETER	*1.83MM*
INSIDE DIAMETER	*0.71MM*
FLOW NITROGEN GAS AT 10BR	*4.5 LIT*

5- ***FILTER DRIER:***

TYPE OF DESSICENT	*MOLOCULARSIEVE XH*
DESSICENT WEIGHT	*7.5 GRAM*

6- ***HEAT EXCHANGER:***

TYPE OF HEAT EXCHANGER	*COAXIAL*

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7- CONTROL SYSTEM:

TYPE OF TERMOSTAT	*SEMI- AUT. PUSH BUTTOM DEF.*
CUT-IN AND CUT- OUT AT NORMAL SETTING	*-8,-16 oc*
DEFRAST CUT- IN	*+5 oc*

8- REFRIGERANT:

REFRIGERANT TYPE	*CFC 12*
CHARGE WEIGHT	*135GR*

D) WORKING PERFORMANCE

THE REFRIGERATOR WAS DESIGNED FOR TROPICAL CLASS AND TWO STAR RATING.

THE PERFORMANCE TEST IS CARRIED OUT AT 43°C AMBIENT TEMPERTURE .

THE RESULT ARE SHOWN IN PERFORMANCE TABLE.

E) ENERGY CONSUMITION

ACCORDING TO ENERGY CONSUMPTION TEST WHICK CARRIED OUT UNDER ISO STANDARD CONDITION

HAVING AMBEINT TEMPERATURE	*32°C*
REFRIGERATOR MEAN TEMPERATURE	*5°C*
EVEPORATOR MEAN TEMPERATURE	*-12°C*
THE ENERGE CONSUMPTION WAS	*1.6 KWH/24H*

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PERFORMANCE TEST

MODEL FRII	*RESULTS*
THEMOSTAT POSITION	*MORMAL*
COMPRESSOR POWER	*106-110 K CAL/H*
AMBIENT TEMP	*43°C*
VOLTAGE	*220V/50HZ*
EVAPORATOR AIR	*-12°C*
CABINET MEAN TEMP.	*+5°C*
CRISPER TEMP.	*+7°C*
PERCENTAGE WORKING	*70%*
ENERGY CONSUMPTION	*1.6 KWH/24H*

THIS PERFORMANCE TEST WAS DONE ON REFRIGERATOR WHICH RUNS ON CFC 12

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DESIGN AND CALCULATION

THE COOLING SYSTEM OF REFRIGERATOR MUST BE DESIGNED TO OVERCOME ALL THE POSSIBLE LEAKAGE AND WORK UNDER STANDARD REQUARMENTS.

THE STEPS FOR CALCULATION ARE TAKEN AS FOLLOWS

SELECTION OF COMPRESSOR

THE FALLOWING CALCULATION WAS DONE.

A) COOLING LOAD CALCULATION

THE COOLING LOAD ON REFRIGERATING EQUIPMENT SELDOM RESULTS FROM ONLY ONE SINGLE SOURCE OF HEAT RATHER IT IS THE SUMMATION OF THE HEAT WHICH USUALLY EVOLVES FROM SEVERAL DIFFERENT SOURCES. SOME OF THE MORE COMMON SOURCES OF HEAT THAT SUPPLY THE LOAD ON REFRIGERATING EQUIPMENT ARE:

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1- HEAT THAT LEAKS INTO THE REFRIGERATED SPACE FROM THE OUTSIDE BY CONDUCTION THROUGH THE INSULATED WALLS.

2- HEAT GIVEN OFF BY A WARM PRODUCT AS ITS TEMPERATURE IS LOWERED TO THE DESIRED LEVEL.

3- HEAT THAT IS BROUGHT INTO THE SPACE BY WARM OUTSIDE AIR ENTER IN THE SPACE WHEN DOOR IS OPENED.

B) WALL GAIN LOAD

THE QUANTITY OF HEAT TRANSMITTED THROUGH THE WALLS OF A REFRIGERATED SPACE PER UNIT OF TIME IS THE FUNCTION OF THREE FACTORS RELATIONSHIP AS EXPRESSED IN THE FOLLOWING EQUATION.

$$Q = A\ U\ D\ T$$

Q = RATE OF HEAT TRANSFERRED FROM WALL(W)

A = OUTSIDE SURFACE AREA OF THE WALL(M^2)

U = OVERALL COEFFICIENT OF HEAT TRANSMISSION IN $W/M^2/K$

TD = TEMPERATURE DIFFERANCE ACROSS THE WLL IN K

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TO DETERMINE U FACTOR

$$U = \frac{1}{\frac{1}{F_1} + \frac{X_1}{K_1} + \frac{X_2}{K_2} + \ldots\ldots \frac{X_N}{K_N} + \frac{1}{FO}}$$

WHERE

$\frac{1}{F1}$ = CONVECTION COEFFICIENT OF INSIDE WALL

$\frac{1}{FO}$ = CONVECTION COEFFICIENT OF OUTSIDE WALL

X = THICKNESS OF INSULATION OR METERIAL

K = TERMAL CONDUCTIVITY

COOLING LOAD CALCULATION FOR REFRIGERATOR:

IN THE REFRIGERATOR BECUSE OF HAVING TWO DIFFERENT TEMPERATURE IN ONE INSULATED CABINET SUCH AS IN EVAPORATOR -12^{oc} AND IN BOTTOM PART AVERAGE $+5^{oc}$.

WE CALCULAT EACH PART SEPARATELY ACCORDING TO THE DIMENTIONS OF REFRIGERATOR ON NEXT PAGE.

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1- DOOR

2- TOP

3- BACK

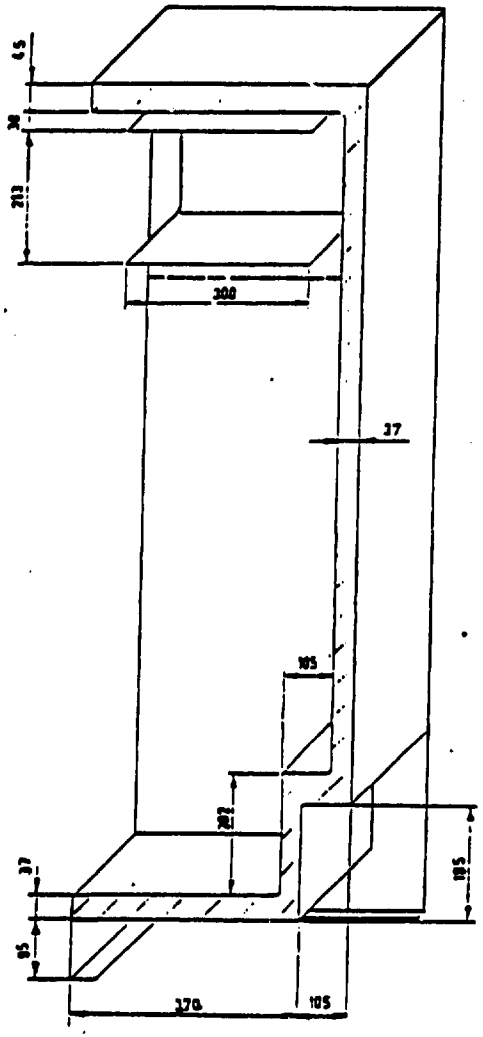
4- BOTTOM

5- LEFT

6- RIGT

7- BACK DOWN

8- BACK UP



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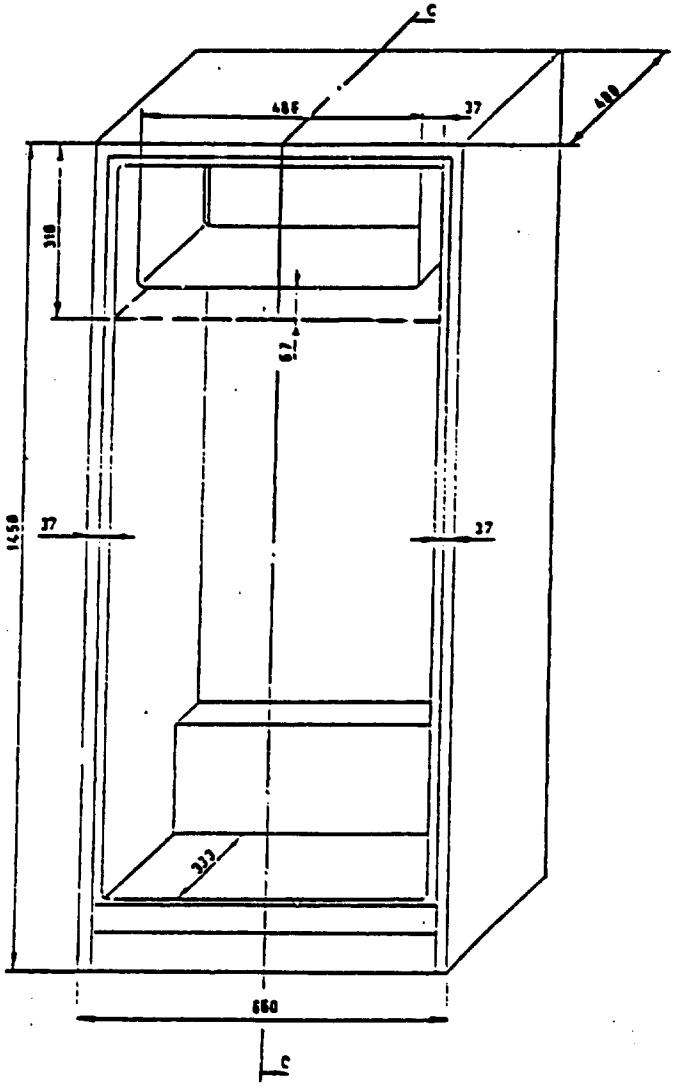

REFRIGERATOR MODEL FR11F

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HAVING KNOW K *INSULATION* $= 0.018$ *W/MK*

K *P. V. C* $= 0.17$ *W/MK*

K *P. S* $= 0.029$ *W/MK*

K *STEEL* $= 58$ *W/MK*

$FI = FO = 9.37$ *W/M2K*

$X2 = T2 = T5 = T6 = 0.9$ *MM*

$X2 = T4 = T7 = T8 = 0.75$ *MM*

$X2$ = *THICKNESS OF STEEL*

$X3$ = *THICKNESS OF P.S = 2MM*

$$\frac{1}{U} = \frac{1}{FO} + \frac{X1}{K1} + \frac{X2}{K2} + \frac{XN}{KN} + \frac{1}{FI}$$

BY USING ABOVE RELATION U FACTOR WILL BE FOUND FOR EACH SURFACE

$U_{1R} = 0.52857$ *W/M²K*

R = REFRIGERATOR PART $U_{1R} = 0.38286$ *W/M²K*

E = EVAPORATOR PART $U_2 = 0.35961$ *W/M²K*

$U_{3R} = 0.44939$ *W/M²K*

$U_{3E} = 0.44939$ *W/M²K*

$U4 = U5R = U5E = U6R = U6E = 0.43844$ *W/M2K*

$U7 = 0.44939$ *W/M²K*

$U8 = 0.333$ *W/M²K*

FOR P.V.C GASKET $U_G = 3.657$ *W/M²K*

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Q = AUDT

USING EQUATION

THE AREA

A_{IR} = 0.6864 M^2

A_{IE} = A3E = 0.2046 M^2

A_2 = 0.3168 M^2

A_{3R} = 0.5643 M^2

A_4 = 0.24235 M^2

A_{SR} = A6R = 0.38005 M^2

A_{SE} = A6E = 0.43844 M^2

A7 = 0.44939 M^2

A8 = 0.068775 M^2

P.V.C GASKET AE = 0.02318 M^2

" " AR = 0.05054 M^2

HAVING AMBINT TEMPERATURE 43°C AND THE AIR TEMPERATURE OF EVAPORATOR -12°C AND AVRAGE TEMPERTURE OF CABIN +5 C

THE SUMMATION OF COOLING LOAD IS.

QTOT = QIR +QIE +Q2 +Q2R +Q3E +Q4 +Q5R +Q6R +Q6E +Q7 +Q8 +QE +QR

QTOT = 77.256 W

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CALCULATION OF PRODUCT LOAD

WE CONSIDER A FEW NUMBER OF MATERIAL FOR CALCULATION OF PRODUCTION LOAD.

FRESH MEAT	*5KG*	*AT*	*3°C*	*CP= 3.14 KJ/KG*
BUTTER AND CHEAS	*1KG*	*AT*	*10°C*	*CP= 2.68 KJ/KG*
VAGETABLE	*4KG*	*AT*	*15°C*	*CP= 3.77 KJ/KG*
FRUITS	*5KG*	*AT*	*15°C*	*CP= 3.81 KJ/KG*
MILK	*1KG*	*AT*	*10°C*	*CP= 3.77 KJ/KG*
WATER	*1KG*	*AT*	*10°C*	*CP= 4 KJ/KG*

CP = SPECIFIC HEAT *W= WEIGHT IN KG*

USING EQUATION $Q = W\ CP\ DT$

Q1= 361.1 KJ

Q2= 13.4 KG

Q3= 150.8 KJ

Q4= 190.5 KJ

Q5= 20 KJ

Q6= 18.85 KJ

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$Q_{TOT} = Q1 + Q2 + Q3 + Q4 + Q5 + Q6$

$Q_{TOT} = 754.65KJ$

FOR THE FREEZING PART OF REFRIGERATOR

THE HEAT REMOVED OF PRODUCTS FROM INITIAL TEMPERATURE TO FREEZING POINT.

MEAT = 2KG *FREEZES AT - 0.5 °C*

FISH = 2KG *FREEZES AT - 2.25 °C*

$$Q = M\ CP\ DT$$

USING

$Q_{MEAT} = 178.98\ KJ$

$Q_{FISH} = 77.91\ KJ$

$Q_{TOTAL} = 256.89\ KJ$

REMOVING HEAT FROM FREEZING POINT TO - 12 °C

$Q_{MEAT} = 38.11\ KJ$ CP_{MEAT} *AFTER FREEZING*

$Q_{FISH} = 33.54\ KJ$ $CP_{FISH} = 1.72\ KJ/KG$

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$Q_{TOTAL} = QMEAT + QFISH$

$Q_{TOTAL} = 71.95$ KJ

REMOVAL OF HEAT FROM FROZEN PRODUCT

$$Q = W \times H$$

USING *WHERE* W = WEIGHT

H = LATENT HEAT

$Q_{MEAT} = 470$ KJ $H_{MEAT} = 228$ KJ/KG

$Q_{FISH} = 456$ KJ $H_{FISH} = 235$ KJ/KG

$Q_{TOTAL} = Q_{MEAT} + Q_{FISH}$

$QT = 926$ KJ

THE TOTAL PRODUCTION LOAD IS

$Q = Q1 + Q2 + Q3 + Q4$

$QT = 2009.49$ KJ

CONVERTING IN WATT FOR 70% WORKING IN 24H

$Q = 34.8869$ W/H

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THE TOTAL COOLING LOAD IS EQUALE TO THE WALL GAIN LOAD PLUS PRODUCTION LOAD PLUS TEN PERCENT FOR CHANGE LOAD AND SAFTY FACTOR.

$$QT = (QW + QP) \times 1.1$$

$$= 123.357 \text{ W/H}$$

$$= 106.148 \text{ KCAL/H}$$

SELECTION OF COOLING COMPONENTS:

AS WE CALCULATE THE TOTAL COOLING CAPACITY FOR REFREGIRATOR MODEL RF11

THE COMPRESSOR POWER MUST BE ABOVE 106.118 KCAL/H

WE SELECT THE COMPRESSOR WHICH HAS 110 KCAL/H FROM COMPRESSOR MANFACTUR CATALOGUE.

DETERMINATION OF CONDENSERS POWER :

THE TOTAL HEAT REJECTION AT THE CONDENSER INCLUDES BOTH THE HEAT ABSORBED IN THE EVAPORATOR AND THE ENERGY EQUIVALENT OF THE WORK OF COMPRESSION. ANY SUPERHEAT ABSORBED BY THE SUCTION VAPOUR FROM THE SURROUNDING AIR ALSO BECOMES A PART OF THE LOAD ON THE CONDENSER.

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CONDENSER POWER CAN BE DETERMINE IN DIFFERANT METHOD:

1- USING CONDENSER MANUFACTURE METHOD.

2- USING STANDARD HEAT TRANSFER FORMULA.

3- USING PRESSUR ENTHALPY CHART.

ARMCO. CONDENSER MANUFACTUR METHOD:

HAVING GOT THE POWER SUPPLIED BY THE COMPRESSOR AND EVAPORATING TEMPERATURE NECESSARY FOR A PARTICULAR REFRIGERATION CIRCUIT THE CONDNESERS THERMAL EFFICINCY KS CAN BE DETERMINED THROUGH THE FORMULA,

$$KS = \frac{S \times 1.25}{TD}$$

S = POWER SUPPLIED BY THE COMPRESSOR

1.25 = RATIO OF ENTHALPIES DIFFERANCE OF CONDENSATION AND EVAPORATION.

TD = 20 IS TEMPERATURE DIFFERANCE

THEREFOR KS = 6.9 KCAL/H

ACCORDING TO ARMCO. STATIC WIRED CONDENSERS MODE 15-51-176,18 WILL BE ACCEPTABLE AS SHOWN.

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USING STANDARD HEAT TRANSFER FORMULA :

FOR HERMETIC COMPRESSOR CONDENSER LOAD IS DETERMINE AS FOLLOWING FORMULA.

$$Q_{COX} = Q_{COM} + Q_{INP} - Q_D$$

WHERE:

Q_{COX} : *CONDENSER LOAD*

Q_{COM} : *COMPRESSOR CAPACITY*

Q_{INP} : *POWER INPUT*

Q_D : *AMUNT OF HEAT DISIPATED FROM COMPRESSOR SHELL*

TO DETERMINE QD USING

$$Q = A\,U\,D\,T$$

WHERE:

A = *COMPRESSOR SHELL AREA*

$U = (H + 16\varepsilon T^3)$

$H = 0.19\ DT \quad W/M^2K$

DT = *TEMPERATURE DIFFERANCE BETWEEN AMBIENT AND COMPRESSOR SHELL*

ε = *RADIATION COEFFICIENT OF SHELL*

T = *COMPREESSOR SHELL TEMPERATURE*

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HAVING GOT $Q_{con} = 127.6 W$

AND $Q_{LS} = 120 W$

Q. $Q_D = A(H + 46\varepsilon T^3)$

$Q_D = 53 W$

THEREFOR $Q_{con} = 127.6 + 120 - 53$

$= 191.6 W$

$= 167.3 K CAL/H$

HAVING GOT THE CONDENSER LOAD WE CAN SELECT THE RIGHT SIZE OF CONDENSER FROM DIFFERENT MANUFACTURE OR USING THE FORMULA

Q = A U D T AND CLCALATE THE U.FACTOR WHICH IS OVERALL COEFFICIENT OF HEAT TRANSMISSION OF CONDENSOR. THE SURFACE AREA OF CONDANSER CAN BE FOUND. ON THE OTHER HAND THE U.FACTOR OF CONDENSER CAN BE OBTAINED FROM CONDENSER SUPPLIERS.

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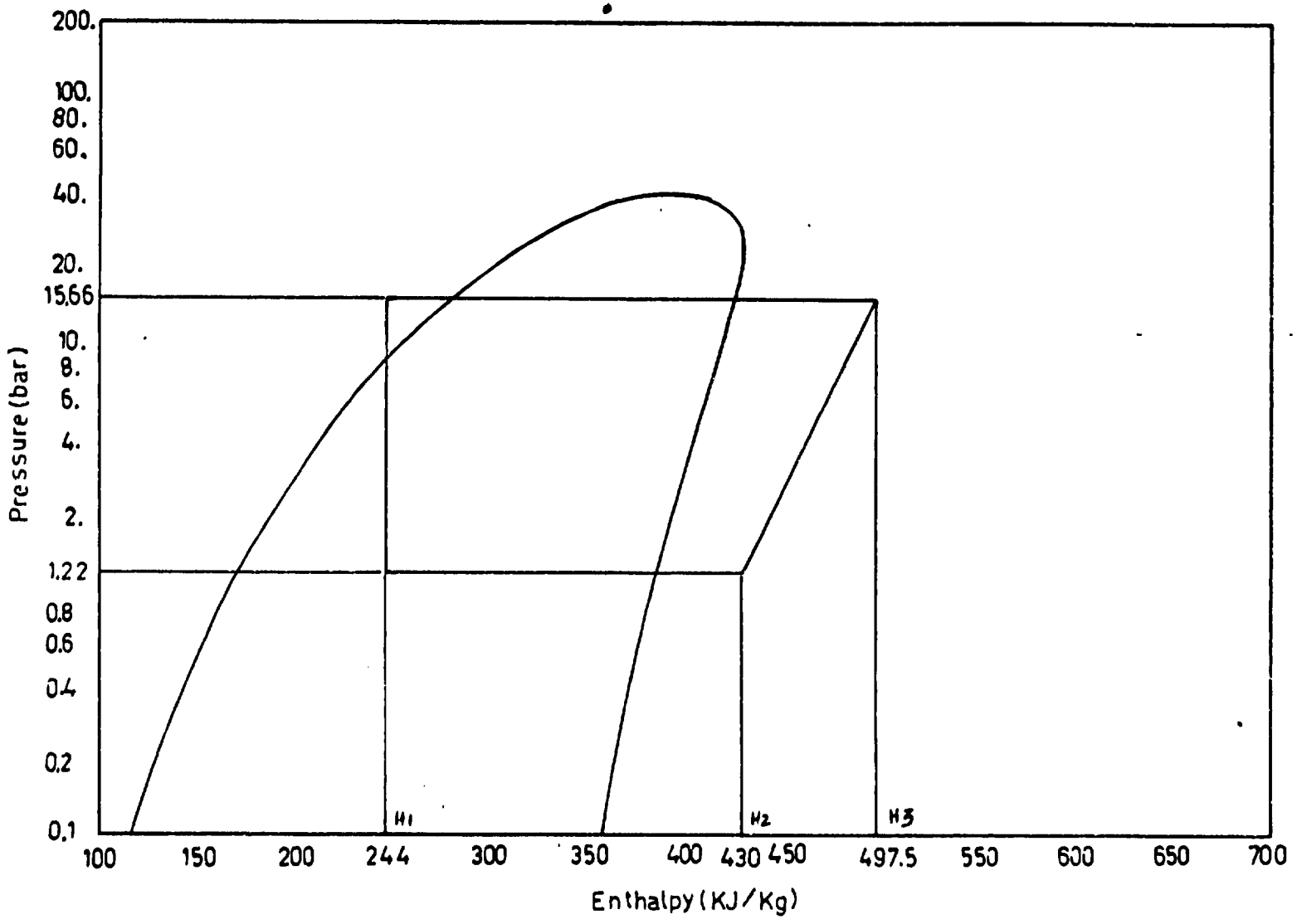
HFC_134a

Pressure —— Enthalpy Diagram



USING PRESSUR ENTHALPY CHART.

A REFRIGERATION CYCLE CAN BE DROWN ON PREESSURE ENTHALPY CHART AS SHOWN IN NEXT PAGE. THE CONDENSER LOAD CAN BE DETERMINED FROM THE CHART BY USING

$$Qcon = M[(H2 - H1) + (H3 - H2)]$$

Qcon = CONDENSER LOAD KCAL/H

M = MASSFLOW RAT KG/H

H = ENTHALPY KJ/KG

DETERMINATION OF CAPILLARY,S CAPACITY:

THE CAPACITY OF CAPILLARY TUBE DEPENDS ON LENGTH, INTERNAL DIAMETER, SURFACE SMOOTHNESS AND THE TYPE OF REFRIGERANT PASSING THROUGH IT.

THIS COMPONENT IS GENERALLY RECOMMENDED BY THE COMPRESSOR MANUFACTUR OR IS FOUND BY EXPERIENCE.

IF CONDENSATION TEMPERATURE 55°C AND COMPRESSOR MASS FLOW 2.3 KG/H OF R134A IS CONSIDERED FROM THE REFRIGERANT PROPERTIES TABLE OF R 134A AT - 30°C OF EVAPORATATION TEMPERATURE :

LIQUID : 0.720 L/KG

VAPOUR : 0.2215M³/KG

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FOR CALCULATION OF CAPILLARY CAPACITY IN L/MIN USING THE FORMULA.

$$PC = PF \times PSV \times \frac{1000}{60}$$

WHERE *PC = CAPILLARY CAPACITY IN L/MIN*

PF = THE QUANTITY OF R134 DELIVERED BY COMPRESSOR IN KG/H

Psv = SPECIFIC GRAVITY OF STEAM IN M /KG

1000 M = 1 LITER

1 HOUR = 60 MINUTES

$$Pc = 2.3 \times 0.2245 \times \frac{1000}{60}$$

$$Pc = 8.6077 \text{ L/MIN}$$

TO FIND THE CAPILLARY LENGTH USING

$$V_A = 2.35 \sqrt{P^2 - 1} \times Q^{2.5} \times L^{-0.5}$$

WHERE *V_A = PC = C APILLARY CAPACITY IN L/MIN*

P = CONDENSATION PRESSURE AT 55°C IN KG/CM²

P AT 55°C= 15.55 KG/CM2

Q = CAPILLARY INTERNAL DIAMETE 0.71 MM

L = LENGTH OF CAPILLARY IN MM

$$8.6077 = 2.35 \sqrt{15.55^2 - 1} \times 0.71^{2.5} \times L^{-0.5}$$

LENGTH *L = 3.28M*

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DETERMINATION OF EVAPORATOR:

THE CAPACITY OF ANY AVAPORATOR IS THE RATE AT WHICH HEAT WILL PASS THROUGH THE EVAPORATOR WALLS FROM THE REFRIGERATED SPACE OF PRODUCT TO THE VAPORIZING LIQUID INSIDE AND IS USUALLY EXPRESSED IN WATTS A EVAPORATOR SELECTED FOR ANY SPECIFIC APPLICATION SHOULD HAVE SUFFICIENT HEAT TRANSFER CAPACITY TO ALLOW THE VAPORIZING REFRIGERANT TO ABSORB HEAT AT THE RATE NECESSARY TO PRODUCE THE REQUIRED COOLING WHEN OPERATING AT THE DESIGN CONDITIONS.

THE EVAPORATING SURFACE IS CALCULATED BY FOLLOWING FORMULA

$$Q = A.\ U.\ TD$$

WHERE Q = *QUANTITY OF HEAT TRANSFERRED*

A = *OUTSIDE SURFACE AREA OF EVAPORATOR*

U = *OVERALL CONDUCTANCE FACTOR*

DT = *DIFFERANCE TEMPERATURE OF OUTSIDE THE EVAPRATOR AND REFRGERANT*

$$\frac{1}{U} = \frac{1}{FO} + \frac{X}{K} + \frac{1}{FI}$$

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$$\frac{1}{U} = \frac{1}{FO} + \frac{X}{K} + \frac{1}{FI}$$

$\frac{1}{FO} = \frac{1}{FI}$ = CONDUCTANCE FACTOR OF INSIDE AND OUTSIDE SURFACE

X = THICKNESS OF EVAPORATOR

K = THERMAL CONDUCTIVITY IN W/MK

$$\frac{1}{FO} = \frac{1}{FI} = \frac{1}{9.37}$$

X = 1.1 MM

K = 209.1 W/MK ALUMINUM

USING THE FORMULA

U = 1.6818 W/M K

$$Q = A\ U\ DT$$

USING $Q = A\ U\ DT$ WHERE $Q = 110$ KCAL/H = 127.6W

$110 = A \times 1.6818(-30 - 5)$ $T_1 = -30^{\circ}C$

A = 0.778 M2

$T_2 = +5^{\circ}C$

ONE SIDE AREA

A = 0.39M²

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UP RIGHT FREEZER MODEL FRFQ

A) DIMENTIONAL SPECIFICATIONS:

1- OVERALL DIMENTIONS (L.W.D)	1450 x 660 x 530MM
2- TOTAL GROSS VOLUME	255 LIT
3- NET VOLUME	230 LIT

B) INSULATION SPECIFICATIONS:

1- TYPE OF INSULATION	POLYURETHAN FOAM	
2- THICKNESS	60	MM
3- MOLD DENSITY	32	KG/M
4- FREE RISING DANSITY	22	KG/M
5- WEIGHT PER UNIT	6	KG
6- K.FACTOR	0.018	W/MK

C) REFRIGERATING UNIT COMPONEN:

1- **COMPRESSOR:**

COMPRESSOR TYPE	HERMETIC
MOTOR SIZE	1/4 HP
COOLING CAPACITY (ASHRAE)	160 KCAL/H
APPLICATION	L.B.P

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WORKING VOLTAGE	*220V/50HZ*
CURRENT CONSUMPTION	*1.5 A*
COOLING SYSTEM	*OIL COOLER*
VOLTAG RANGE	*161 - 240 V*
MOTOR TYPE	*RSIR*

2- ***CONDENSER:***

CONDENSER TYPE	*WIRE ON TUBE*
TUBE SIZE	*3 "* / *16*
TUBE LENGTH	*1200 MM*
OVERALL SIZE (L.H.W)	*1019 x 520 MM*
TUBE TYPE	*BUNDY*

3- *EVAPORATOR:*

EVAPORATOR TYPE	*WIRE ON TUBE*
EVAPORATOR NET VOLUME	*568 CC*
EVAPORATOR TUBE LENGTH	*18000 MM*
EVAPORATOR TUBE SIZE	*5"* / *16*

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4- *CAPILLARY TUBE:*

LENGTH OF TUBE	*3550 MM*
OUTSIDE DIAMETER	*2.06 MM*
INSIDE DIAMETER	*0.787 MM*
FLOW N_2 AT 10 BR	*6.5 LIT/100 PSI*

5- *FILTER DRIER:*

TYPE OF DESSICENT	*MOLOCULARSIEVE Hx6*
DESSICENT WEIGHT	*15 GR*

6- *HEAT EXCHANGER:*

TYPE OF HEAT EXCHANGER	*COAXIAL*

7- *DEWPOINT HEATER:*

TYPE OF HEATER	*GAS TUBE*
LENGTH OF TUBE	*5100 MM*
DIMENSION OF TUBE	*ID 1.76 MM OD 3.16 MM*

8- *CONTROL SYSTEM:*

TYPE OF TERMOSTAT	*NORMAL*

CUT - IN AND CUT - OUT AT NORMA SETTING -14°C, -22 °C

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9- *REFRIGERANT:*

REFRIGERANT TYPE	*CFC 12*
CHARGE WEIGHT	*230 GR*

D) WORKING PERFORMANCE

THE FREEZER IS DESIGNED FOR TROPICAL CLASS AND THREE STAR RATING THE PERFORMANCE TEST IS CARRIED OUT AT 13°C AMBIENT TEMPERTURE. THE RESULT IS SHOWN IN THE PERFORMANCE TABLE.

E) ENERGY CONSUMPTION

ACCORDING TO ENERGY CONSUMPTION TEST WHICH WAS CARRIED OUT UNDER ISO STANDARD CONDITION WITH AMBIENT TEMPERATURE 32°C AND CABINET MEAN TEMPERATURE -21°C AT THE STEADY STATE CONDITION THE ENERGY CONSUMPTION WILL BE 2.4 KWH/24H

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PERFORMENCE TEST OF FREEZER

MODEL FRF9	RESULTS
TERMOSTAT POSITION	NORMAL
COMPRESSOR POWER	160- 180 KCAL/H
AMBIET TEMPERATURE	13°C
VOLTAGE	220V/50HZ
CABINET MEAN TEMP.	21°C
EVAPORATIV TEMP.	-23°C
CONDENSING TEMP	+51°C
PERCENTAG WORKING	70%
ENERGY CONSUMPTION	2.4 KWH/24H

THIS PERFORMANCE TEST IS DONE ON FREEZER WHICH RUN WITH REFRIGERENT CFC 12.

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DESIGN AND CALCULATION

FOR THE SELECTION OF COMPRESSOR THE FALLOWING CALCULATION HAS TO BE DONE.

COOLING LOAD CALCULATION WHICH CONSISIS OF

1- WALL GAIN LOAD:

THE AMUNTE OF HEAT TRANSMITTED THROUGH THE WALLS OFA REFRIGERATED SPACE PER UNIT OF TIME IS CALCULATED BY EQUATIONS GIVEN BELOW.

$$Q = A\ U\ DT$$

AND

$$U = \frac{1}{\frac{1}{FI} + \frac{X1}{K1} + \frac{X2}{K2} + \ldots\ldots + \frac{XW}{KN} + \frac{1}{FO}}$$

ALL FACTORS OF EQUATION ARE THE SAME AS IN REFRIGERATOR. THE ONLY DIFFERANCE IS THICKNESS OF INSULATION.

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THEREFOR $X1 = 60$ MM

$U_{1F} = 0.1085$ W/M2K

$U_{2F} = U3F = U1F = U5F = U6F$

$U_{7F} = U8F = 0.291$ W/M2K

FOR P.V.C GASKAT $U_F = 3.657$ W/M2K

HAVING THE AREA OF ALL SIDES

$A1F = 0.891$ M^2

$A2F = 0.3163$ M^2

$A3F = 0.7689$ M^2

$A1F = 0.21235$ M^2

$A5F = A6F = 0.181857 M^2$

$A7F = 0.1221$ M^2

$A8F = 0.068775$ M^2

P.V.C GASKET $AGF = 0.07372$

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$$Q = A\ U\ DT$$

USING EQUATION $TI = 43^{oC}$

FOR EACH WALL

$Q1F = 22.202\ W$

$Q2F = 5.43\ W$

$Q3F = 13.179\ W$

$Q4F = 4.154\ W$

$Q5F = 8.259\ W$

$Q6F = 8.259\ W$

$Q7F = 2.0929\ W$

$Q8F = 1.178\ W$

P.V.C $QGF = 16.415\ W$

THE TOTAL $QT = Q1+ Q2+ Q3+ Q4+ Q5+ Q6+ Q7+ Q8+ QG$

THE TOTAL WALL GAIN LOAD IS.

$QT = 81.1999W$

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1- DOOR

2- TOP

3- BACK

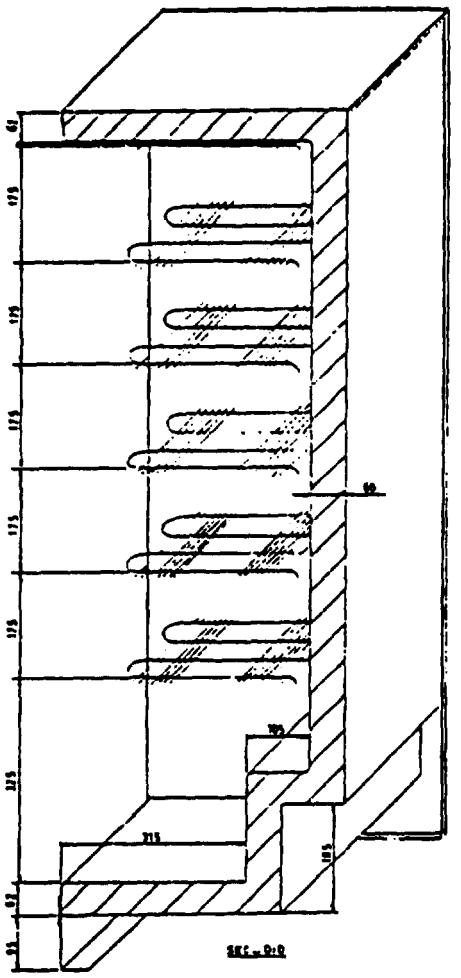
4- BOTTOM

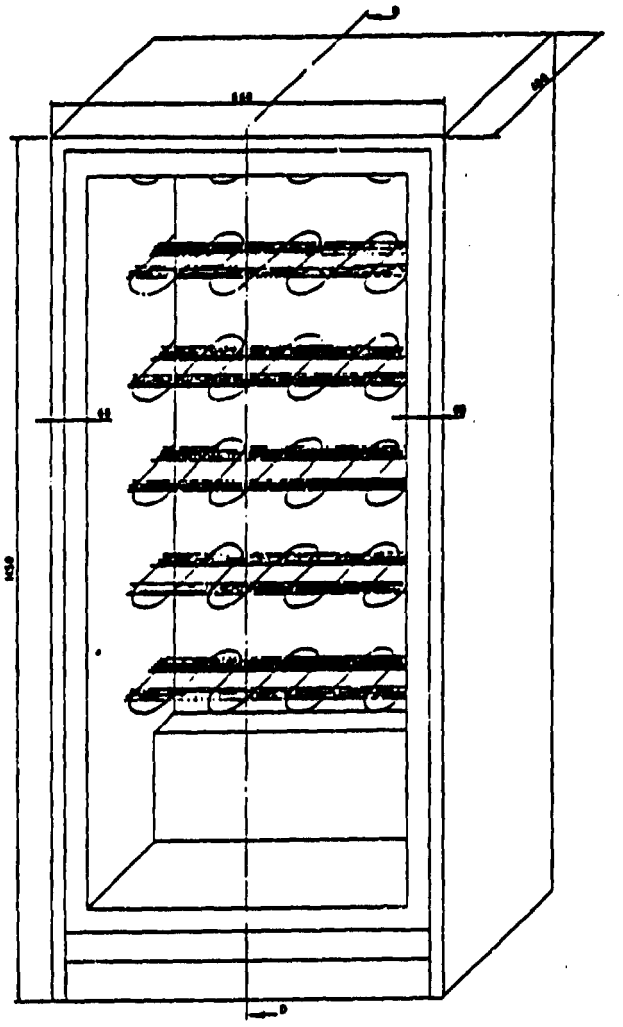
5- LEFT

6- RIGT

7- BACK DOWN

8- BACK UP





UP RIGHT F REEZER MODEL FR9F

2- PRODUCTION LOAD CALCULATION:

ACCORDING TO THE FACTORY STANDARD WE CONSIDER FOUR KIND OF MATERIAL WITH MAXIMUM TEMPERATURE FOR CALCULATION.

NAME	WEIGHT	INITIAL TEMP.	FREEZING POINT	CP BEFOR FREEZING	CP AFTER FREEZING	LATENT HEAT
POULTRY	1KG	28°C	-2.75°C	3.18KJ/KGK	1.55KJ/KGK	246KJ/KGK
BEEF	1KG	28°C	-0.5°C	3.14 "	1.67 "	228 "
FISH	3KG	15°C	-2.25°C	3.18 "	1.72 "	235 "
VAGETABLE	3KG	15°C	-1.25°C	3.64 "	1.97 "	277 "

TO FIND THE AMOUNT OF HEAT REJECTED FROM THE PRODUCTS FROM INITAL TEMPERATURE TO FREEZING POINT USING.

$$Q = M\ CP\ DT$$

$QP = 391.11$ KJ

$QB = 357.96$ KJ

$QF = 161.565$ KJ

$QV = 177.15$ KJ

$Q1 = QP + QB + QF + QV$

$Q1 = 1001.115$ KJ

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THE LOAD FROM FREEZING POINT TO - 18 °C

QP = 91.55 KJ

QB = 116.9 KJ

QF = 81.27 KJ

QV = 98.9925

Q2 = 391.7125 KJ

THE HEAT REMOVAL FROM FROZEN PRODUCTS

$$Q = W H$$

USING *W = WEIGHT*

H = LATENTHEAT

QP = 981 KJ

QB = 912 KJ

QF = 705 KJ

QV = 831 KJ

Q3 = 3132 KJ

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THE TOTAL PRODUCTION LOAD IS

$$QT = Q1 + Q2 + Q3$$

$$QT = 4911.8275 \text{ KJ}$$

CONVERTING IN WAT AND CONSIDERING 70%0 WORKING IN 24H

$$Q = 183.179 \text{ W}$$

OR $Q = 157.625$ KCAL/H

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SELECTION OF COOLING COMPONENTS

HAVING CALCULATE THE TOTAL COOLING LOAD OF FREEZER, THE COOLING CAPACITY OF COMPRESSOR MUST BE ABOVE THE COOLING LOAD.

THEREFORE COMPESSOR REAQARED FOR THIS FREEZER MUST HAVE COOLING CAPACITY BTWEEN 160 KCAL/H TO 180 KCAL/H

AS THE CONDENSER IS STATIC COOLED AND DEW-POINT HEATER IS GAS TYPE AND WILL ACT AS SMALL CONDENSER THEREFOR THE OIL COOL TYPE COMPRESSOR MUST BE SELECTED.

DETERMINATION OF CONDENSER POWER:

USING CONDENSER MANUFACTUR METHOD.

THE TOTAL HEAT REJECTION AT THE CONDENSER EQUALS TO COMPRESSOR CAPACITY + POWER INPUT HAVING GOT THE POWER SUPPLIED BY THE COMPRESSOR USING THE FORMULA TO FIND THE RIGHT SIZE OF CONDENSER.

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$$KS = \frac{S \times 1.25}{TD}$$

S = POWER SUPPLED BY THE COMPRESSOR KCAL/H

TD = 20 TEMPERATURE DIFFERNLCE

KS = THERMAL EFFICINCY

1.25 = RATIO ENTHALPLES DIFFERANCE OF CONDENSATION AND EVAPORATION

S = 160 KCAL/H

THERE FOR KS = 10 KCAL/H

ACCORDING TO ARMCO. STATIC WIRED CONDENSERS MODE 45 - 51 - 476, 24 WILL BE CONSIDERED BUT BECUSE THERE IS A DEWPONT GAS HEATER WHICH ACT AS A SMALL CONDENSER PRACTICALY MODE 45 - 51 - 476, 20 WILL BE ACCEPTABLE FOR THIS FREEZER.

USING STANDARD HEAT TRANSSFER FORMULA.

FOR HERMETIC COMPRESSOR CONDENSER LOAD IS DETERMINE AS FOLLOW.

$$Q_{CON} = Q_{COM} + Q_{INP} - Q_D$$

AS WE HAVE $Q_{COM} = 185.6\ W$

$Q_{INP} = 162\ W$

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$Q_D = A(H + 46\varepsilon T^3)$

SHELLAREA $A = 0.11369M^2$

$H = 0.19\ DT$

THERE FOR $Q = 62.8\ W$

BY USING THE MAIN EQUATION CONDANSER LOAD

IS $QCON = 284.8\ W$

WKICH IS $QCON = 245\ KCAL/H$

HAVING GOT THE CONDANSER LOAD WE CAN CALCULATE U.FACTOR VALUE OR GET IT FROM CONDANSER SUPPLIER. USING THE FORMULA Q = A U DT

THE SURFACE AREA OF CONDANSER CAN EASLY BE CLCALATED OR SELECT THE RIGHT SIZE FORM SUPPLIYER CATOLUG.

DETERMINATION OF CAPILLARYS CAPACITY:

THE SIZE OF CAPILLARY TUBE MOST BE DETERMINED BY PRACTICAL EXPERIENCE OR AS GIVEN BY COMPRESSOR MANUFACTURER.

ASSUMING CONDENSATION TEMPERATURE OF HFC 134A IS 55°C AND COMPRESSOR MASSFLOW IS 2.7 GR/H OF REFRIGERANT.

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ON R134A PROPERTIES TABLE AT - 30°C OF EVAPORATIVE TEMPERATURE

LIQUID : 0.720 L/KG

VAPOUR : 0.2245 M³/KG

USING FALLOWING EAQATIO FOR CALCULATION OF CAPILLARY CAPPAC.TY.

$$Pc = P_F \times P_{SV} \times \frac{1000}{60}$$

WHERE Pc = *CAPILLARY CAPACITY IN L/MIN*

P_F = *THE AQANTITY OF R134A DELIVERED BY COMPRESSOR IN KG/H*

P_{SV} = *SPECIFIC GRAVITY OF STEAM IN M/KG*

THEREFOR
$$Pc = 2.7 \times 0.2245 \times \frac{1000}{60}$$

$Pc = 10.105$ *L/MIN*

TO FIND THE CAPILLARY LENGTH USING RELATION

$$V_A = 2.35 \sqrt{P^2 - 1} \times A^{2.5} \times L^{-0.5}$$

$V_A = PC$ = *CAPILLARY CAPACITY IN L/MIN*

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P = CONDANSATION PRESSURE AT 55^{oc} KG/CM^2

P = 15.55 KG/CM^2

A = CAPILLARY INTERNAL DIAMETER 0.787 MM

L = LENGTH OF CAPILLARY IN MM

$10.105 = 2.35 \sqrt{15.55^2 - 1} \times 0.787^{2.5} \times L^{-0.5}$

THEREFOR $L = 3.93M$

FROM EXPERIENCE $L = 4$ M

DETERMINATION OF EVAPORATOR:

THE CAPACITY OF EVAPORATOR THAT IS THE RATE AT WHICH HEAT PASSES THROUGH THE WALLS AND EQUALE THE RATE OF HEAT FLOW BY CONDUCTION THROUGH ANY HEAT TRANSFER SURFACE AND IS EXPRESSED BY THE EQUATION.

$$Q = A\,U\,D\,T$$

U = OVERALL CONDUCTANCE FACTOR

$U = 9.4$ W/M^2K FOR EVAPORATOR MADE UP BY STEEL TUBE AT- 18^{oc} AIR TEMPERATURE AND -30^{oc} REFRIGERANT TEMPERATURE

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$Q = 160$ KCAL/H $= 185.6$ W

$T = 12^{oC}$

APPLYING THE FORMULA $Q = AUDT$

$185.6 = A \times 9.4 \times 12$

$A = 1.64\ M^2$

ALWAYS FOR CONSTRUCTIVE REASONS THE DIMENTION OF OUR EVAPORATOR FOR EACH LEVEL OF FREEZER IS 513x320 MM. FOR ALL SIX LEVEL 1.64 M2 IS SUFFICIENT.

NECESSARY CHANGES REQUIRE IN THE CODLING COMPONENTS BY USING HFC 134A IN REFRIGERATOR AND FREEZER

1- CONDENSER AND EVAPORATOR:

ACCORDING TO OUR CALCULATION AND LABORATORY TESTS THE SIZE OF THESE COMPONENTS CAN BE THE SAME FOR 134A AS IT WAS FOR CFC 12.

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2- ***CAPILLARY TUBE:***

ALTHOUGH SOME COMPRESSOR MANUFACTURE HAVE RECOMENDED TO INCREASE 10-15% ON CAPILLARY LENGTH BUT THE LABORATORY TESTS SHOWES NO NEED FOR ANY CHANGES

3- ***DRYER:***

DESSIGENT XH5 WHICH IS USED FOR CFC12 HAS TO BE CHNGED TO XH6 AND XH9 FOR HFC 134A GASES

4- ***REFRIGERANT CHARGE:***

THE AMOUNT OF REFRIGERANT CHARGE ON THE COOLING SYSTEM MUST BE REDUCE TO BY 10% BECUSE OF THERMODYNAMIC PROPERTY OF 134A IN THE SYSTEM.

5- ***COMPRESSOR:***

ACCORDING TO THE THERMODYNAMIC PROPERTY OF R134A THE DESIGN OF COMPRESSOR WILL CHANGE AND ALSO THE TYPE OF OIL WHICH USE AS LUBRICANT. MINERAL OILS ARE NOT SUITABLE AS LUBRICANT WITH HFC 134A DUE TO INSUFFICIENT MISCIBLITY AND LUBRICITY.

POLYOL ESTER IS MISCIBLE WITH HFC-134A WHICH IS THE BEST REPLACEMENT OIL.

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COMPRESSOR CAPACITY DUE TO DIFFERENCES OF PROPERTIES BETWEEN R 134A AND R12 A BUT 10-15% CAPACITY DROP WILL OCCUR AT -23.3°C AND 20-30% AT -30°C WITH O.T ANY MODITICATION ON SYSTEM DESIGN.

THIS CAPACITY DROP MUST BE COMPENSATED BY THE IMPROVEMENT OF COMPRESSOR DESIGN.

VACUUM AND LEAK DETECTION :

AS THE MOLECULE SIZE OF R134A IS SMALLER THAT OF R12, R134A WILL TEND TO LEAK MORE EASILY THAN R12. ADDITIONAL CARE IS NEEDED IN PIPE WELDING. MAXIMUM ACCEPTABLE SYSTEM MOISTURE IS 100MG. EVACUATION TO 0.3 - 0.5 MM HG IS RECOMMENDED.

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REFRIGERATION CYCLE COMPARISON

R134A HAS BEEN DEVELOPED AS SUBSTITUTE FOR R12, BUT IS NOT A DIRECT REPLACEMENT. NATURALLY THE THERMODYNAMIC PROPERTIES OF R134A ARE NOT IDENTICAL TO THOSE OF R12.

THE FIGURE SHOWS ASIMULATED REFRIGERATION PROCESS PLOTTED ON PRESSURE/ENTHALPY DIAGRAMS FOR R12 AND R134A

A COMPARISON TABLE WILL BE PREPARED TO COMPERE ALL COMPRESSOR CAPACITIES WITH RESPECT TO ACTUAL COOLING CAPACITY REQUIRED FOR EACH MODEL.

IN COMPARISON UNDER L.B.P CONDITIONS THE VOLUMETRIC REFRIGERATION CAPACITY IS LESS FOR THAN R12. UNDER H.B.P CONDITIONS IT IS HIGHER.

THE PRESSURE/ ENTHALPY DIAGRAMS SHOW THAT THE LATENT HEAT FOR R134A IS SIGNIFICANTLY HIGHER THAN FOR R12. THIS MEANS LESS MASS FLOW FOR A GIVEN CAPACITY.

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THE STANDARD TEST CONDITION FOR PERFORMANCE TEST FOR COMPRESSOR ARE AS FOLLOWS.

THIS TEST IS UNDER ASHRAE CONDITIONS.

1- EVAPORATING	*TEMPERATURE*	*-23.30C*
2- RETURN GAS	*TEMPERATURE*	*320C*
3- CONDENSING	*TEMPERATURE*	*54.40C*
4- AMBIENT	*TEMPERATURE*	*320C*
5- LIQUID	*TEMPERATURE*	*320C*

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REFRENCE

1) DEUTCH STANDARDS DIN 8950 FOR REFRIGERATOR.

2) I S O 8187 FOR HOUSEHOLD REFRIGERATING APPIANCES.

3) INSTITUTE OF STANDARDS AND INDUSTRIAL RESERCH OF IRAN ISIRI 254 FOR HOUSEHOLD REFRIGERATORS.

4) ISIRI 2482 FOR HOUSEHOLD FREEZER AND FROZEN FOOD STORAGE CABINET.

5) ASHRAE HANDBOOK.

6) PRINCIPLES OF REFRIGERATION FROM ROY J.DOSSAT.

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50 HZ MODEL COMPARISON CHART

R-12 MODEL	COOL'G CAPACITY (Kcal / BTU)/Hr	INPUT (WATT)	E.E.R. (BTU/W.Hr)	R-134a MODEL	COOL'G CAPACITY (Kcal / BTU)/Hr	INPUT (WATT)	E.E.R. (BTU/W.Hr)	RECOMMENDED MODEL
VS 24 AJG	48 / 191	82	2.3	VS 24 LAEG VS 28 LAEG	43 / 171 55 / 218	78 80	2.2 2.7	VS 28 LAEG
VS 28 AJG	56 / 222	88	2.5	VS 28 LAEG VS 30 LAEG	55 / 218	80	2.7	VS 30 LAEG
				VS 36 LAEG	72 / 288	93	3.07	VS 36 LAEG
VS 36 AJG	75 / 298	99	3.0	NR 45 LAEG	93 / 369	104	3.55	NR 45 LAEG
VC 45 AJG VL 45 AJG	102 / 405 101 / 401	115 118	3.5 3.4	NR 52 LAEG	113 / 449	119	3.77	NR 52 LAEG
VC 52 AJG VL 52 AJG	120 / 476 120 / 476	136 136	3.5 3.4	NR 58 LAEG	124 / 492	130	3.79	NR 58 LAEG
VC 62 AJG V 62 KEG	137 / 544 138 / 548	144 148	3.8 3.7	NR 62 LAEG	134 / 532	132	4.03	NR 62 LAEG
				V 69 LAEG	147 / 585			V 69 LAEG
VC 75 AJG V 75 KEG	168 / 667 168 / 667	180 187	3.7 3.6	V 75 LAEG	167 / 663	157	4.22	V 75 LAEG
				V 80 LAEG				V 80 LAEG

Simulated refrigeration Processes in enthalpy diagram for R 12 and R134a

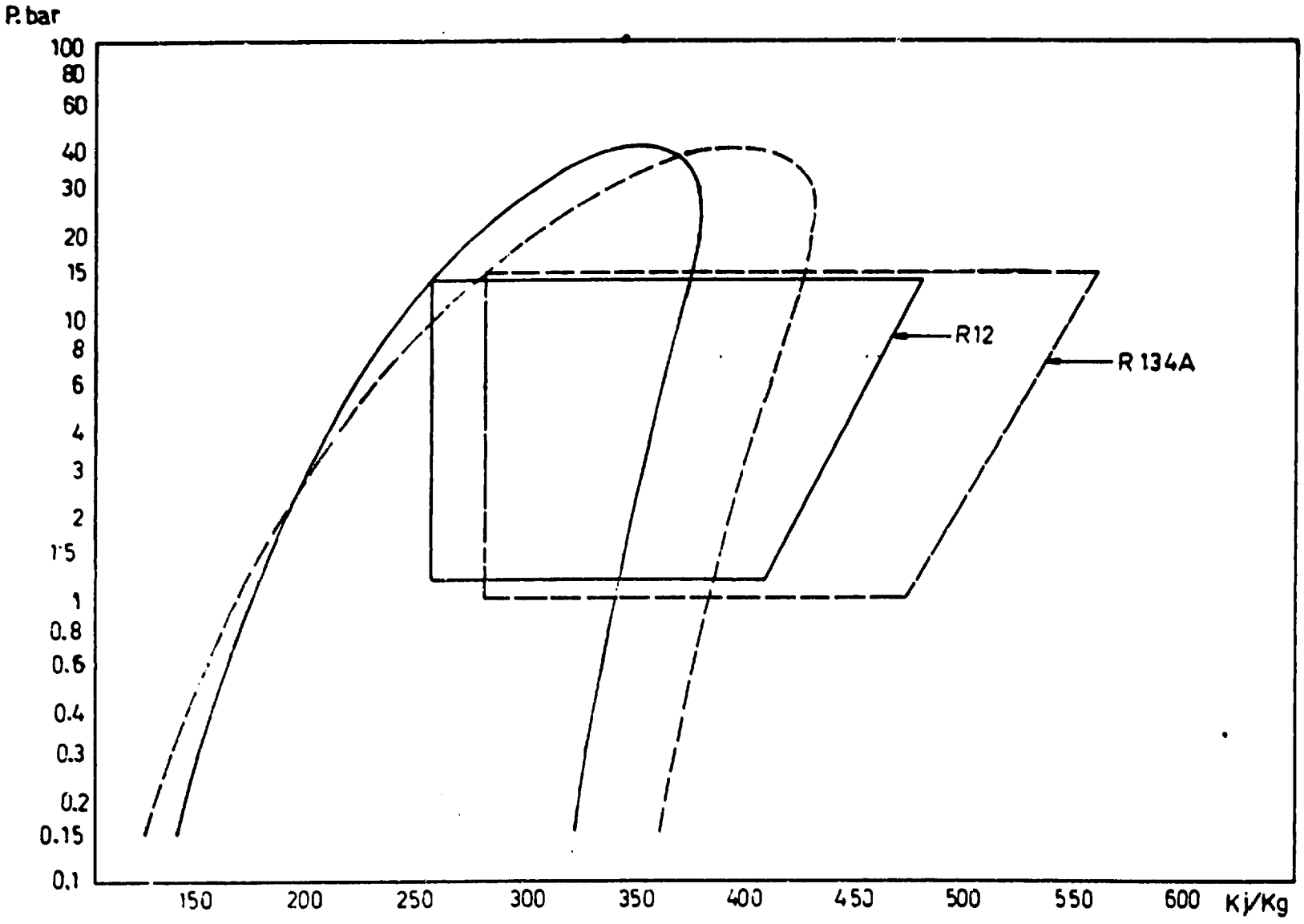
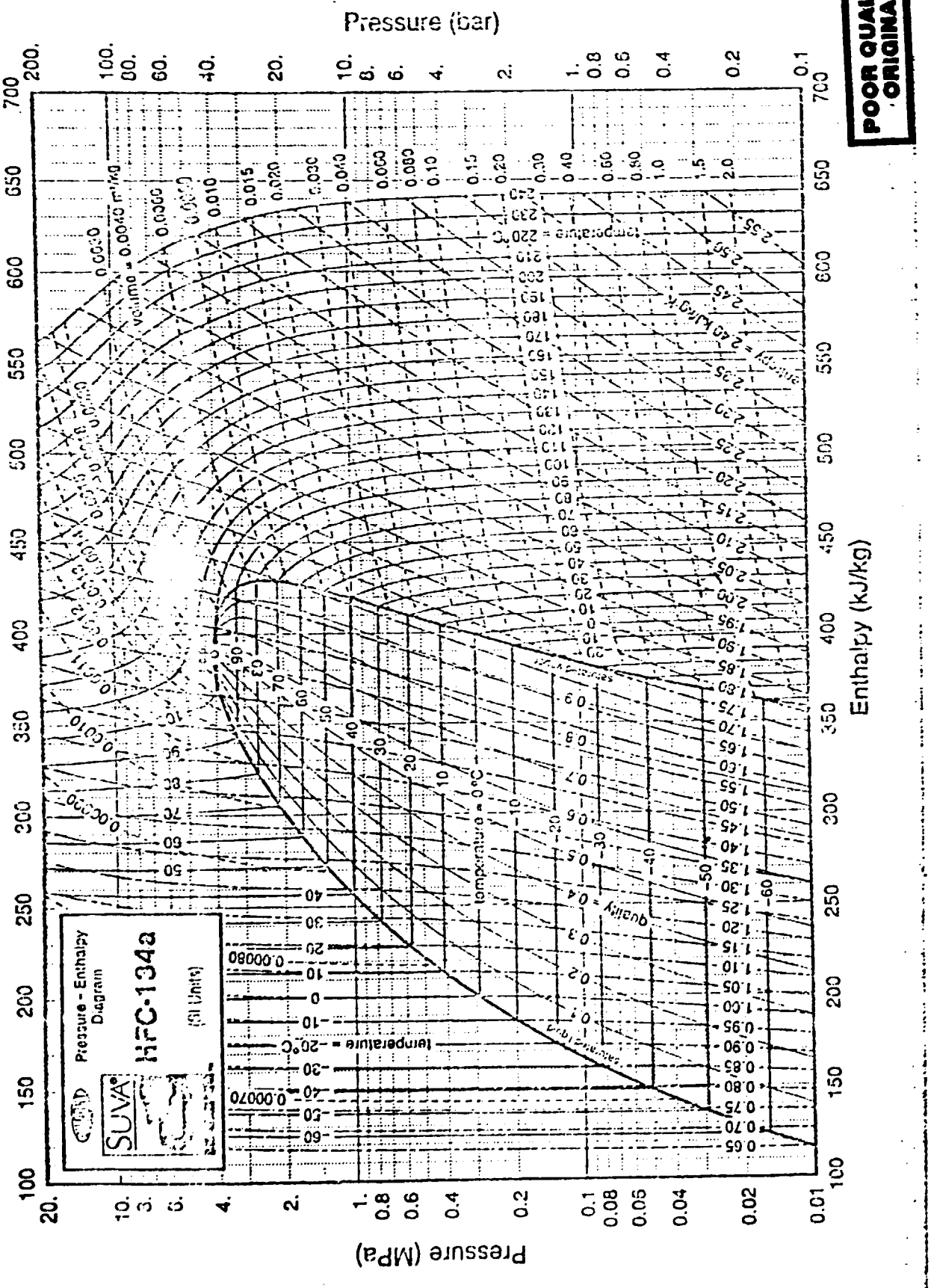


Figure 8. Pressure-Enthalpy Diagram for HFC-134a (SI Units).

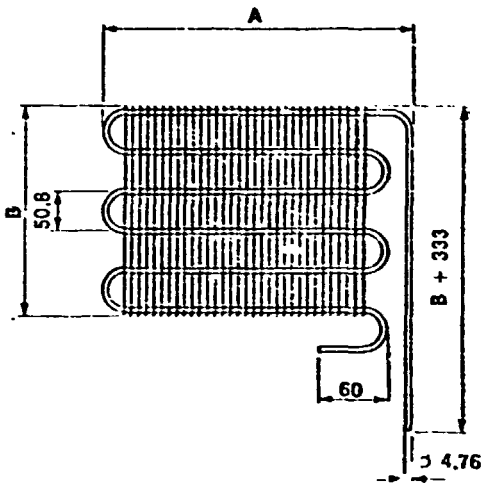


CONDENSATORI IN TUBO ø e 4,76 mm.
3/16" OD TUBING CONDENSERS

N. = NUMERO TUBI / NUMBER OF LEGS

V (cm³) = VOLUME INTERNO / INTERNAL VOLUME

KS (Kcal/h°C) = RESA TERMICA / RATING



Serie 40-51-476 Series

	MODELLO · MODEL									
	40-51-476 06	40-51-476 08	40-51-476 10	40-51-476 12	40-51-476 14	40-51-476 16	40-51-476 18	40-51-476 20	40-51-476 22	40-51-476 24
A	466	466	466	466	466	466	466	466	466	466
B	267	369	471	572	674	775	876	979	1079	1179
N.	6	8	10	12	14	16	18	20	22	24
V	30,91	40,20	49,49	58,78	68,07	77,36	86,66	95,95	105,24	114,54
KS	2,60	3,40	4,15	4,95	5,70	6,50	7,25	8,00	8,80	9,55

Serie 45-51-476 Series

	MODELLO · MODEL									
	45-51-476 06	45-51-476 08	45-51-476 10	45-51-476 12	45-51-476 14	45-51-476 16	45-51-476 18	45-51-476 20	45-51-476 22	45-51-476 24
A	515,50	515,50	515,50	515,50	515,50	515,50	515,50	515,50	515,50	515,50
B	267	369	471	572	674	775	876	979	1079	1179
N.	6	8	10	12	14	16	18	20	22	24
V	33,51	43,67	53,82	63,98	74,14	84,30	94,46	104,62	114,78	124,94
KS	2,90	3,75	4,60	5,45	6,25	7,10	7,95	8,80	9,65	10,50

I modelli di condensatori su fondo giallo sono quelli di normale produzione, gli altri possono essere forniti su richiesta dei clienti.

Yellow underlined condensers are of standard production, the others may be supplied on Customers' request.

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CONVERSI N OF DOMESTIC REFRIGERATOR PRODUCTION A ILITIES TO PHASE OUT FC 12 AT IRAN POUYA CO.

PO ECT NO. MP / IRA / 94 /403

E OND PROGRASSIVE REPORT

P ODUCED BY E. GHAFFARI

R & D MANGER

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SYNOPSIS

THIS IS THE SECOND PROGRESS REPORT FOR THE PROJECT OF ELIMINATING THE USE OF C.F.C R12 FOR THE PRODUCTION OF REFRIGERATORS AND FREEZERS IN IRAN POUYA CO.

THE PURPOSE OF ELIMINATION OF C.F.C R12 IS TO HELP REDUCE OZONE DEPLETATION OF ATMOSPHERE BY REPLACING H.F.C 134A. THE FIRST PROGRESSIVE REPORT WAS CONSISTED OF PHYSICAL DIMENSION OF PRODUCTS, TYPES OF INSULATION, DESIGN AND CLCULATIONS, PERFORMANCE, ENERGY CONSUMPTION AND SELECTION OF COMPATIBLE COMPONENTS FOR USE OF H.F.C 134A IN THE SYSTEM.

THIS REPORT COVERS THE DETERMINATION OF CABINET CONSTANT. SELECTION OF COMPATIBLE COMPONENTS ACCORDING TO CALCULATION FROM THE FIRST PROGRESSIVE REPORT, TESTING FOUR PROTOTYPES PER MODEL FOR FUNCTIONALITY AND PERFORMANCE.

A COMPARISION EVALUATION OF TEST RESULTS OF R12 AND R 134A IS ALSO INCLUDED.

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INTRODUCTION

THE MAIN TASK OF FIRST PROGRESSIVE REPORT WAS TO CALCULATE AND REDESIGN THE REFRIGERATION CYCLE FOR ONE MODEL REFRIGERATOR AND ONE MODEL FREEZER AND SELECTION OF RIGHT COMPONENTS FOR USE OF R134A AS THE REFRIGERANT.

IN THE SECOND PROGRASS REPORT THE FOLLOWING STEPS HAVE TO BE TAKEN TO CARRY OUT THIS PROJECT FIRST IS TO MAKE FOUR PROTOTYPES FOR EACH MODEL WORKING ON H.F.C 134A.

THE NEXT STEP IS TO TEST EACH MODEL FOR FUNCTIONALITY AND PERFORMANCE TO FIND OUT IF THE RIGHT SELECTION OF COMPONENT HAS BEEN DONE.

IF THE TEST RESULTS DID NOT REACH UP TO THE STANDARD LEVEL THE OPTIMIZATION OF COMPONENTS HAS TO BE DONE UNTIL ACCEPTABLE TEST RESULTS ARE REACHED.

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THE TESTS ARE DONE UNDER STANDARD CONDITIONS OF ISO 7371 AND USING COMPUTER FACILITY IN THIS FACTORY.

ALL THE TEST RESULTS ARE SHOWN IN A TABULATED FORM IN THE REPORT. THE RESULTS WERE EVALUATED ACCORDING TO ISO STANDARD.

THE TESTS CONSISTES OF THE FOLLOWING.

1- CONTINUOUS RUN TEST

2- CYCLING RUN TEST

3- ENERGY CONSUMPTION TEST

4- ICE FREEZ TEST

5- STORAGE TEMPERATURE TEST

6- FREEZING POWER TEST

7- TEMPRATURE RISE TEST

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DETERMINATION OF THE CBINET CONSTANT C

THE PURPOSE OF THIS METHOD IS TO DETERMINE THE ACTUAL HEAT LOSS THROUGH THE WALL OF A REFIGERATED SPACE. THIS METHOD ALSO DETERMINE THE QUALITY OF INSULATION WHICH IS USED IN THE CABINET.

THIS METHOD FOR DETERMINATION OF THE WALL GAIN LOAD WORKS ON ONE TEMPERATURE CABINET, BUT ON TWO TEMPERATURE CABINET BECAUSE OF NO INSULATION FOR SEPRATION, DOES NOT WORK VERY WELL.

THE METHOD OF OPERATION

AN INSULATED CABINET WITH THE DOOR SEALED WAS PLACED ON THE STAND OF HOT ROOM WITH AMBIENT TEMPRATURE OF 32°C AND HAVING A ELECTRICAL HEATER INSIDE THE CABINET. THE DIFFERANCE IN TEMPERATURE OF INSIDE AND OUT SIDE AT STEADY STATE SHOULD BE 20°C THE POWER USED TO MAINTAIN THIS TEMPERATURE DIFFERANCE WAS READ IN WATTS.

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USING THE FOLLOWING FORMULA

$$C = \frac{P}{T_2 - T_1}$$

C = CABINET CONSTANT

P = ELECTRICAL POWER IN WATTS

T_1 = AMBIENT TEMPERATURE

T_2 = INSIDE TEMPERATURE

FOR SINGLE DOOR REFRIGERATOR MODEL FR11F

P = 20 WATTS

T_1 = 30°C

T_2 = 50°C

$$C = \frac{20W}{50 - 30}$$

C = 1.33 W IS CABINET CONSTANT

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FOR UP RIGHT FREEZER MODEL FR9F

$P = 25\ W$

$T1 = 30^{0}C$

$T2 = 50^{0}C$

$$C = \frac{P}{T2 - T1}$$

$C = 1.25\ W$

HAVING CALCULATE THE CABINET CONSTANT USING

$C = U \times A$

U = *THE OVERALL COEFFICIENT OF HEAT TRANSMISSION*

A = *EFFECTIVE HEAT TRANSMISSION AREA*

FOR ONE TEMPERATURE CABINET THE WALL GAIN LOAD IS $Q = C D T$

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FOR TWO TEMPERATURE CABINET SUCH AS TWO STAR REFRIGERATOR SEPERATE CABINET CONSTANT OF FREEZER COMPARTMENT AND REFRIGERATOR COMPARTMENT CAN BE FOUND AS FOLLOW

$C_1 = A1\ U$

$C_2 = A2\ U$

A_1 = *EFFECTIVE HEAT TRANSFER AREA OF TWO STAR FREEZER COMPARTMENT*

A° = *EFFECTIVE HEAT TRANSFER AREA OF FRESH FOOD COMPARTMENT*

$Q_1 = C1\ DT$

$Q_2 = C2\ DT$

$Q = Q1 + Q2$

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METHOD OF SELECTION OF COMPATIBLE COMPONENTS

ALL COMPONENTS OF REFRIGERATOR AND FREEZER HAVE BEEN DESIGNED BEFORE AND THEY ARE ALREADY IN PRODUCTION WITH USE OF R12 AS A REFRIGERANT. THE ONLY COMPONENTS NEED TO BE CHANGED AND RESELECTED FOR USE OF 134A ARE THE COOLING COMPONENTS.

IN THE FIRST PROGRESS REPORT WHICH WAS SUBMITTED EARLIER WE CALCULATED ALL THE COMPONENTS AND FOUND OUT THE SIZE OF THEM FOR THE USE OF R134A FOR REFRIGERATOR AND FREEZER AS A REFRIGERANT.

THE SUMMARY OF THESE CALCULATIONS ARE SHOWN BELLOW.

SELECTION OF COMPRESSOR

FOR COMPRESSOR SELECTION THE FOLLOWING CALCULATIONS HAVE TO BE DONE.

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COOLING LOAD CALCULATION

1- WALL GAIN LOAD

THE HEAT LOSS THROUGH THE WALL OF CABINET CAN BE CALCULATED BY

USING $Q = A\ U\ D\ T$

2- PRODUCTION LOAD AT FREEZER SIDE AND AT FRESH FOOD SIDE.

3- AIR CHANGE LOAD BY OPENING THE DOOR.

ALL ABOVE MENTIONED LOADS HAVE BEEN CALCULATED IN THE FIRST PROGRASS REPORT. SUMMATION OF ALL LOADS IS THE CAPACITY OF COMPRESSOR FOR THE PARTICULAR REFRIGERATOR AND FREEZER.

WE ARRIVED 106.8 KCAL/H FOR REFRIGERATOR AND 160 KCAL/H FOR UP RIGHT FREEZER.

FROM MANUFACTURE COMPRESSOR TABLE WE SELECT COMPRESSOR WITH COOLING CAPACITY OF 110 KCAL/H FOR REFRIGERATOR AND 167 KCAL/H FOR FREEZER.

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SELECTION OF CONDENSER

CONDENSER LOAD IS CALCULATED BY HEAT TRANSMISSON COEFFICIENT METHOD USING FOLLOWING FORMULA.

$Q_{CON} = QCOM + QINP - QD$

Q_{CON} = CONDENSER LOAD

Q_{COM} = COMPRESSOR CAPACITY

Q_{INP} = COMPRESSOR INPUT POWER

Q_D = AMOUNT OF HEAT DISSIPATED FROM COMPRESSOR SHELL

$Q_D = A\ U\ D\ T$

$A_U = (0.19H + 4\sigma\epsilon T^3)A$

ANOTHER METHOD FOR CALCULATION OF CONDENSER LOAD AND SELECTION USING R134A IS TO FIND KS VALUE WHICH IS INTRODUCED BY CONDENSER MANUFACTURER.

$$KS = \frac{Q \times 1.25}{DT}$$

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Q = COMPRESSOR CAPACITY

KS = COEFFICENT OF HEAT TRANSMISSION

DT = TEMPRETURE DIFFERANCE

1.25 = RATIO DIFFERENCE IN ENTHALPIES OF CONDENSATION AND EVAPORATION

SELECTION OF EVAPORATOR

FOR CALCULATING EVAPORATOR SIZE THE FOLLOWING FORMULA.

$$Q = A\,U\,D\,T$$

Q = EVAPORATOR CAPACITY

A = SURFACE AREA

DT = TEMPRETURE DIFFERANCE

U = OVER ALL HEAT TRANSMISSION COEFFICIENT

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TO FIND U FACTOR

$$U = \frac{1}{\frac{1}{F_1} + \frac{X_1}{K_1} + \frac{X_2}{K_2} + \ldots\ldots + \frac{X_N}{K_N} + \frac{1}{FO}}$$

F1 = CONVECTION COEFFICIENT OF INSIDE SURFACE

FO = CONVECTION COEFFICIENT OF OUTSIDE SURFACE

K = THERMAL CONDUCTIVITY

X = INSULATION THICKNESS AND OTHER MATRIAL

HAVING CALCULATED AND SELECTED ALL THE COMPONEANTS WE CAN MAKE PROTOTYPES AND TEST THEM IN THE HOT ROOM. THE TEST RESULTS WILL SHOW THE PERFORMANCE OF THE PROTOTYPES.

FOR OPTIMIZATION AND BETTER PERFORMANCE WE NEED TO CHANGE THE SIZE OF SOME COMPONENT AND TEST THEM AGAIN UNTIL WE REACH HIGHER PERFORMANCE.

THE COMPRESSOR MANUFACTURERS ALSO GIVE GUID LINES WHICH CAN HELP TO SELECT THE RIGHT COMPATIBLE COMPONENTS. ON THEIR LABRATORY TESTS TO FIND THE BEST RESULTS WILL SHOW NECESSARY CHANGES IN THE COOLING SYSTEM.

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THE PROTOTYPES ARE MADE BASED ON THE COMPONENTS WHICH HAVE BEEN CALCULATED IN THE FIRST PROGRESSIVE REPORT USING R 134A AS THE REFRIGERANT.

THE MINOR CHANGE COMPARED TO PREVIOUS SYSTEM ARE AS FOLLOW.

1- CABINET INSULATION THICKNESS BY POLYURETHAN FOAM IS AVERAGE 40MM FOR REFRIGERATOR AND 60MM FOR FREEZER NO CHANGE IS NEEDED.

2- COMPRESSOR POWER 1/6 HP AND 1/4 HP IS THE SAME AS BEFORE

3- THE SIZE OF EVAPORATOR HAS NO CHANGE.

4- CAPILLARY TUBE INCREASED 10% IN LENGTH.

5- MAKE CONDENSER SLIGHTLY BIGGER.

6- LARGER DRIER SIZE BECAUSE OF SENSITIVITY OF COMPRSSOR OIL TO HUMIDITY AND USING DIFFERENT GRADE OF MOLECULAR SIEVE LIKE XH7.

7- AMOUNT OF CHARGE OF HFC 134A 10% LESS THAN THAT OF R12 SYSTEM.

THE PROTOTYPES WERE TESTED IN THE HOT ROOM FOR PERFORMANCE. THE RESULTS WERE SETISFACTORY ON SEVERAL TESTS. FOR BETTER PERFORMANCE SMAL CHANGE ON CAPILLARY TUBE LENGTH IS NEEDED TO BE DONE.

IN THE CASE OF ENERGY CONSUMPTION SOME CHANGE IS NEEDED TO BE DONE ON THE COMPONENTS TO GET LOWER ENERGY CONSUMPTION.

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TLX : 213850 SSPA IR - 222711 POYA IR
TEL : 6692001 - 4

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(Public Joint Stock Co.)
The Leading Manufacturer of Refrigerator, Freezer
and Aluminium Profile

Our Ref :
Date :

PREPRATION OF TRIAL TEST EQUIPMENT

FOR THE TRIAL TEST U.N.IDO. HAS SENT SOME EQUIPMENT FOR THIS POURPOSE WHICH ARRIVED IN IRAN POUYA CO. RECENTLY.

THIS EQUIPMENT CONSISTS OF.

1- CHARGING MACHINE FOR USE OF R134A.

2- EVACATION PUMPS.

3- LEAK DETECTOR FOR R134A.

THERE ARE SOME EQUIPMENTS AVALBLE IN IRAN POUYA FOR TRIAL TESTS ALREADY.

1- COMPUTER BECORER FOR DIFFERENT TEMPERATURE AND PRINTING FOR EVALUATION.

THE COMPUTER HAS CAPABLITY OF RECORDING HIGHT SIDE AND LOW SIDE PRESSURES. ALTHOUGH THERE IS A DRY AIR SYSTEM IN THE ASSEMBLY LINE BUT TO BE ON THE SAFE SIDE FROM MOISTURE POINT OF VIEW WE USE N2 GAS FOR FIRST CHECK OF LEAKAGE ON THE BRAZED POINTS.

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TEMPERATURE TEST PROCEDURE

ALL TESTS ON PROTOTYPS ARE DONE UNDER ISO STANDARD 7371 AND ACCORDING TO ISO REFRIGERATORS ARE CLASSIFIED IN THREE LEVELS. ONE STAR TWO STAR AND THREE STAR.

THREE STARE CABINET HAS TO KEEP AVERAGE +5°C FRESH FOOD COMPARTMENT AND -18°C IN FREEZER SECTION, IN TWO STAR -12°C AND IN ONE STAR -6°C FREEZER CLASSIFIED IN THREE STAR AND FOUR STAR, WHICH MEANS THREE STAR IS CAPABLE OF KEEPING FROZEN FOOD -18°C AND FOUR STAR IS CAPABLE OF FREEZING FRESH FOOD TO -18°C IN THE CASE OF IRAN POUYA REFRIGERATOR IT IS IN CLASS OF TWO STAR AND CLIMATE CLASS IS TROPICAL.

THE TEST CONDITION ON THE PROJECT IS AS FOLLOWS.

1- AMBIENT TEMPRATURE +32°C AND 43°C

2- TEMPRATURE OF FREEZING COMPARTMENT -12°C

3- FRESH FOOD COMPARTMENT TEMPERAURE BETWEEN 0°C TO 10°C

4- CELLER COMPARTMENT TEMPERATURE BETWEEN 8°C TO 14°C

/

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5- EVAPORATING TEMPERATURE -23.3°C

6- CONDENSING TEMPERATURE +55°C

7- GAS SUPERHEAT TEMPERATURE TO 32°C

8- LIQUID SUBCOOL TEMPERATURE TO 32°C

9- AMBIENT TEMPERATURE 32°C

TEST PROCEDURE WHICH COMPLY WITH ISO 7371 AND ISO 5155 ARE AS FOLLOWS.

CONTINEOUS RUN PERFORMANCE TEST

IN THIS TEST THE AMBIENT TEMPRETURE IS KEPT 43°C. THE THERMOSTAT IS SHORTED AND NO TEST PACKAGE IS INSIDE CABINET.

THE THERMOCOUPLES ARE PLACED INSIDE CABINET ACCORDING TO ISO STANDARD.

THE REFRIGERATOR IS RUN FOR 24H AND COMPUTER WILL RECORD ALL CONNECTING POINT TEMPRETURE EVERY MINUTS.

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WHEN THE REFRIGERATOR CAME TO STEADY STATE CONDITION THAT MEANS FURTHER RECORD ALL ARE THE SAME, WE GET THE RECORD AFTER 24H.

AT THIS STAGE THE RESULT SHOWS THE COOLING CAPACITY OF REFRIGERATOR.

NOW THE EVALUATION IS DONE.

ICE FREEZ TEST

IN THIS TEST THE CONDITION IS THE SAME AS CONTINEOUS RUN TEST THAT MEANS KEEPING THE AMBIENT TEMPERATURE 43°C.

THERMOSTAT IS SHORTED AND THE ICE TRAYS ARE FILLED WITH WATER AT 30°C TEMPRATURE AND PLACED IN THE FREEZER SIDE.

PUTTING THE THERMOCOUPLES IN THE WATER AND RUN THE REFRIGERATOR UNTIL THE TEMPERETURE OF WATER REACH -7°C TIME TO REACH -7°C IS CAPACITY OF ICE FREEZING OF REFRIGERATOR.

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CYCLING TEST (CLASSIFICATION)

IN THIS TEST THE ROOM TEMPRATURE IS KEPT AT 43°C AND THE THERMOCOUPLES PLACED IN REFRIGERATING PART AND TESTS PIECES IN THE FREEZER PART ACCORDING TO ISO STANDARD.

THE THERMOSTAT IS POSITIONED SUCH AS REFRIGERATOR AFTER RUNNING AND REACHING THE STEADY STATE CONDITION THE TEMPRATURE OF WORMEST TEST PIECE IN FREEZER SIDE FOR TWO STORS BE -12°C AND IN REFRIGERATOR SIDE AVERAGE BE +5°C + 0.5 THIS CONDITION MUST BE ACHIVED THAT THE PERCENTAGE OF WORKING IS NOT MORE THAN 80%

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ENERGY CONSUMPTION TEST

IN THIS TEST THE AMBIENT TEMPERATURE IS 32°C AND THE PROCEDURE IS EXACTLY THE SAME AS CYCLING TEST.

THE THERMOSTAT IS REGULATED IN PLACE WHERE REFRIGERATOR AFTER RUNNING AND REACHING THE STEADY STATE CONDITION THAT THE TEMPERATURE OF MORMEST TEST PLECE IN FREEZER SIDE BE -12°C AND IN REFRIGERATOR SIDE BE +5°C 0.5 ING THIS STAGE THE AMOUNT OF ELECTRICAL ENERGY CONSUMED IN 24H IN KWH BY THE REFRIGERATOR IS THE ENERGY CONSUMPTION OF THIS UNIT.

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STORAGE TEMPERATURE TEST FOR FREEZER

IN THIS TEST THE AMBIENT TEMPERATURE IS 43°C RUNNING THE FREEZER FOR 24HR WITHOUT ANY TEST PACKAGES UNTIL TO WE REACH EQUILIBRUM CONDITION.

PUTTING TEST PACKAGES (25KG TEST PIECES FOR EACH 100 LITRE VOLUME) WHICH ARE ALREADY AT -18°C IN THE CABINET AND CONNECTING THE THERMOCOUPLES. AFTER 24HR TH TEMPERATURES OF TEST PIECES SHOULD BE KEPT BELOW -18°C WHICH IS THE STANDRD LEVEL.

PREEZING POWER TEST FOR FREEZER

IN THIS TEST THE ABBIENT TEMPERATURE IS 32°C RUNNING FREEZER EMPTY FOR 24HR TO REACH EQUILIBRIUM CONDITION, PUTTING 4.5KG TEST PIECES FOR EACH 100 LITTERS VALUME AT 32°C TEMPERATURE ACCORDING TO ISO STANDARD.

THE THEMOCOUPLES ARE PLACED IN TEST PIECES AND AFTER 24HR THE TEMPERATURE OF TEST PEACES SHOULD GO UNDER -18A°C WHICH SHOW THE FREEZING POWER OF FREEZER.

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TEMPERATUER RISE TEST FOR FREEZER

IN THIS TEST THE AMBIENT TEMPERATURE IS 32°C. HAVING THE FREEZER WITH TEST PIECES AT -18°C. TURN THE POWER OFF AND RECORD THE TIME UNTIL THE WORMEST TEST PIECE REACHS -9°C. THIS PERIOD WILL SHOW THE QUALITY OF FREEZER. THE LONGER THIS PERIOD THE BETTER THE QUALITY.

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OPTIMIZATION PLAN

THE REFRIGERATOR AND FREEZER WHICH PRODUCED BY NEW DESIGNED COMPONENTS FOR R 134A AND TESTED SEVERAL TIME THE RESULTS WITH MINER OPTIMIZATION ON CAPILLARY TUBE WHERE SATISFACTORY.

THE PRODUCTION WILL START WITH NEW - DESIGN BUT, THE OPTIMIZATION PLAN WILL START ON THE NEW PRODUCT. SOME STUDY HAS ALREADY DONE FOR OPTIMIZATION. THE AREA OF STUDY ARE FOLLOWS.

1- STUDY TO REDUCING THE AMOUNT OFREFRIGERANT CHARGE IN THE SYSTEM BY REDUCING THE NUMBER OF CHANAL IN THE RULBOUND EVAPORATOR AND LENGTH OF CONDENSER IN REFRIGERATOR. IN THE FREEZER REDUCTION ON THE LENGTH OF EVAPORATOR TUBE.

2- STUDY ON THE DOOR GASKET DESIGN TO REDUCE THE AIR LAKAGE AND HEAT TRANSFOR THROUGH THE GASKET CHANGING THE MAGNETIC STRIP DIMENTION AND INCREASING THE MAGNETIC POWER.

3- A MAIN TASK OF OPTIMIZATION PLAN IS REDUCING ENERGY CONSAMPTION FOR THIS POURPOS THE WORK HAS BEEN DONE TO INCREASE THE INSULATION THICKNESS AND QUALITY.

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ENARGY CONSUMPTION EVALUATION

THE ENARGY CONSUMPTION TEST CARRIED OUT ACCORDING TO ISO STANDARD ON REFRIGERATOR AND FREEZER. THE TEST AT 32°C AMBIENT TEMPERATURE LOADED WITH TEST PACKAGES. THE THERMOSTAT IS REGULATED TO A POSITION TO GET STANDARD TEMPRETURE FOR TWO STAR REFRIGERATOR AND THREE STAR FREEZER.

THE ENARGY CONSUMPTION OF TEST RESULTS FOR REFRIGERATOR AND FREEZER ARE AS FOLLOW. AMBIENT TEMPERTURE 32°C

FOR REFRIGERATOR

1- MEAN TEMP. OF FRESH FOOD SECTION 5°C

2- FREEZER SECTION -12°C

3- ENERGY CONSUMPTION 1.8 KW/24H

FOR FREEZER

1- FREEZER CABIEN TEMP. -18°C

2- ENERGY CONSUMPTION 2.5 KW/24H

NOTE.

IN THE OPTIMIZATION PLAN BY INCREASING THE THICHKNESS OF INSULATION THE VALUE OF ENARGY CONSUMPTION WILL REDUCE.

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R12 AND R134A REFRIGERANT TEST SHEETS EVALUATION REVIEW

COMPERING THE TEST RESULTS OF REFRIGERATOR AND FREEZER USING R12 AND R134A HAVING THE SAME TEST CONDITION.

DUO TO DIFFERENCE OF THERMODYNAMIC PROPERTIES BETWEEN HFC 134A AND CFC 12 ABOUT 10-15% CAPACITY DROP HAS SHOWN AT -23.3° AND 20 -30% AT -30° WITHOUT ANY SYSTEM MODIFICATION. AFTER CHANGING THE SYSTEM COMPONENTS AND ADOPTING TO 134A THIS CAPACITY DROP REDUCE TO MINIMUM.

FROM ENERGY CONSUMPTION POINT OF VIEW IN THE OPTIMIZED SYSTEM OF R134A HAS NOT MUCH DIFFER WITH R12 SYSTEM.

ON R134A SYSTEM THE TEST SHOW LOWER TEMPERATURE ON DISCHARGE LINE AND TIME FOR REACHING TO EQUILIBRIM CONDITION IS SLIGHTLY LONGER THAN R12.

A TABLE OF COMPARISON IS INCLUDED.

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R - 134A , R - 12		R - 12	R -134A
EVAPORATING PRESSURE(-25°C)	BAR	1.237	1.067
CONDENSING PRESSURE (55°C)	BAR	13.66	14.912
ENTHALPY H_2 -25°C/32°C	KJ/KG	373	431
ENTHALPY H_1 55°C LIQUID	KJ/KG	254	279
ENTHALPY DIFFERENCE H_2-H_1	KJ/KG	119	152
COMPRESSOR CAPACITY	W	95	87
MASS FLOW	KG/H	2.87	2.06
GAS TEMPERATURE (INLET)	°C	94	84
SPECIFIC VOLUME	M^3/KG	0.2	0.28
VOLUME FLOW (INLET)	M^3/H	0.57	0.57
INLET CAPILLARY TNBE	°C	55	55
SPECIFIC VOLUME	DM^3/KG	0.841	0.927
VOLUME FLOW	DM^3/H	2.41	1.91
ENTHALPY H_1,55°C LIQUID	KJ/KG	254	279
ENTHALPY H_3,32°C LIQUID	KJ/KG	231	244
ENTHALPY DIFFERENCE	KJ/KG	23	35
CAPACITY WITH SUB-COOLING TO 3°C:			
MASS FLOW X (H_2 - H_3)	KJ/H	407.5	385.2
CAPACITY WITHOUT SUB - COOLING:			
MASS FLOW X (H_2 - H_1)	KJ/H	341.5	313.1
PERFORMANCE RELATION(H_2-H3)/(H_2-H_1)	KJ/H		

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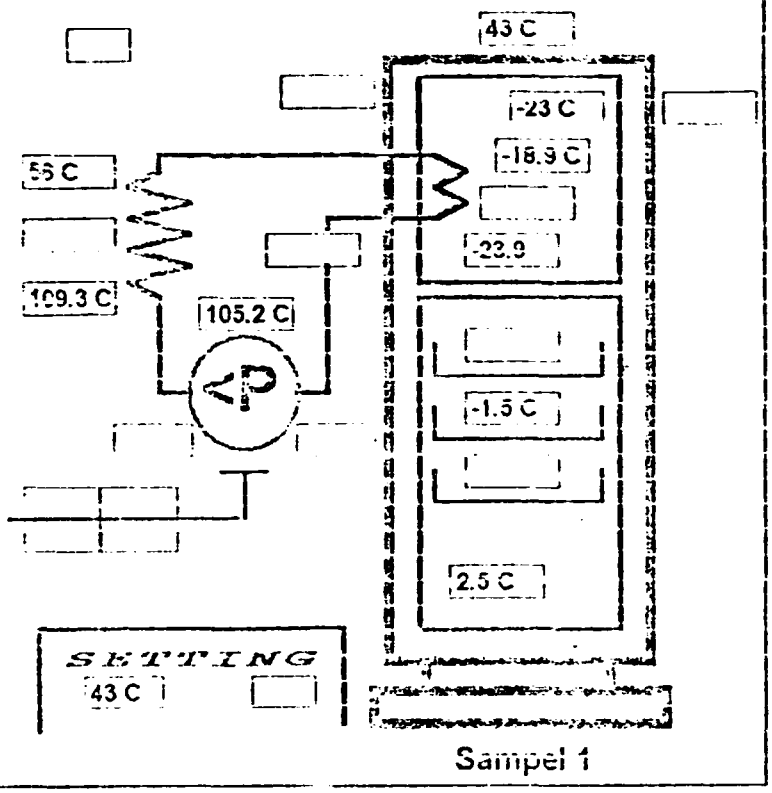
IRAN POUYA Co. HOT ROOM TEST تست بمجل

Contineous Run Performance



Sampel 1

H740619R.D10

Test Number	H740619R.D10
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR32 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	24 hour
—	
—	
—	
Record No	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Contineous
Evaprator Air	-23 C
Cabin Mean Temprature	
Crisper Temprature	2.5 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	105.2 C
Condenser inlet temp.	109.3 C
Condenser exit temp.	56 C

after 24_hour contineous RUN

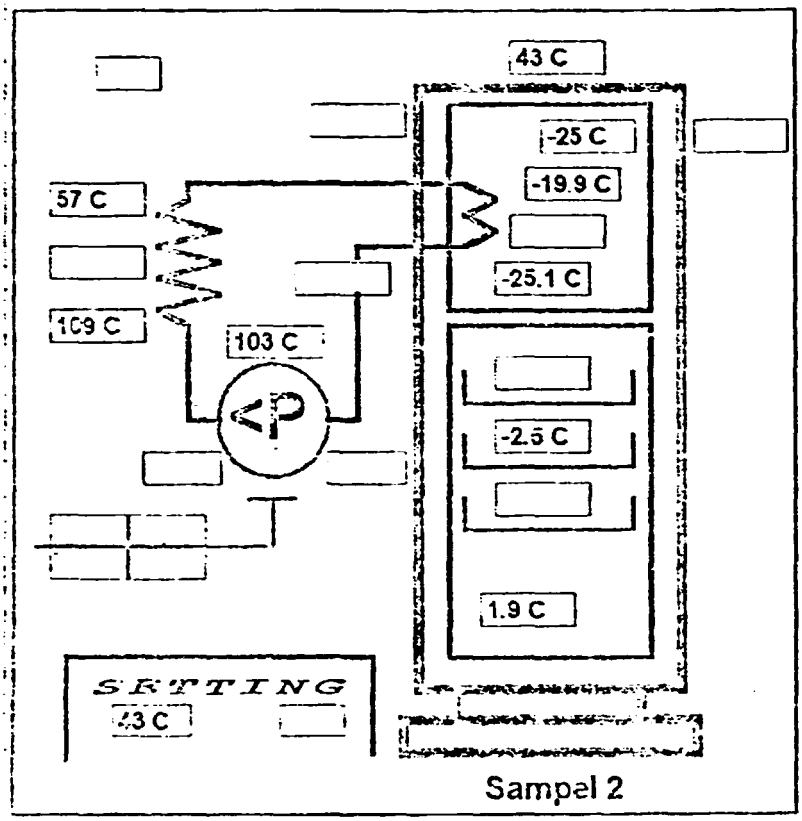
the RESULTS are satisfactory

R & D Manager: CHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست محفظه

Contineous Run Performance



Sampel 2

H740619L.D10

Test Number	H740619L.D10
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	TECUMSEH
Compresor Model	AEZ 1353
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	24 hour

Record No	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Contineous
Evaprator Air	-25 C
Cabin Mean Temprature	
Crisper Temprature	1.9 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	103 C
Condenser inlet temp.	109 C
Condenser exit temp.	57 C

After 24_hour contineous RUN

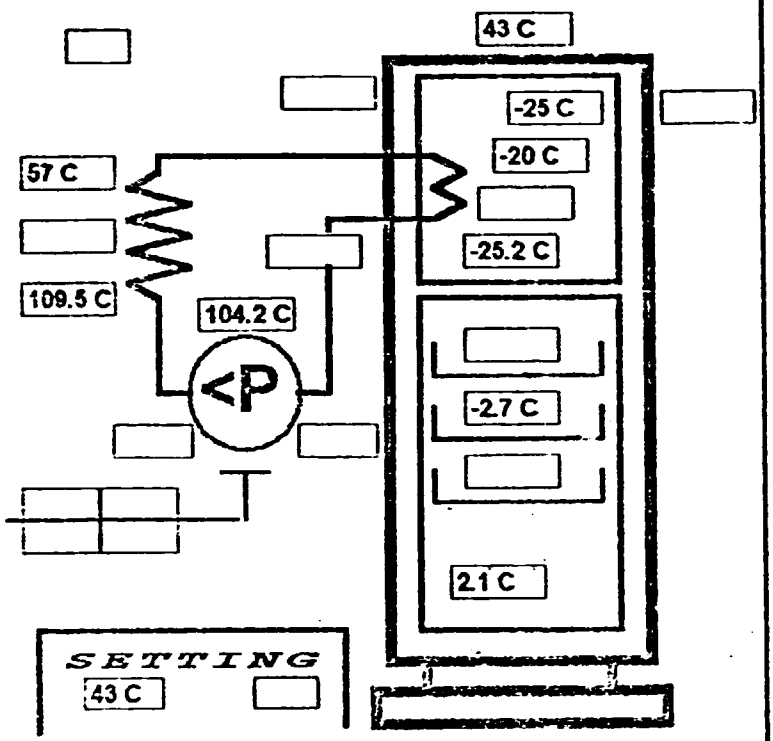
the RESULTS are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست محیط

Contineous Run Performance



Sampel 1

H740617R.D13

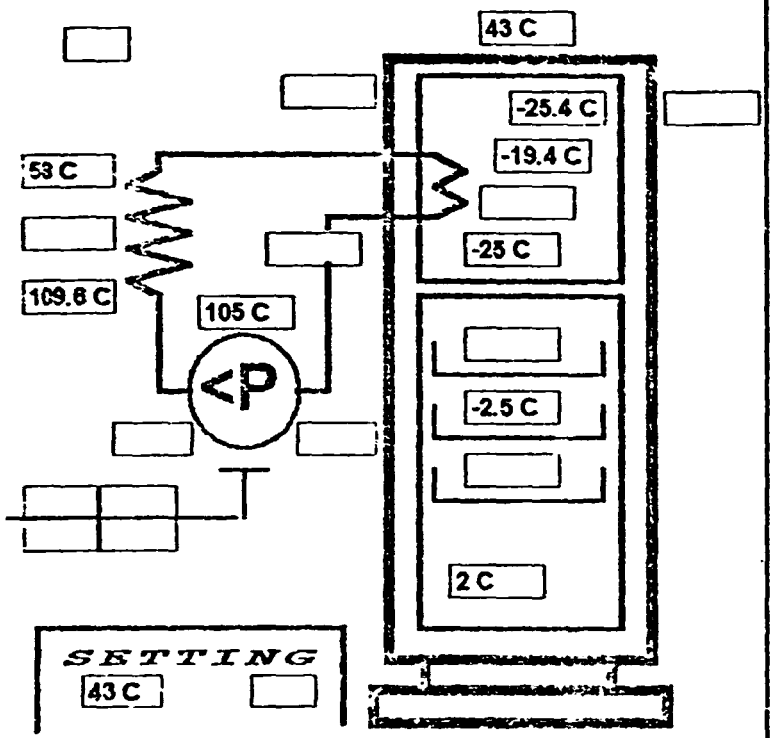
Test Number	H740617R.D13
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	24 hour
—	
—	
—	
Record No	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Contineous
Evaprator Air	-25 C
Cabin Mean Temprature	
Crisper Temprature	2.1 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	104.2 C
Condenser inlet temp.	109.5 C
Condenser exit temp.	57 C

After 24_hour Contineous RUN the RESULTS are Satisfactory

R & D Manager: GHAFFARI

Contineous Run Performance



Sampel 2

H740617L.D13

Test Number	H740617L.D13
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost position	
Thermost Type	Semi Auto
Total Test Time	24 hour
—	
—	
—	
Record No	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Contineous
Evaprator Air	-25.4 C
Cabin Mean Temprature	
Crisper Temprature	2 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	105 C
Condenser inlet temp.	109.6 C
Condenser exit temp.	58 C

After 24_hour contineous

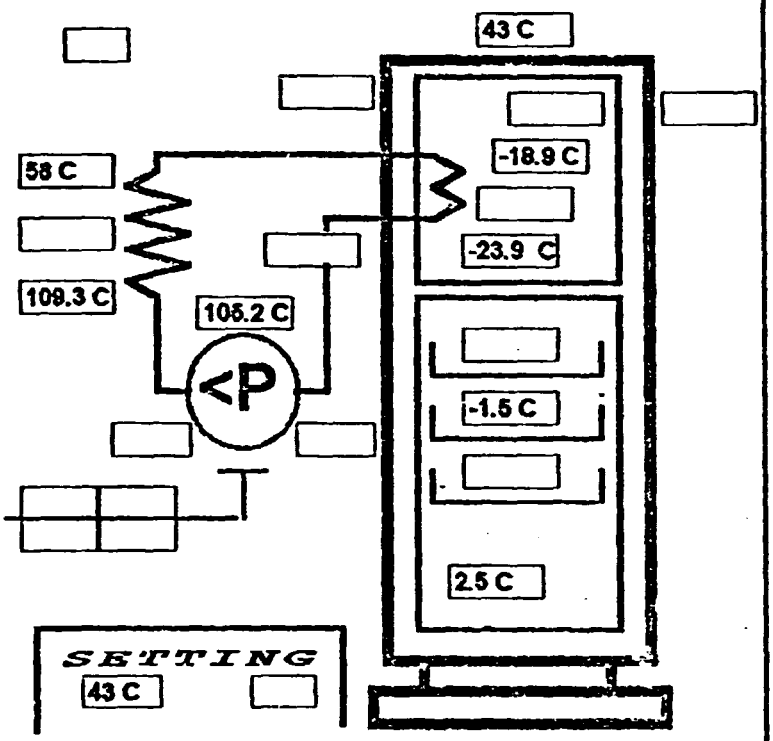
RUN the RESULTS are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست هات روم

Pull Down Test



Sampel 1

H740624R.D11

Test Number	H740624R.D11
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Mod.	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost position	
Thermost Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record No	
Exam - state	

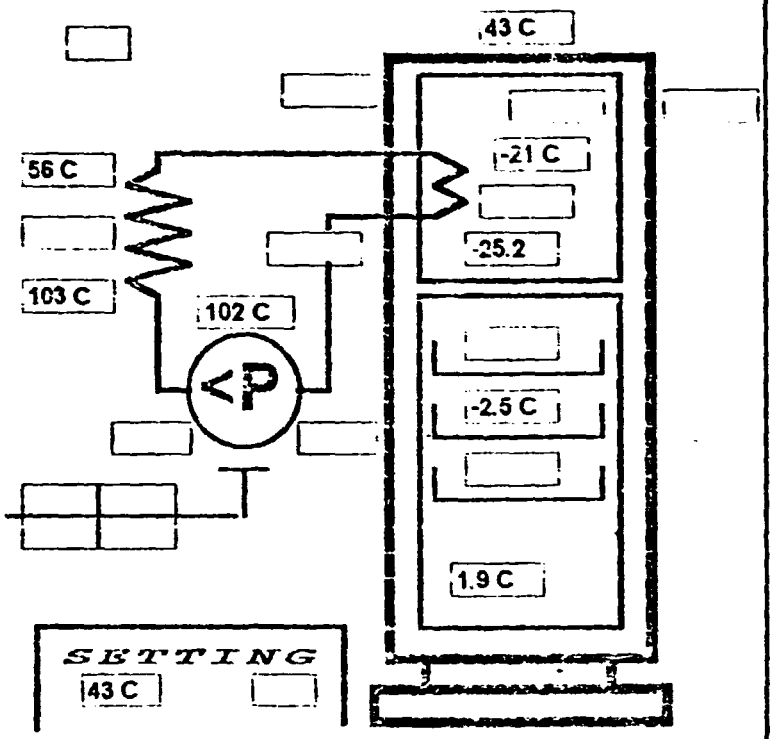
Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Contineous
Evaprator Air	-18.9 C
Cabin Mean Temprature	-1.5 C
Crisper Temprature	2.5 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	105.2 C
Condenser inlet temp.	109.3 C
Condenser exit temp.	56 C

Pull Down time is 6_hod

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست یخچال

Pull Down Test



Sampel 2

H740623L.D09

Test Number	H740623L.D09
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	

Record - No	
Exam - state	

Result: Remark: توضیحات :

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-21 C
Cabin Mean Temprature	-2.5 C
Crisper Temprature	1.9 C
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	102 C
Condenser inlet temp.	103 C
Condenser exit temp.	56 C

PULL DOWN time is 4:30_hour

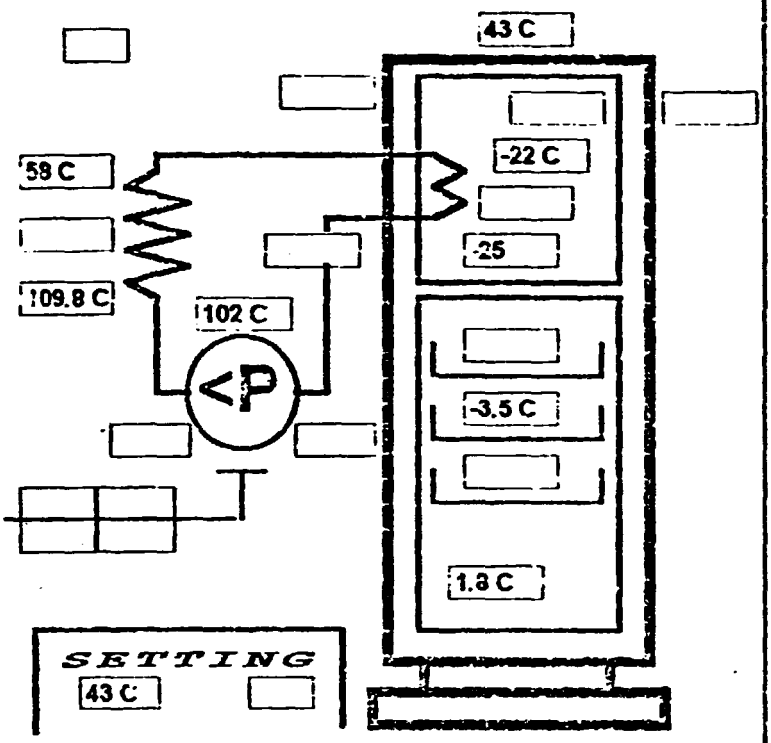
The results are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست هتچال

Pull Down Test



Sampel 1

H740623R.D09

Test Number	H740623R.D09
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	TECUMSEH
Compresor Model	AEZ1358 Y
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost position	
Thermost Type	Semi Auto
Total Test Time	
—	
—	
—	
Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-22 C
Cabin Mean Temprature	-3.5 C
Crisper Temprature	1.8 C
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	102 C
Condenser inlet temp.	109.8 C
Condenser exit temp.	58 C

Remark: توضیحات :

PULL DOWN time is 4:15

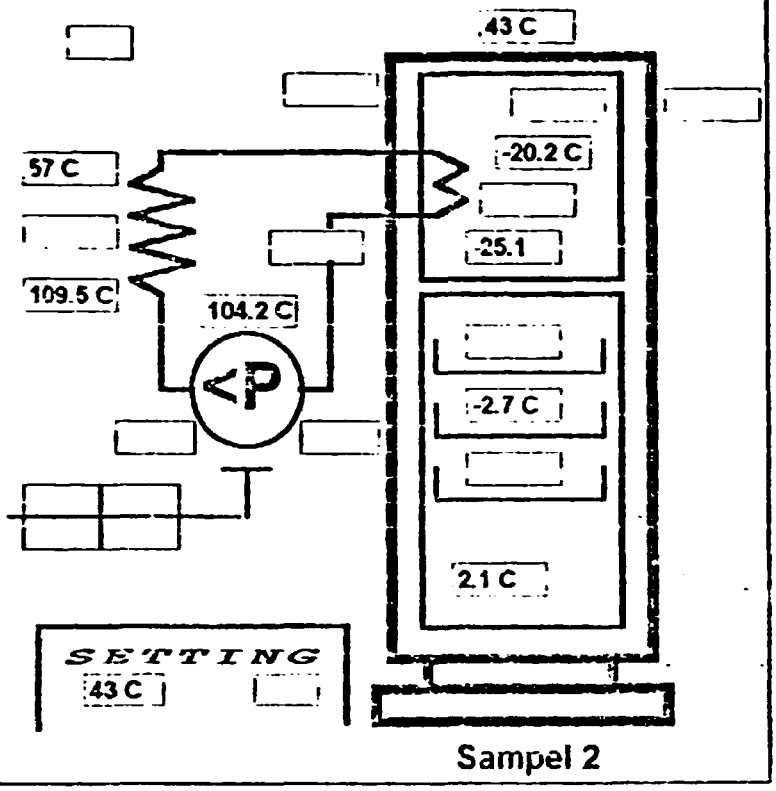
The results are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست یخچال

Pull Down Test



Sampel 2

H740624L.D11

Test Number	H740624L.D11
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	
—	
—	
—	
Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-20.2 C
Cabin Mean Temprature	-2.7 C
Crisper Temprature	2.1 C
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	104.2 C
Condenser inlet temp.	109.5 C
Condenser exit temp.	57 C

Remark: توضیحات :

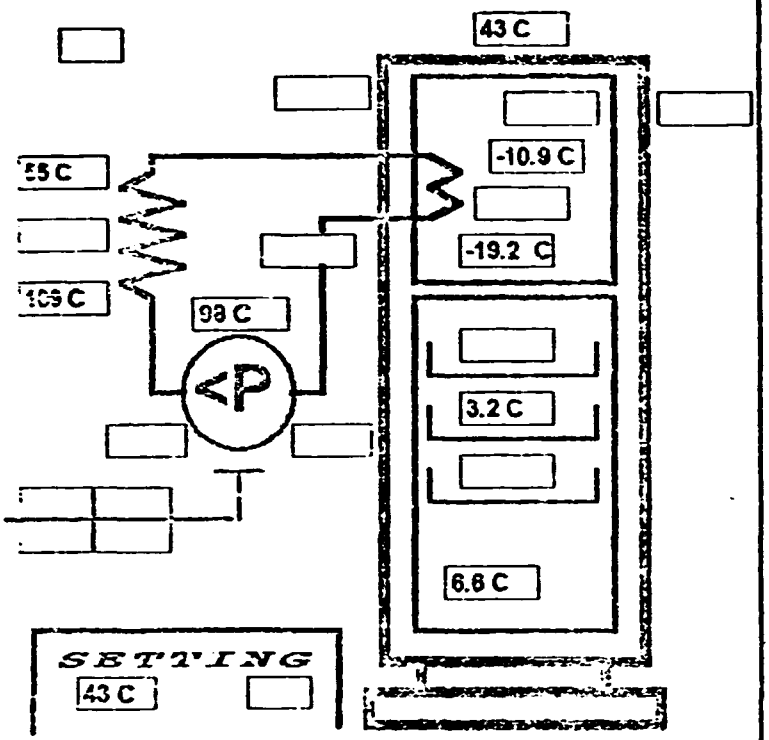
PULL DOWN time is 4:30_hour

The results are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست حجره

Cycling Performance Test



Sampel 1

H740616R.D10

Test Numbar	H740616R.D10
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/8 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record No	
Exam - state	

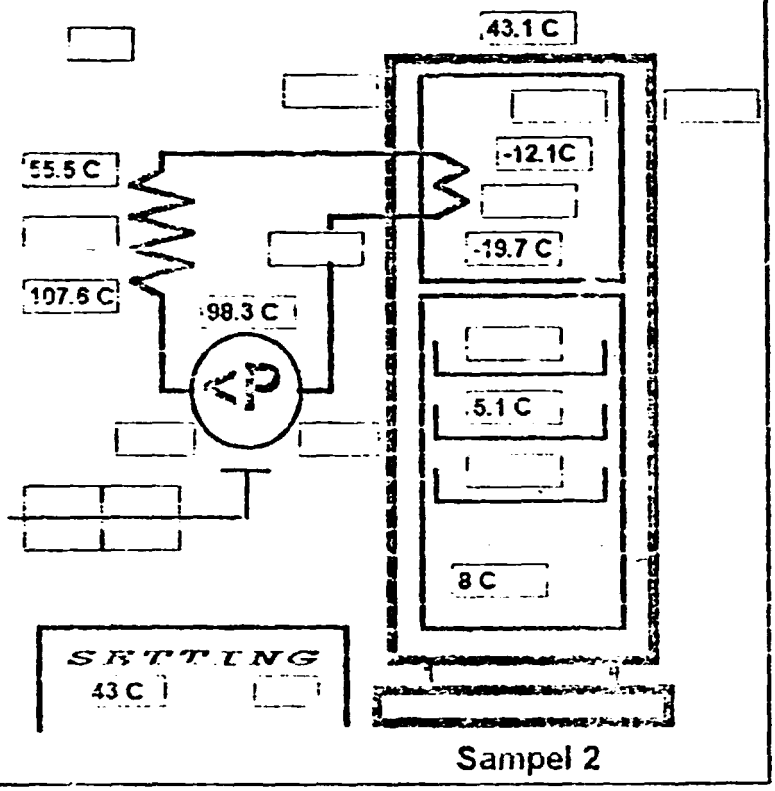
Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	% 65
Evaprator Air	-10.9 C
Cabin Mean Temprature	3.2 C
Crisper Temprature	6.6 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	98 C
Condenser Inlet temp.	109 C
Condenser exit temp.	55 C

System stablized after 4:30_hour & after 24_hour the RESULTS are unsatisfactor

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست هتجال

Cycling Performance Test



Sampel 2

H740615L.D08

Test Number	H74C615L.D08
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost position	5
Thermost Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record - No	
Exam - state	

Result:

Ambient Temparature	43.1 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	61 %
Evaprator Air	-12.2C
Cabin Mean Temprature	5.1 C
Crisper Temprature	8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	98.3 C
Condenser inlet temp.	107.8 C
Condenser exit temp.	55.5 C

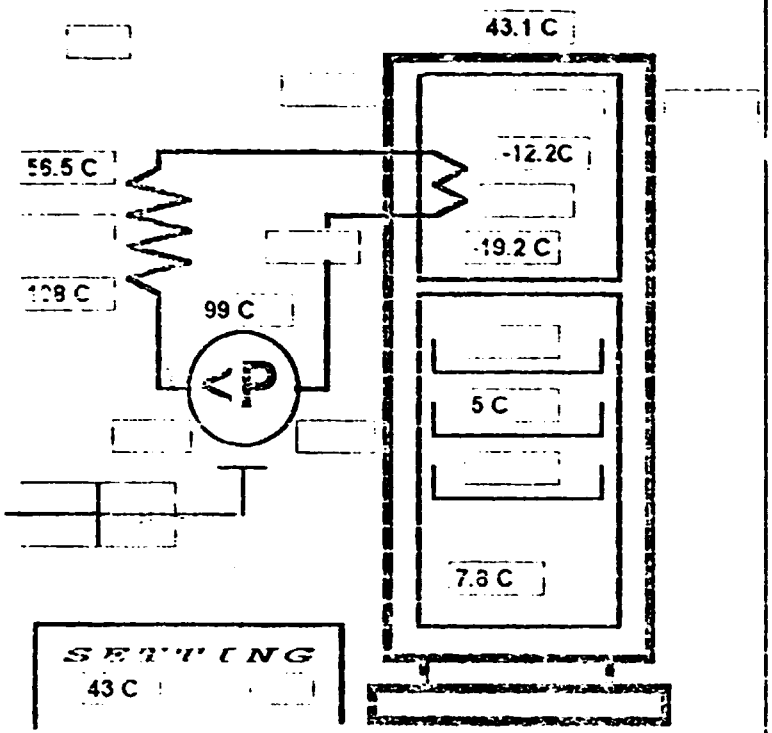
Remark: توضیحات :

System stablized after 4_hour & after 24_hour the RESULTS are satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست یخچال

Cycling Performance Test



Sampel 1

H740615R.D08

Test Number	H740615R.D08
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr

Record - No	
Exam - state	

Result:

Ambient Temperature	43.1 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	62 %
Evaprator Air	-12.2C
Cabin Mean Temprature	5 C
Crisper Temprature	7.8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	108 C
Condenser exit temp.	56.5 C

Remark: توضیحات :

System stablized after 4:15_hour

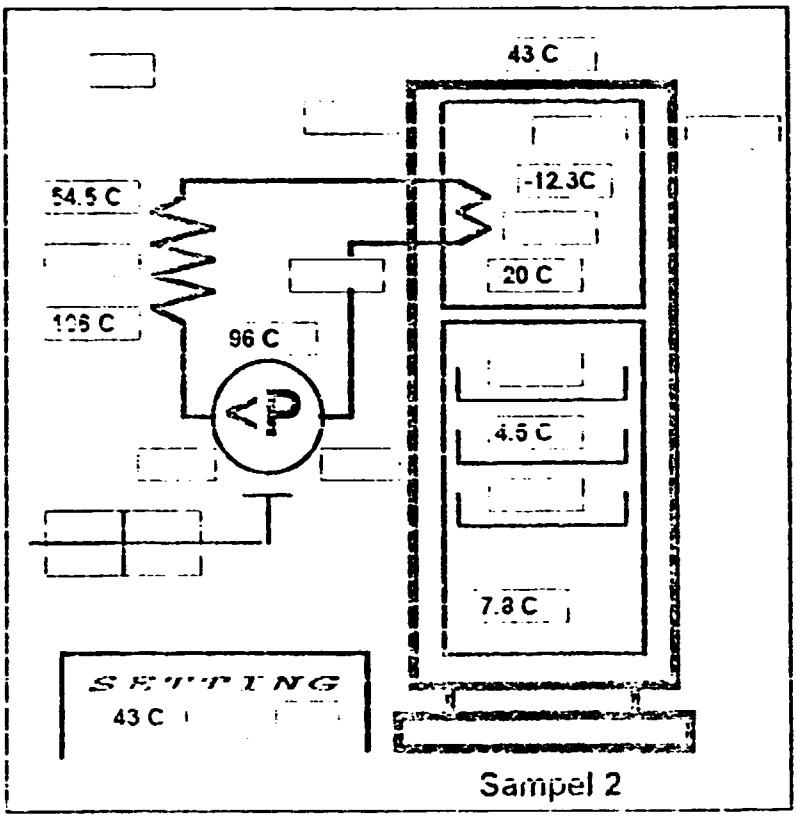
& after 24_hour the RESULTS are

satisfactory

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست یخچال

Cycling Performance Test



Sampel 2

H740616L.D10

Test Number	H740616L.D10
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	TECUMSEH
Compresor Model	AEZ 1358 Y
Compresor Power	1/6 HP
Compresor Current	1.2 A
Thermost. position	5
Thermost Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	61 %
Evaprator Air	-12.3C
Cabin Mean Temprature	4.5 C
Crisper Temprature	7.8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	96 C
Condenser inlet temp.	106 C
Condenser exit temp.	54.5 C

Remark: توضیحات :

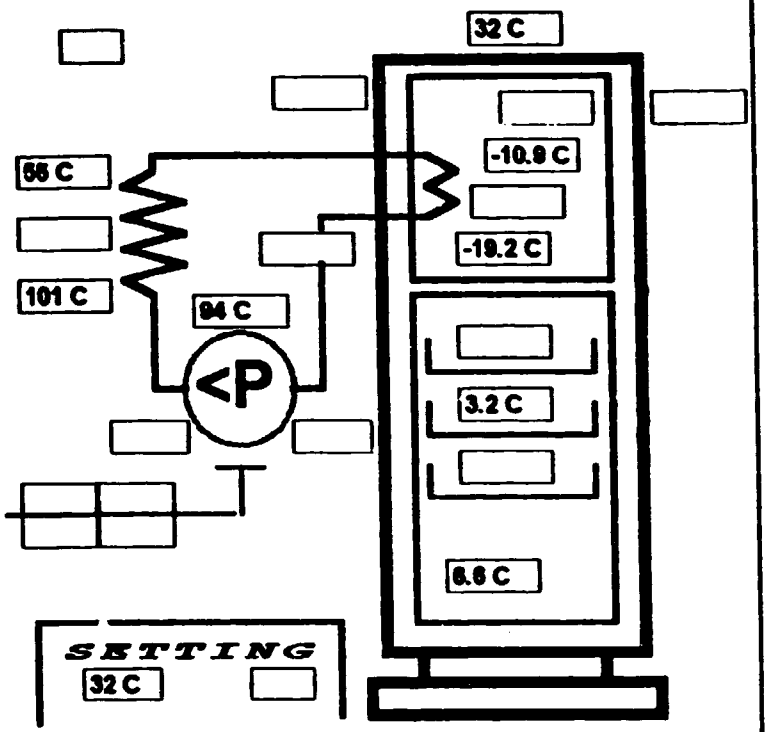
System stablized after 3:30_hour & after 24_hour the RESULTS are satisfactory

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست هات روم

Energy Consumption Test



Sampel 1

H740616R.D10

Test Number	H740616R.D10
Product Name	Refrigerator
Product Model	RF-11-F
product Capecity	320 Lit
Compresor Name	GOLD STAR
Compresor Model	NR52 LAEG
Compresor Power	1/8 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record No	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	% 63
Evaprator Air	-10.9 C
Cabin Mean Temprature	3.2 C
Crisper Temprature	6.6 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	1.89 KWh
—	—
Motor Winding Temp.	
Compressor top temp.	94 C
Condenser inlet temp.	101 C
Condenser exit temp.	55 C

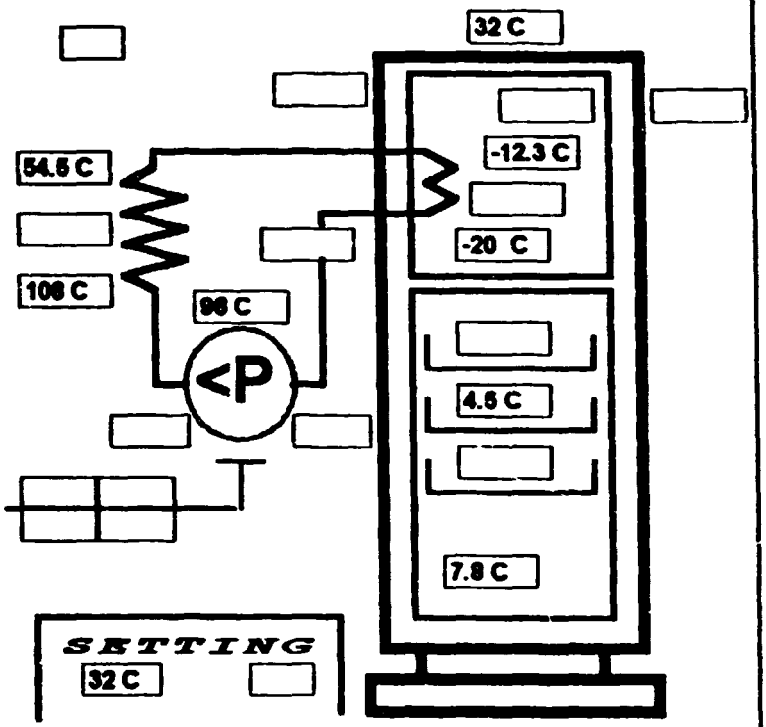
Energy Consumption at 24_hour is 1.891 Kwh

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست هتروم

Energy Consumption Test



Sampel 2

H740616L.D10

Test Number	H740616L.D10
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	TECUMSEH
Compresor Model	AEZ 1358
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr
—	
—	
—	
Record No	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	% 58
Evaprator Air	-12.3 C
Cabin Mean Temprature	4.5 C
Crisper Temprature	7.8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	1.74 KWh
—	—
Motor Winding Temp.	
Compressor top temp.	96 C
Condenser inlet temp.	106 C
Condenser exit temp.	54.5 C

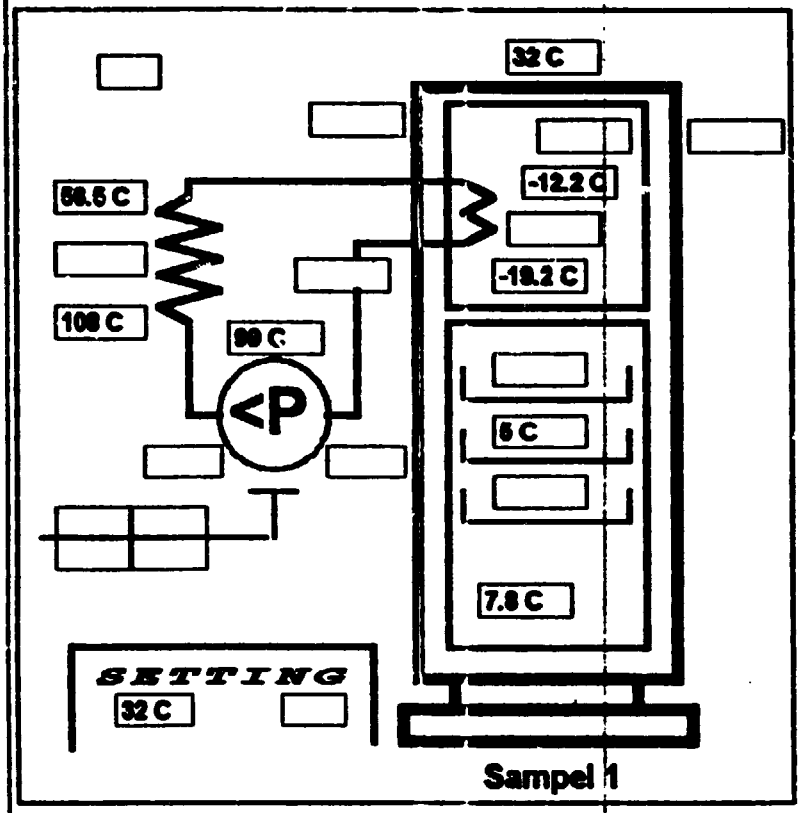
Energy Consumption at 24_hour Is 1.74 Kwh

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست هات روم

Energy Consumption Test



Sampel 1

H740615R.D08

Test Number	H740615R.D08
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	GOLD STAR
Compresor Model	NR52 LAEG
Compresor Power	1/8 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr

Record No	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	% 57
Evaprator Air	-12.2 C
Cabin Mean Temprature	5 C
Crisper Temprature	7.8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	1.71 KWh
-	-
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	108 C
Condenser exit temp.	56.5 C

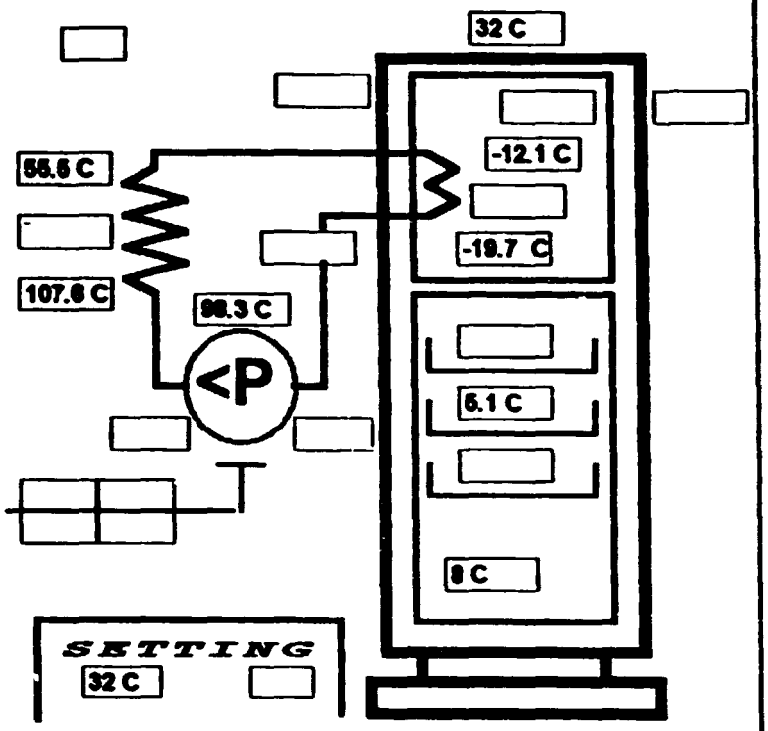
Energy Consumption at 24_hour is 1.71 Kwh

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست هات روم

Energy Consumption Test



Sampel 2

H740615L.D08

Test Number	H740615L.D08
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	5
Thermost. Type	Semi Auto
Total Test Time	24 hr

Record No	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	% 58
Evaprator Air	-12.1 C
Cabin Mean Temprature	3.1 C
Crisper Temprature	8 C
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	1.74 KWh
--	--
Motor Winding Temp.	
Compressor top temp.	98.3 C
Condenser inlet temp.	107.6 C
Condenser exit temp.	55.5 C

Energy Consumption at

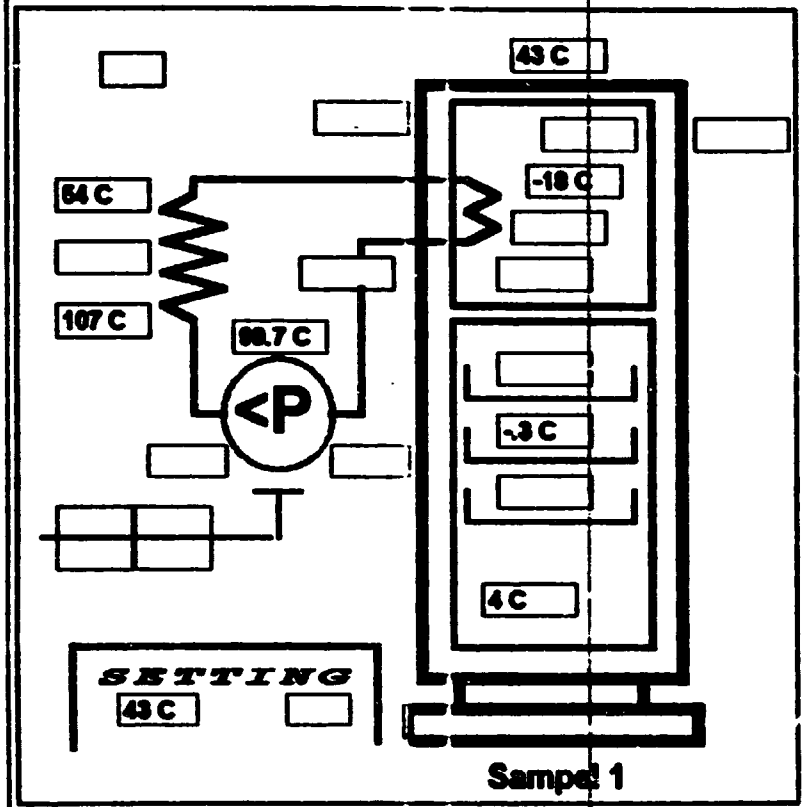
24 _hour is 1.74 Kwh

R & D Manager: GHAFFARI

IRAN POLYA Co.

HOT ROOM TEST تست هتروم

Ice Freeze Test



Sample 1

H740620R.D14

Test Number	H740620R.D14
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR62 LAE9
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	6 hr
—	
—	
—	
Record No	
Exam - state	

Ambient Temperature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A
Percentage working	Continuous
Evaprator Air	-18 C
Cabin Mean Temprature	-.3 C
Crisper Temprature	4 C
Total Test Time	6 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	99.7 C
Condenser inlet temp.	107 C
Condenser exit temp.	54 C

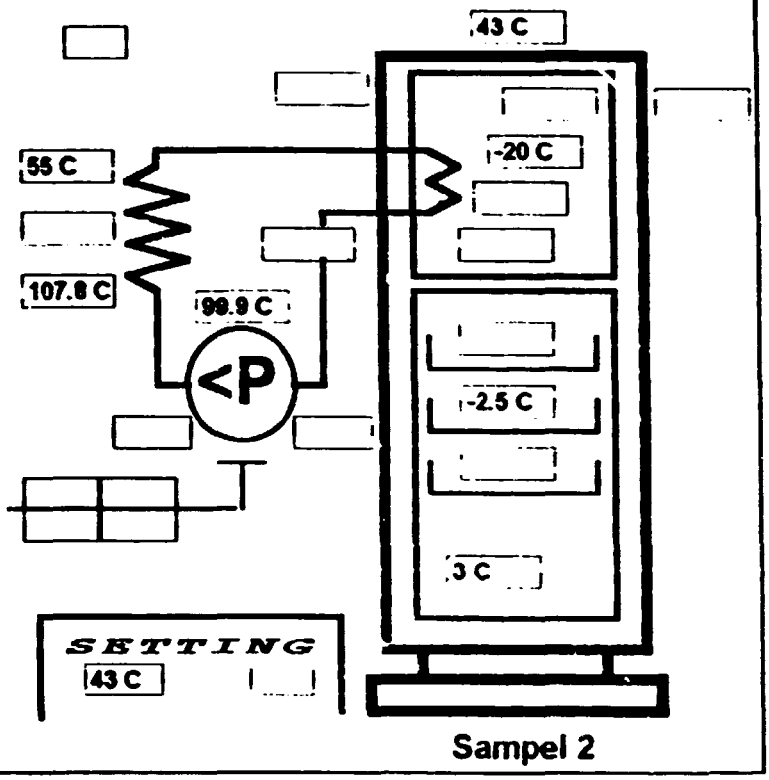
After 6_hour the temperature of water reached to -7 C

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست یخچال

Ice Freeze Test



Sampel 2

H740620L.D14

Test Number	H740620L.D14
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	

Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-20 C
Cabin Mean Temprature	-2.5 C
Crisper Temprature	3 C
Total Test Time	3:45
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	99.9 C
Condenser Inlet temp.	107.8 C
Condenser exit temp.	55 C

Remark: توضیحات :

After 3:45_hour the temperature of water reached to -7 C

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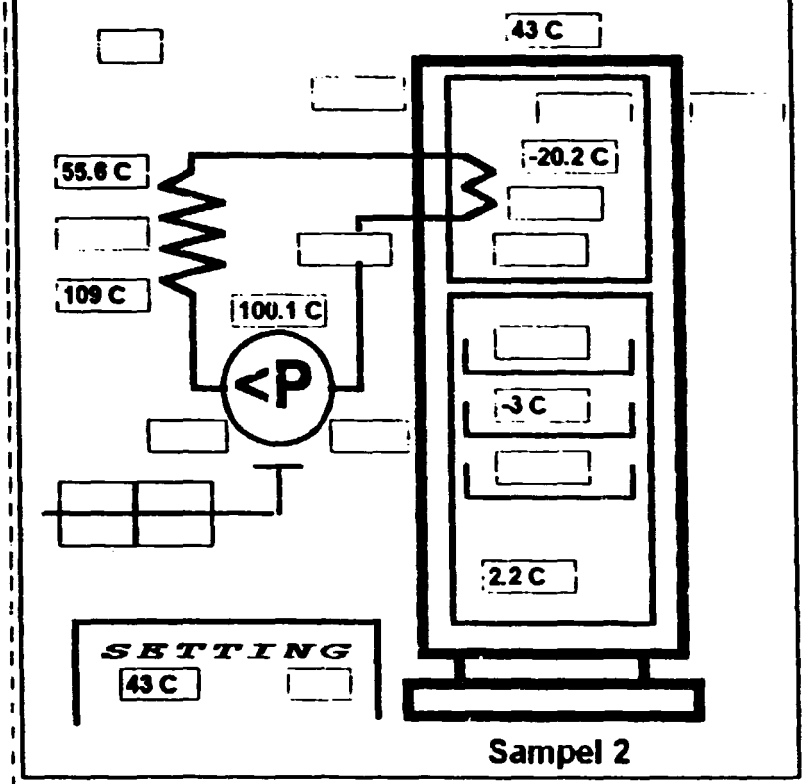
R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست یخچال

Ice Freeze Test



Sampel 2

H740621L.D17

Test Number	H740621L.D17
Product Name	Refrigerator
Product Model	RF-11-F
product Capacity	320 Lit
Compresor Name	Gold Star
Compresor Model	NR52 LAEG
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	

Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-20.2 C
Cabin Mean Temprature	-3 C
Crisper Temprature	2.2 C
Total Test Time	4
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	100.1 C
Condenser inlet temp.	109 C
Condenser exit temp.	55.6 C

Remark: توضیحات :

After 4_hour the temperature of water reached to -7 C

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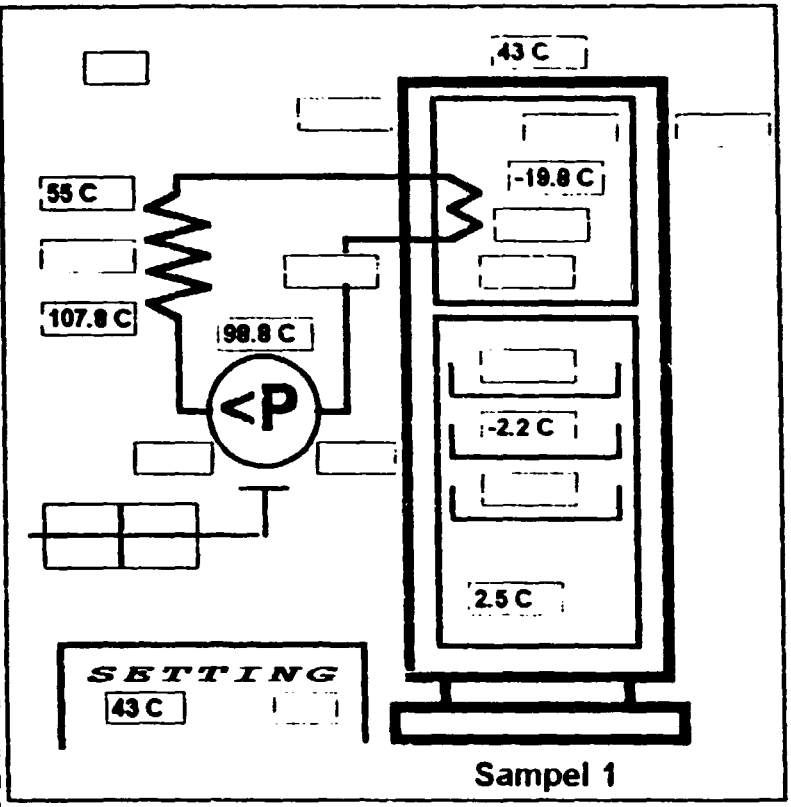
R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست یخچال

Ice Freeze Test



Sampel 1

H740621R.D17

Test Number	H740621R.D17
Product Name	Refrigerator
Product Model	RF-11-F
product. Capacity	320 Lit
Compresor Name	TECUMSEH
Compresor Model	AEZ1358 Y
Compresor Power	1/6 HP
Compresor Current	1 A
Thermost. position	
Thermost. Type	Semi Auto
Total Test Time	
—	
—	
—	
Record - No	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.1 A 125 W
Percentage working	
Evaprator Air	-19.8 C
Cabin Mean Temprature	-2.2 C
Crisper Temprature	2.5 C
Total Test Time	4
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	98.8 C
Condenser Inlet temp.	107.8 C
Condenser exit temp.	55 C

Remark: توضیحات :

After 4_hour the temperature of water reached to - 7 C

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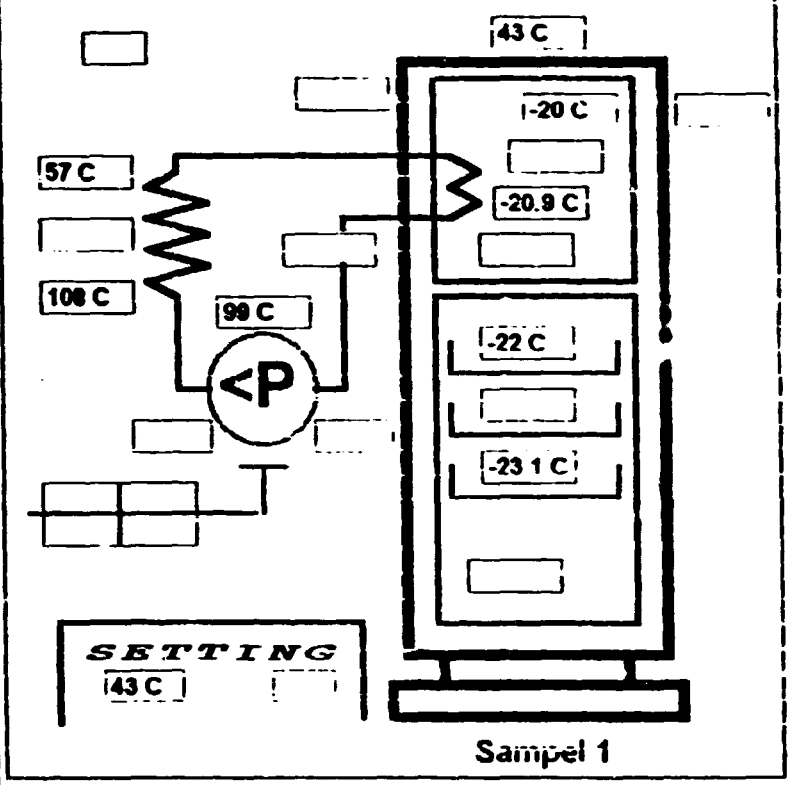
R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Pull down & Contineous run Test



Sampel 1

H740628R.D11

Test Number	H740628R.D11
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-20 C
Cabin Mean Temprature	-20.9 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	108 C
Condenser exit temp.	57 C

After 2:30 _hour temperature reached to - 18 C & after 24_hour the RESULTS are OK.

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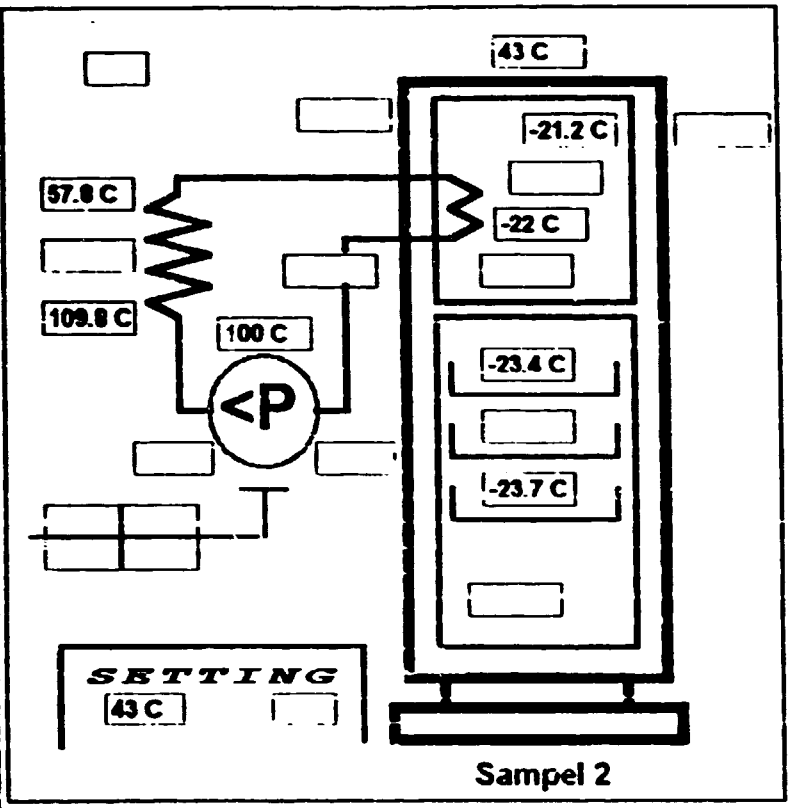
R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست فریزر

Pull down & Contineous run Test



Sampel 2

H740628L.D11

Test Number	H740628L.D11
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V76 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-21.2 C
Cabin Mean Temprature	-22 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	100 C
Condenser inlet temp.	109.8 C
Condenser exit temp.	57.8 C

After 2:30 _hour temperature reached to - 18 C & after 24_hour the RESULTS are OK.

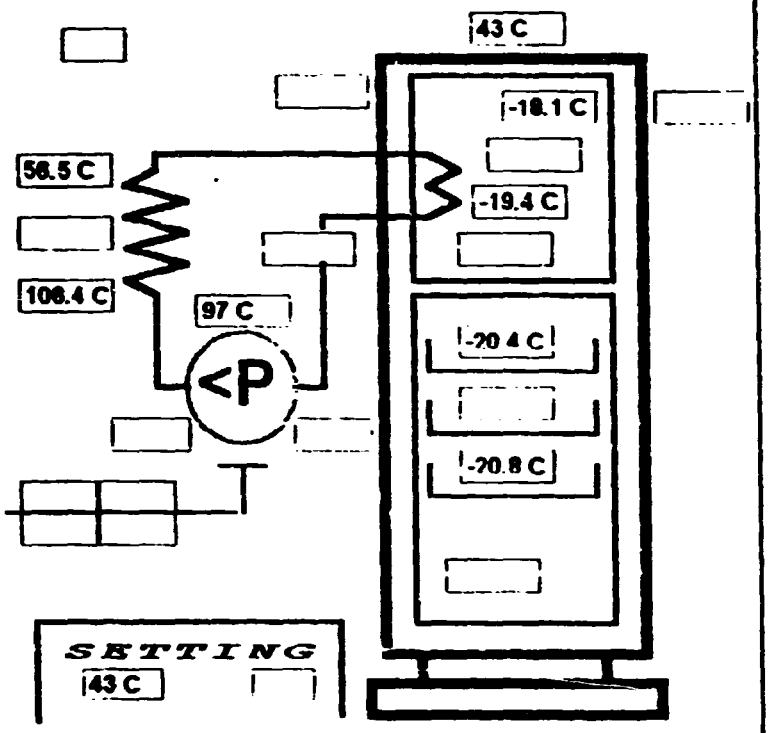
==========

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Pull down & Contineous run Test



Sampel 1

H740629R.D13

Test Number	H740629R.D13
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Ambient Temprature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-18.1 C
Cabin Mean Temprature	-19.4 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	97 C
Condenser inlet temp.	106.4 C
Condenser exit temp.	56.5 C

After 3:30 _hour temperature reached to - 18 C & after 24_hour the RESULTS are unsatisfactory

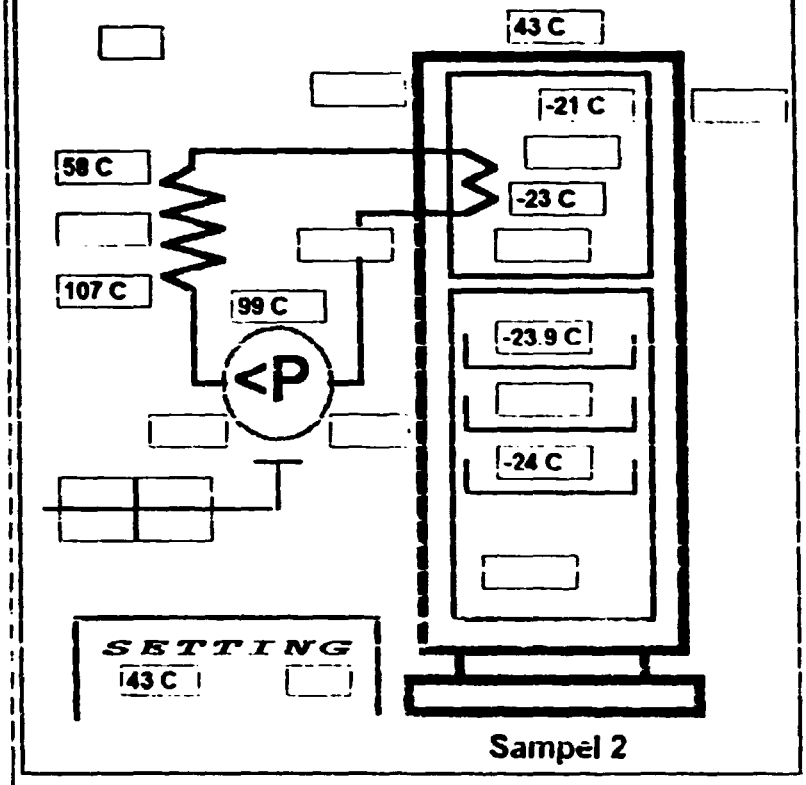
==========

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Pull down & Contineous run Test



Sampel 2

H740629L.D13

Test Number	H740629L.D13
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-21 C
Cabin Mean Temprature	-23 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	107 C
Condenser exit temp.	58 C

After 2:30 _hour temperature reached to - 18 C & after 24_hour the RESULTS are OK

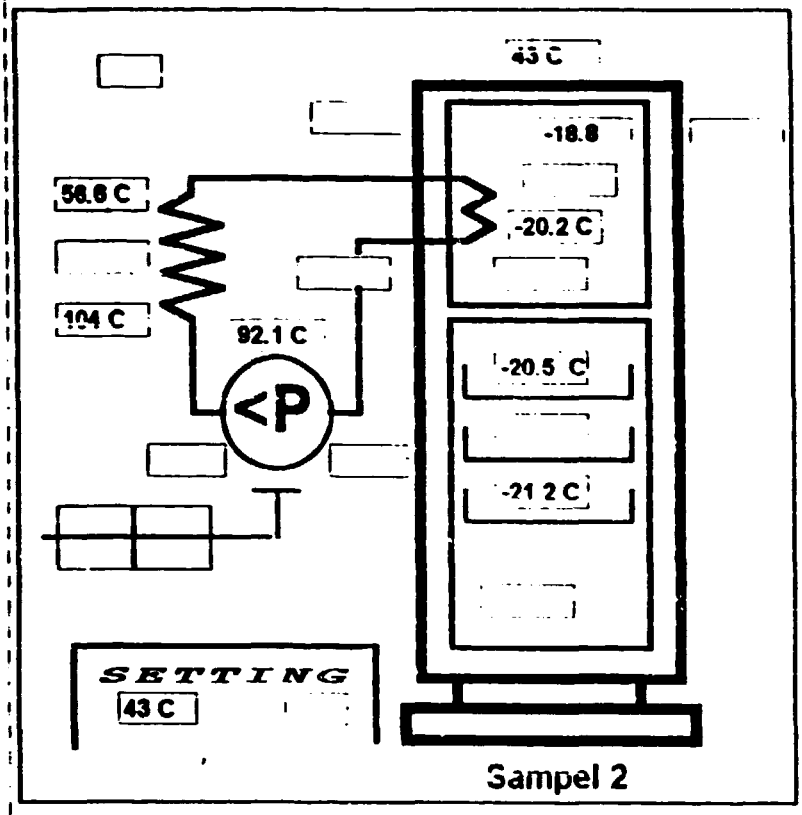
==========

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Cycling Performance Test



Sampel 2

H740625L.D17

Test Number	H740625L.D17
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	5
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	72 %
Evaprator Air	-18.8
Cabin Mean Temprature	-20.2 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	92.1 C
Condenser inlet temp.	104 C
Condenser exit temp.	56.6 C

Remark: توضیحات :

After 24_hour work the RESULTS are satisfactory

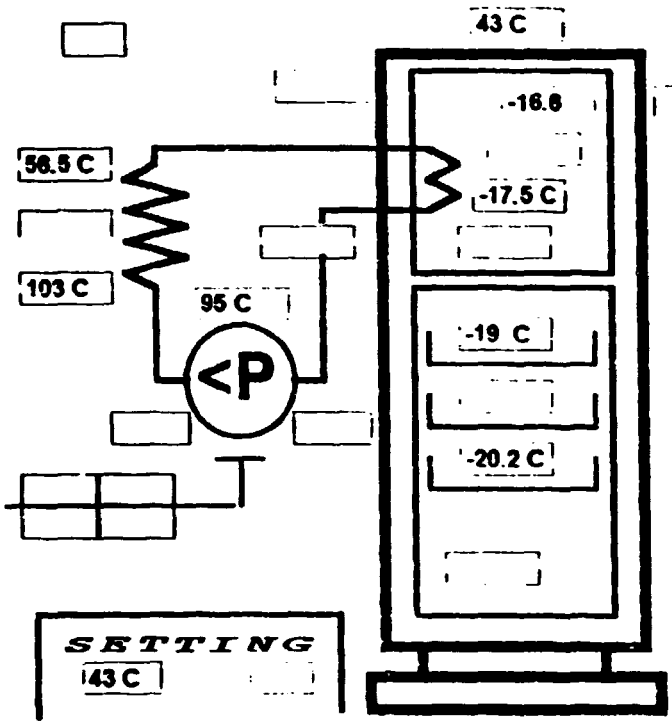
==========

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست فریزر

Cycling Performance Test



Sampel 2

H740627L.D08

Test Number	H740627L.D08
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	5
Thermost. Type	Normal
Total Test Time	24 hr
—	
—	
—	
Exam - state	

Result:

Ambient Temperature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	76 %
Evaprator Air	-16.6
Cabin Mean Temprature	-17.5 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	95 C
Condenser inlet temp.	103 C
Condenser exit temp.	56.5 C

Remark: توضیحات :

After 24_hour work the RESULTS are unsatisfactory

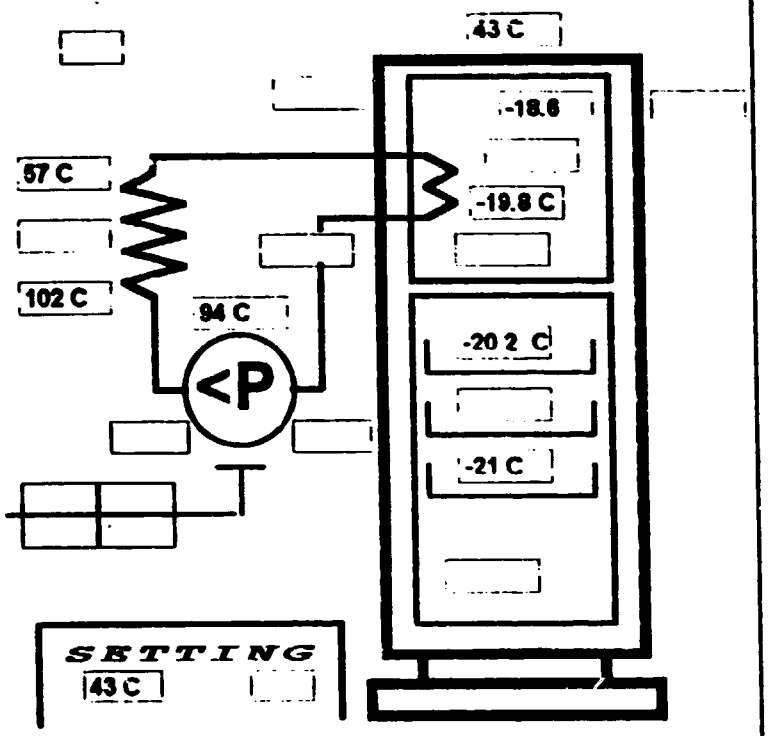
==========

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست فریزر

Cycling Performance Test



Sampel 1

H740627R.D08

Test Number	H740627R.D08
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	5
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	74 %
Evaprator Air	-18.6
Cabin Mean Temprature	-19.8 C
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	94 C
Condenser inlet temp.	102 C
Condenser exit temp.	57 C

Remark: توضیحات :

After 24_hour work the RESULTS are satisfactory

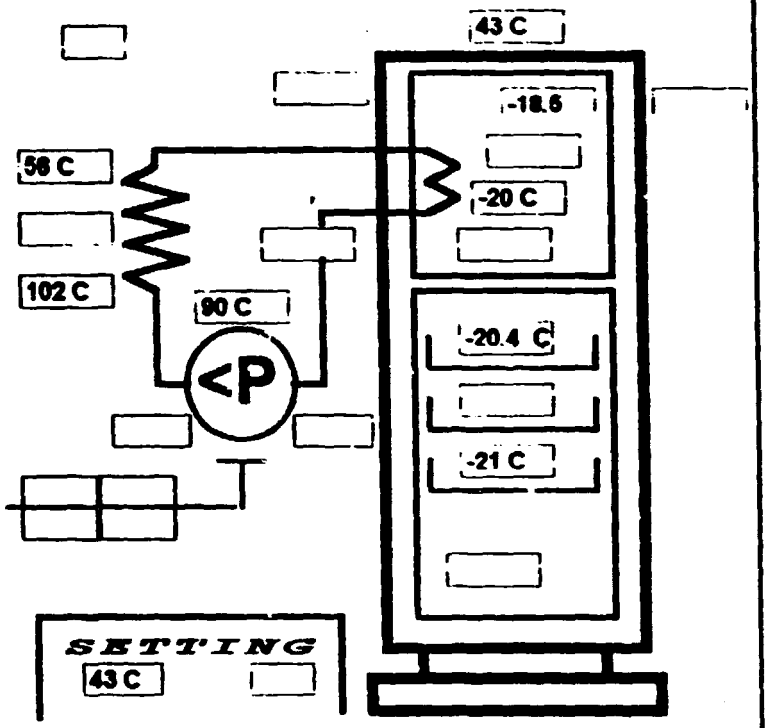
==========

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست فریزر

Cycling Performance Test



Sampel 1

H740625R.D17

Test Number	H740625R.D17
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	5
Thermost. Type	Normal
Total Test Time	24 hr
—	
—	
—	
Exam - state	

Result:

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	70 %
Evaprator Air	-18.5
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	90 C
Condenser inlet temp.	102 C
Condenser exit temp.	56 C

Remark: توضیحات :

After 24_hour work the

RESULTS are satisfactory

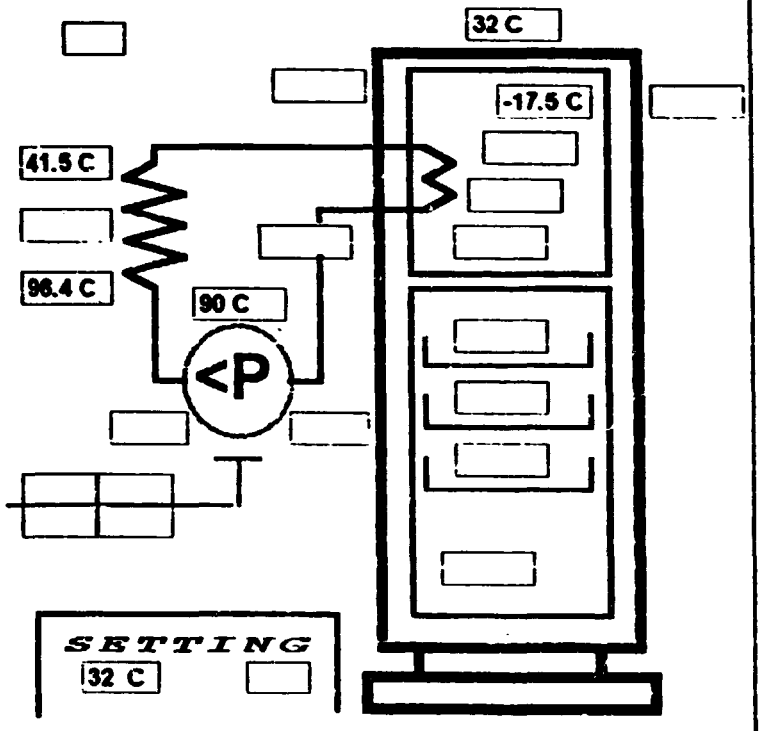
==========

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Freezer power test



Sampel 1

H740601R.D09

Test Number	H740601R.D09
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-17.5 C
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	~
Motor Winding Temp.	
Compressor top temp.	90 C
Condenser inlet temp.	96.4 C
Condenser exit temp.	41.5 C

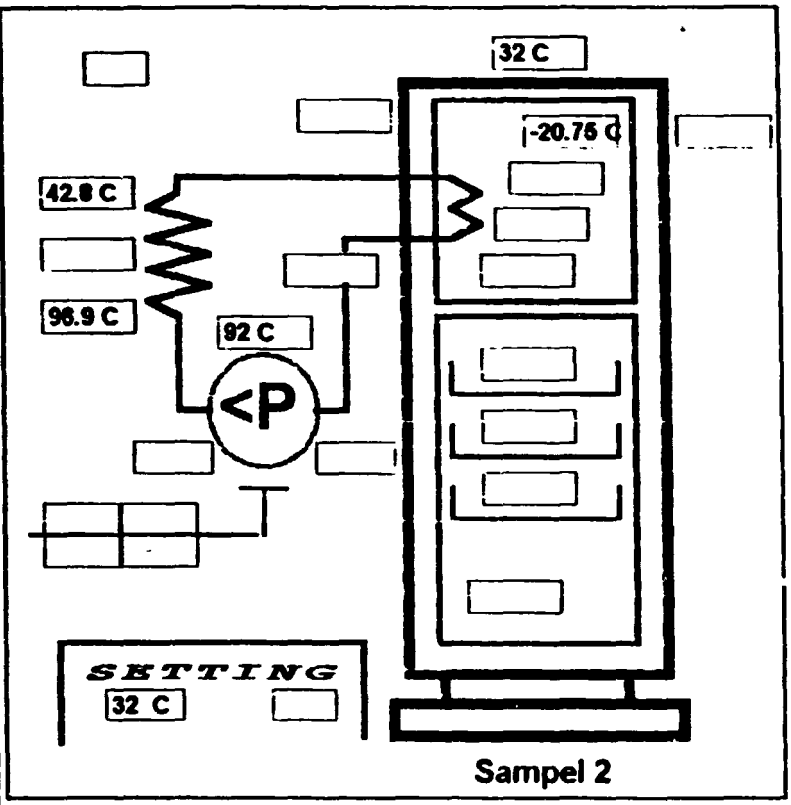
After 24_hour the temperature of 12 Kg fresh meat reached from 30 C to - 17.5 C

R & D Manager: GHAFFARI

IRAN P0UYA Co.

HOT ROOM TEST تست فریزر

Freezer power test



Sampel 2

H740601L.D09

Test Number	H740601L.D09
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-20.75 C
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	92 C
Condenser inlet temp.	96.9 C
Condenser exit temp.	42.8 C

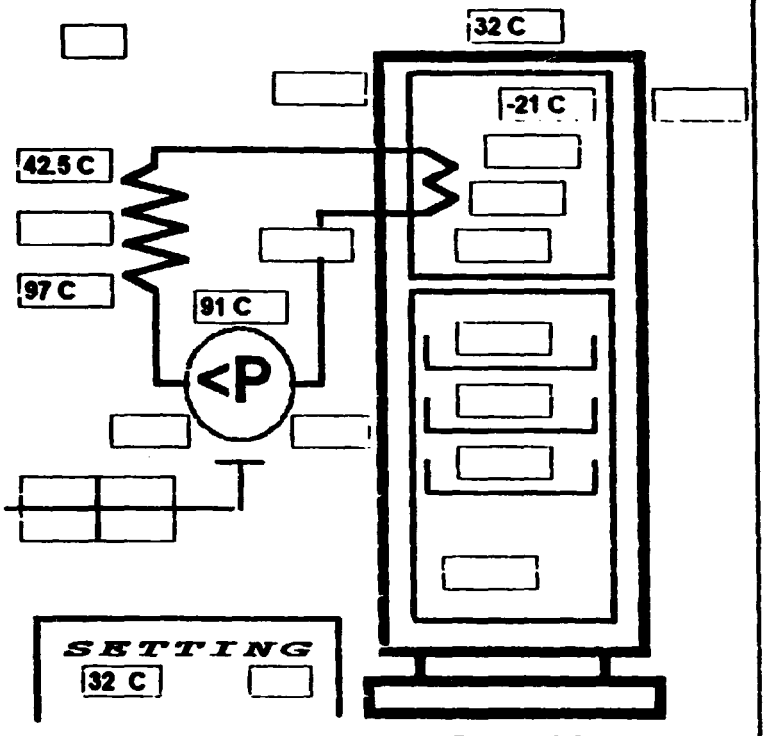
After 21:45_hour the temperature of 12 Kg fresh meat reached from 30 C to - 18 C

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Freezer power test



Sampel 2

H740630L.D18

Test Number	H740630L.D18
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-21 C
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	91 C
Condenser inlet temp.	97 C
Condenser exit temp.	42.5 C

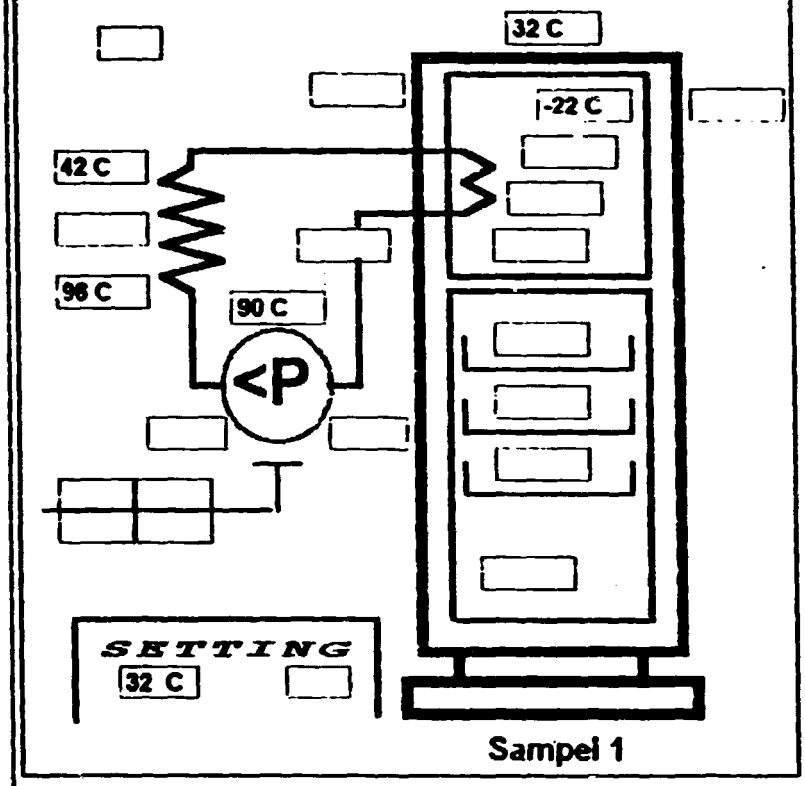
After 22 _hour the temperature of 12 Kg fresh meat reached from 30 C to - 18 C

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Freezer power test



Sampel 1

H740630R.D18

Test Number	H740630R.D18
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hr

Exam - state	

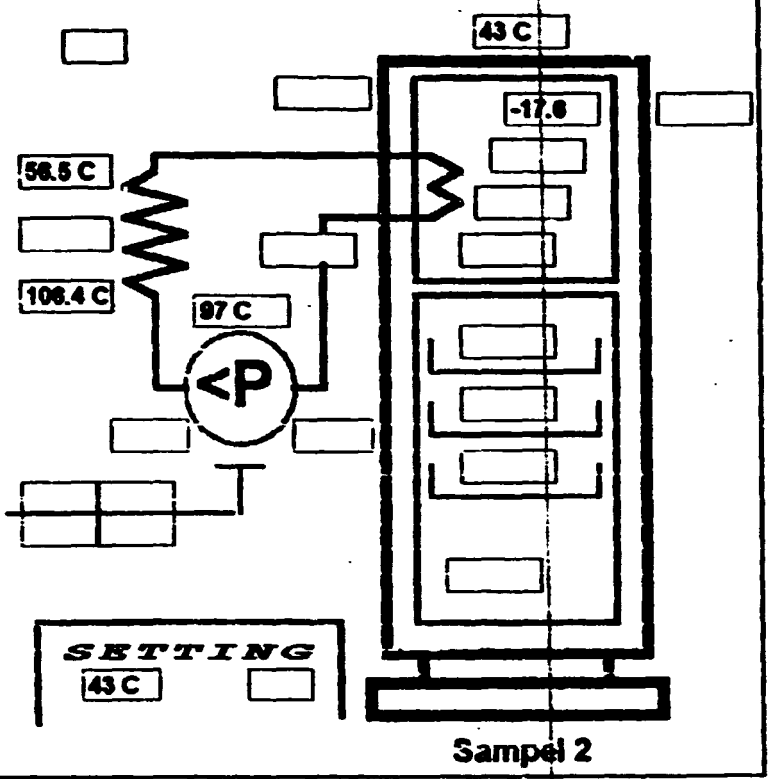
Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 Amp
Percentage working	
Evaprator Air	-22 C
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hour
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	90 C
Condenser inlet temp.	96 C
Condenser exit temp.	42 C

After 21 _hour the temperature of 12 Kg fresh meat reached from 30 C to - 18 C

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست فریزر

Froozen Food Storage Test



Sampel 2

H740607L.D09

Test Number	H740607L.D09
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hour
—	
—	
—	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 A
Percentage working	Contineous
Evaprator Air	-17.6
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	97 C
Condenser inlet temp.	106.4 C
Condenser exit temp.	56.5 C

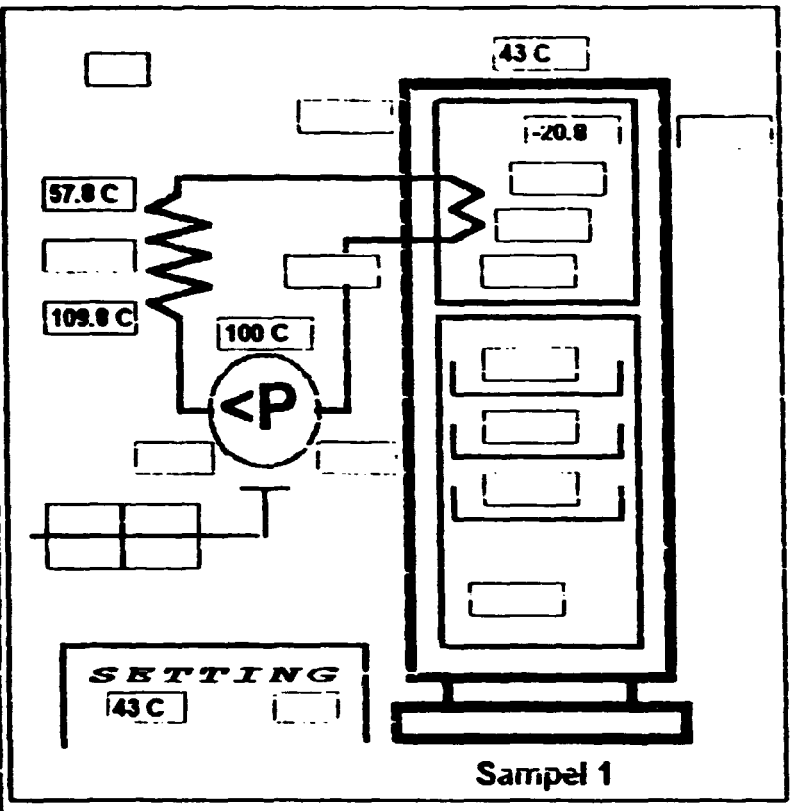
The temperature 65 Kg Froozen test package after 24_hour changed from -13 C to -17.8

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Froozen Food Storage Test



Sampel 1

H740608R.D12

Test Number	H740608R.D12
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost position	
Thermost. Type	Normal
Total Test Time	24 hour
—	
—	
—	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 A
Percentage working	Contineous
Evaprator Air	-20.8
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	100 C
Condenser inlet temp.	109.8 C
Condenser exit temp.	57.8 C

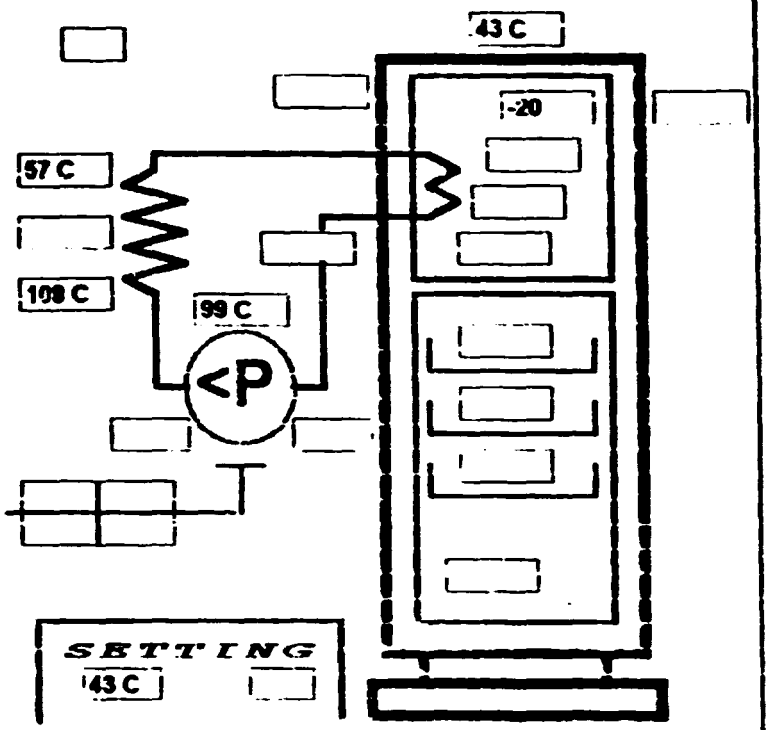
The temperature 65 Kg Froozen test package after 24 _hour changed from -18 C to -20.8

R & D Manager: GHAFFARI

iRAN POUYA Co.

HOT ROOM TEST تست فریزر

Froozen Food Storage Test



Sampel 2

H740608L.D12

Test Number	H740608L.D12
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hour
—	
—	
—	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 A
Percentage working	Continuous
Evaprator Air	-20
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	108 C
Condenser exit temp.	57 C

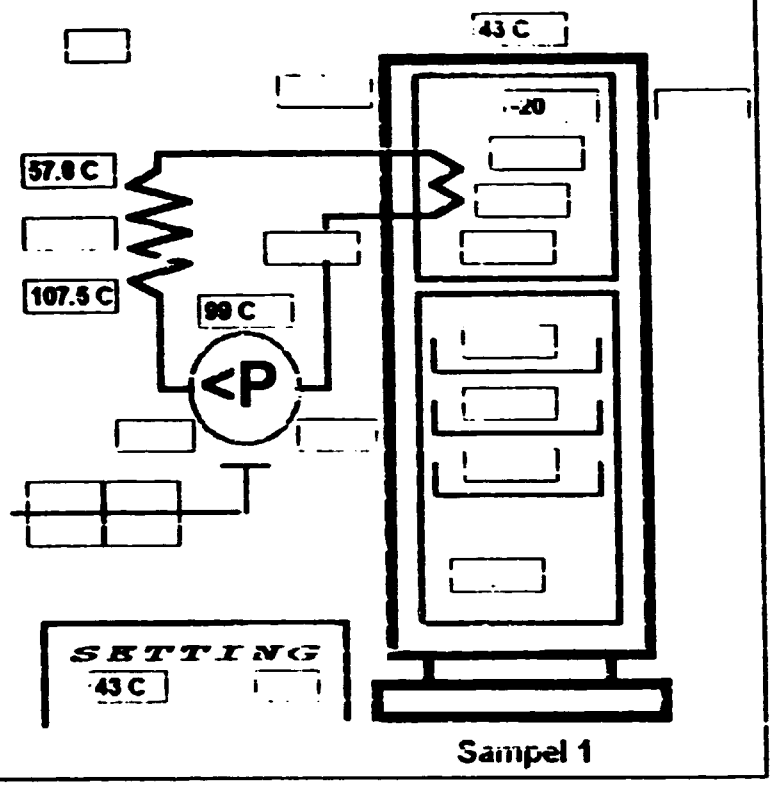
The temperature 65 Kg Froozen test package after 24_hour changed from -18 C to -20

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Froozen Food Storage Test



Sampel 1

H740607R.D09

Test Number	H740607R.D09
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	24 hour
—	
—	
—	
Exam - state	

Ambient Temparature	43 C
Voltage frequency	220 V 50 Hz
Motor current/power	1.3 A
Percentage working	Contineous
Evaprator Air	-20
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	24 hr
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	99 C
Condenser inlet temp.	107.5 C
Condenser exit temp.	57.8 C

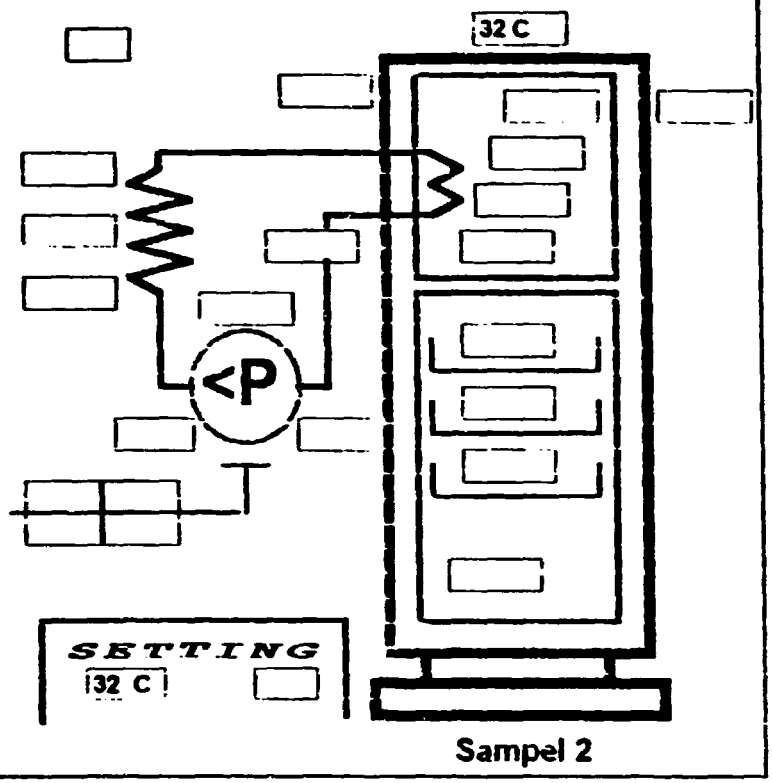
The temperature 65 Kg Froozen test package after 24 _hour changed from -18 C to -20

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Temperature Rise Test



Sampel 2

H740603L.D10

Test Number	H740603L.D10
Product Name	Freezer
Product Model	FR 9F
product. Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	
—	
—	
—	
Exam - state	

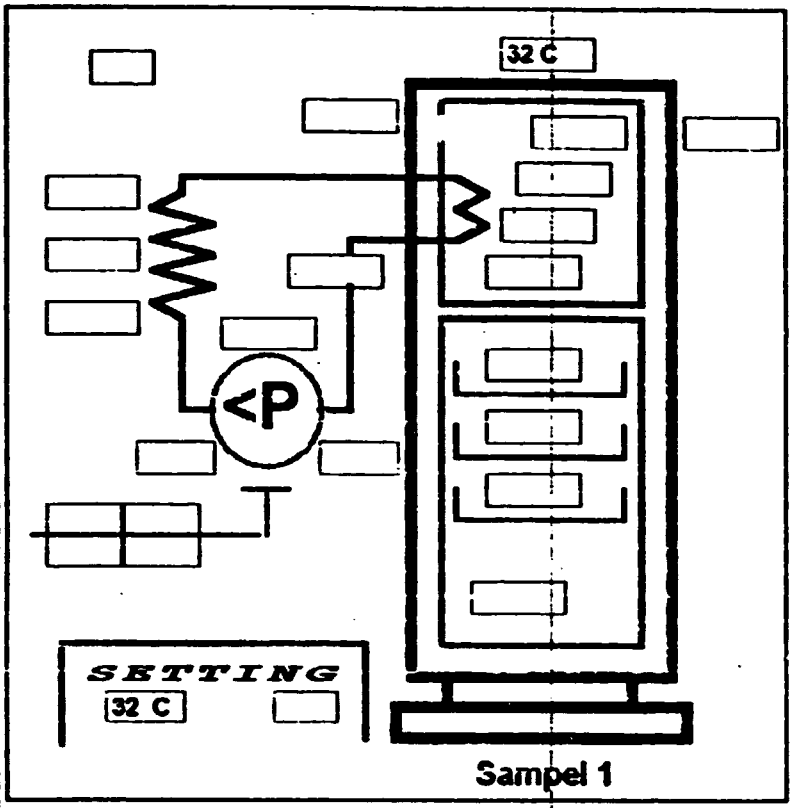
Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	
Percentage working	No working
Evaprator Air	
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	
Condenser inlet temp.	
Condenser exit temp.	

After 5 _hour one package reached from - 18 C to - 9 C

R & D Manager: GHAFFARI

IRAN POUYA Co. HOT ROOM TEST تست فریزر

Temperature Rise Test



Sampel 1

H740603R.D10

Test Number	H740603R.D10
Product Name	Freezer
Product Model	FR 9F
product. Capacity	256 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	
Percentage working	No working
Evaprator Air	
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
-	-
Motor Winding Temp.	
Compressor top temp.	
Condenser inlet temp.	
Condenser exit temp.	

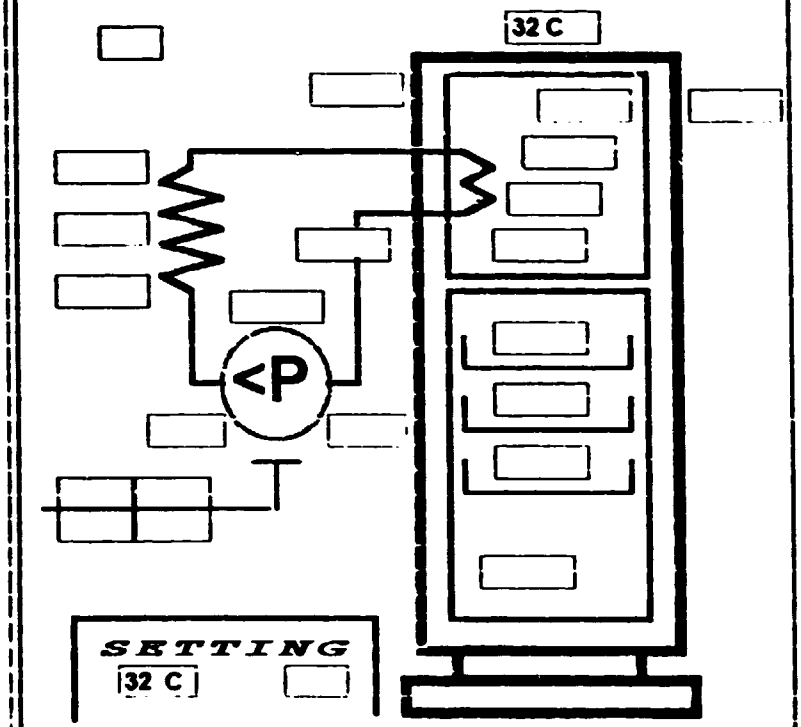
After 8:15_hour one package reached from - 18 C to - 9 C

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Temperature Rise Test



Sampel 2

H740602L.D13

Test Number	H740602L.D13
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	
Percentage working	No working
Evaprator Air	
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
–	–
Motor Winding Temp.	
Compressor top temp.	
Condenser inlet temp.	
Condenser exit temp.	

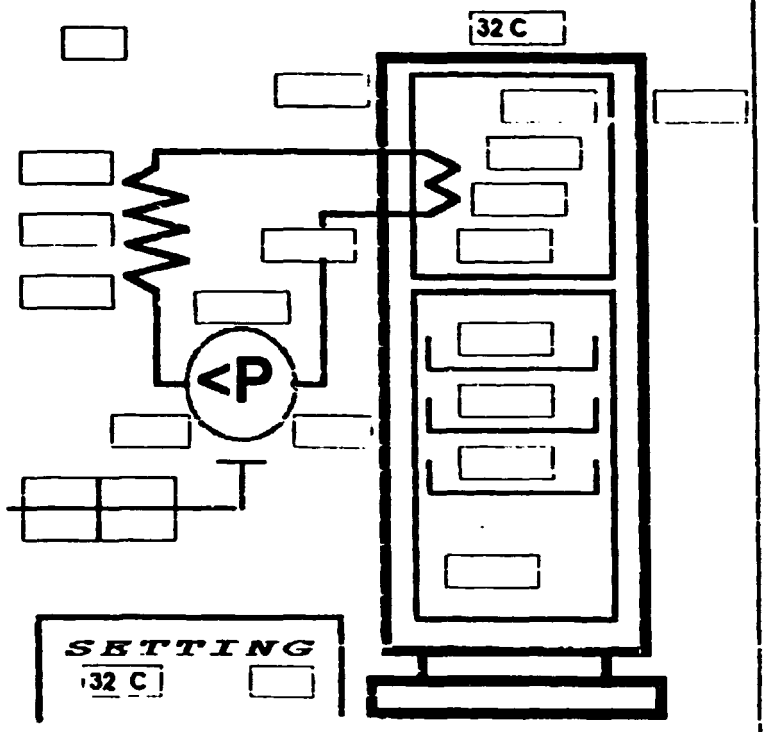
After 8 _hour one package reached from - 18 C to - 9 C

R & D Manager: GHAFFARI

IRAN POUYA Co.

HOT ROOM TEST تست فریزر

Temperature Rise Test



Sampel 1

H740602R.D13

Test Number	H740602R.D13
Product Name	Freezer
Product Model	FR 9F
product Capacity	255 Lit
Compresor Name	Gold Star
Compresor Model	V75 LAEG
Compresor Power	1/4 HP
Compresor Current	1.3 A
Thermost. position	
Thermost. Type	Normal
Total Test Time	
—	
—	
—	
Exam - state	

Ambient Temparature	32 C
Voltage frequency	220 V 50 Hz
Motor current/power	
Percentage working	No working
Evaprator Air	
Cabin Mean Temprature	
Crisper Temprature	
Total Test Time	
Time (start >> sst)	
Time (sst >> report)	
Energy Consumption	
—	—
Motor Winding Temp.	
Compressor top temp.	
Condenser inlet temp.	
Condenser exit temp.	

After 9:30 _hour one package reached from - 18 C to - 9 C

R & D Manager: GHAFFARI

IRAN POUYA CO. « EX. GENERAL STEEL »
(Public Joint Stock Co.)
The Leading Manufacturer of Refrigerator, Freezer and Aluminium Profile

Our Ref

Date

CONVERSION OF DOMESTIC REFRIGERATOR PRODUCTION FACILITIES TO PHASE OUT CFC 11 AND CFC 12

IRAN POUYA COMPANY

FINAL PROGRASSIVE REPORT

PROJECT NO. MP /IRA /94 /403

UNIDO CONTRACT 94 /095

PREPARED BY E. GHAFFARI

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IRAN POUYA CO. « EN. GENERAL STEEL
(Public Joint Stock Co.)
The Leading Manufacturer of Refrigerator, Freezer and Aluminium Profile

Our Ref

Date

INTRODUCTION:

IN THE FINAL REPORT ACCORDING TO UNIDO INSTRUCTION WE DO THE FINAL ANALYSIS OF THE PROJECT.

IN THE FIRST AND SECOND PROGRESS REPORTS WE HAVE DONE THE DESIGN PHASE AND PROTOTYP PHASE WITH SUCCESFULLY COMPLETED.

IN THIS FINAL REPORT WE COME TO THE FINAL CONCLUTION AND EVALUATION OF SO FARE WHAT WE HAVE DONE.

ALTHOUGH THIS PROJECT IS THE FIRST PART OF MAIN CFC PHASE OUT PROJECT BUT IT IS THE IMPORTANT PART OF IT.

IRAN POUYA CO. AS A LEADING MANUFACTURER OF REFRIGERATOR AND FREEZER IN IRAN HAD STUDIED ON THIS FILED FOR CHANGE OF CFC GASES BEFORE AND HAD TO CHANGE THEME BY ITS OWN FINANCE. WHEN UNIDO IS INTRODUCED BY THE GOVERMENT TO HELP INDUSTRIES WHO ARE USING CFC GASES AND REMOVE THEME WITH THEIR FINANCIAL SUPPORT.

THIS SUPPORT MADE INDUSTRY TO DO THIS PROJECT FASTER AND MORE EFFICENT. IN THIS REPORT WE TALK ABOUT BACKGRAND OF COMPANY FOR THIS PROJECT AND ACTIVITES WHICH TAKEN DURING AND BEFORE PROJECT, CONCLUSION AND RECOMENDATIONS.

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PROJECT BACKGROUND IN THE COMPANY:

IRAN POUYA COMPANY IS LARGE MANUFACTURER OF HOME APPLEIANCES IN IRAN HAS STARTED MANUFACTURING 35 YEARS AGO.

THE FACTORY IS LOCATED NEAR BY TEHRAN AND MANUFACTURES ONE MODEL REFRIGERATOR AND ONE MODEL FREEZER. THE MAXIMUM PRODUCTION CAPACITY OF FACTORY IS 200000 UNITS PER YEAR.

IN 1987 WHEN THE MONTREAL PROTOCOOL WERE SIGNED BY 81 COUNTRIES INCLUDING IRAN AND HAD TIME LIMIT FOR USING CFC GASES. IRAN POUYA COMPANY START TO COLLECTING INFORMATION ABOUT CFC SUBSTITUTION FROM DU PONT AND DOW CHAMICAL COMPANIES. THE INFORMATION ABOUT R12 SUBSITUTION HFC 134A AND R11 SUBSITUTION FIRST HCFC 141B AND THEN CYCLOPANTAN. COLLECTING INFORMATION FROM COMPRESSOR MANUFACTUR ABOUT COMPRESSOR WITH USE OF R134A AND ASKING FOR SAMPELS. STUDY ABOUT SYSTEM MODIFICATION AND REDESIGN OF THEME.

THIS STUDY WERE CARRING ON UNTIL UNIDO START FOR NEGOTIATION AND HELPING FOR MODIFICATION. FROM THEN UNIDO WERE MADE A CONTRACT WITH IRAN POUYA COMPANY FOR THIS MODIFICATION.

THE TOTAL AMOUNT OF CFC CONSUME ANNUALY IN IRAN POUYA COMPANY ARE 120 TONS. 85TONS R11 AND 35TONS R12 FOR PRODUCTION LINE AND SERVICE STATIONS.

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SYNOPSIS:

THE UNIDO PROJECT IS CONVERSION OF DOMESTIC REFRIGERATOR PRODUCTION FACILITIES TO PHASE OUT CFC - 12 AND 11. THE FIRST PART OF THIS PROJECT WHICH HAS MADE A CONTRAT WITH IRAN POUYA COMPANY WERE ABOUT FOLLOWING SUBJECTS. DESIGN , CALCULATION AND DRAFTING FOR MODEL REDEFINITION PROTOTYPING.

PROTOTYPE TESTING FOR FUNCTIONALITY AND PERFORMANCE OF TWO MODELS REFRIGERATOR AND FREEZER.

THIS PROJECT HAS BEEN MADE THREE PARTS. THE FIRST PROGRASS REPORT COVERS THE FOLLOWING SUBJECTS.

1 - DIMENTIONAL AND INSULATION SPECIFICATIONS.

2 - REFRIGERATING UNIT COMPONENT DETAILS.

3 - DESIGN AND CALCULATION.

4 - COOLING LOAD CALCULATION.

5 - PRODUCTION LOAD CALCULATION.

6 - SELECTION OF COMPRESSOR.

7 - DETERMINATION OF CONDENSER.

8 - DETERMINATION OF CAPILLARY TUBE.

9 - DETERMINATION OF EVAPORATOR.

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SECOND PROGRESS REPORT CONTAINS.

1 - DETERMINATION OF CABINET CONSTANT.

2 - METHOD OF SELECTION OF COMPATIBLE COMPONENTS.
WITH RESPECT TO THE TEST RESULTS AND OPTIMIZATION PROGAMME.

3 - EVALUATION OF PROTOTYPES WITH RESPECT TO MINOR MODIFICATION OF CHANGES AND TEST RESULTS.

4 - PREPARATION OF TRIAL TEST EQUIPMENT.

5 - TEMPERATURE TEST PROCEDURE WHICH COMPLY WITH ISO OR DIN STANDARDS.

6 - OPTIMIZATION PLAN.

7 - ENERGY CONSUMPTION VALUATION REPORT.

8 - R-12 AND R-134 A REFRIGERANT TEST SHEETS EVALUATION AND REVIEW.

IN THE FINAL PROGRASS REPORT WE WILL CONSIDER THE FOLLOWING SUBJECTS TO END UP THIS PART OF PROJECT.

1 - ACTIVITIES.

2 - TASKS.

3 - PROTOTYPES EVALUATION AND ANALYSIS.

4 - CONCLUSION.

5 - RECOMMENDATIONS.

6 - BIBLIOERPHY AND REFERENCES.

7 - ATTACHMENTS.

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ACTIVITIES:

SINCE INTRODUCING THE PROJECT OF CONVERSION OF DOMESTIC REFRIGERATOR PRODUCTION FACILITIES TO PHASE OUT CFC 12 & CFC 11 BY UNIDO AND A COTRACT HAS BEEN MADE WITH IRAN POUYA COMPANY TO CARRY OUT THE PROJECT THE FOLLOWING ACTIVITIES WERE DONE DURING THIS PROJECT.

1 - *ACCEPTING THE TERM OF REFRENCE WHICH MADE BY UNIDO AND SINING THE CONTRAT.*

2 - *MAKING A TIME SCHEDULE FOR CARRING OUT THE PROJECT.*

3 - *COLLECTING INFORMATION ABOUTE CFC GASES AND COMPRESSORS WITH USE OF R134A FROM DIFFERENT MANUFACTURER AND ASKING FOR SAMPELS.*

4 - *PARTICIPATING IN TRAINING COURSE WHICH ARRANGED BY UNIDO IN GERMANY BER RESEARCH CENTET TO HELP IRANIAN EXPORTS TO DESIGN AND CALCULAT THEIR REFRIGERATOR AND FREEZER AND TEST THEM UNDER THE STANDARD DIN 8956.*

5 - *COLLECTING THE EQUIPMENTS WHICH UNIDO SENT TO US UNDER THE CONTRACT NO. 91/093 SUCH AS CHARGING MACHINE LEAK DETECTOR MACHINE AND VACUUM PUMP.*

6 - *INSTALLING THE MACHINE AND USING FOR PROTOTYPE FOR THE TIME BEING AND READY FOR ACTULE PRODUCTION.*

7 - *HELPING THE UNIDO EXPORTS AND PROVIDING THE NECESSARY INFORMATION AND ALSO PRODUSING LAY OUT FOR FOAMING PLANT.*

8 - *MAKING FIRST PROGRESS REPORT FOR SUBMITTING TO UNIDO. THIS REPORT WAS ABOUT CALCULATION AND DESIGNING OF TWO MODEL REFRIGERATORAND FREEZER FOR USE OF R 134A.*

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9 - SELECTION OF COMPATIBLE COMPONENTS AND MAKING TEN PROTOTYPES FIVE PER MODEL AND TEST THEME IN THE HOT ROOM FOR FUNCTIONALITY AND PERFORMANCE.

10- PREPARING SECOND PROGRESS REPORT AND SUBMITTED TO UNIDO.

11- MODIFYING TWO COMPONENTS INSIDE REFRIGERATOR ACCORDING TO OPTIMIZATION FOR BETTER PERFORMANCE.

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TASKS:

THE TASKS HAVE BEEN ACCOMPLISHED TO CARRY OUT THIS PROJECT ARE AS FOLLOW. THE FIRST STEP IS TO STUDY ON REDESIGNING OF REFRIGERATOR AND FREEZER FOR USE OF R134A.

FOR CALCULATION AND DESIGNING OF A PARTICULAR REFRIGERATOR AND FREEZER ARE REQUIRED NECESSARY INFORMATION SUCH AS TECHNICAL SPECIFICATIONS OF EACH MODEL.

TECHNICAL SPECIFICATIONS MUST CONTAIN THE FOLLOWING INFORMATIONS.

1 - DIMENTIONAL SPECIFICATIONS.

2 - INSULATION SPECIFICATIONS.

3 - REFRIGERATING UNIT COMPONENT DETAILS.

FOR DETERMINATION OF COMPRESSOR CAPACITY FOR USE OF CFC 134A IN THE SYSTOM THE FOLLOWING ITEMS HAVE TO CALCULATED.

1 - CALCULATION OF COOLING LOAD.

A) AMOUNT OF HEAT LEAKING INTO THE REFRIGERATED SPACE THROUGH THE WALL.

B) AMOUNT OF HEAT GIVEN OFF BY WARM PRODUCT.

C) AMOUNT OF HEAT BROUGHT INTO THE REFRIGERATED SPACE BY OPENED DOOR.

D) AMOUNT OF LOAD FOR FREEZING PRPDUCTION AND KEEPING THEME FOR LONG PERIOD.

THE SUMMATION OF ALL LOADS IS TOTAL COOLING LOAD. SELECTING

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COMPRESSOR CAPACITY MUST BE EQUAL OR HIGHER THAN TOTAL COOLING LOAD.

FOR SELECTION OF COMPATIBLE COMPONENTS FOR REFRIGERATOR AND FREEZER WHICH ARE THE IMPORTANT PART OF THIS SECTION.

IN THE FIRST PROGRESS REPORT ALL COOLING LOAD WERE CACULATED FOR BOTH MODEL AND COMPRESSOR CAPACITY ALSO DETERMINED AND SELECTED.

FOR DETERMINATION OF COOLING COMPONENTS THE WORK CONDITION OF ALL COMPONENTS HAVE TO BE CONSIDERED.

SELECTION OF COOLING COMPONENTS:

THERE ARE TWO METHOD OF DETERMINATION

1 - CALCULATING ALL PARTS AND DETERMINING THE RIGHT SIZE.

2 - EXPERIMENTAL METHOD BY DETERMINING CABINET CONSTANT FOR COOLING LOAD AND SELECTING COMPNENTS FROM DIFFERENT MANUFACTURE TABLE.

IN THE FIRST REPORT THE SIZE OF ALL COMPONENTS HAVE BEEN CALCULATED ACCORDING TO ASHRAE FUNDAMENTAL HAND BOOK.

FOR AIR CHANGE LOAD BY OPENING THE DOOR AND AIR LEAKS THROUGH THE GASKET, CALCULATION OF AMOUNT OF AIR LEAKAGE THROUGH THE GASKET CAN NOT BE ACCURATE AND AMOUNT OF AIR CHANGE BY OPENING THE DOOR EACH TIME AND NUMBER OF TIME THAT DOOR GET OPEN IN 24HOURS MUST BE

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ESTMATED WHICH IS NOT ACCURATE TOO. THEREFORE WE WILL ADD TEN PERCENT OF TOTAL LOAD TO IT FOR THIS PURPOSE, SOME MANUFACTURE CONSIDER THREE KG OF ICE IN THE FREEZER COMPARTMENT OF REFRIGERATOR ONLY.

SOME MANUFACTURE HAVE FOLLOWED ASHRAE METHOD AND CONSIDERING MAXIMUM PRODUCT ACCORDING TO CAPACITY OF REFRIGERATOR AND FREEZER AND CALCULATING THEIR LOAD.

HAVING CALCULATE ALL COMPONENTS AND GET THE SIZE AND CAPACITY OF THEME FOR USE OF HFC 134A THE COMPATIBLE COMPONENTS CAN BE SELECTED EASYLY AND START MAKING PROTOTYPE FOR EACH MODEL.

IRAN POUYA COMPANY PRODUCING TWO MODELS AND PROTOTYPES ARE AS FOLLOW.

1 - MODEL RF11R FIVE UNITS
2 - MODEL FR9F FIVE UNITS

FOR THESE TWO MODELS WE USED COMPRESSOR FROM TWO DIFFERANT MANUFACTURES

1 - GOLDSTAR MODEL NR 52 FOR REFRIGERATOR AND V75 LAEG FOR FREEZER.
2 - TECAMSEH MODEL AEZ 1358 FOR REFRIGERATOR AND AEZ 2380 FOR FREEZER.

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WHEN THE PROTOTYPS GET COMPLETED THE FOLLOWING TESTS HAVE BEEN DONE TO THEME UNDER STANDARD CONDITION.

THE TESTS WERE CARRIED OUT AT 43°C AND 32°C AMBIENT TEMPERATURE.

FOR RERIGERATORS PROTOTYPES:

1 - PULL DOWN TEST

2 - CONTINEOUS RUN PERFORMANCE TEST.

3 - ICE FREEZER TEST.

4 - CYCLING PERFORMANCE TEST.

5 - ENERGY COSUMPTION TEST

FOR FREEZER PROTOTYPES :

1 - PULL DOWN TEST.

2 - CONTINEOUS RUN PERFORMANCE TEST.

3 - CYCLING PERFORMANCE TEST.

4 - FREEZING POWER TEST.

5 - FROOZEN FOOD STORAGE TEST.

6 - TEMPERATURE RISE TEST.

THIS TESTS HAVE DONE ON TEN PROTOTYPES AND THE RESULTS HAVE TAKEN FOR EVALUATION.

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OPTIMISATION PLAN :

ACCORDING TO TEST RESULTS OPTIMISATION HAS TO BE DONE ON THE CABINET PART OF REFRIGERATOR.

TWO COMPANENTS SUCH AS MEAT TRAY AND EVAPORATOR DOOR NEED TO BE MODIFY TO GET STANDARD TEMPERATURE IN DIFFERANT PART OF CABINET.

THIS MODIFICATION HAS BEEN DONE AND THE TEST RESULTS BECAME SATISFACTORY.

CABINET CONSTANT "C":

FOR DETERMINATION OF CABINET CONSTANT A TEST HAS TO CARRY OUT FOR THIS PURPOSE, IN THE SECOND PROGRESS REPORT THE PROCEDURE OF THIS TEST AND THE FORMULATION HAS DONE IN DETAIL.

COMPARING R12 SYSTEM WITH R 134A:

THE SAME PERFORMANCE TESTS HAVE BEEN DONE WITH R12 SYSTEM AND RESULTS HAVE BE COMPERED.

WE HAVE EDITED TWO PROGRESS REPORTS FOR ALL WORK HAVE BEEN DONE SO FARE FOR UNIDO UNDER THE CONTRACT NUMBER 94/095 RECIVED THE TRIAL TEST EQUIPMENTS AND INSTALLED THEME IN THE PRODUCTION LINE AND MADE PREPARATION FOR PRODUCING REFRIGERATOR WITH R134A.

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PROTOTYPES EVALUATION AND ANALYSIS:

AFTER CALCULATION, DESIGN, SELECTION OF COMPATIBLE COMPONENTS AND MAKING PROTOTYPE WITH USE OF HFC 134A THE PERFORMACE TESTS WERE CARRIED OUT UNDER THE STANDARD CONDITION. ON THE FIRST PROTOTYPE TWO TESTS WERE DONE (CONTINEOUS RUN PERFORMANCE AND CYCLING PERFORMANCE TESTS).

THE RESULTS TURNED OUT NOT SATATACTORY.

THE OPTIMIZATION PLAN IS STARTED. THE FIRST STEP TO GET BETTER COOLING CAPACITY IN THE CABINET WAS TO CHANGE THE SIZE OF CAPILLARY TUBE.

AFTER THE MODIFICATION THE SAME TESTS WERE DONE ON NEW PROTOTYPE. THE RESULTS WERE SHOWN THAT THE COOLING CAPACITIES HAVE IMPROVED.

IN THE CYCLING PERFORMANCE TEST THE TEMPERATURE INSIDE CABINET WERE NOT STANDARD CONDITION. IT MEANS THAT 'M' TEST PACKAGES IN FREEZER COMPARTMENT DID NOT REACH -12°C AND MEAN TEMPERATURE OF FRESH FOOD CABINET GONE BELOW +5°C. TO OVERCOME TO THIS PROBLEM IS TO HAVE BETTER INSULATION IN THE EVAPORATOR DOOR AND MEAT TRAY.

IN THE OPTIMIZATION THE DESIGN OF THESE TWO PARTS WERE CHNGED.

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THE NEW EVAPORATOR DOOR AND MEATTRAY HAVE BEEN MADE.

THE CYCLING PERFORMANCE TEST HAVE DONE ON NEW PROTOTYPE.

THE RESULTS TURNED OUT SATISFACTORY.

THE REST OF PROTOTYPES HAVE BEEN MADE WITH NEW COMPANENTS AND TEST THEME SUCCESFULY.

IN OPTIMIZATION OF FREEZER THE LENGTH OF CAPILLARY TUBE AND THE THICKNESS OF INSULATION HAVE BEEN CHANGED.

THE STANDARD TEST HAVE BEEN CARRIED OUT AND RESULTS WERE SATISTACTORY.

ACCORDING TO THE CONTRACT WITH UNIDO AFTER REDISING WE HAVE TO MAKE FOUR PROTOTYPES PER MODEL AND TEST EACH PROTOTYPE FOR FUNCTIONALITY AND PERFORMANCE.

THE FOLLOWING MODEL HAVE BEEN MADE.

REFRIGERATOR RF11F FIVE UNITS

FREEZER FR9F FIVE UNITS

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FROM THREE COMPRESSOR MANUFACTURE A NUMBER OF COMPRESSOR HAVE BEEN SELECTED AND USED FOR THESE PROTOTYPES.

FROM GOLDSTAR 1/6 *HP MODEL NR 52*

FROM GOLDSTAR 1/4 *HP MODEL [illegible]*

FROM TECUMSEH 1/6 *HP MODEL AEZ 1338Y*

FROM TECUMSEH 1/4 *HP MODEL AEZ 1380Y*

FROM MATSUSHITA 1/4 *HP MODEL QA 77C*

THE TESTS HAVE BEEN DONE TO ALL PROTOTYPES UNDER ISO STANDARD 7371 AND 5155.

A COPY OF ALL TEST RESULTS ARE IN THE SECOND PROGRASS REPORT WHICH HAVE SUBMITTED BEFORE.

THE TESTS HAVE DONE AT 18°C, 32°C AND 43°C AMBIENT TEMPERATURE.

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THE EVALUATION ON THE TEST RESULTS ARE AS FOLLOW.

A) REFRIGERATORS TEST RESULTS.

1 - IN PULLDOWN TEST THE TIME TO REACH TO STEADY STATE WAS STANDARD. THE SHELL TEMPERATURE OF COMPRESSOR WAS HIGH ON MOST CASES.

2 - IN CONTINEOUS RUN PERFORMANCE, THE TEST RESULTS WERE OK. EXCEPT ONE OF THEME WAS WEAK AT 43°C AMBIENT TEMPERATURE. BECAUSE OF INSULATION PROBLEM OR DOOR TIGHTNESSED.

3 - IN CYCLING PERFORMANCE TEST RESULTS HAVE SHOWN THE WARMST TEST PACKAGE IN FREEZER COMPARTMENT -12°C AND MEAN TEMPERATURE OF FRASH FOOD COMPARTMANT +5°C AND IN THE CRISPER +8°C WHICH IS STANDARD RANGE.

THIS TEST CLASSIFY THE REFRIGERATOR IN TWO STAR POSITION.

4 - IN ICE FREEZ TEST ALTHOUGH ISO STANDARD HAVE NOT MENTIONED THAT AT WHAT TEMPERATURE OF ICE IS THE END OF TEST BUT IN IRANIAN NATIONAL STANDARD -7°C OF ICE TEMPERATURE IS THE END OF TEST.

THE RESULT OF TESTS WERE ACCEPTABLE.

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5 - IN ENARGY CONSUMPTION TESTS, THE AMOUNT OF ENARGY CONSUMED FOR 24 HOURS WERE ABOUT 1.6 KWH/24H AND PERCENTAGE OF WORKING IN 24 HOURS WERE 58%

THESE RESULTS WERE SATISFACTORY.

B) THE FREEZER TEST RESULTS.

1 - IN PULL DOWN AND CONTINEOUS RUN PERFORMANCE TESTS, ALTHOUGH REACHING TO STEADY STATE CONDITION WERE LONG BUT THE TEMPERATURE INSIDE CABINET HAVE REACHED TO A STANDARD LEVEL.

2 - IN CYCLING PERFORMANCE TEST, THE WARMST 'M' PACHAGES WAS REACHED -18°C WHICH IS ACCEPTABLE. THE ENARGY CONSUMPTION AND PERCENTAGE OF WORKING WERE 1.8 KW/24HOURS AND 70% RESPECTABLY WHICH ARE ACCEPTABLE.

ONE OF THE MODEL BECAUSE OF INSULATION PROBLEM DID NOT REACH TO STANDARD LEVEL.

3 - IN FREEZING POWER TEST, USING 12 KG FRESH MEAT THE TEMPERATURE WERE REACHED -18°C LESS THAN 24 HOURS IT MEANS THE FREEZER PASED IN THIS TEST.

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4 - IN FROOZEN FOOD STORAGE TEST THE TEST RESULTS WERE OK.

5 - IN TEMPERATURE RISE TEST WITH PACKAGES AT -18°C THE TIME TO REACH -9°C WERE 8.15 HOURS WHICH ARE REASONABLE.

ONE MODEL WHICH AFTER 15 HOURS REACHED TO -9°C IS NOT ACCEPTABLE ONLY BECAUSE OF INSULATION PROBLEM.

FOR COMPARISON OF UNIT WITH R12 AND R134A SYSTEM, THE SAME TESTS HAVE BEEN DONE ON R12 SYSTEM UNDER THE SAME CONDITION. A TABLE OF COMPARISON IS AS FOLLOW.

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COMPARISON TABLE OF A REFRIGERATOR PERFORMANCE RESULT WITH TWO DIFFRENT COMPRESSOR OF R134A IN CYCLING PERFORMANCE TEST.

DESCRIPTION	*GOLD STAR*	*TECHAMSH*
COMPRESSOR MODEL	*NR52 LAEG*	*AEZ 1358*
COMPRESSOR CAPACITY	*118 KCAL/H*	*120 KCAL/H*
AMBIENT TEMPERATURE	*43°C*	*43°C*
EVAPORATOR AIR TEMP.	*-12°C*	*-12.5°C*
CABINET MEAN TEMP.	*+5.1°C*	*+4.5°C*
CRISPER AIR TEMP	*8°C*	*+7.3°C*
COMPRESSOR SHELL TEMP.	*98.3°C*	*96°C*
CONDENSER INLET TEMP.	*107.8°C*	*106°C*
CONDENSER OUT LET TEMP.	*55.5°C*	*54.5°C*
PERCENTAGE OF WORKING	*61%*	*61%*
POWER CONSUMPTION	*1.74KW/H*	*1.74KW/H*
THERMOSTAT POSITION	*5*	*5*
VOLTAGE AND HZ	*220/50HZ*	*220/50 HZ*
AMPER AND WATTS	*1.1A 125W*	*1.1A 125W*

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COMPARISON TABLE OF A REFRIGERATOR PERFORMANCE RESULT OF R134A AND R12 SYSTEM IN CYCLING PERFORMANCE TEST.

DESCRIPTION	*GOLD STAR*	*TECHAMSH*
COMPRESSOR MODEL	*NR52 LAEG*	*VC 52*
COMPRESSOR CAPACITY	*118 KCAL/H*	*115 KCAL/H*
AMBIENT TEMPERATURE	*43°C*	*43°C*
EVAPORATOR AIR TEMP.	*-12°C*	*-12.2°C*
CABINET MEAN TEMP.	*+5.1°C*	*+4.8°C*
CRISPER AIR TEMP	*8°C*	*+7.5°C*
COMPRESSOR SHELL TEMP.	*98.3°C*	*90°C*
CONDENSER INLET TEMP.	*107.8°C*	*101°C*
CONDENSER OUT LET TEMP.	*55.5°C*	*54°C*
PERCENTAGE OF WORKING	*61%*	*63%*
POWER CONSUMPTION	*1.74KW/24H*	*1.80KW/24H*
THERMOSTAT POSITION	*5*	*5*
VOLTAGE AND FRI	*220/50HZ*	*220/50 HZ*
AMPER AND WATTS	*1.1A 125W*	*1.1 125 W*

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CONCLUSION:

ACCORDING TO THE TEST RESULTS AND PERFORMANCE OT THE PROTOTYPES COMPERING WITH THE STANDARD REDESIGNING AND SELCTING OF COMPONENTS ARE RIGHT. THE MODIFICATION OF REFRIGERATOR OF R12 TO R134A SYSTEM ARE AS FOLLOW.

1 - INCREASING CAPILLARY TUBE LENGTH BY 10 PERCENT.

2 - CHANGING DRIER TO DESICCANT XH9

3 - CHANGING COMPRESSOR

4 - USING R134A 15% LESS CHARGE

5 - CHANGING EVAPORATOR DOOR FOR REFRIGERATOR

6 - CHANGING MEAT TRAY FOR REFRIGERATOR.

AS THE PROTOTYPES HAVE BEEN DONE AND EQUIPMENT HAVE BEEN ARRIVED AND INSTALLED THE PRODUCTION LINE WE ARE READY FOR TRIAL TEST. THE PRODUCTION WILL START AS SOON AS WE RECEIVE COMPRESSOR FROM ABROAD.

THE WORKER IN PRODUCTION LINE HAVE BEEN TRAINED HOW TO ASSEMBL COMPRESSOR AND DRIER WITH USE OF HFC 134A. OIL USED IN THE COMPRESSOR IS ESTER OIL WHICH IS VERY SENSIBLE TO HUMIDITY AND MOLSTURE THEREFOR MORE CARE HAS TO BE TAKEN IN THE PRODUCTION LINE. HFC 134A IS MORE HYGROSCOPISTIC THAN CFC 12. THE SOLUBILITY OF WATER IN HFC 134A IS 2800 PPM AT 298.15K WHILE IN CFC12 IS 90 PPM.

THE AMOUNT OF VACUUM IN THE SYSTEM MUST BE MORE THAN R12 SYSTEM.

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TEL : 6692001 - 4

IRAN POUYA CO. « EX. GENERAL STEEL »
(Public Joint Stock Co.)
The Leading Manufacturer of Refrigerator, Freezer
and Aluminium Profile

Our Ref :
Date :

RECOMMENDATIONS:

IRAN POUYA COMPANY IS ONE OF THE FIVE COMPANY IN IRAN WHICH HAVE SIGNED THE CONTRACT WITH UNIDO FOR THE PROJECT OF PHASE OUT CFC GASES IN REFRIGERATOR INDUSTRIES IN IRAN. WE ARE GLAD THAT WE ARE CRRING OUT THE PROJECT SUCCESFULLY SO FOR.

WE ARE IN PROCESS OF PURCHASING THE COMPONENTS WHICH, ARE NOT PRODUCE IN IRAN FOR PRODUCTION OF REFRIGERATOR AND FREEZER IN PRODUCTION LINE.

WE ARE HOPPING IN NEAR FUTURE THE PRODUCTION LINE WILL BE COMPLITLY CHANGE FROM R12 TO R134A.

THIS CONTRACT GAVE US OPPORTUNITY TO REDESIGN OUR PRODUCT IN DIFFERANT METHOD AND OPTIMIZING THEME TO REACH THE STANDARD LEVEL.

THERE ARE DIFFERANT METHOD OF CALCULATION. SOME MANUFACTURER HAVE THEIR OWN METHOD AND MOSTLY USE EXPERIMANTAL WAY.

WE HAVE USED ASHRAR METHOD WHICH IS MORE ACCURATE WAY OF CALCULATION USUALY UNIVERSITIES AND RESEARCH CENTERS USING ASHRAE. WE RECOMMEND THAT ASHRAE METHOD OF CALCULATION IS BEST TO USE IN THIS PROJECT.

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Date :

SOME COMPRESSOR AND REFRIGERATOR MANUFATURER IN EUROPE HAVE SELECTED HADROCARBONS SPECIALLY ISO BUTAN 600A AS REFRIGERANT AND THEY HAVE CHANGED THEIR PRODUCTION LINE PRODUCING REFRIGERATOR AND COMPRESSOR WITH R 600A.

WE RECOMEND THAT WE DONOT COSENTRAT ON HFC 134A AS REFRIGERANT ONLY BUT WE WORK ON R 600A WHICH HAVE SOME ADVANTAGE ON R134A.

IN THE SECOND PART OF PROJECT WHICH ARE ABOUT MAKING PROTOTYPES AND TESTING THEME FOR FUNCTIONALITY AND PERFORMANCE. WE RECOMMEND THAT THE PROTOTYPES MAST BE MADE WITH USING COMPRESSOR FROM DIFFERENT MANUFACTURE AND WE WISH WE HAD ENOUGH TIME TO TEST THEME IN THREE DIFFERENT AMBIENT TEMPERATURE 18^{oC} , 32^{oC} , 43^{oC}.

THESE TESTS WILL HELP US THAT WHICH COMPRESSOR IS MOST SUITABLE FOR OUR REFRIGERATOR AND FREEZER.

ALL THE PROTOTYPE HAVE BEEN TESTED IN HOT ROOM WITH POOR FACILITIES.

WE RECOMMEND THAT UNIDO COULD DESIGNATE A BUDGET FOR EQUIPTING HOT ROOM WITH ACCURATE FACILITIES.

IRAN POUYA COMPANY WOULD LIKE TO TAKE THIS OPARTUNITY TO THANKS UNIDO, MR. MALAYERI, MR. NOWOTNY AND MR. BANAFSHEH THAT HELPED US TO CARRY OUT THIS PROJECT.

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IRAN POUYA CO. « EX. GENERAL STEEL »
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The Leading Manufacturer of Refrigerator, Freezer and Aluminium Profile

Our Ref :
Date :

REFRENCES

1) DEUTCH STANDARDS DIN 8950 FOR REFRIGERATOR.

2) ISO 7371 FOR HOUSEHOLD REFRIGERATING APPLIANCES.

3) INSTITUTE OF STANDARDS AND INDUSTRIAL RESERCH OF IRAN ISIRI 254 FOR HOUSEHOLD REFRIGERATORS.

4) ISIRI 2482 FOR HOUSEHOLD FREEZER AND FROZEN FOOD STORAGE CABINET.

5) ASHRAE FUNDMENTAL HAND BOOK.

6) ASHRAE APPLICATION HAND BOOK.

7) PRINCIPLES OF REFRIGERATION FROM ROY J.DOSSAT.

8) HEAT TRANSFER J.P.HOLMAN

9) DAEWOO ELECTRONIC TECHNICAR REPORT.

10) DANFOSS TECHNICAL REPORT.

FACTORY, 4th Km. Old Karaj Rd.
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TECHNICAL BRIEF
(DWAR - 10)

DAEWOO *HFC-134a* Compressor

DAEWOO Electronics Co.

1993. 5. 1

1. Description of HFC-134a (CH_2F-CF_3, 1,2,2,2 - *Tetra fluoro ethane*)

(1) Toxicity

HFC-134a is a chlorine-free fluorinated non-ozone depleting refrigerant.

It is non-toxic, non-flammable, and non explosive.

Its AEL(Acceptable Exposure Limit) level is 1000 *ppm*.

(2) Purity

There may be impurities in the ***HFC-134a*** as the residues in the manufacturing process(R114, R114a, R124, etc.). The main concern of these impurities is the effect of chlorinated residues on the capillary tube. Therefore more than 99.95% of purity must be secured.

(3) Hygroscopicity

HFC-134a is more hygroscopistic than CFC12. The solubility of water in ***HFC-134a*** is 2800 *ppm* at 298.15K while in CFC12 is 90 *ppm*.

(4) Miscibility with Lubricant

It is desirable that the refrigerant and lubricant are completely miscible over the range of expected operating pressure-temperature conditions for the safe oil-return from condenser to compressor.

Mineral oils are not suitable as lubricant with ***HFC-134a*** due to insufficient miscibility and lubricity.

Polyol ester is miscible with ***HFC-134a*** although not all over the region but within the operating conditions.

Fig. 1 shows typical miscibility diagram of polyol ester with ***HFC-134a***.

(5) Stability

The stability of ***HFC-134a*** with metals and lubricant is evaluated by the sealed glass tube tests.

Tests were conducted at the 175℃ conditions for 21 days with the presence of steel, copper, aluminum, and ester oils. Gas samples were analyzed by gas chromatography and no indication of ***HFC-134a*** decomposition was observed.

(6) Compatibility with Desiccant

XH-7 or XH-9 is recommended. If not, decomposition of ***HFC-134a*** may be proceeded.

2. Description of HFC-134a Compressor

(1) Capacity

Due to the differences of thermodynamic properties between ***HFC-134a*** and CFC12, about 10～15% capacity drop is experienced at -23.3℃ (-104°F), and 20～30% at -30℃(-22°F) without any system modification.

This capacity drop has been compensated by the improvement of compressor design. (Improvement of volumetric efficiency, improvement of suction gas passage.)

(2) Material Compatibility

The compatibility of various commercially available motor insulating film, magnetic wire, plastic materials has been evaluated and only suitable materials are selected.

Polyol ester formulated with additives showed the best result in view of stability.

One thing to note is the hygroscopicity of POE(Polyol Ester).

POEs can absorb moisture very quickly from the ambient air. The saturation level is approximately 1000 *ppm*, compared to 20~100 *ppm* for mineral oils. Fig. 2 shows hygroscopicity curve of POE and mineral oil.

Therefore it is imperative that compressor, evaporator, condenser, and other tubes must be kept sealed before the set assembly.

It is recommended that the maximum exposure time limit of compressor after opening the rubber caps is 10 minutes under the 60% relative humidity condition.

3. Description of HFC-134a Refrigerator

(1) Evaporator-Condenser-Pipe

It is generally concluded that the size of evaporator and condenser can be the same as those used for R12. Sometimes, 10~15% increase of condenser size is recommended. Mineral oil or similar process oil coated on the inside of pipe must be cleaned prior to use.

(2) Refrigerant charge size

The refrigerant charge size of ***R134a*** refrigeration system is about 10~20% less than that of R12 system .

Excessive charge may cause mechanical failure during flooded start condition.

Exact charge size must be determined through laboratory test.
Fig. 3 shows pressure - solubility diagram of ***HFC-134a*** with POE.

(3) Capillary tube

Generally the length of capillary tube may need to be adjusted through laboratory test.
For reference, 10~15% increase is recommended.

(4) Dryer

XH-7 or XH-9 is recommended as described in 1-(6).

(5) Process Material

Residues of mineral oil based process material which is insoluble with POEs may contaminate the capillary tube and chlorinated substances are not admitted.
The compatibility of each process material must be checked through sealed tube test.

(6) Refrigerant Charge

The ***R134a*** refrigerant must be charged with ***R134a*** charging machine. Sealing material must be compatible with ***R134a***. If the charging process be done with R12 system, R12 residues remained in the sealing material may penetrate into the ***R134a*** refrigeration system to be a unacceptable chlorinated impurity.

(7) Vacuum and Leak Detection

As the molecule size of ***R134a*** is smaller than that of R12, ***R134a*** will tend to leak more easily than R12. Additional care is needed is pipe welding. Maximum acceptable system moisture is 100 *mg*.

Evacuation to 0.3~0.5 *mmHg* is recommended. Leak detection must be done with proper ***R134a*** leak detection equipment.

POE is hydrolyzed at very high temperature with the presence of moisture and air. Especially, the effect of air is remarkable.

Table 1 shows the effect of moisture and air on the hydrolysis of POE.

Table 1 Hydrolysis of POE

	with air	with N_2	with ***R134a***
T.A.N *	0.20	0.03	0.03

* T.A.N - Total Acid Number [*mgKOH/g*]

test condition : 130℃ × 10 days

moisture level : 1000 *ppm*

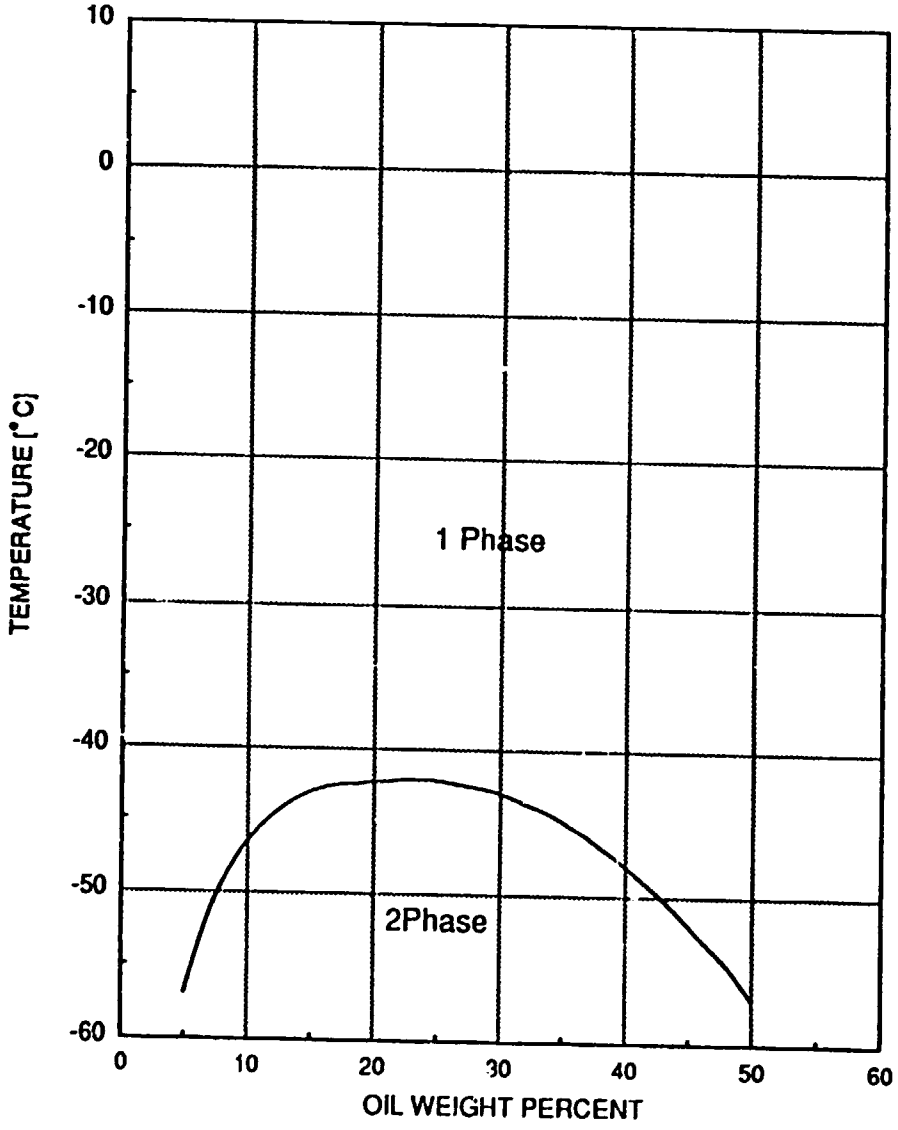


Fig. 1 Miscibility of ***HFC - 134a*** in Polyol ester

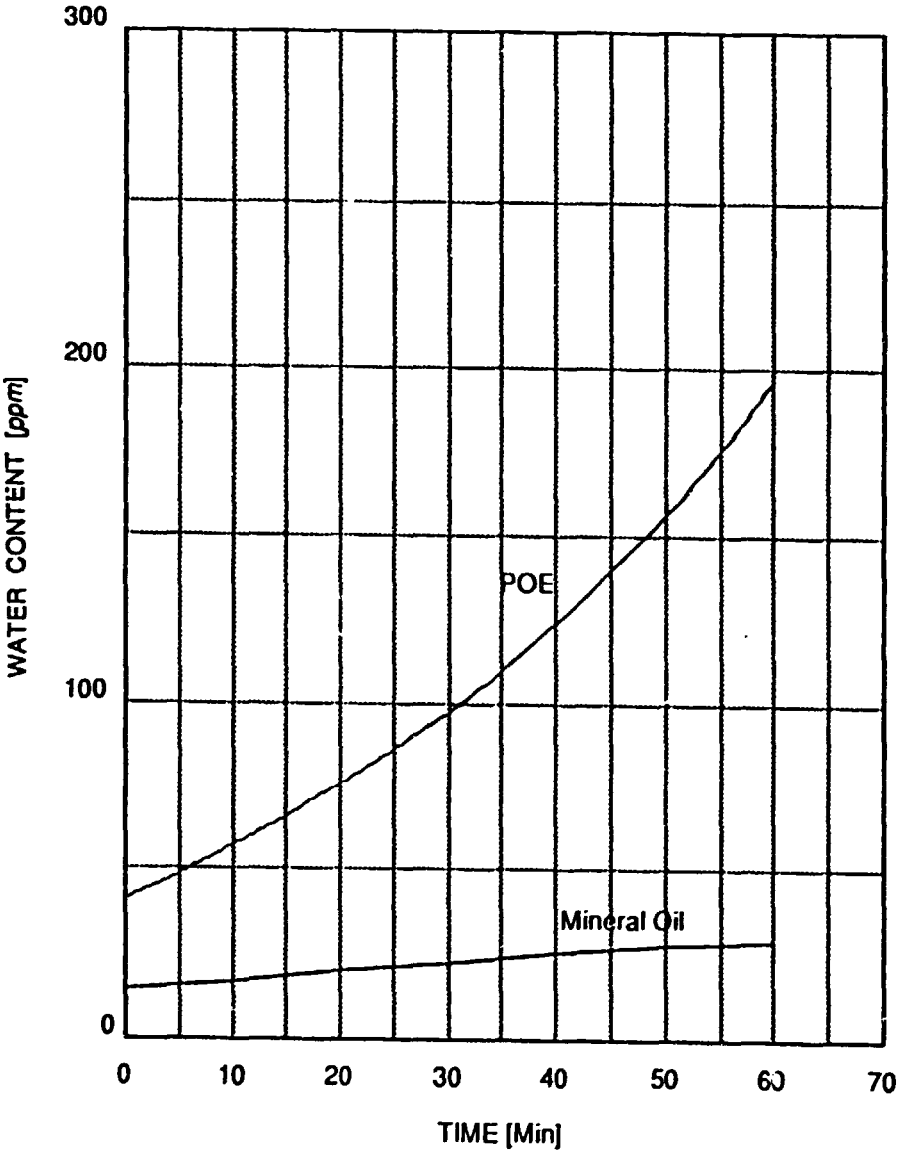


Fig. 2 Hygroscopicity Curves of POE and Mineral Oil at 60℃ with 80%RH

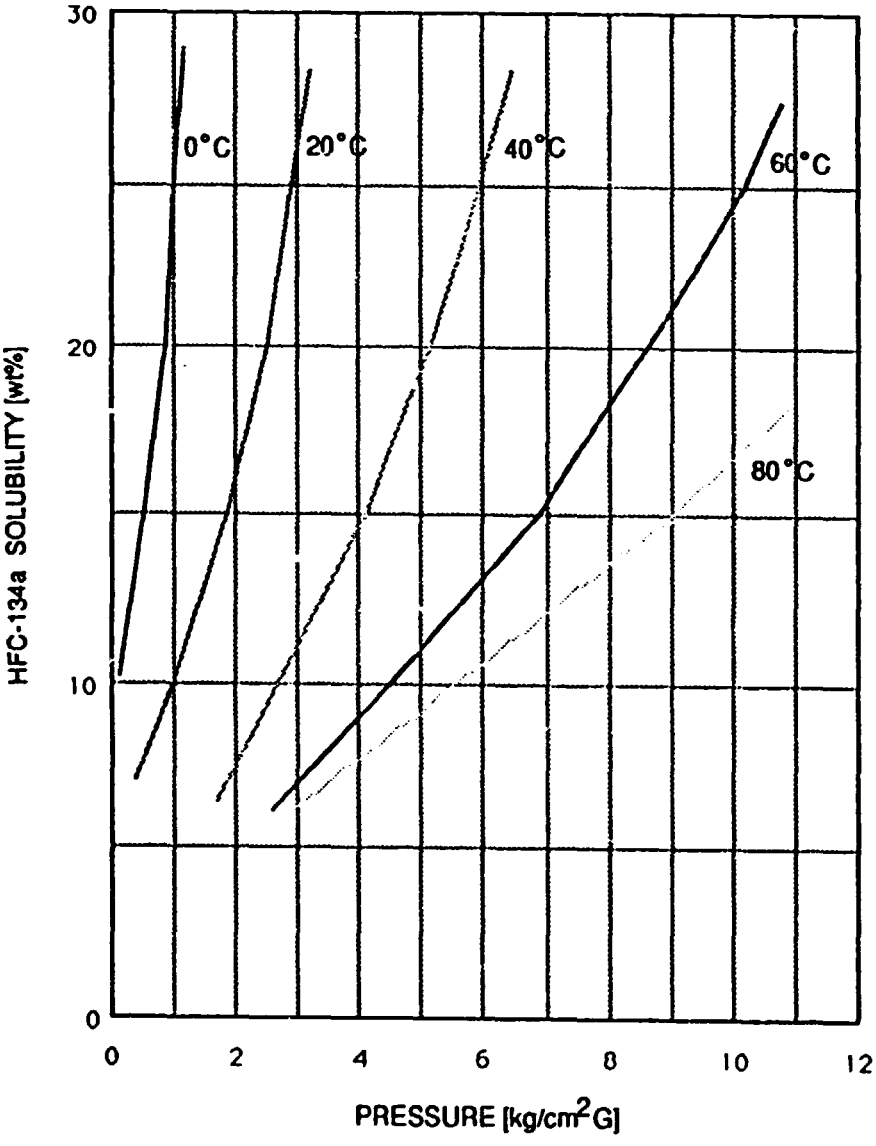


Fig. 3 Pressure-Solubility Diagram of ***HFC-134a*** with POE

Hoechst Refrigerant R 134a

Substitute for R 12 in refrigeration engineering

Current position

With regard to the ecological compatibility of chlorofluorocarbon refrigerants there is a fundamental difference in the behaviour of the hydrogen-free perhalogenated chlorofluorocarbons and the hydrogen-containing partially halogenated chlorofluorocarbons. The following abbreviations have come into general use in classifying the chlorofluorocarbons into individual subgroups:

CFC:	chlorofluorocarbons, perhalogenated (no hydrogen atom in the molecule)
HCFC:	hydrochlorofluorocarbons chlorofluorocarbons, partially halogenated (one or more hydrogen atoms in the molecule)
FC:	fluorocarbons, which contain only fluorine and carbon in the molecule (no chlorine atoms)
HFC:	hydrofluorocarbons fluorocarbons, partially halogenated (contain hydrogen as well as fluorine atoms in the molecule)

The major contribution to the ozone problem comes from the CFCs. Because of the high chemical stability of these products they persist in the atmosphere for a long period of time, and so theoretically the entire amounts released can diffuse into the stratosphere and interfere with the ozone/oxygen balance. Longterm persistence in the atmosphere coupled with accumulation there is also responsible for the high greenhouse potential of these compounds.

Although FCs contain no chlorine atoms and consequently do not affect the ozone layer, their greenhouse potential is high because of their very long persistence in the atmosphere.

Hoechst is therefore concentrating on HCFCs and HFCs as substitutes, in other words partially halogenated compounds with considerably shorter persistence in the atmosphere. The ozone depletion potential of the HCFCs is only a fraction of that of the CFCs (HFCs are chlorine-free and have no ozone depletion potential), whilst HCFCs and HFCs will at least contribute substantially less to the greenhouse effect.

Requirements of refrigerant substitutes

By taking a closer look at the requirements profile of refrigerants it can be seen that substitutes for perhalogenated chlorofluorocarbons can come only from this class of compound, but for the reasons discussed above the products must be only partially halogenated, i.e. they must contain hydrogen. The requirements profile of refrigerants comprises the following points in addition to acceptable ecological properties:

- *non-flammability*
- *good physiological properties*
- *chemical and thermal stability*
- *appropriate physical and thermodynamic properties*
- *miscibility with lubricants*
- *industrial scale production*
- *reasonable selling price*

From a whole series of products investigated the choice has been narrowed down so far to HCFC 123 (dichlorotrifluoroethane) as a substitute for R 11 and HFC 134a (tetrafluoroethane) as a substitute for R 12 because the physical and thermodynamic properties currently known are very similar to those of the two refrigerants they are intended to replace.

HFC 227 (heptafluoropropane) was another product investigated in the search for a substitute; this is a refrigerant that can replace both R 12 and R 114 in some applications.

Hoechst

of the substitute HFC 134a

		HFC 134a
Chemical formula	–	CH_2F-CF_3
Chemical name	–	1,1,1,2-tetrafluoroethane
Molar mass	g/mol	102.03
Boiling point at 1.013 bar	°C	–26.5
Critical temperature	°C	101,15
Critical pressure (abs)	bar	40.64
Critical density	kg/l	0.508
Density of liquid		
at 20°C	kg/l	1.226
at 40°C	kg/l	1.147
Density of saturated vapour		
at 20°C	kg/m³	27.91
at 40°C	kg/m³	50.27

A vapour table for HFC 134a (wet vapour range) calculated on the basis of measurements of the critical data, the vapour pressure curve and the density of the boiling liquid is given at the end of this data sheet.

Thermodynamic properties

Comparative refrigerating circuit calculations
Because R 134a has similar physical and thermodynamic properties to R 12 it will become a substitute of major importance in refrigeration engineering following the withdrawal of some CFC refrigerants.

A comparison of the thermodynamic properties of the two refrigerants is made on the basis of four main refrigerating variables:

- compression ratio p_c/p_o
- volumetric cooling capacity $q_{o,m}$
- compressor discharge temperature t_ε
- coefficient of performance ε_K

Table 1 lists these four variables for the following operating conditions:

- evaporating temperature: –25 to 0 °C
- condensing temperature: 40 °C
- suction vapour superheating: 10 K
- liquid subcooling: 5 K

Figs. 1 – 4 show the cycle calculations in graph form.

The compression ratio p_c/p_o is higher in the case of R 134a cycles, whereas the volumetric cooling capacity increasingly approaches that of R 12 as the evaporating temperature rises. The coefficients of performance are roughly comparable.

The compressor discharge temperature under all operating conditions investigated was generally somewhat lower than that of R 12. Whilst the compressor discharge temperature in R 134a cycles is lower, R 134a can also be observed to have a volumetric cooling capacity on average up to 10% lower at low evaporating temperatures. Results obtained by compressor manufacturers have shown that disadvantages in terms of energy consumption are not likely if the compressor is adapted accordingly and the circuit is optimized.

Table 1:

R 134a					*R 12*				
t_o °C	p_c/p_o –	$q_{o,m}$ kJ/m³	t_ε °C	ε_K –	t_o °C	p_c/p_o –	$q_{o,m}$ kJ/m³	t_ε °C	ε_K –
–25	9.51	748	59.1	2.8	–25	7.78	822	62.6	2.9
–20	7.63	942	57.7	3.2	–20	6.37	1012	60.8	3.3
–15	6.19	1176	56.5	3.7	–15	5.27	1235	59.3	3.8
–10	5.05	1455	55.4	4.2	–10	4.39	1495	57.9	4.3
–5	4.17	1785	54.5	4.9	–5	3.68	1797	56.6	5.0
0	3.46	2174	53.7	5.8	0	3.11	2146	55.6	5.8

Fig. 1 **Compression ratio**

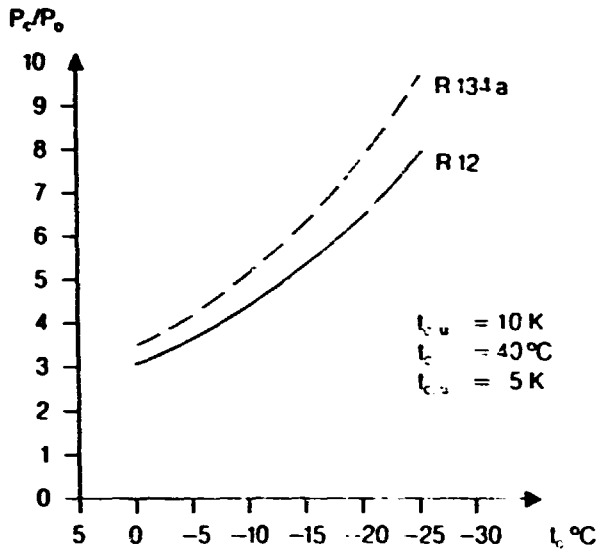


Fig. 3 **Compressor discharge temperature**

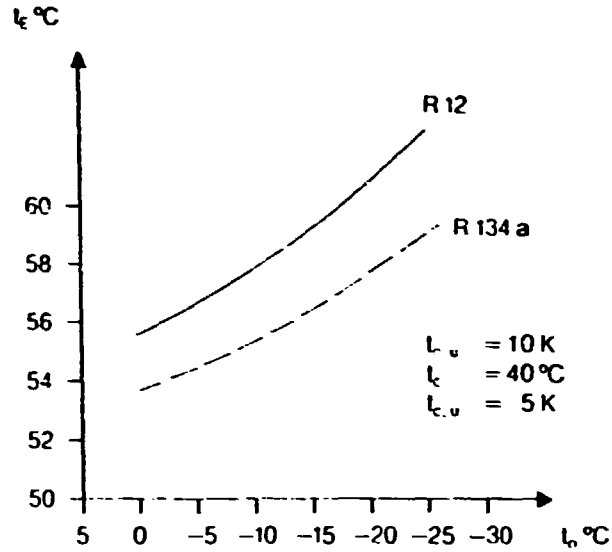


Fig. 2 **Volumetric cooling capacity**

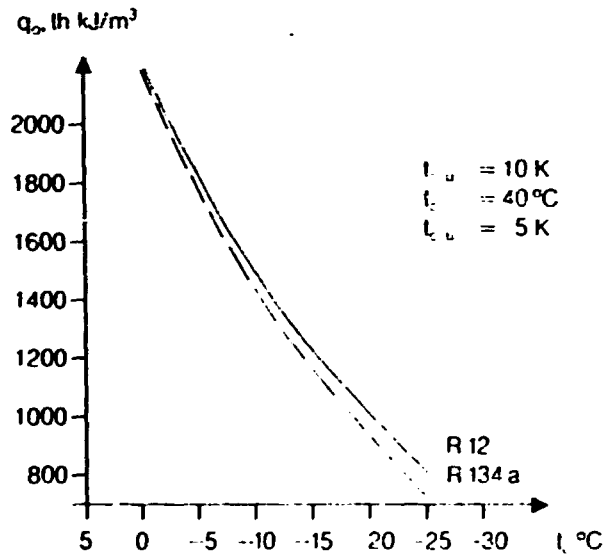
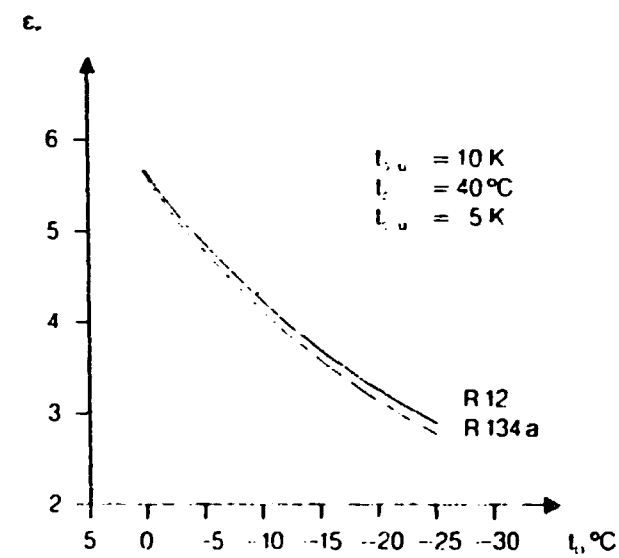


Fig. 4 **Coefficient of performance**



Materials

Metallic materials

R 134a is similar to R 12 in that it is compatible with all metals and metal alloys commonly used in machine and equipment manufacture. Only zinc, magnesium, lead and aluminium alloys with more than 2% by mass magnesium should be avoided.

Storage tests with moist refrigerant showed good stability to hydrolysis and no corrosive attack on metals such as ferritic steel, V2A steel, copper, brass and aluminium.

Elastomers

As expected, no problems are encountered in selecting an elastomer for the chlorine-free R 134a.

Refrigerant hoses suitable for R 12, for instance those used in car air-conditioning units, are not suitable for partially halogenated refrigerants such as R 134a (and also R 22) because their diffusion characteristics are different.

ASTM abbreviation	Polymer	Registered trademark	Change in mass in %	Amount of extract in %	Change in length in %
IIR	Butyl rubber		-1.1	0	0
NBR	Acrylonitrilebutadiene rubber	*Perbunan	-0.4	0	0
CR	Chloroprene rubber	*Neoprene	-0.6	0	0
FPM	Fluorinated rubber	*Viton	7.3	0.1	10.8
NR	Natural rubber		-0.6	0	0

Aftertreatment of specimen: dried for 1 hour at 50°C

Aftertreatment of extract: dried for 24 hours at 100°C

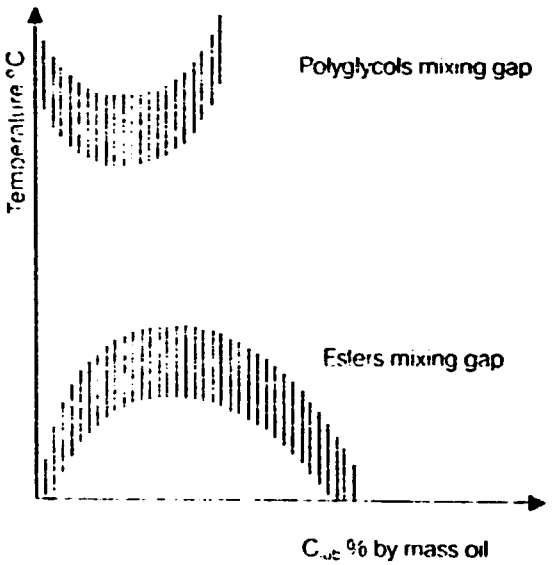
Lubricants

R 134a is virtually immiscible with conventional refrigeration oils based on mineral oil as well as with some synthetic lubricants such as alkylbenzenes. If the use of a lubricant that is readily miscible with R 134a is required, the only suitable products are synthetic compounds. This applies equally to the other chlorine-free HFC refrigerants. Polyglycols (PEG), for example, have adequate miscibility and are produced on the industrial scale in a range of viscosities – albeit for other applications. Polyglycols based on propylene oxide have mixing gaps as a function of their viscosity in the temperature range from about +60°C upwards (see fig. 5). Low-viscosity polyglycols with viscosities of less than 20 mm^2/s at 50°C are almost completely miscible.

However there appear to be limits to the use of the polyglycols owing to their extremely hygroscopic nature, because too high a moisture content in the polyglycol coupled with limited thermal stability can cause material problems.

Ester compounds evidently do not have these disadvantages but at high viscosities have increasing mixing gaps in the lower temperature range (see fig. 5). In the final resort service life wear tests determine the serviceability of a material as a lubricant. Until R 134a is produced on the industrial scale suitable compressor lubricants can be expected to be marketed for HFC refrigerants.

Fig. 5 **Mixing diagram for R 134a**



Thermal stability

At the end of the Philipp test in accordance with DIN 51593 (refrigeration oil based on mineral oil heated in a U-tube together with refrigerant over a period of 96 hours to 250°C) no fluoride ions were detectable in the refrigerant. The oil was as clear as at the beginning of the test. The Philipp test is therefore regarded as having been passed. (It is also passed by R 12.) The thermal stability of HFC 134a appears to be higher than that of R 12.

Vapour table for the wet vapour range

Temperature	Pressure	Specific volume		Density		Enthalpy		Heat of vaporization	Entropy	
		of liquid	of vapour	of liquid	of vapour	of liquid	of vapour		of liquid	of vapour
t	p	v'	v''	ϱ'	ϱ''	h'	h''	r	s'	s''
°C	bar	l/kg	l/kg	kg/l	kg/m³	kJ/kg	kJ/kg	kJ/kg	kJ/kg K	kJ/kg K
-60	0.163	0.679	1052.08	1.472	0.950	126.54	359.84	233.30	0.6984	1.7930
-59	0.174	0.680	991.41	1.470	1.009	127.64	360.49	232.85	0.7035	1.7909
-58	0.185	0.682	934.82	1.467	1.070	128.74	361.13	232.39	0.7087	1.7888
-57	0.197	0.683	882.01	1.464	1.134	129.85	361.78	231.93	0.7138	1.7868
-56	0.209	0.684	832.70	1.461	1.201	130.96	362.43	231.47	0.7189	1.7849
-55	0.223	0.686	786.61	1.459	1.271	132.08	363.08	231.00	0.7241	1.7830
-54	0.236	0.687	743.51	1.456	1.345	133.20	363.72	230.53	0.7292	1.7811
-53	0.251	0.688	703.19	1.453	1.422	134.32	364.37	230.05	0.7343	1.7793
-52	0.266	0.689	665.43	1.451	1.503	135.45	365.02	229.57	0.7394	1.7775
-51	0.282	0.691	630.05	1.448	1.587	136.58	365.67	229.09	0.7445	1.7757
-50	0.299	0.692	596.88	1.445	1.675	137.72	366.32	228.60	0.7496	1.7740
-49	0.316	0.693	565.77	1.442	1.767	138.86	366.96	228.10	0.7547	1.7723
-48	0.335	0.695	536.57	1.440	1.864	140.01	367.61	227.60	0.7598	1.7707
-47	0.354	0.696	509.15	1.437	1.964	141.16	368.26	227.10	0.7649	1.7691
-46	0.374	0.697	483.37	1.434	2.069	142.32	368.91	226.59	0.7700	1.7675
-45	0.396	0.699	459.14	1.431	2.178	143.48	369.55	226.08	0.7751	1.7660
-44	0.418	0.700	436.34	1.428	2.292	144.64	370.20	225.56	0.7802	1.7645
-43	0.441	0.701	414.88	1.426	2.410	145.81	370.84	225.03	0.7853	1.7630
-42	0.465	0.703	394.67	1.423	2.534	146.98	371.49	224.51	0.7903	1.7616
-41	0.490	0.704	375.62	1.420	2.662	148.16	372.13	223.97	0.7954	1.7602
-40	0.516	0.706	357.66	1.417	2.796	149.34	372.78	223.44	0.8005	1.7588
-39	0.544	0.707	340.72	1.414	2.935	150.53	373.42	222.89	0.8056	1.7575
-38	0.572	0.708	324.73	1.412	3.079	151.72	374.07	222.35	0.8106	1.7562
-37	0.602	0.710	309.63	1.409	3.230	152.91	374.71	221.79	0.8157	1.7549
-36	0.633	0.711	295.36	1.406	3.386	154.11	375.35	221.24	0.8208	1.7536
-35	0.666	0.713	281.87	1.403	3.548	155.32	375.99	220.67	0.8258	1.7524
-34	0.699	0.714	269.12	1.400	3.716	156.53	376.63	220.10	0.8309	1.7512
-33	0.734	0.716	257.05	1.397	3.890	157.74	377.27	219.53	0.8359	1.7501
-32	0.770	0.717	245.62	1.394	4.071	158.96	377.91	218.95	0.8410	1.7489
-31	0.808	0.719	234.80	1.391	4.259	160.18	378.54	218.37	0.8460	1.7478
-30	0.848	0.720	224.55	1.388	4.453	161.40	379.18	217.78	0.8510	1.7467
-29	0.888	0.722	214.83	1.385	4.655	162.63	379.82	217.18	0.8561	1.7456
-28	0.931	0.723	205.61	1.383	4.864	163.87	380.45	216.58	0.8611	1.7446
-27	0.975	0.725	196.86	1.380	5.080	165.10	381.08	215.98	0.8661	1.7436
-26	1.020	0.726	188.56	1.377	5.303	166.35	381.71	215.37	0.8712	1.7426
-25	1.067	0.728	180.67	1.374	5.535	167.59	382.34	214.75	0.8762	1.7416
-24	1.116	0.730	173.18	1.371	5.774	168.84	382.97	214.13	0.8812	1.7406
-23	1.167	0.731	166.06	1.368	6.022	170.10	383.60	213.50	0.8862	1.7397
-22	1.220	0.733	159.28	1.365	6.278	171.36	384.23	212.87	0.8912	1.7388
-21	1.274	0.734	152.84	1.362	6.543	172.62	384.85	212.23	0.8962	1.7379
-20	1.330	0.736	146.71	1.359	6.816	173.88	385.48	211.59	0.9012	1.7370
-19	1.389	0.738	140.87	1.356	7.099	175.16	386.10	210.94	0.9062	1.7362
-18	1.449	0.739	135.31	1.353	7.390	176.43	386.72	210.29	0.9112	1.7354
-17	1.511	0.741	130.01	1.349	7.692	177.71	387.34	209.63	0.9162	1.7345
-16	1.575	0.743	124.96	1.346	8.002	178.99	387.95	208.96	0.9211	1.7337

Vapour table for the wet vapour range

Temperature	Pressure	Specific volume		Density		Enthalpy		Heat of vaporization	Entropy	
		of liquid	of vapour	of liquid	of vapour	of liquid	of vapour		of liquid	of vapour
t	p	v'	v''	ϱ'	ϱ''	h'	h''	r	s'	s''
°C	bar	l/kg	l/kg	kg/l	kg/m³	kJ/kg	kJ/kg	kJ/kg	kJ/kg · K	kJ/kg · K
-15	1.642	0.744	120.15	1.343	8.323	180.28	388.57	208.29	0.9261	1.7330
-14	1.711	0.746	115.55	1.340	8.654	181.57	389.18	207.62	0.9311	1.7322
-13	1.781	0.748	111.17	1.337	8.995	182.86	389.79	206.93	0.9360	1.7315
-12	1.855	0.750	106.99	1.334	9.347	184.16	390.40	206.25	0.9410	1.7308
-11	1.930	0.751	102.99	1.331	9.710	185.46	391.01	205.55	0.9459	1.7301
-10	2.008	0.753	99.17	1.328	10.084	186.76	391.62	204.85	0.9509	1.7294
-9	2.088	0.755	95.52	1.325	10.469	188.07	392.22	204.15	0.9558	1.7287
-8	2.171	0.757	92.03	1.321	10.866	189.38	392.82	203.44	0.9608	1.7280
-7	2.256	0.759	88.70	1.318	11.274	190.70	393.42	202.73	0.9657	1.7274
-6	2.344	0.760	85.51	1.315	11.695	192.02	394.02	202.00	0.9706	1.7268
-5	2.435	0.762	82.45	1.312	12.128	193.34	394.62	201.28	0.9755	1.7261
-4	2.528	0.764	79.53	1.309	12.574	194.66	395.21	200.55	0.9804	1.7255
-3	2.624	0.766	76.73	1.305	13.033	195.99	395.80	199.81	0.9853	1.7250
-2	2.723	0.768	74.04	1.302	13.505	197.33	396.39	199.06	0.9902	1.7244
-1	2.825	0.770	71.47	1.299	13.991	198.66	396.98	198.31	0.9951	1.7238
0	2.929	0.772	69.01	1.295	14.491	200.00	397.56	197.56	1.0000	1.7233
1	3.037	0.774	66.65	1.292	15.005	201.34	398.14	196.80	1.0049	1.7227
2	3.147	0.776	64.38	1.289	15.533	202.69	398.72	196.03	1.0097	1.7222
3	3.261	0.778	62.21	1.285	16.076	204.04	399.30	195.26	1.0146	1.7217
4	3.377	0.780	60.12	1.282	16.634	205.39	399.87	194.48	1.0195	1.7212
5	3.497	0.782	58.11	1.279	17.207	206.74	400.44	193.70	1.0243	1.7207
6	3.620	0.784	56.19	1.275	17.797	208.10	401.01	192.91	1.0291	1.7202
7	3.747	0.786	54.34	1.272	18.402	209.46	401.58	192.11	1.0340	1.7197
8	3.876	0.788	52.56	1.269	19.024	210.83	402.14	191.31	1.0388	1.7193
9	4.010	0.790	50.86	1.265	19.663	212.20	402.70	190.51	1.0436	1.7188
10	4.146	0.793	49.22	1.262	20.319	213.57	403.26	189.69	1.0484	1.7184
11	4.286	0.795	47.64	1.258	20.992	214.94	403.81	188.87	1.0532	1.7179
12	4.430	0.797	46.12	1.255	21.684	216.32	404.36	188.05	1.0580	1.7175
13	4.577	0.799	44.66	1.251	22.394	217.70	404.91	187.22	1.0628	1.7171
14	4.728	0.802	43.25	1.248	23.122	219.08	405.46	186.38	1.0676	1.7167
15	4.883	0.804	41.89	1.244	23.870	220.46	406.00	185.54	1.0724	1.7163
16	5.042	0.806	40.59	1.241	24.637	221.85	406.54	184.69	1.0771	1.7159
17	5.204	0.808	39.33	1.237	25.425	223.24	407.08	183.83	1.0819	1.7155
18	5.371	0.811	38.12	1.233	26.233	224.64	407.61	182.97	1.0867	1.7151
19	5.541	0.813	36.95	1.230	27.061	226.04	408.14	182.10	1.0914	1.7147
20	5.716	0.816	35.83	1.226	27.912	227.44	408.66	181.23	1.0961	1.7143
21	5.894	0.818	34.74	1.222	28.784	228.84	409.19	180.35	1.1009	1.7140
22	6.077	0.821	33.69	1.219	29.678	230.25	409.70	179.46	1.1056	1.7136
23	6.264	0.823	32.68	1.215	30.596	231.65	410.22	178.56	1.1103	1.7132
24	6.456	0.826	31.71	1.211	31.536	233.07	410.73	177.66	1.1150	1.7129
25	6.651	0.828	30.77	1.207	32.501	234.48	411.24	176.76	1.1197	1.7125
26	6.852	0.831	29.86	1.204	33.490	235.90	411.74	175.84	1.1244	1.7122
27	7.056	0.833	28.98	1.200	34.505	237.32	412.24	174.92	1.1291	1.7119
28	7.266	0.836	28.13	1.196	35.545	238.75	412.74	173.99	1.1338	1.7115
29	7.480	0.839	27.31	1.192	36.611	240.17	413.23	173.05	1.1384	1.7112

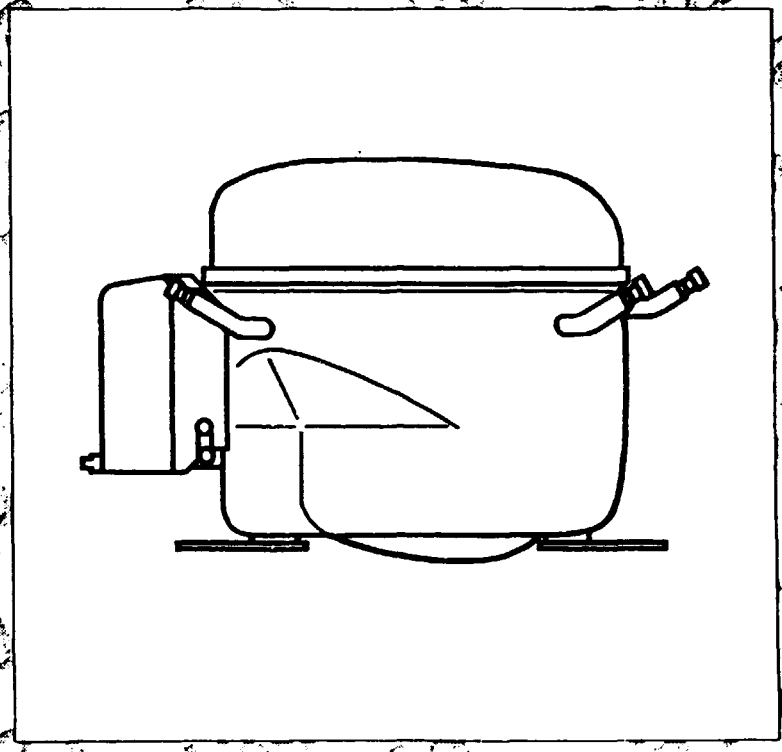
Vapour table for the wet vapour range

Temperature	Pressure	Specific volume		Density		Enthalpy		Heat of vaporization	Entropy	
		of liquid	of vapour	of liquid	of vapour	of liquid	of vapour		of liquid	of vapour
t	p	v'	v''	ρ'	ρ''	h'	h''	r	s'	s''
°C	bar	l/kg	l/kg	kg/l	kg/m³	kJ/kg	kJ/kg	kJ/kg	kJ/kg · K	kJ/kg · K
30	7.698	0.842	26.52	1.188	37.704	241.61	413.71	172.11	1.1431	1.7108
31	7.922	0.844	25.76	1.184	38.825	243.04	414.20	171.16	1.1478	1.7105
32	8.150	0.847	25.02	1.180	39.974	244.48	414.68	170.20	1.1524	1.7102
33	8.384	0.850	24.30	1.176	41.152	245.92	415.15	169.23	1.1571	1.7098
34	8.622	0.853	23.61	1.172	42.360	247.36	415.62	168.26	1.1617	1.7095
35	8.865	0.856	22.94	1.168	43.598	248.81	416.08	167.27	1.1664	1.7092
36	9.113	0.859	22.29	1.164	44.867	250.26	416.54	166.28	1.1710	1.7089
37	9.367	0.862	21.66	1.160	46.169	251.72	417.00	165.28	1.1756	1.7085
38	9.626	0.865	21.05	1.156	47.503	253.18	417.45	164.27	1.1802	1.7082
39	9.890	0.868	20.46	1.152	48.871	254.64	417.89	163.25	1.1849	1.7079
40	10.160	0.871	19.89	1.147	50.273	256.11	418.33	162.23	1.1895	1.7075
41	10.435	0.875	19.34	1.143	51.711	257.58	418.77	161.19	1.1941	1.7072
42	10.716	0.878	18.80	1.139	53.186	259.05	419.20	160.14	1.1987	1.7069
43	11.002	0.881	18.28	1.135	54.698	260.53	419.62	159.09	1.2033	1.7065
44	11.294	0.885	17.78	1.130	56.249	262.02	420.04	158.02	1.2079	1.7062
45	11.592	0.888	17.29	1.126	57.839	263.50	420.45	156.94	1.2125	1.7058
46	11.896	0.892	16.82	1.121	59.471	265.00	420.85	155.86	1.2171	1.7055
47	12.205	0.895	16.35	1.117	61.144	266.50	421.25	154.76	1.2217	1.7051
48	12.521	0.899	15.91	1.112	62.861	268.00	421.64	153.65	1.2263	1.7047
49	12.843	0.903	15.47	1.108	64.622	269.51	422.03	152.52	1.2309	1.7044
50	13.171	0.907	15.05	1.103	66.430	271.02	422.41	151.39	1.2355	1.7040
51	13.505	0.910	14.64	1.098	68.285	272.54	422.78	150.24	1.2401	1.7036
52	13.846	0.914	14.25	1.094	70.189	274.07	423.15	149.08	1.2447	1.7032
53	14.193	0.918	13.86	1.089	72.144	275.60	423.50	147.90	1.2493	1.7028
54	14.547	0.922	13.49	1.084	74.151	277.14	423.85	146.71	1.2539	1.7024
55	14.907	0.927	13.12	1.079	76.212	278.69	424.19	145.51	1.2586	1.7020
56	15.274	0.931	12.77	1.074	78.329	280.24	424.52	144.29	1.2632	1.7015
57	15.648	0.935	12.42	1.069	80.505	281.80	424.85	143.05	1.2678	1.7011
58	16.028	0.940	12.09	1.064	82.741	283.37	425.16	141.80	1.2724	1.7006
59	16.416	0.944	11.76	1.059	85.039	284.94	425.47	140.53	1.2771	1.7002
60	16.811	0.949	11.44	1.054	87.401	286.53	425.76	139.24	1.2817	1.6997
61	17.213	0.954	11.13	1.049	89.831	288.12	426.05	137.93	1.2864	1.6992
62	17.622	0.959	10.83	1.043	92.332	289.72	426.33	136.60	1.2911	1.6987
63	18.038	0.964	10.54	1.038	94.905	291.34	426.59	135.25	1.2958	1.6981
64	18.463	0.969	10.25	1.032	97.554	292.96	426.84	133.88	1.3005	1.6976
65	18.894	0.974	9.97	1.027	100.282	294.59	427.09	132.49	1.3052	1.6970
66	19.333	0.980	9.70	1.021	103.092	296.24	427.31	131.07	1.3099	1.6964
67	19.781	0.985	9.43	1.015	105.990	297.90	427.53	129.63	1.3147	1.6958
68	20.236	0.991	9.18	1.009	108.977	299.57	427.73	128.17	1.3194	1.6951
69	20.699	0.997	8.92	1.003	112.060	301.25	427.92	126.67	1.3242	1.6944
70	21.170	1.003	8.68	0.997	115.242	302.95	428.10	125.15	1.3290	1.6937
71	21.649	1.009	8.44	0.991	118.529	304.66	428.25	123.59	1.3339	1.6930
72	22.137	1.016	8.20	0.985	121.926	306.39	428.40	122.00	1.3388	1.6922
73	22.633	1.022	7.97	0.978	125.439	308.14	428.52	120.38	1.3437	1.6914
74	23.137	1.029	7.75	0.972	129.075	309.90	428.63	118.72	1.3486	1.6906

Vapour table for the wet vapour range

Temperature t °C	Pressure p bar	Specific volume of liquid v' l/kg	Specific volume of vapour v'' l/kg	Density of liquid ϱ' kg/l	Density of vapour ϱ'' kg/m³	Enthalpy of liquid h' kJ/kg	Enthalpy of vapour h'' kJ/kg	Heat of vaporization r kJ/kg	Entropy of liquid s' kJ/kg · K	Entropy of vapour s'' kJ/kg · K
75	23.651	1.036	7.53	0.965	132.840	311.68	428.71	117.03	1.3536	1.6897
76	24.173	1.044	7.31	0.958	136.744	313.49	428.78	115.29	1.3586	1.6888
77	24.704	1.051	7.10	0.951	140.795	315.31	428.82	113.51	1.3637	1.6878
78	25.245	1.059	6.90	0.944	145.001	317.16	428.84	111.68	1.3688	1.6868
79	25.794	1.068	6.69	0.937	149.375	319.03	428.84	109.80	1.3739	1.6857
80	26.353	1.076	6.50	0.929	153.927	320.93	428.81	107.87	1.3791	1.6846
81	26.921	1.086	6.30	0.921	158.672	322.86	428.75	105.88	1.3844	1.6834
82	27.499	1.095	6.11	0.913	163.625	324.82	428.66	103.83	1.3898	1.6821
83	28.087	1.105	5.92	0.905	168.803	326.81	428.53	101.72	1.3952	1.6808
84	28.685	1.116	5.74	0.896	174.225	328.84	428.37	99.53	1.4007	1.6794
85	29.292	1.127	5.56	0.887	179.915	330.91	428.17	97.26	1.4063	1.6778
86	29.910	1.139	5.38	0.878	185.900	333.03	427.93	94.90	1.4120	1.6762
87	30.539	1.151	5.20	0.869	192.209	335.19	427.63	92.44	1.4178	1.6745
88	31.177	1.165	5.03	0.859	198.881	337.40	427.29	89.88	1.4237	1.6726
89	31.827	1.179	4.86	0.848	205.959	339.68	426.88	87.20	1.4298	1.6706
90	32.487	1.194	4.68	0.837	213.499	342.02	426.40	84.38	1.4361	1.6684
91	33.159	1.211	4.51	0.826	221.566	344.44	425.85	81.41	1.4425	1.6661
92	33.841	1.230	4.34	0.813	230.246	346.95	425.21	78.26	1.4492	1.6635
93	34.535	1.250	4.17	0.800	239.649	349.57	424.46	74.89	1.4561	1.6606
94	35.241	1.272	4.00	0.786	249.924	352.31	423.59	71.28	1.4633	1.6574
95	35.958	1.298	3.83	0.771	261.274	355.20	422.55	67.36	1.4709	1.6539
96	36.688	1.327	3.65	0.753	273.999	358.28	421.32	63.04	1.4790	1.6498
97	37.429	1.362	3.47	0.734	288.566	361.62	419.82	58.20	1.4878	1.6450
98	38.183	1.405	3.27	0.712	305.774	365.32	417.95	52.62	1.4975	1.6393
99	38.949	1.461	3.06	0.685	327.219	369.60	415.46	45.87	1.5087	1.6319
100	39.728	1.544	2.80	0.648	357.099	374.97	411.79	36.83	1.5228	1.6215
101	40.520	1.742	2.37	0.574	422.387	384.56	403.26	18.70	1.5481	1.5981
101.15	40.640	1.970	1.97	0.508	507.500	392.27	392.27	0.00	1.5687	1.5687

TL compressors for R134a
220V - 240V 50Hz



Application

The TL-F and TL-G compressors have been developed especially for refrigerating systems using refrigerant R134a (CF_3-CH_2F).
TL2.5F and TL3F are designed for medium evaporating temperatures for use in domestic refrigerators without freezer compartment and similar applications.
TL4F, TL5F, TLS5F, TLS6F, and TLS7F are designed for low evaporating temperatures for use in domestic refrigerators and freezers.
The TL-F compressors are released for 220V, 230V, and 240V 50Hz mains and max. 38°C ambient temperature (subtropical climate). The TLS-F compressors are released for max. 32°C ambient temperature. With a 4 µF run capacitor the TLS-F compressors can be used in max. 38°C ambient temperature.
TL3G, TL4G, and TL5G are designed for high evaporating temperatures for use in liquid coolers and dehumidifiers.
The TL-G compressors are primarily designed for use at 220V, 230V, and 240V 50 Hz mains. At 220V and 230V 60 Hz mains the compressors can be used at low evaporating temperatures.
The TL-G compressors can also be used at 50 Hz mains and low evaporating temperatures in cases of undervoltage where increased motor power is required.

Design

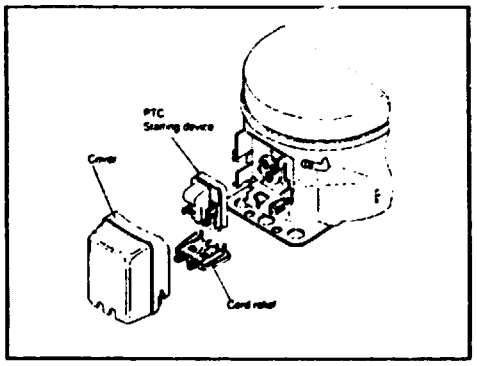
The displacements of the compressors are the same as for the corresponding TL compressors for R12. This causes displaced capacity curves, and consequently the motors have been modified accordingly. TLS6F and TLS7F are new designs.
The TLS compressors have semi-direct intake. Please note that the suction- and process connectors for TLS models have been interchanged compared to the other TL compressors.
The compressors are charged with Polyolester oil and they are approved only for use with this oil and refrigerant R134a. A blue stripe and "R134a" on the compressor label identifies the compressors.

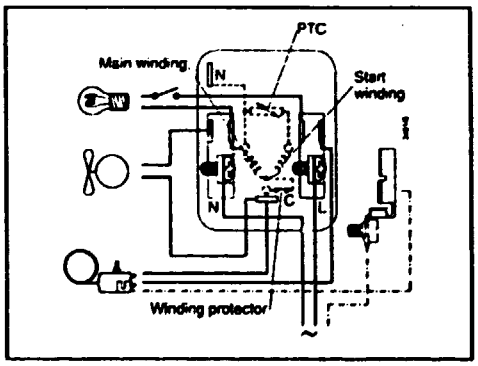
Electrical equipment

The compressors (excl. TL2.5F) have universal motors which means that they can obtain a high (HST) or a low (LST) starting torque depending on the electrical equipment used.
The PTC starting device for low starting torque (LST) requires a pressure-equalized system before each start and a compressor standstill period of 5 minutes to cool down the PTC before a new start.
The electrical equipment containing a starting relay and a starting capacitor gives the compressor a high starting torque (HST) and the compressor can be used in refrigerating systems with expansion valve or in systems with capillary tube where the pressure is not equalized before each start.
The motor protector is built into the motor.

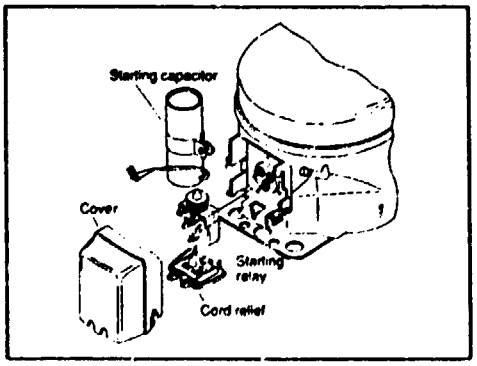
No attempt must be made to start the compressor without a complete starting device.

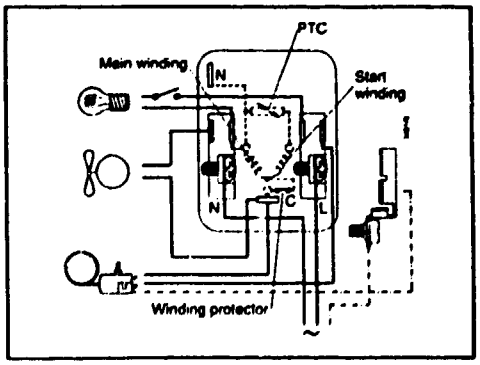
LST





HST





Motor temperature

The compressors have been released for max. 125°C motor temperature at stable conditions and max. 135°C at peak load.

Refrigerant charge

The refrigerant charge must not exceed 400 g.

Dimensioning of condenser

In order to protect the compressors against overloading the max. condensing temperature must not exceed the following levels in the highest ambient temperature:

In the normal operating range	:	max. 60°C
During peak load	:	max. 70°C

Approvals

The compressors have been approved according to IEC 335-2-34 (CENELEC HD277 S1) with the protection screen 103N0476 mounted on the starting device.
Compressors with HST starting device have been approved according to IEC 335-1.

Delivery

The compressors are supplied with sealed connectors. Normal consignments consist of 125 compressors on a pallet with the dimensions 1144 x 800 mm.

Conversion from R12 to R134a

Normally, the capillary tube shall be adjusted at low evaporating temperatures. Compared to an optimized R12 system with the same evaporator capacity, the R134a system must have an increased resistance defined as approx. 10% less N_2 flow at 10 bar inlet pressure.

The same size of capillary tube as used for R12 can be used at high evaporating temperatures.

A drier with 3Å desiccant of Molecular Sieves must always be used.

Rules for dryness and cleanliness of system components (DIN 8964) are transferred to R134a systems.

The system components must not contain mineral oil or other greasy substances.

The compressors must be brazed into the system no later than 15 minutes after the connector seals have been removed.

The same evacuation procedure as for R12 systems must be used.

Max. 1% non-condensable gases.

The system must not contain any chlorine.

The charging equipment and the vacuum pump must only be used for R134a.

The compressors are not released for use in refrigerating systems which have been charged with R12.

Application

TL2.5F and TL3F are designed for medium evaporating temperatures for use in refrigerators without freezer compartment (cold cabinets).
TL4F and TL5F are designed for low evaporating temperatures for use in domestic refrigerators and freezers.
TL3G, TL4G, and TL5G are primarily designed for high evaporating temperatures for use in liquid coolers and dehumidifiers but they can also be used in refrigerators and freezers.

Technical data

Evaporating temperature
TL2.5F - TL3F : 0°C to -25°C
TL4F - TL5F : -10°C to -35°C
TL3G - TL5G : 15°C to -30°C

Voltage range
220V : 198 - 254V, 50Hz
240V : 216 - 264V, 50Hz

Refrigerant
R134a

Compressor cooling
Static

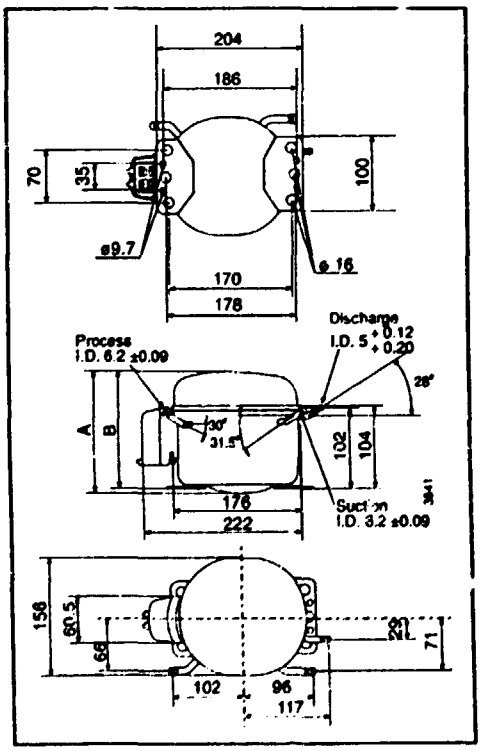
Compressor		TL2.5F	TL3F	TL4F	TL5F	TL3G	TL4G	TL5G
Application		MBP	MBP	LBP	LBP	HBP	HBP	HBP
Capacity (CECOMAF)	Watt	86	108	61	82	222	269	346
Efficiency (COP)	W/W	1.11	1.11	0.77	0.83	1.68	1.82	1.70
Capacity (ASHRAE)	Watt	106	133	83	112	270	326	419
Efficiency (COP)	W/W	1.36	1.37	0.99	1.07	1.96	2.13	1.97
Displacement	cm^3	2.61	3.13	3.86	5.08	3.13	3.86	5.08
Motor type		RSIR	RSIR/CSIR			RSIR/CSIR		
Motor size[3]	Watt	60	75	95	110	95	110	140
Locked rotor cur.[4] LST/HST	Amp.	2.3/	2.8/4.5	3.2/4.7	4.1/5.9	3.5/4.8	4.1/5.9	5.4/5.7
Cut-in current LST	Amp.	7.0	7.5	7.5	8.6	8.3	8.6	9.7
Oil quantity	cm^3	180	180	180	180	280	280	280
Weight without electrical equipment	kg	6.7	6.7	6.7	7.5	6.8	7.5	7.5

Testing conditions	CECOMAF	ASHRAE
Evaporating temperature	MBP : -10°C LBP : -25°C HBP : 5°C	MBP : -10°C LBP : -23.3°C HBP : 7.2°C
Condensing temperature	55°C	54.4°C 54.4°C
Ambient and suction gas temperature	32°C	32°C 35°C
Liquid temperatur	55°C	32°C 46°C

[3] At half breakdown torque of motor.

[4] Measured after 4 seconds.

Dimensioned sketch



Compressors	Dimensions	
	A	B
TL2.5F	160	156
TL3F	160	156
TL3G	160	156
TL4F	160	156
TL4G	170	166
TL5F	170	166
TL5G	170	166

Danfoss

Capacity (CECOMAF)

Watt

Compressor	Evaporating temperature °C												
	-35	-30	-25	-23.3	-20	-15	-10	-5	0	5	7.2	10	15
TL2.5F			31	36	47	65	86	110	137				
TL3F			41	46	58	81	108	139	176				
TL3G		28	41	46	59	81	109	141	179	222	242	270	323
TL4F	31	44	61	68	82	107	137						
TL4G		43	58	64	79	105	137	175	219	269	292	324	386
TL5F	44	60	82	91	110	144	183						
TL5G		56	76	85	103	138	175	228	283	346	376	417	494

Liquid temperature 55°C

Capacity (ASHRAE)

Watt

Compressor	Evaporating temperature °C												
	-35	-30	-25	-23.3	-20	-15	-10	-5	0	5	7.2	10	15
TL2.5F			38	44	57	80	106	136	169				
TL3F			50	57	72	99	133	172	217				
TL3G		35	50	57	72	100	134	175	222	275	301	335	401
TL4F	38	54	75	83	101	132	169						
TL4G		53	72	79	97	129	169	216	271	333	363	403	480
TL5F	54	74	101	112	136	177	226						
TL5G		69	94	104	127	170	221	281	351	429	467	517	614

Liquid temperature 32°C

Power consumption

Watt

Compressor	Evaporating temperature °C												
	-35	-30	-25	-23.3	-20	-15	-10	-5	0	5	7.2	10	15
TL2.5F			53	56	61	69	78	86	94				
TL3F			64	67	74	85	97	110	123				
TL3G		57	67	70	76	87	97	108	120	132	138	145	158
TL4F	58	68	79	84	92	106	120						
TL4G		72	83	87	94	105	115	126	137	148	153	159	170
TL5F	67	83	99	105	116	134	152						
TL5G		85	99	105	115	132	149	166	185	204	213	224	245

Current consumption

Amp.

Compressor	Evaporating temperature °C												
	-35	-30	-25	-23.3	-20	-15	-10	-5	0	5	7.2	10	15
TL2.5F			0.46	0.47	0.48	0.51	0.54	0.57	0.60				
TL3F			0.56	0.57	0.59	0.61	0.64	0.67	0.70				
TL3G		0.67	0.69	0.70	0.71	0.73	0.76	0.79	0.82	0.86	0.88	0.90	0.95
TL4F	0.61	0.62	0.64	0.65	0.67	0.72	0.76						
TL4G		0.73	0.75	0.76	0.78	0.80	0.84	0.87	0.92	0.96	0.99	1.02	1.06
TL5F	0.72	0.75	0.79	0.80	0.84	0.90	0.96						
TL5G		0.85	0.88	0.89	0.91	0.96	1.00	1.06	1.13	1.19	1.23	1.27	1.36

Testing conditions:
Condensing temperature 55°C
Ambient and suction gas temperature 32°C
Static cooling, 220V 50Hz

Application

TLS5F, TLS6F, and TLS7F are designed for low evaporating temperatures for use in domestic refrigerators and freezers.

Technical data

Evaporating temperature
-10°C to -35°C

Voltage range
220V : 198 - 254V, 50Hz
240V : 216 - 264V, 50Hz

Refrigerant
R134a

Compressor cooling
Static

Compressor		TLS5F	TLS6F	TLS7F
Application		LBP	LBP	LBP
Capacity (CECOMAF)	Watt	93	105	118
Efficiency (COP)	W/W	0.85	0.88	0.88
Capacity (ASHRAE)	Watt	127	144	162
Efficiency (COP)	W/W	1.09	1.15	1.15
Displacement	cm^3	5.08	5.70	6.49
Motor type		RSIR/CSIR	RSIR/CSIR	RSIR/CSIR
Motor size[3]	Watt	125	125	140
Locked rotor cur.[4] LST/HST	Amp.	5.0/5.9	5.0/5.9	5.4/5.7
Cut-in current LST	Amp.	9.5	9.5	9.7
Oil quantity	cm^3	180	180	180
Weight without electrical equipment	kg	7.3	7.3	7.5

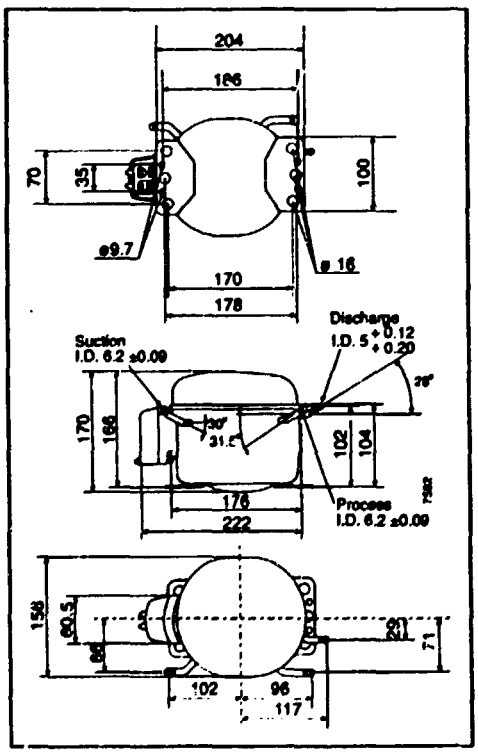
Testing conditions	CECOMAF	ASHRAE
Evaporating temperature	-25°C	-23.3°C
Condensing temperature	55°C	54.4°C
Ambient and suction gas temp.	32°C	32°C
Liquid temperature	55°C	32°C

220V 50Hz

[3] At half breakdown torque of motor.

[4] Measured after 4 seconds.

Dimensioned sketch



Capacity (CECOMAF)

Watt

Compressor	Evaporating temperature °C						
	-35	-30	-25	-23.3	-20	-15	-10
TLS5F	44	70	93	104	123	161	207
TLS6F	54	78	105	118	140	182	232
TLS7F	60	86	118	133	158	205	260

Liquid temperature 55°C

Capacity (ASHRAE)

Watt

Compressor	Evaporating temperature °C						
	-35	-30	-25	-23.3	-20	-15	-10
TLS5F	54	86	115	128	152	199	256
TLS6F	67	96	129	144	172	224	286
TLS7F	74	106	146	162	195	253	321

Liquid temperature 32°C

Power consumption

Watt

Compressor	Evaporating temperature °C						
	-35	-30	-25	-23.3	-20	-15	-10
TLS5F	75	87	109	117	131	152	172
TLS6F	84	101	119	125	138	159	181
TLS7F	95	114	135	142	156	180	205

Current consumption

Amp.

Compressor	Evaporating temperature °C						
	-35	-30	-25	-23.3	-20	-15	-10
TLS5F	0.75	0.80	0.85	0.87	0.91	0.97	1.04
TLS6F	0.82	0.85	0.90	0.92	0.95	1.02	1.10
TLS7F	0.95	0.99	1.03	1.05	1.08	1.14	1.20

Testing conditions:
Condensing temperature 55°C
Ambient and suction gas temperature 32°C
Static cooling, 220V 50Hz

220V compressors for R134a

Application range °C	Compressor	Displacement cm³	CECOMAF Capacity Watt	CECOMAF COP W/W	ASHRAE Capacity Watt	ASHRAE COP W/W	Code number Compressor
MBP -25 to 0	TL2.5F	2.61	86	1.11	106	1.36	102G4200
	TL3F	3.13	108	1.11	133	1.37	102G4300
LBP -35 to -10	TL4F	3.86	61	0.77	83	0.99	102G4400
	TL5F	5.08	82	0.83	112	1.07	102G4501
	TLS5F	5.08	93	0.85	127	1.09	102G4520
	TLS6F	5.70	105	0.88	144	1.15	102G4620
	TLS7F	6.49	118	0.88	162	1.15	102G4720
HBP -30 to 15	TL3G	3.13	222	1.68	270	1.96	102G4350
	TL4G	3.86	269	1.82	326	2.13	102G4452
	TL5G	5.08	346	1.70	419	1.97	102G4550

Testing conditions	CECOMAF			ASHRAE		
Evaporating temperatur	MBP : -10°C	LBP : -25°C	HBP : 5°C	MBP : -10°C	LBP : -23.3°C	HBP : 7.2°C
Condensing temperature		55°C			54.4°C	
Ambient and suction gas temperature		32°C			32°C	35°C
Liquid temperature		55°C			32°C	46°C

Electrical equipment

Low starting torque

PTC starting device (6.3 mm spade connectors)	103N0011
PTC starting device (4.8 mm spade connectors)	103N0018
Protection screen for PTC	103N0476
Cord relief	103N1006
Cover	103N2010

For 4µF run capacitor

PTC starting device (6.3 mm spade connectors)	103N0016
PTC starting device (4.8 mm spade connectors)	103N0021

High starting torque

Starting relay for :	TL3F	117U6007
	TL4F, TL3G	117U6009
	TL5F, TLS5F, TLS6F	117U6004
	TL4G, TL5G	117U6004
	TLS7F	117U6000
Starting capacitor (60µF)		117U5014
Cord relief		103N1006
Cover		103N2010

Mounting accessories

Bolt joint for 1 compressor (1 bag)	118-1917
Bolt joint in quantities	118-1918
Snap-on in quantities	118-1919

Alternative Motors for TL Compressors 220 - 240V

Replaces CN.42.C1.51

Alternative motors have been introduced in the TL5F, TLS5F, and TLS6F compressors from week 8, 1995. From week 19 alternative motors will be introduced in TLS9F and TL4G compressors and from week 20 in TL4F compressors The motors will be used in parallel to the present motors. The new motors have the same characteristics as the present motors, but the resistance values are different,

Compressor	Main winding Ω		Start winding Ω	
	New	Present	New	Present
TL4F	28	24.3	14	14.2
TL5F	18.2	16	15.1	17
TL4G	18.2	16	15.1	17
TLS5F	18.2	16	15.1	17
TLS6F	18.2	16	15.1	17
TLS9F	18.2	16	15.1	17

The introduction of the new motors has necessitated new compressor approvals which means that the following supplementary references must be used in connection with existing approvals,

Compressor	New approvals	Supplementary reference
TL4F	DEMKO, VDE, BEAB, NF	CCA-DE 8134
TL5F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00584
TL4G	DEMKO, VDE according to IEC 335-2-34, sub clause 19.3	CCA-DK 95-01803
TLS5F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS6F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS9F	DEMKO, VDE, BEAB, NF	CCA-DK 95-01804

The supplier code stamping for the alternate motor is "0".

Ab Woche 8, 1995, wurden alternative Motoren für die Verdichtertypen TL5F, TLS5F und TLS6F eingeführt. Ab Woche 19 werden alternative Motoren für die Verdichtertypen TLS9F und TL4G und ab Woche 20 für den Verdichtertyp TL4F eingeführt. Diese Motoren werden parallel zu den jetzigen Motoren verwendet.
Die alternativen Motoren haben die selben Eigenschaften, wie die jetzigen Motoren, jedoch die Widerstandswerte weichen wie folgt ab:

Verdichter	Hauptwicklung Ω		Hilfswicklung Ω	
	Neuer Motor	Jetziger Motor	Neuer Motor	Jetziger Motor
TL4F	28	24,3	14	14,2
TL5F	18,2	16	15,1	17
TL4G	18,2	16	15,1	17
TLS5F	18,2	16	15,1	17
TLS6F	18,2	16	15,1	17
TLS9F	18,2	16	15,1	17

Diese Änderung bewirkt, daß neue Verdichtergenehmigungen eingeholt werden mußten. Die folgenden Referenzen müssen deshalb in Verbindung mit den existierenden Approbationen verwendet werden:

Verdichter	Neue Genehmigungen	Referenznummer
TL4F	DEMKO, VDE, BEAB, NF	CCA-DE 8134
TL5F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00584
TL4G	DEMKO, VDE gemäß IEC 335-2-34, sub clause 19.3	CCA-DK 95 01803
TLS5F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS6F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS9F	DEMKO, VDE, BEAB, NF	CCA-DK 95-01804

Für den alternativen Motor gilt der Zulieferercode "0" in der Verdichterstempelung.

Fra uge 8, 1995, indførtes alternative motorer på kompressortyperne TL5F, TLS5F og TLS6F. Fra uge 19 indføres alternative motorer på kompressortyperne TLS9F og TL4G og fra uge 20 på kompressortypen TL4F. De alternative motorer har de samme egenskaber som de nuværende motorer og vil blive anvendt parallelt med disse.
Modstandsværdierne i de alternative motorer afviger på følgende punkter:

Kompressor	Kørevikling Ω		Startvikling Ω	
	Alternativ motor	Nuværende motor	Alternativ motor	Nuværende motor
TL4F	28	24,3	14	14,2
TL5F	18,2	16	15,1	17
TL4G	18,2	16	15,1	17
TLS5F	18,2	16	15,1	17
TLS6F	18,2	16	15,1	17
TLS9F	18,2	16	15,1	17

Anvendelse af de nye motorer har betydet, at der er indhentet nye kompressorgodkendelser. I forbindelse med eksisterende kølemøbelapprobationer skal følgende referencenumre anvendes:

Kompressor	Nye approbationer	Referenceummer
TL4F	DEMKO, VDE, BEAB, NF	CCA-DE 8134
TL5F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00584
TL4G	DEMKO, VDE i h.t. IEC 335-2-34, sub clause 19.3	CCA-DK 95-01803
TL35F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS6F	DEMKO, VDE, BEAB, NF	CCA-DK 95-00875
TLS9F	DEMKO, VDE, BEAB, NF	CCA-DK 95-01804

Leverandørkoden i kompressorstemplingen vil være "0" for den alternative motor.

COMPRESSEURS BASSE PRESSION D'ÉVAPORATION
LOW BACK PRESSURE COMPRESSORS
KOMPRESSOREN FÜR NIEDERDRUCK VERDAMPFUNG
COMPRESORES BAJA PRESIÓN DE EVAPORACIÓN

COMPRESSEURS / COMPRESSORS / KOMPRESSOREN / COMPRESORES	Réfrigérant / Refrigerante / Kältemittel / Refrigerante	Cylindrée / Hubraum (cm³) Displacement / Cilindrada	Charge d'huile cm³ / Ölfüllung cm³ / Oil charge cm³ / Carga de aceite cm³	Détente / Expansion (3) Expansion device / Expansión	Refroidissement / Kühlung (3) Cooling / Enfriamiento	PRODUCTIONS FRIGORIFIQUES A 50 Hz / REFRIGERATING CAPACITY AT 50 Hz / KALTELEISTUNG BEI 50 Hz / PRODUCCIONES FRIGORIFICAS A 50 Hz (Watts) — Température d'évaporation - Verdampfungstemperatur / Evaporating temperature - Segun temperatura évaporación							Poids brut / Bruto gewicht / Peso bruto (kg) Gross weight	TENSIONS / VOLTAGE / SPANNUNG / VOLTAJE (4)	
						(1) (6)						CECOMAF (2)				
						- 40 °C - 40 °F	- 35 °C - 31 °F	- 30 °C - 22 °F	- 23.3 °C - 10.0 °F	- 20 °C - 4 °F	- 15 °C + 5 °F	- 10 °C + 14 °F	- 25 °C - 13 °F		1 Ph	3 Ph
AZ1320A	12	2.25	270	C	N		21	32	50	59	75	95	37	6	C. F. G	
AZ1320D															A. F. G	
AZ1320Y	134a	2.95	270	C	N		18	29	53	67	81	120	37	6	F	
AZ1328A	12	2.95	270	C	N		30	45	68	80	102	128	51	6	F. G	
AZ1328D															A. F. G	
AZ1330Y	134a	3.6	270	C	N		30	48	78	95	124	161	56	6	F	
AZ1335A	12	3.6	400	C	N		43	60	90	107	138	171	68	6.6	F. G. H	
AZ1335D															A. F. G	
AZ1335Y	134a	4	400	C	N		41	57	86	104	137	180	63	6.9	F	
AZ1340A	12	4	270	C	N		51	70	103	123	158	197	78	8.4	F. G	
AZ1340D																
AZ1339Y	134a	5	270	C	N		28	54	96	121	168	221	88	7.4	F	
AZ1348Y	134a	5.6	370	C	N		52	78	122	149	201	261	88	7.4	F	
AZ1355D	12	5.6	300	C	N		67	94	136	160	201	247	103	7.4	F. G	
AEZ1358Y	134a	6.9	500	C	N		48	86	144	178	235	305	103	10	F	
AEZ1368A	12	7.55	500	C	N/F. RH		67	98	154	187	246	314	114	10	A. F. G	
AEZ1365Y	134a	8.1	500	C	N		72	110	177	219	294	379	127	10.5	F	
AEZ1380A	12	8.05	600	C	N/F. RH		84	124	193	232	298	373	144	10.4	A. F. G. H	
AEZ2380C	12	8.1	600	C V	F		98	136	205	244	313	398	154	10.4	A. F. G	
AEZ1380Y	134a	9.4	600	C	F		93	145	224	267	336	418	163	10.4	F	
AEZ2380Y				C V												
AE214190	12	9.4	600	C	F. RH		121	169	251	299	379	467	189	10.4	A. F. G	
AEZ2419D				C V												
AE1418A	12	12.05	600	C	F. RH		105	158	250	304	400	510	186	12	A. C. F. G. H	
CAE2418A				C V	F										A. C. F. G. H	
AE1418B				C	F. RH										F	
AE1418Y	134a	12.05	450	C	F		92	152	257	325	438	565	181	12	F	
AE1412A	12	14.15	600	C	F. RH		141	202	311	376	496	634	232	12	A. F. G. H	
CAE2412A				C V	F									12.9	A. C. F	
AE1412B				C	F. RH									12.9	F	
AE1412Y	134a	14.15	450	C	F		99	169	305	387	515	661	214	12.5	F	
AE1417L	502	11.3	450	C	F	96	168	293	449	533	680	855	315	12.9	F. G. H	
CAE2417L				C V										14.6	A. B. G. H	
AE1117Z	404A	11.3	450	C	F	65	155	275	458	552	709	891	341	12.9	F. G. H	
CAE2117Z				C V										14.6	A. F. G. H	
CAJ2T12	12	28.15	887	C V	F		253	377	611	750	975	1238	453	21.6	A. F. G. H	
CAJ/TAJ 2428L	502	15.2	887	C V	F	105	232	390	620	759	980	1240	428	21.6	A. F. G. H	T
CAJ/TAJ 2428Z	404A	15.2	887	C V	F	71	192	365	637	786	1021	1292	467	21.6	A. F. G. H	T
CAJ2432L	502	18.3	887	C V	F	140	290	490	787	960	1220	1510	544	22	F. H	
CAJ2432Z	404A	18.3	887	C V	F	94	240	459	799	994	1271	1573	584	22	F. H	
CAJ/TAJ 2446L	502	28.15	887	C V	F	270	498	754	1106	1305	1645	2060	779	23.2	F. G. H	T
CAJ/TAJ 2446Z	404A	28.15	887	C V	F	181	411	706	1140	1351	1714	2147	854	23.2	F. G. H	T
CAJ/TAJ 2464L	502	34.45	887	C V	F	324	620	1000	1583	1890	2410	2950	1103	25	F. H	T
CAJ/TAJ 2464Z	404A	34.45	887	C V	F	158	512	948	1611	1958	2490	3088	1192	25	F. H	T
CAN/TAN 2446A	12	53.2	1625	C V	F		203	575	1112	1391	1850	2375	885	33.4	F. H	T
CAN/TAN 2466A	12	74.25	1625	C V	F		867	1045	1617	1925	2485	3100	1214	34.2	F	T
TAH2480J	502	53.2	1625	C V	F	495	872	1338	2068	2505	3277	4183	1435	34.2		T
TAH2480Z	404A	53.2	1625	C V	F	333	720	1252	2100	2593	3415	4359	1546	34.2		T
TAH2511K	502	74.25	1625	C V	F	695	1190	1800	2717	3245	4165	5015	1901	34.2		K. T
TAH2511Z	404A	74.25	1625	C V	F	467	983	1587	2772	3359	4277	5226	2059	34.2		K. T
TAHD 2516J	502	106.4	1625	C V	F	990	1744	2672	4131	5010	6554	8366	2869	76		T
TAHD 2516Z	404A	106.4	1625	C V	F	666	1440	2504	4200	5186	6830	8710	3092	76		T
TAHD2622K	502	148.5	1625	C V	F	1390	2380	3800	5435	6490	8210	10030	3803	76		T
TAHD 2522Z	404A	148.5	1625	C V	F	934	1966	3374	5544	6718	8554	10452	4116	76		T

Chaque modèle TAH/TAG/TAN existe en version spéciale TAHP TAGP TANP pour montage en parallèle
Each model TAH/TAG/TAN is also available in special execution TAHP TAGP TANP for parallel installation
Jedes modell TAH/TAG/TAN ist ebenfalls in TAHP/TAGP/TANP ausführung für parallelmontage erhältlich
Cada modelo TAH/TAG/TAN existe en versión especial TAHP TAGP TANP para montaje en paralelo

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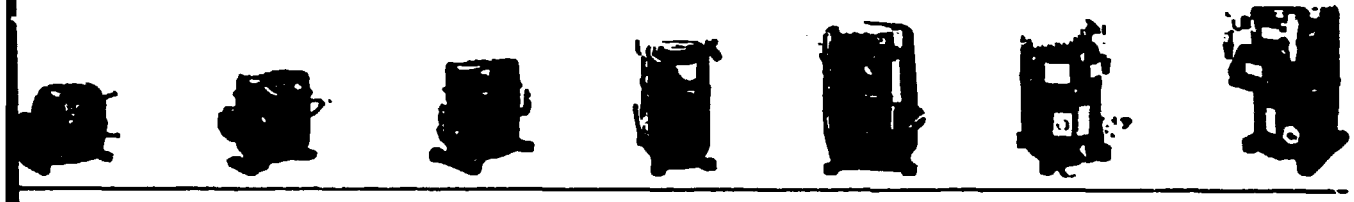

COMPRESSEURS MOYENNE / HAUTE PRESSION D'ÉVAPORATION
MEDIUM / HIGH BACK PRESSURE COMPRESSORS
KOMPRESSOREN MITTLEREN / HOHEN VERDAMPFUNGSDRUCK
COMPRESORES MEDIA / ALTA PRESION DE EVAPORACION

COMPRESSEURS / COMPRESSORS / KOMPRESSOREN / COMPRESORES	Refrigerant / Refrigerante	Déplacement Cylindrée (cm³)	Charge d'huile cm³ / Füllung cm³ / Carga de aceite cm³	Expanseur device / Expansion (3)	Cooling / Enfriamiento (3)	PRODUCTIONS FRIGORIFIQUES A 50 Hz — REFRIGERATING CAPACITY AT 50 Hz — KALTELEISTUNG BEI 50 Hz — PRODUCCIONES FRIGORIFICAS A 50 Hz (Watts) — Temperature d'evaporation · Verdampfungstemperatur · Evaporating temperature · Segun temperatura evaporacion (1) (6)								Gross weight / Tara bruta	TENSIONS VOLTAGE SPANNUNG VOLTAJE (4)	
	Réfrigerant / Kältemittel	Cylindrée / Hubraum		Détente / Expansion	Refroidissement / Kühlung	- 25 °C - 13 °F	- 20 °C - 4 °F	- 15 °C + 5 °F	- 10 °C + 14 °F	- 5 °C + 23 °F	0 °C + 32 °F	+ 7.2 °C + 45 °F	+ 15 °C + 59 °F	CECOMAF (2) + 5° C + 41 °F	Poids brut / Bruto gewicht (kg)	1 Ph	3 Ph.
AZ8360A	12	2.95	400	C	N	55	70	89	111	138	172	229	302	198	6.7	A. F	
AZ4416Y	134a	2.95	400	C/V	N			75	100	131	168	235	329	197	6.7	F. H	
AZ8374A	12	3.6	270	C	N	64	86	113	146	184	225	302	403	260	6.8	A. F. G	
AZ8374A				C/V													
AZ4412Y	134a	3.6	270	C/V	N			91	124	167	216	293	415	252	6.8	A. F. H	
AZ8387A	12	4	300	C	N	77	102	129	161	202	249	330	431	288	7	A. F. G	
AZ8387A				C/V													
AZ4416Y	134a	4	300	C/V	N			98	139	185	247	344	468	290	7	A. F. H.	
AZ8411A	12	5.6	300	C	F	105	140	179	227	283	349	462	606	400	7.5	A. F. G	
AZ8411A				C/V													
AZ2419Y	134a	5.6	300	C	F			154	210	270	343	470	640	398	7.5	F	
AZ4419Y				C/V												A. F. H	
AE582F9	12	7.55	500	C	F			230	302	390	498	642	837	557	10.1	A. B. C	
CAE582F9				C/V												A. C. F	
AE4425E	22	4.5	480	C/V	F			193	255	329	413	550	727	467	10.1	A. F. G. H	
AE2425Y	134a	7.55	500	C	F			187	257	347	460	634	869	539	10.1	F. H	
AE4425Y				C/V												A. F. H	
AE412F11	12	8.85	600	C	F			270	352	450	559	735	982	636	10.5	A. B. C	
CAE412F11				C/V												A. C. F	
AE4430E	22	5.7	480	C/V	F			257	335	428	536	715	943	608	10.5	A. F. G. H	
AE2430Y	134a	8.85	600	C	F			243	328	436	560	773	1071	654	10.5	F. H	
AE4430Y				C/V												A. F. H	
AE2440E	22	7.55	600	C	F			358	468	592	734	975	1302	822	11.6	F. G. H	
AE4440E				C/V												A. F. G. H	
AE2940T	22	7.55	600	C/V	F	200	269	358	468	592	734	975	1302	822	14.6	F	
AE3440A	12	12.05	480	C/V	F			325	443	588	744	991	1295	857	12	A. C. F	
CAE4440A																	
AE2440Y	134a	12.05	480	C	F			305	428	565	728	1022	1416	859	12	F	
CAE4440Y				C/V												A. F. H	
AE3460E	22	9.4	480	C	F			426	556	707	898	1213	1620	1017	14.8	F	
CAE4460E				C/V												A. F. G. H	
CAE9460T	22	9.4	600	C/V	F	220	313	426	559	707	898	1213	1620	1017	14.8	A. F. G. H	
	502					209	320	431	561	717	906	1220	1643	1027			
CAE4440Y	134a	14.15	450	C/V	F			401	531	699	889	1241	1708	1046	12.5	F	
CAE9460T	22	11.3	480	C/V	F	320	425	559	714	913	1139	1513	2006	1279	14.8	A. F. G. H	
	502					293	422	568	727	915	1137	1526	2032	1290			
CAE4470L	502	13.25	480	C/V	F			695	844	1060	1370	1760	2290	1491	14.8	F. G. H	
CAJ4462A	12	15.2	887	C/V	F	175	295	435	595	775	970	1283	1650	1114	21	A. F. G. H	
CAJ4462Y	134a	15.2	887	C/V	F			360	540	732	956	1348	1888	1131	21	F. G. H	
CAJ/TAJ4461A	12	18.3	887	C/V	F	240	375	540	725	935	1185	1508	1905	1316	21.5	A. F. G. H	T
CAJ/TAJ4461Y	134a	8.3	887	C/V	F			483	657	864	1113	1560	2175	1310	21.5	F. G. H	T
CAJ/TAJ9480T	22	15.2	887	C/V	F	325	501	715	972	1283	1591	2128	2773	1797	23	F. G. H	T
	502					378	556	759	992	1275	1595	2155	2844	1820			
CAJ/TAJ4482A	12	25.95	887	C/V	F	385	575	810	1080	1395	1740	2295	3000	1993	22.5	A. F. G. H	T
CAJ/TAJ4482Y	134a	25.95	887	C/V	F			560	900	1240	1600	2278	3177	1900	22.5	F. G. H	T
CAJ/TAJ9518T	22	18.3	887	C/V	F	540	731	983	1232	1543	1901	2513	3284	2128	23	F. G. H	T
	507					545	750	978	1238	1562	1936	2501	3315	2174			
CAJ/TAJ4511A	12	32.7	887	C/V	F	595	835	1140	1495	1900	2330	3032	4000	2832	23	F. G. H	T
CAJ/TAJ4511Y	134a	32.7	887	C/V	F			857	1252	1682	2167	2804	4177	2523	23	F. G. H	T
CAJ/TAJ9513T	22	24.2	887	C/V	F	527	753	1074	1481	1968	2402	3239	4395	2720	23	F. G. H	T
	502					540	779	1113	1454	1878	2359	3187	4288	2877			
CAJ4511E	22	25.95	887	C/V	F			1230	1680	2170	2770	3632	4740	3089	21.5	F	
TAJ4517T	22	25.95	887	C/V	F			1230	1680	2170	2770	3632	4740	3089	21.5		T
	502							1360	1800	2265	2785	3680	4640	3150			

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R134a, 50Hz/LBP Application

Series	Model	Displacement	Motor Type	Compressor Cooling	Refrigerant Control	Oil Charge	Weight	"ASHRAE" Performance												"CECOMAF" Performance				
								Capacity						Power consumption						Capacity				
								Evaporating temp. (℃)						Evaporating temp. (℃)						Evaporating temp. (℃)				
								-30	-25	23.3	-20	-15	-10	-30	-25	23.3	-20	-15	-10	-30	-25	-20	-15	-10
		cc				cc	kg(lb)	kcal/h	kcal/h	kcal/h	kcal/h	kcal/h	kcal/h	w	w	w	w	w	w	kcal/h	kcal/h	kcal/h	kcal/h	kcal/h
VS	VS24L	2.12	RSIR	N	C	200	4.8 (10.6)	–	39	43	54	73	94	–	76	78	83	92	100	–	31	43	59	76
	VS28L	2.84	RSIR	N	C	200	5.8 (12.8)	–	48	55	67	92	120	–	78	80	86	95	104	–	39	54	75	97
	VS36L	3.58	RSIR	N	C	200	5.8 (12.8)	–	67	72	88	115	146	–	89	93	100	112	125	–	54	72	93	119
NR	NR45L	4.50	RSIR	N	C	210	8.5 (18.7)	59	84	93	114	146	189	87	100	104	114	126	143	49	67	90	117	149
	NR52L	5.20	RSIR	N	C	210	8.5 (18.7)	75	101	113	135	173	220	98	112	119	128	146	164	61	82	108	140	179
	NR62L	6.22	RSIR	N	C	210	8.8 (19.4)	87	122	134	163	209	267	108	128	132	148	167	190	69	99	131	166	215
V	V75L	7.46	RSIR	F, O	C	390	10.2 (22.5)	110	152	167	204	262	334	127	150	157	172	193	224	87	123	162	212	269

1) Performance data were obtained under 230V/50Hz running condition.
2) The High Efficiency models "RSCR" can be also available with permanent run capacitor
3) Refrigerant Control : C (Capiliary tube)
4) Voltage range : 187V~264V

Compressor Cooling

N = Natural Convection
O = Oil Cooling
F = Fan Cooling

Test Conditions

	ASHRAE	CECOMAF
Condensing temperature	54.4℃ (130°F)	55℃ (131°F)
Gas superheated to	32.2℃ (90°F)	32℃ (90°F)
Liquid subcooled to	32.2℃ (90°F)	55℃ (131°F)
Ambient temperature	32.2℃ (90°F)	32℃ (90°F)

Notes

1) Capacity Conversion
   1kcal/h = 3.97 Btu/h
   1kcal/h = 1.16 Watt
2) E.E.R(Btu/Wh) = $\frac{\text{Capacity (kcal/h)} \times 3.97}{\text{Motor Input(Watt)}}$
3) RSIR = Resistance Start Induction Run
   RSCR = Resistance Start Capacitor Run

TITLE	PERFORMANCE DATA
DWG. NO.	PER-HF5A