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تاریخ : ....
شماره : ....
پیوست: ....

MINA
MINAVAND REFRIGERATIONS
میناوند
شرکت کارخانجات یخچال و فریزر میناوند

Final Report

UNIDO Contract 2000/038P

Project Number MP/IRA/99/163

July 2000

آدرس : تهران، خیابان ولیعصر، میدان ونک، خیابان ونک، برج آئینه، طبقه ششم، شماره ۶۰۱
تلفن : ۲ - ۸۷۸۶۴۴۱ فاکس : ۸۷۸۶۴۴۳

Summery

We are glad to send you herewith our report concerning implementation of making three prototypes we have made and test successfully these prototypes and we tested them at our hot chamber to ensure safe and comprehensive operation to fulfill the standards designated for domestic and commercial refrigerators.

In this report we give you a brief definition of the project which is implementing at our factory by UNIDO, we also describe our major activities in this regard which mainly focused on training our technical staff, supplying material for making prototypes, redesign of our original design to fulfill new criteria, drafting for converted design, component selection and testing prototypes to ensure proper function of refrigeration system.

Aim of the Project as Stated in Terms of Reference

The *aim of the immediate* project is to;

a) Design, calculation and drafting for model redefinition.
b) Testing prototypes for functionality and performance criteria.
c) Redesign the cooling units of the all models so that they could run on the new Ozone friendly R134a instead of the ODP active CFC12.

Scope of the Contract

A study will be made for 5 models of commercial refrigerators made by Ghandil Co. to specify;

a) Dimensional specification;
b) Type and thickness of insulation
c) Refrigeration unit component details
d) Working performance
e) Energy consumption

f) Selection of HFC 134a compatible components
g) Redesign of the refrigeration circuit as necessary

h) Specifying necessary changes in the cooling system if required
i) Preparation of the trial equipment one prototype per model
j) Testing of prototypes for functionality and performance
k) Evaluation of the test results

Supply of the Material

Following components and material have been used to make prototypes .

a) R134a Compressors
b) R134a Refrigerant
c) Refrigerant Accumulators
d) Specially designed filter drier
e) Specially designed evaporator and condenser

Activities

Please see below our activities

a) Site survey of the counterpart premises in order to be familiar with the counterpart facility and production line and also define the prototypes for conversion.
b) Site survey of the counterpart premises in order to collect necessary data for calculation of prototype.
c) Preparation of Technical data sheet in order to define detail technical specification
d) Review the existing technical drawing for the purpose of assessment of possible changes in the design criteria.
e) Review each prototype refrigeration circuit for determination of cooling circuit components
f) Review and assessment of design criteria following cooling circuit component in order to minimize possible changes and design improvement.

- Compressor technical specification
- Condenser type, material and design criteria
- Evaporator type, material and design criteria
- Capillary tube design, dimensions and material
- Filter drier, size and material

- Determination of R12 refrigerant charge for each prototype in order to adjust R134a charge weight

a) Coordination with the counterparts for performing, performance test after completion of making prototypes
b) Calculation of prototypes in order to determine the size of R134a compressor and implement necessary changes to the cooling circuits
c) Preparation of Performance Test Results Sheet, in order to record all data obtained during functional test.

Preparation of prototypes for performance test as

The prototypes shall be tested under designated ambient temperature mostly at
+ 32 C, the test performance revealed that no significant changes is necessary for refrigeration system circuit, because the original size of evaporator and condensers are much bigger than cooling requirements.

The adjustment will be applied to the mainly to the amount of refrigerant charge and length of capillary tube.

Each prototypes should under go for performance test at the following test criteria.

Pull down test at + 32 C

Continues run Test at = 32 C ambient temperature

Cyclic run test at + 32 C ambient temperature.

The test condition was selected in accordance with appropriate ISO test standards.

The material as sample for making prototypes are supplied mainly from local market, due to the limitation for purchasing R134a compressor from local market we had to contact several manufacturers to find out the technical specification for appropriate compressor.

The prices for material specially R134a and R141b blended polyol are much higher than R12 and R11,

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Training

Before making prototypes we conducted a training course to train the technical staffs to make their own prototypes and also make them familiar with the new technology.

The following topics were thought during the theatrical training course.

- An orientation to UNIDO CFC phases out project.

1. Montreal Protocol
2. Ozone Layer and CFC side effect to Ozone layer
3. Familiarization with new R134a Refrigerant, application, safety precaution, use and maintenance.
4. Familiarization with the new vacuum and charging equipment, vacuum pump and charging board.
5. Recovery and recycling of R12 refrigerant, and also R134a.
6. Alternative for R11 and R12.
7. Some explanation about R141b blowing agent,
8. Selection of refrigeration components to be replaced with R12 refrigeration system.
9. Calculation and redesign of prototypes
10. Performance test
11. Test results Evaluation.
12. Refrigeration system adjustment.
13. Selecting Prototype Model

14. Refrigeration System components Familiarization
15. Heat Load Calculation
16. Thermostat Selection and Adjustment
17. Refrigerant Charging Methods
18. Testing Prototypes
19. Analyzing Prototype Test Results

Following subjects were taught during conduction of the course

Refrigeration Load Calculation for different type of Water Coolers

Water cooler cabinet usually consist of a sheet metal housing built around a steel framework, inside this sheet housing there is usually a condensing unit, located near the floor, and above this is the water-cooling mechanism. The latter is the only part insulated (foamed plastic) from the room. The insulation is usually specially formed and between one and one half inches and two inches thick. These cabinets are made in such a way that one or more sides may be easily removed to gain access to the interior. The basin of the water cooler is generally made of porcelain-coated cast iron, porcelain coated - steel, or stainless steel. Heat exchangers are frequently used on water coolers. These make use of the low temperature of waste water and the suction line to pre-cool the fresh water line to the evaporator coil.

Self-cooler are of two types,

1- Bottle Type.
2- Tap water type

The bottle cooler usually uses a 20 to 25 liter bottle of water inverted on the top of the cabinet. Overflow and drain water are stored in a container built the cabinet. These coolers use air-cooled condensing units exclusively. They are used where water and drains are not available or where available the plumbing insulation may be expensive.

Water cooler using a plumbing supply and drain connection, must be installed according the relevant approved standards. The plumbing should be concealed, a hand shutoff valve should be installed in the fresh water line. Drain pipe at least 1 inches in diameter provided, and rubber opening must be above the drain in such a way as to eliminate the chance for accidental siphoning of the drain water back into the fresh water system. The tap water models use variety of evaporator coil wrapped around the water-cooling tank.

Temperatures of the cooling water are variable depending on the persons who
are drinking the water. We consider 10 C for the temperature of drinking water, while our inlet temperature is considered 24 C.

In large business establishment, in office buildings, or in factories, multiple water cooler, instead of individual ones, are popular. These

coolers have one large condensing unit supplying many bubbles and these may be of many different types.

Water cooler is a device that usually is used in the public area to supply cold drinking water to the customers and different people. The appliance is mainly used in
the Airports, Railways Station, Coach Terminals, Banks, Offices, Parks, and etc. therefore, it is hard to specify an standard for cold water consumption during the day from the water cooler.

We consider three refrigeration load components that should be taken into our consideration.

Heat gain by heat transmission from, main water storage tank wall insulation.

Heat removed from water entering to the water tank at the initial refrigeration system operating condition, (water stored in storage tank during the night, with normal ambient temperature) which is divided by 24 hrs.

Heat removed from Drinking Water flow that are consumed during designated operating hours "$\dot{M}$ "

The problem of determining the refrigeration load of a water-cooled installation is basically a specific heat and heat leakage problem combination. The water is cooled to temperature which vary upward from about 4 degree centigrade , and the amount heat removed from the water to cool it to a predetermined temperature is simple specific heat problem. The water, being maintained at these low temperature,

results in a heat leakage from room into the water, and this part involves the heat leakage portion of installation.

$Q1 = m\ C\ \Delta T$, Where:

Q1 Total heat removed from total drinking water tank volume capacity (lit.) during specific period, related to compressor cooling capacity power in Watts, at initial compressor start up, and early in the morning. When the water temperature is 30 C.

m total weight of water in the water cooler storage tank in Kg. Considering that one litter of water at 24 C is equal to approximately one Kg.

C Specific heat factor of water in Kcal/Kg °C

ΔT Temperature difference (Ti–Tc), where, Ti is inlet water temperature, and Tc is final cooled water.

$$Q2 = \dot{M}\ C\ \Delta T$$

Q2 Total heat removed from total drinking water flow (lit.) during specific period, 16 hours. In Kcal.

$\dot{M}$ total weight of water flow during 16 hours. in Kg.

C Specific heat factor of water in Kcal/Kg °C

T Temperature difference (Ti–Tc), where, Ti is inlet water temperature, and Tc is final cooled water temperature.

$$\mathbf{Q3 = UA\ \Delta T}$$

Where:

Q3 Total Leak, gained through side wall of drinking water storage tank by conduction in Kcal..

U Heat Resistance Coefficient Factor in Kcal/Sq. mt. C

A Total Area which heat is transmitted by. In Sq. Mt.

ΔT Temperature difference (Ta – Tc), where, T is ambient temperature, and Tc is final cooled water temperature.

Refrigeration Load Calculation for different type of Domestic and Commercial Appliances

Refrigeration load consist of four individual components:

1- Transmission load;
Heat transfer through walls (sides, back panels, top and bottom) and door panel.

2 - Product load;
Heat Removed from and produced by the products which are brought and stored in the refrigerator;

3 - Internal load;
Heat produced by internal sources such as lights, fan or heaters;

4 - Infiltration load
Heat gains associated with air entering the refrigerated space;

The above mentioned components will be discussed separately to analyze and extract the most useful and practical equipment.

Transmission Load

Heat gain through walls of a refrigerated space depend on cabin Temperature, liner, insulation and cabin conductivity and also the surrounded ambient air. In other word, there are four different resistance opposing heat flow between cabin space and ambient air as given in resistance circuit.

Considering the above mentioned resistance, Rl, Rc and Ra are not comparable in magnitude with Ri (Insulation resistance) and so can be neglected in our calculations. Therefore, the resultant circuit and relevant equations are.

$R = \frac{x}{KA}$ Heat Resistance

$Q_{TL} = \frac{\Delta T}{R}$ Heat Transfer

Where:

x = Insulation Thickness, mm

K = Insulation Conductivity, $Wmm/m^2 \cdot C$

A = Outside Area, m^2

$\Delta T =$ Temperature difference (Ta - Tc), C

If the insulation thickness of side walls, back panels, top, bottom and door are different, heat transfer for each part can be calculated separately and then summed for two door refrigerators, due to different cabin temperature of freezer and refrigerator compartments, heat transfer for each compartment should be calculated separately and then added together.

Product Load

Heat removed from products (meat, fruits, vegetables, water and etc.) to reduce temperature from receiving to storage temperature is known as product load. Following steps can be taken to calculated of product loads.

1 - Heat removed from initial temperature (Ti) to storing temperature (Trs) in refrigerator compartment is;

Qrs = $\dot{M}$ C (Ti - Trs)

Where:

$\dot{M}$ = Mass of product, Kg / h

C = Specific heat of product, Kcal / Kg

2 - Heat removed from intial temperature (Ti) to freezing temperature (Tf) is ;

$$Qaf = \dot{M}\ C\ (Ti - Tf)$$

Where :

$\dot{M}$ = Mass of product, Kg / h

C = Specific heat of product above freezing point, Kcal / Kg

3 - Latent heat of fusion for products is equal to;

$$QL = \dot{M}\ h$$

Where h = Latent heat of product, Kcal / Kg

4 - Heat removed from freezing temperature (Tf) to final storage temperature (Tfs) is;

$$Q\ bf = \dot{M}\ Cbf\ \ (T f - Tfs)$$

Where: Cbf = Specific heat of products below freezing temperature.

For upright freezers or freezer compartment of refrigerators, total product load is

$$Qpl = Qaf + Ql + Qbf$$

For storage products to some lower temperatures above freezing temperature in refrigerator compartment is;

$$Qpl = Qrs$$

Internal Load

Electrical energy dissipated in the refrigerated space such as lights, fan motors, heaters, ... are included in the internal heat load.

Due to the little amount of consumption of lighting, the effect of lighting can be negligible and only electrical

heaters of two door refrigerators or fan motors (if exist) are considered in our load calculation.

Infiltration Load

Infiltration air load is the heat transfer due to exchanging of refrigerated air with ambient caused by opening of the door or leakage through the gasket area. Infiltration load is one of the most important load components and roughly it is about 20 % of total refrigeration load.

Total Refrigeration load

As it was mentioned before, transmission load (Qtl), product load (Qpl) and internal load (Q il) can be calculated separately. For infiltration load (air exchange through doorways or gasket leakage), we can take into account from 10 to 25% of sum of the above mentioned components, (transmission load, product load and internal load). Therefore total refrigeration load can be expressed as:

$$QTL = 1.25\ (QTL + QPL + QIL)$$

As per **ASHREA** standard we can use following formula which is depended directly to the number of air change per day and internal volume of the appliance.

$$Q = (V \times N \times H) \div 86400$$

Where;

Q = Heat Load due to the Air Change
V = Appliance Internal Volume
H = Heat removed from cubic meter of air = 75000 jul/sec

Equipment Selection

Calculation of refrigeration load is the basis for selecting system equipment. First step is selection of a suitable compressor with cooling capacity comparable to calculated load, then a capillary tube should be selected so that the compressor and tube fix a balance point at the desired evaporating temperature, also two evaporator

and condenser should be selected to balance compressor capacity.

Compressor selection

Assuming 16 hours daily operating time for the compressor, the calculated refrigeration load will be modified to:

$$Qc = \frac{Q_{TL \times 24}}{16} = 1.5Q_{TL}$$

Where :

Qc = required cooling capacity

For selection of compressor from manufacturer's catalogue, we have to mention appropriate evaporating temperature;

- In refrigerators with ice compartment mounted inside, maximum evaporating temperature can be selected in order to have - 12 C (Two Stars) *inside ice compartment.*

- For upright freezers or freezer compartment of two door refrigerators, evaporating temperature should be in order to obtain -18 C (Three Stars) cabin temperature.

Capillary tube

Capillary tube is one of the most important components in refrigerator circuits . capillary acts as a pressure reducing device to meter the flow of refrigerant to the low pressure side (evaporator) of the system. In other word, capillary tube should be capable to pass refrigerant pumped by the compressor and feed it to evaporator at available load and demand conditions.

On the contrary of the R12 or R22 refrigerants, practical equations, charts or graphs are not available for calculation of capillary size in R134a refrigeration circuits. Comparing saturation properties of R134a with R12 at a certain temperature, R134a pressure is less than R12, therefore, capillary tube for R134a shall be adjusted at low evaporating temperatures in comparison with R12 system. The capillary for R134a refrigeration system must have an increase resistance which can be estimated about 10 - 15% increase in length for a definite bore. However the exact size (bore and length)

can be attainable after laboratory performance tests.

Condenser & Evaporator

The statically cooled condenser is designed for use in small refrigeration appliance with sufficient space for the necessary condenser area. These condensers are manufactured either in tube-on-finned plate type or wire-on-tube design. Assuming that compressor casing and tubing will dissipate 80% of the heat equivalent of electrical in put, the condenser should be capable to reject heat absorbed by the refrigerant in the evaporator plus 20% of compressor power input heat equivalent.

The evaporator should balance the selected compressor capacity, not the original calculated load. Most of the refrigerators mainly employ aluminum evaporators produced on the roll-bond principal, where wire-on tube evaporators are usually installed in upright freezers.

Due to the higher latent heat (hfg) of R134a in comparison with R12 and therefore less refrigerant charge in the system, it seems that evaporators and condensers used for R12 are also suitable for R134a refrigeration system. However more detailed information about role of these two components in the system would be cleared after laboratory performance tests. Therefore partial modifications should be done if needed.

Refrigerant charge

As mentioned in previous sections, R134a latent heat of vaporization is about 28-30% higher than R12 in temperature range -30 C up to + 10 C. Table 2-2 shows thermodynamics saturation properties (with respect to a certain temperature) for these two refrigerants. In practice, charging amount of R134a can be 10-15% less than R12 with the same refrigeration load.

R134a is capable to absorb more humidity of the oil in comparison with R12. Therefore, the filter drier selected for R134a should be a drier with 3A desiccant with 20% more molecular sieve (by weight) in comparison with conventional types.

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Development of Prototype at Minavand Refrigeration Company Iran

PROJECT NO. MP/IRA/99/163

Contract Number 2000/038P
First Progress Report

Please Find attached our First Progress report which shows the calculation of refrigeration load of three models, Freezer Model KS12B2,Refrigerator and Freezer Model KS12Bh, and Refrigerator Model KS12B4, the calculation was bade based on technical specification of these three models which should be converted to Ozone friendly Refrigerant R134a. the redesign for improvement of models will be done after close supervision of our engineers and the main aim of the programme will be training our staff in order to be familiar with new refrigerant characteristic and behavior.

This report was prepared based on the contract duly signed with UNIDO to convert Minavand Production line to use new refrigerant and phase out CFC-12.

The main activities up to now are focused on data gathering for redesign of the new prototypes, checking Iranian market for availability of material for probable changes and modifications, also test critera is of importance of project implementation that

we are planning to achieve the test of prototypes. As well as

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these activities we will start very soon to train the technical staff. A comprehensive training program should be prepared, the topic and head line of the training will be presented in our next progress report.

Minavand company will purchase the R134a Compressors as samples to test on the prototypes. We will try to do minimum modification to the refrigeration system circuits, but the problem at this time is that due to the lack of refrigerant charging board we can not charge proper amount of refrigerant into the refrigeration system, therefore we have to wait until we receive the refrigerant charger equipment which have been ordered by UNIDO.

It is highly appreciated if UNIDO can expedite shipment of the said equipment to Iran for continuation of the CFC phase out project in a timely manner.

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Refrigeration Load Calculation *Heat Leaks Through Walls* $Q = U \cdot A \cdot \Delta T$ *Minavand Freezer Model KS12B2*									
Description	Dim.	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness cm.	K Thermal Conductivity Watt/Mt.K	U Coeff. Heat Resistance Watt/Sq. Mt.K	Q U . A . ΔT *Watt*
Side Walls	2x60x150	1.8	32	-18	50	5	0.0175	0.35	31.5
Door	60x150	0.9	32	-18	50	5	0.0175	0.35	15.75
Back Panel	60x150	0.9	47	-18	65	5	0.0175	0.35	20.5
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Total									80.35

Product Load Calculation
Minavand Freezer Model KS12B2

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m.\,C_2.\,\Delta T$	Q_3 $M.\,h$
ICE	5	4180	1650	333	24	-18	42	5.8	1.7	19.3

Total $= Q_1 + Q_2 + Q_3 = Q_1 = [(5x24x4180)/86400 = 5.8, \quad Q_2 = (5x18x1650)/86400 = 1.7$
$Q_3 == (5x333000)/86400 = 19.3] = 5.8 + 1.7 + 19.3 = 29.8$

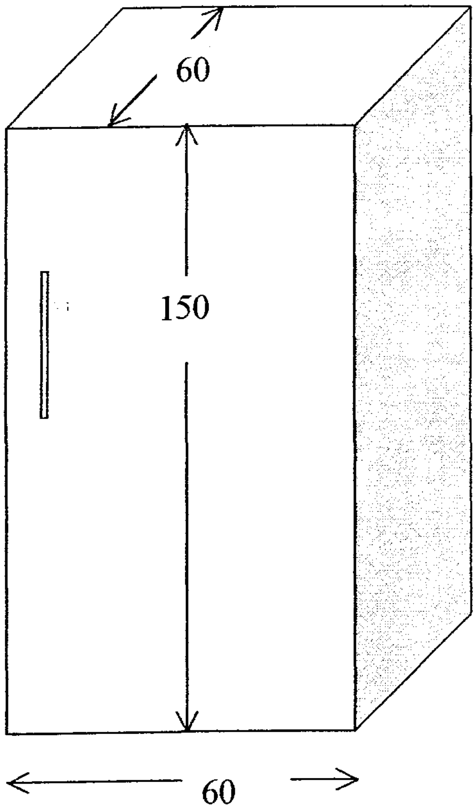
Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT *U=0.07* *L = 4.2 Mt.* ΔT*=50*	Electrometer	Florescent Lamp	Total
(0.253x20x75000x)86400=4.4	14.7	N/A	N/A	19.1

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
80.35	29.8	19.1	12.9	142

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 142 Watts. This cooling capacity is able to make 5 Kg. Ice in 24 Hr.



Freezer
Minavand KS12B2

Refrigeration Load Calculation *Heat Leaks Through Walls* $Q = U . A . \Delta T$ *Minavand Ref. Freezer Model KS12BH*									
Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q U . A . ΔT *Watt*
Upper Side Walls	2x45x60	0.54	32	-18	50	5	0.0175	0.35	9.45
Lower Side Walls	2x140x60	1.68	32	+4	28	5	0..0175	0.35	16.5
Upper Door	60x45	0.27	32	-18	50	5	0.0175	0.35	4.7
Lower Door	60x140	0.84	32	+4	28	5	0.0175	0.35	14.7
Upper back Panel	45x 60	0.27	47	-18	65	5	0.0175	0.35	7.9
Lower Back Panel	140x60	0.84	47	+4	43	5	0.0175	0.35	12.6
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	+4	28	5	0.0175	0.35	3.5
Total									75.7

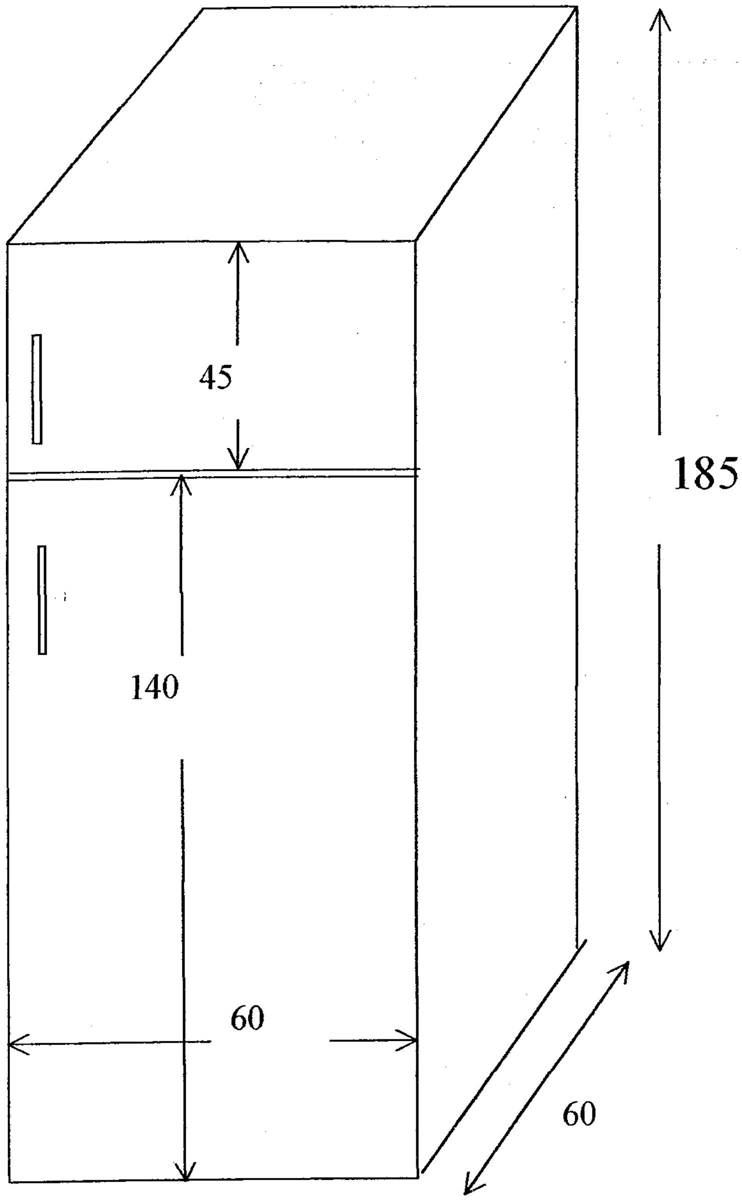
Product Load Calculation Minavand Ref.- Freezer Model KS12BH										
Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\ C_1\ \Delta T$	Q_2 $m\ .\ C_2\ .\ \Delta T$	Q_3 $M\ .\ h$
ICE	10	4180	1650	333	24	-18	42	5.8	1.7	19.3

***Total** $= Q_1 + Q_2 + Q_3 = Q_1$ =[(10x24x4180)/86400=11.6, Q_2 =(10x118x1650)/86400=3.4*
Q_3==(10x333000)/86400=19.3]= 11.6 + 3.4 +38.6 = 59.6

Miscellanies Heat Load				
Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT $U=0.07$ $L_1 = 2.1$, $L_2=4$ $\Delta T_1=50$, $\Delta T_2=28$	Elec.	Florescent Lamp	Total
(0.337x20x75000x)86400=5.8	15.2	N/A	N/A	19.1

Total refrigeration Load				
Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
75.7	59.6	21	15.6	172

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 172 Watts. This cooling capacity is able to make 10 Kg. Ice in 24 Hr.



Refrigerator and Freezer
Minavand Model KS12BH

Refrigeration Load Calculation
Heat Leaks Through Walls
Q = U . A . ΔT
MinavandUpright Refrigerator Model KS12B4

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q U . A . ΔT *Watt*
Upper Side Walls	2x20x60	0.24	322	-18	50	5	0.0175	0.35	4.2
Lower Side Walls	2x130x60	1.56	32	+4	28	5	0..0175	0.35	15.8
Upper Door Side	20x60	0.12	32	+4	50	5	0.0175	0.35	2.1
Lower Door Side	130x60	0.78	32	+4	28	5	0.0175	0.35	7.6
Upper back Panel	20x60	0.12	47	-18	65	5	0.0175	0.35	2.7
Lower Back Panel	130x60	0.78	47	+4	43	5	0.0175	0.35	11.7
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	+4	28	5	0.0175	0.35	5.0
Total									55.4

Product Load Calculation
Minavand Refrigerator Model KS12B4

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	3	4180	1650	333	24	-18	42	5.8	1.7	19.3

Total $= Q_1 + Q_2 + Q_3 = Q_1$ ***=[(3x24x4180)/86400=3.5,*** Q_2 ***=(3x18x1650)/86400=1.3***
Q_3***==(3x333000)/86400=11.6]= 3.5+1.3 +11.6 = 16.4***

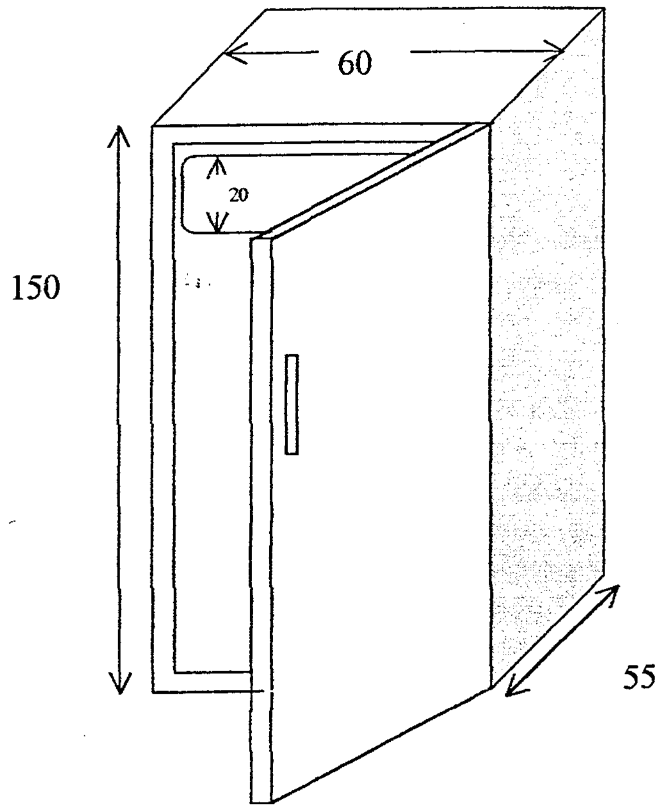
Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT ***U=0.07*** ***L = 4.2 Mt.*** ***ΔT=50***	Electrometer	Florescent Lamp	Total
(0.253x20x75000x)86400=4.4	14.7	N/A	N/A	19.1

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
54.4	16.4	19.1	9	99

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 99 Watts. This cooling capacity is able to make 3 Kg. Ice in 24 Hr.



Refrigerator
Minavand Model KS12B4

MINAVAND REFRIGERATIONS
میناوند
شرکت کارخانجات یخچال و فریزر میناوند

Development of Prototype at Minavand Refrigeration Company Iran

PROJECT NO. MP/IRA/99/163

Contract Number 2000/038P
First Progress Report

Please Find attached our First Progress report which shows the calculation of refrigeration load of three models, Freezer Model KS12B2,Refrigerator and Freezer Model KS12Bh, and Refrigerator Model KS12B4, the calculation was bade based on technical specification of these three models which should be converted to Ozone friendly Refrigerant R134a. the redesign for improvement of models will be done after close supervision of our engineers and the main aim of the programme will be training our staff in order to be familiar with new refrigerant characteristic and behavior.

This report was prepared based on the contract duly signed with UNIDO to convert Minavand Production line to use new refrigerant and phase out CFC-12.

The main activities up to now are focused on data gathering for redesign of the new prototypes, checking Iranian market for availability of material for probable changes and modifications, also test critera is of importance of project implementation that

we are planning to achieve the test of prototypes. As well as

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تلفن : ۲ - ۸۷۸۶۴۴۱ فاکس : ۸۷۸۶۴۴۳

these activities we will start very soon to train the technical staff. A comprehensive training program should be prepared, the topic and head line of the training will be presented in our next progress report.

Minavand company will purchase the R134a Compressors as samples to test on the prototypes. We will try to do minimum modification to the refrigeration system circuits, but the problem at this time is that due to the lack of refrigerant charging board we can not charge proper amount of refrigerant into the refrigeration system, therefore we have to wait until we receive the refrigerant charger equipment which have been ordered by UNIDO.

It is highly appreciated if UNIDO can expedite shipment of the said equipment to Iran for continuation of the CFC phase out project in a timely manner.

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تلفن : ۲ - ۸۷۸۶۴۴۱ فاکس : ۸۷۸۶۴۴۳

Refrigeration Load Calculation *Heat Leaks Through Walls* $Q = U \cdot A \cdot \Delta T$ *Minavand Freezer Model KS12B2*									
Description	Dim.	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness cm.	K Thermal Conductivity Watt/Mt.K	U Coeff. Heat Resistance Watt/Sq. Mt.K	Q $U \cdot A \cdot \Delta T$ *Watt*
Side Walls	2x60x150	1.8	32	-18	50	5	0.0175	0.35	31.5
Door	60x150	0.9	32	-18	50	5	0.0175	0.35	15.75
Back Panel	60x150	0.9	47	-18	65	5	0.0175	0.35	20.5
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Total									80.35

Product Load Calculation
Minavand Freezer Model KS12B2

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	5	4180	1650	333	24	-18	42	5.8	1.7	19.3

$Total = Q_1 + Q_2 + Q_3 = Q_1 = [(5x24x4180)/86400=5.8,\ \ Q_2 = (5x18x1650)/86400=1.7$

$Q_3 == (5x333000)/86400=19.3] = 5.8 + 1.7 + 19.3 = 29.8$

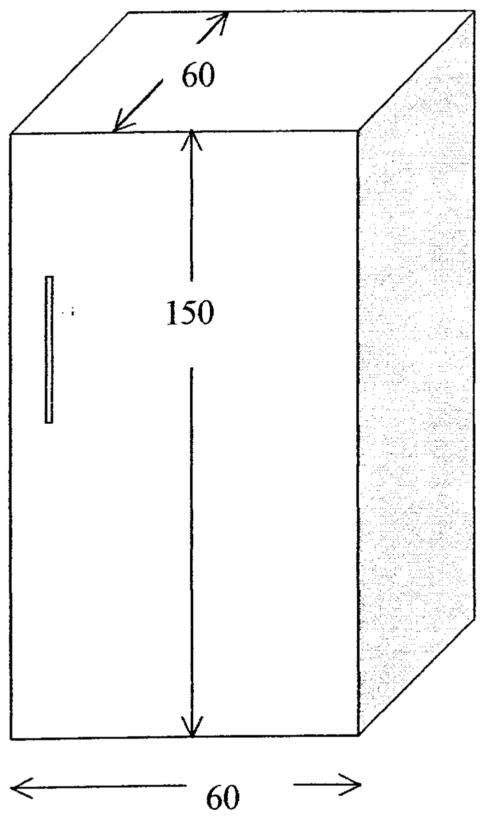
Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket $U\,.\,A.\,\Delta T$ *U=0.07* *L = 4.2 Mt.* ΔT*=50*	Electrometer	Florescent Lamp	Total
(0.253x20x75000x)86400=4.4	14.7	N/A	N/A	19.1

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
80.35	29.8	19.1	12.9	142

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 142 Watts. This cooling capacity is able to make 5 Kg. Ice in 24 Hr.



Freezer
Minavand KS12B2

Refrigeration Load Calculation
Heat Leaks Through Walls
Q = U . A . ΔT
Minavand Ref. Freezer Model KS12BH

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q U . A . ΔT *Watt*
Upper Side Walls	2x45x60	0.54	32	-18	50	5	0.0175	0.35	9.45
Lower Side Walls	2x140x60	1.68	32	+4	28	5	0..0175	0.35	16.5
Upper Door	60x45	0.27	32	-18	50	5	0.0175	0.35	4.7
Lower Door	60x140	0.84	32	+4	28	5	0.0175	0.35	14.7
Upper back Panel	45x 60	0.27	47	-18	65	5	0.0175	0.35	7.9
Lower Back Panel	140x60	0.84	47	+4	43	5	0.0175	0.35	12.6
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	+4	28	5	0.0175	0.35	3.5
Total									75.7

Product Load Calculation
Minavand Ref.- Freezer Model KS12BH

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Tem p. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	10	4180	1650	333	24	-18	42	5.8	1.7	19.3

Total $= Q_1 + Q_2 + Q_3 = Q_1$ ***=[(10x24x4180)/86400=11.6,*** Q_2 ***=(10x118x1650)/86400=3.4***

Q_3***==(10x333000)/86400=19.3]= 11.6 + 3.4 +38.6 = 59.6***

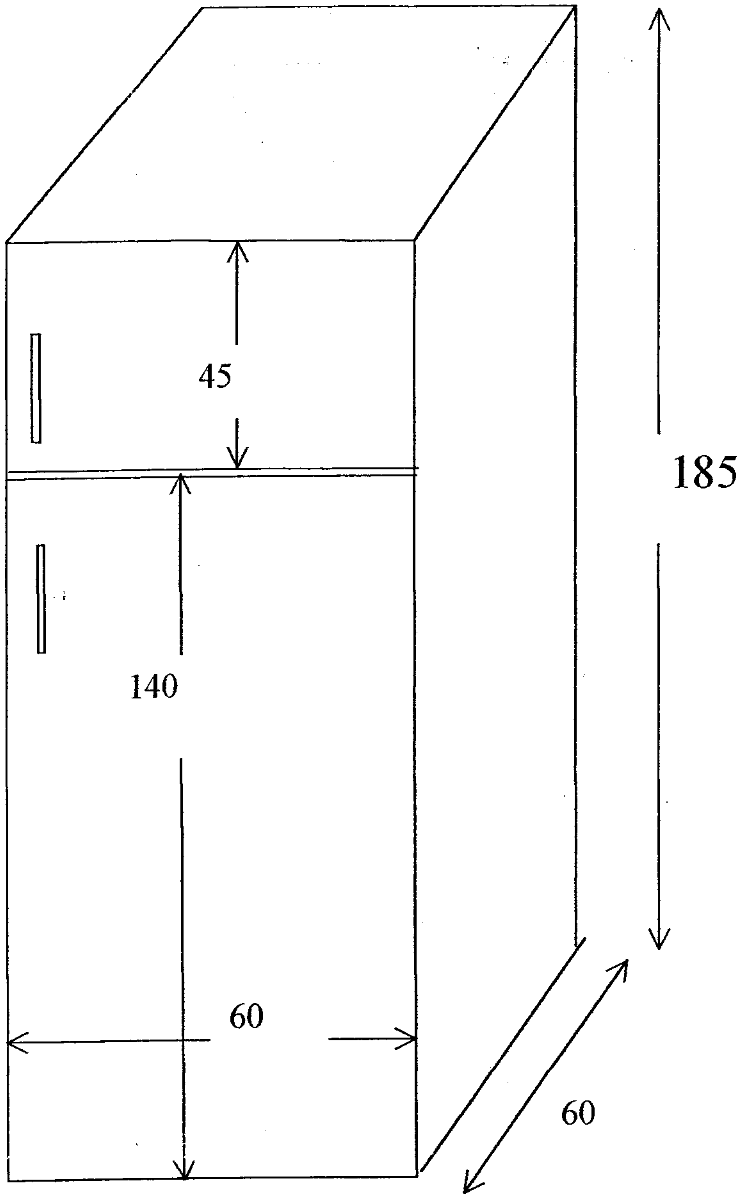
Miscellanies Heat Load

Air Change	Gasket	Elec.	Florescent Lamp	Total
Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	U . A. ΔT $U=0.07$ $L_1 = 2.1$, $L_2=4$ $\Delta T_1=50$, $\Delta T_2=28$			
(0.337x20x75000x)86400=5.8	15.2	N/A	N/A	19.1

Total refrigeration Load

Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
75.7	59.6	21	15.6	172

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 172 Watts. This cooling capacity is able to make 10 Kg. Ice in 24 Hr.



Refrigerator and Freezer
Minavand Model KS12BH

Refrigeration Load Calculation
Heat Leaks Through Walls
$$Q = U \,.\, A \,.\, \Delta T$$
MinavandUpright Refrigerator Model KS12B4

Description	Dimension	Surface Area Sq. Mt.	Ambient Temp. °C	Reference Inside Temp.	ΔT Temp. Diff.	X Insulation Thickness	K Thermal Conductivity	U Coeff. Heat Resistance	Q U . A . ΔT *Watt*
Upper Side Walls	2x20x60	0.24	322	-18	50	5	0.0175	0.35	4.2
Lower Side Walls	2x130x60	1.56	32	+4	28	5	0..0175	0.35	15.8
Upper Door Side	20x60	0.12	32	+4	50	5	0.0175	0.35	2.1
Lower Door Side	130x60	0.78	32	+4	28	5	0.0175	0.35	7.6
Upper back Panel	20x60	0.12	47	-18	65	5	0.0175	0.35	2.7
Lower Back Panel	130x60	0.78	47	+4	43	5	0.0175	0.35	11.7
Top surface	60x60	0.36	32	-18	50	5	0.0175	0.35	6.3
Bottom Surface	60x60	0.36	32	+4	28	5	0.0175	0.35	5.0
Total									55.4

Product Load Calculation
Minavand Refrigerator Model KS12B4

Product to be loaded	Product Mass Load Kg.	Product Specific heat Above Freezing Point J/Kg. K	Product Specific heat Below Freezing Point J/Kg. K	Latent Heat of Fusion J/Kg. K	Product Initial Temp	Product Final Temp.	Temp. Diff.	Q_1 $m\,C_1\,\Delta T$	Q_2 $m\,.\,C_2\,.\,\Delta T$	Q_3 $M\,.\,h$
ICE	3	4180	1650	333	24	-18	42	5.8	1.7	19.3

Total $= Q_1 + Q_2 + Q_3 = Q_1 = [(3x24x4180)/86400 = 3.5, \quad Q_2 = (3x18x1650)/86400 = 1.3$
$Q_3 = = (3x333000)/86400 = 11.6] = 3.5 + 1.3 + 11.6 = 16.4$

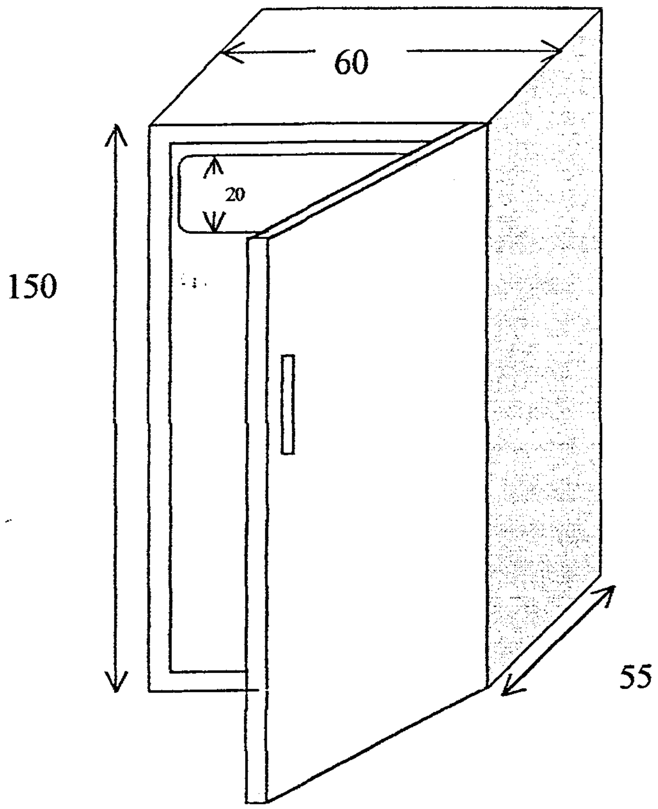
Miscellanies Heat Load

Air Change = V . N . H V = Refrigerator Internal Volume N = Number of Air Change per Day H = Heat removed from cubic meter of air = 75000 jul/sec.	Gasket U . A. ΔT ***U=0.07*** ***L = 4.2 Mt.*** ΔT***=50***	Electrometer	Florescent Lamp	Total
(0.253x20x75000x)86400=4;4	14.7	N/A	N/A	19.1

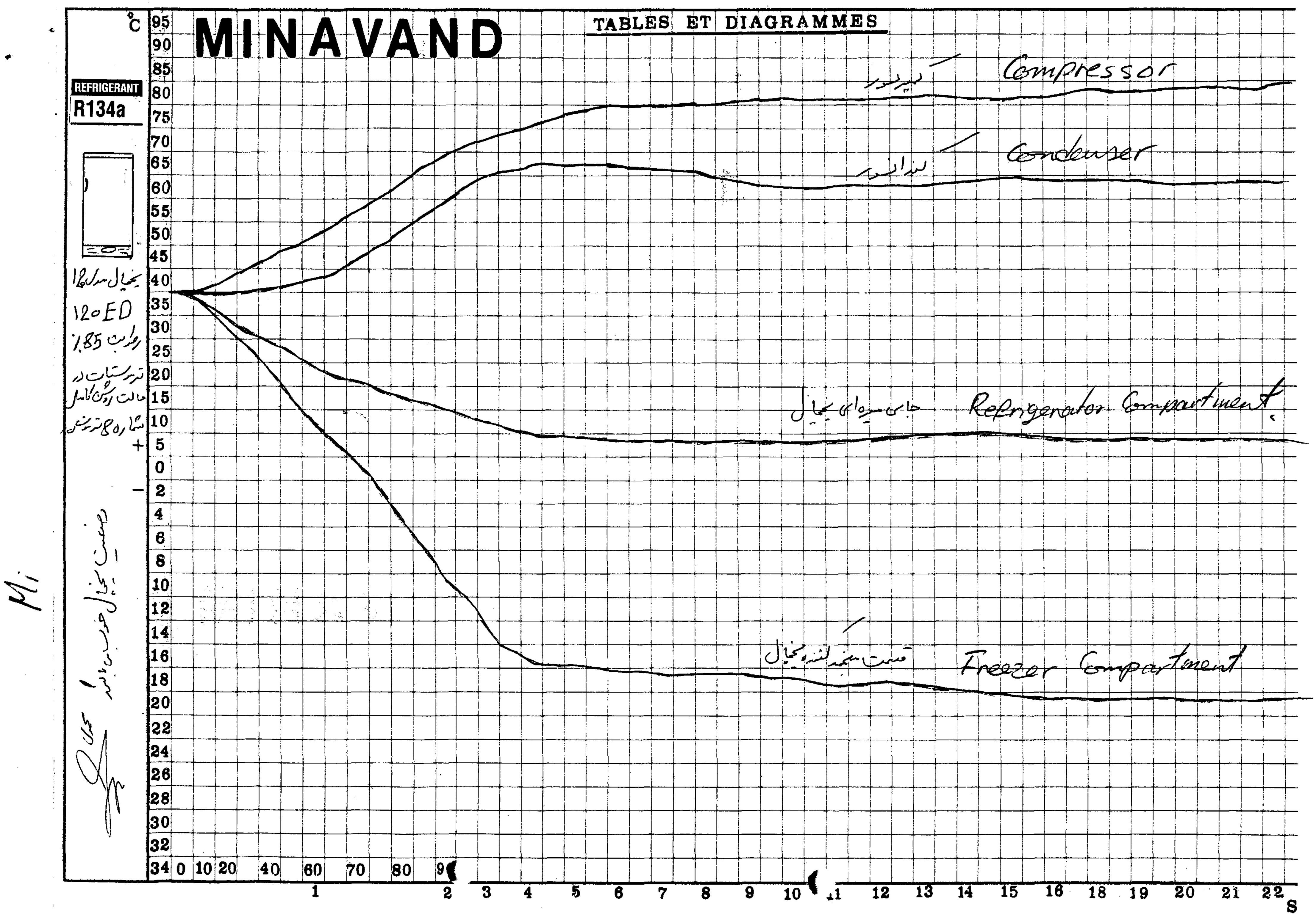
Total refrigeration Load

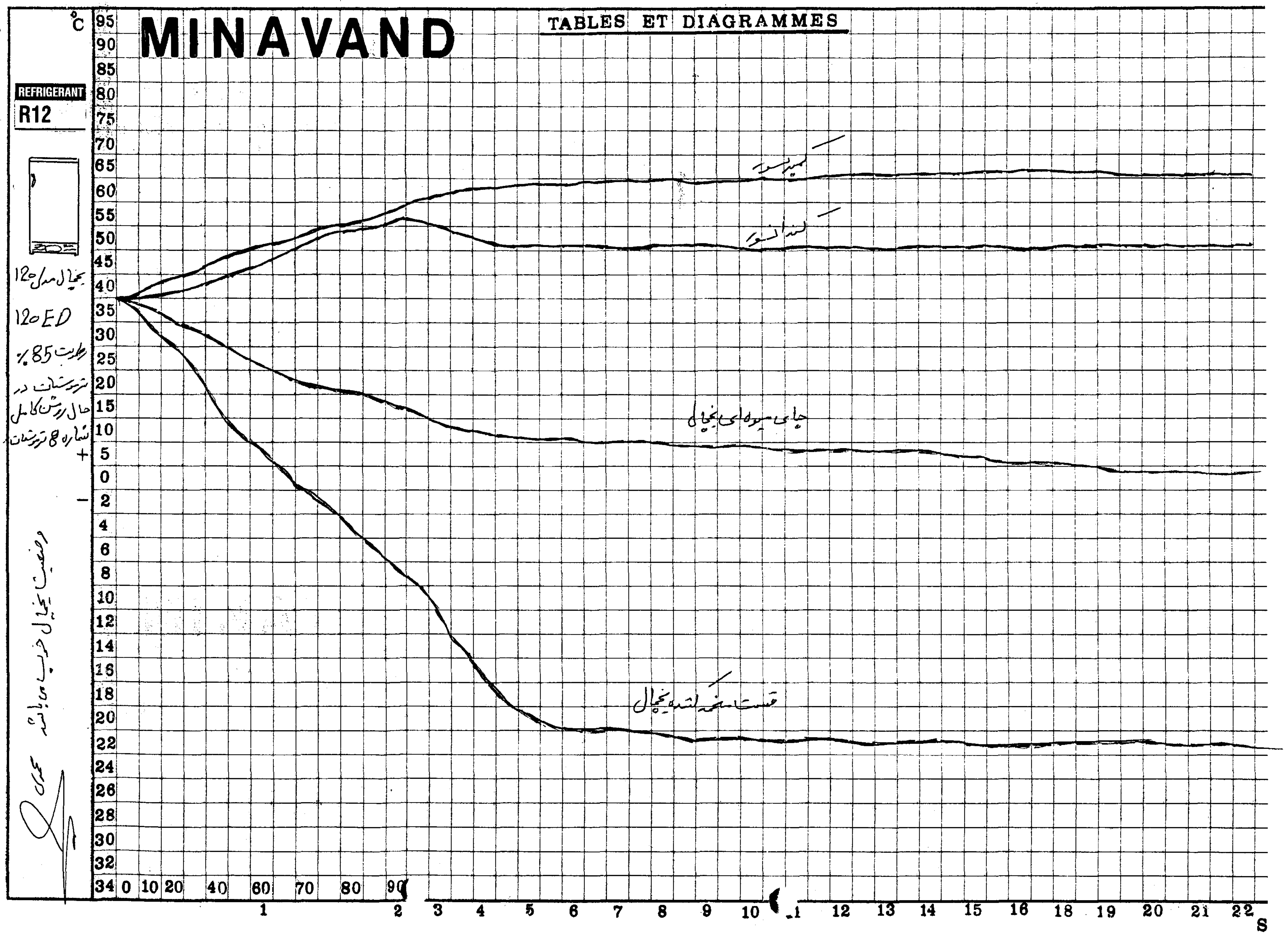
Heal Leaks Through Walls	Product Load	Miscellanies Load	Safety Factors	Grand Total
54.4	16.4	19.1	9	99

The suitable compressor with respect to the Manufacture designated C.O.P. of compressor should comply with required cooling capacity which is 99 Watts. This cooling capacity is able to make 3 Kg. Ice in 24 Hr.

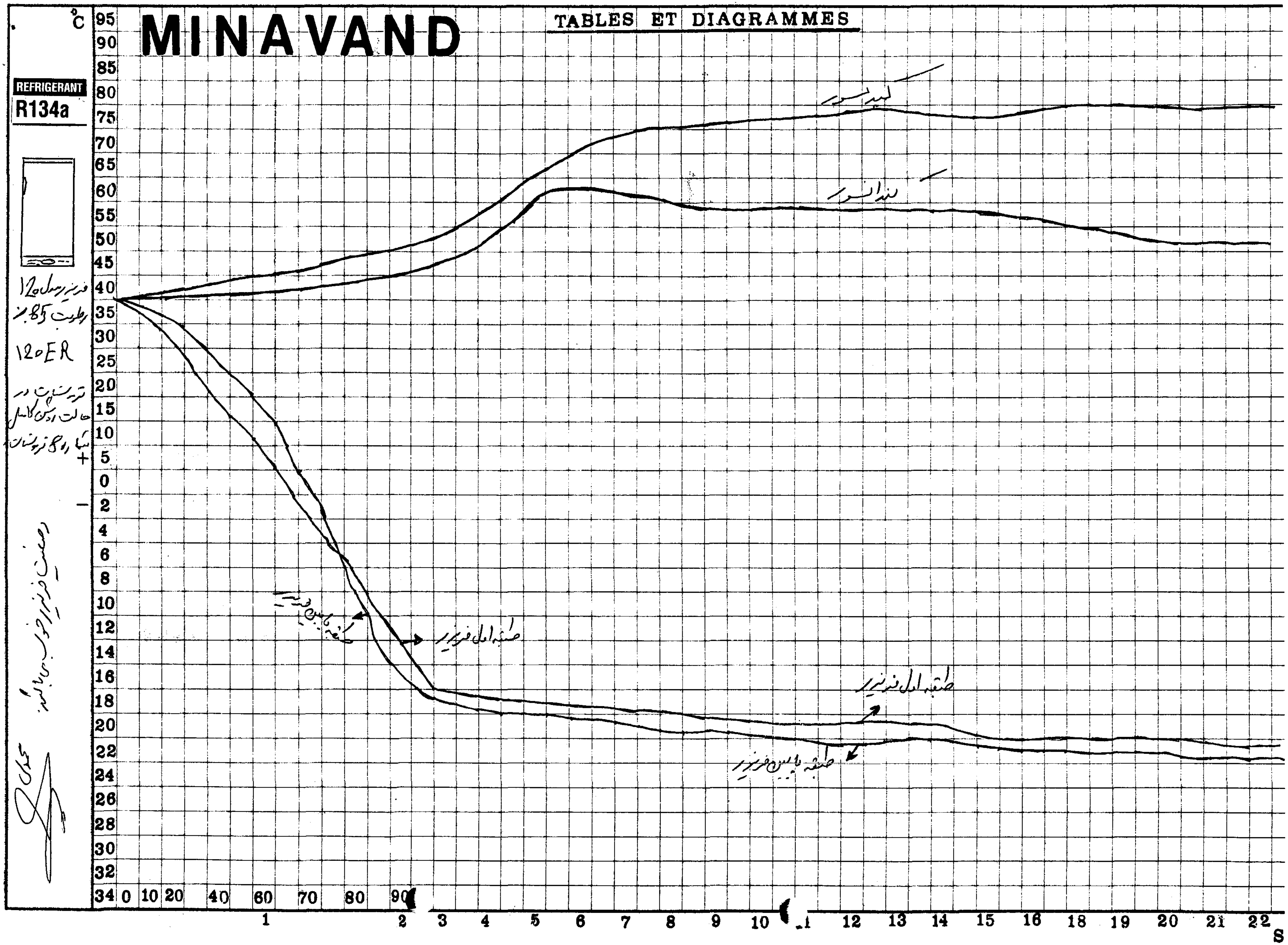


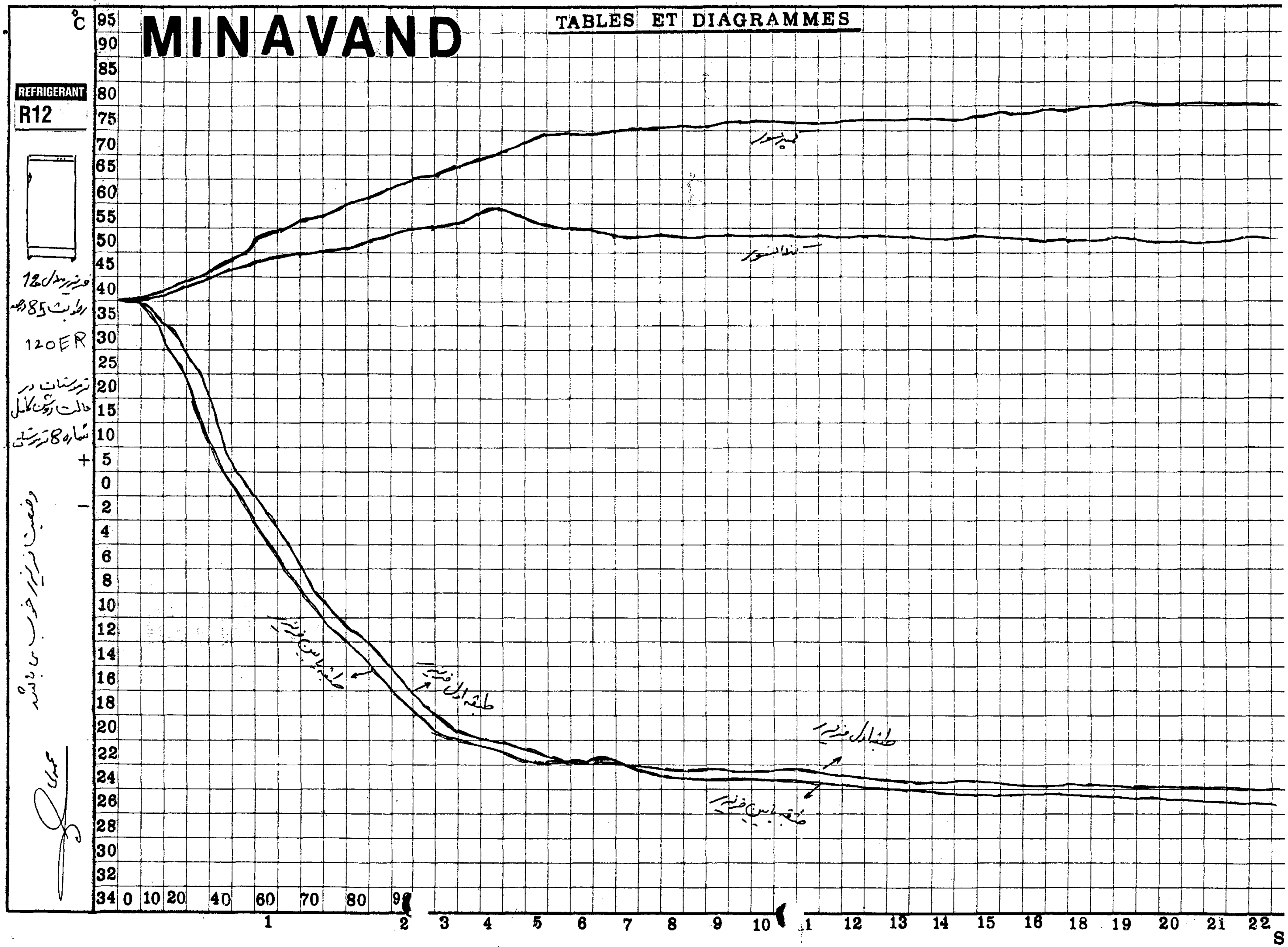
Refrigerator
Minavand Model KS12B4


MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R134a
°C
Compressor
Condenser
Refrigerator Compartment
Freezer Compartment
قسمت منجمد کننده یخچال
120ED
رطوبت 85%
S

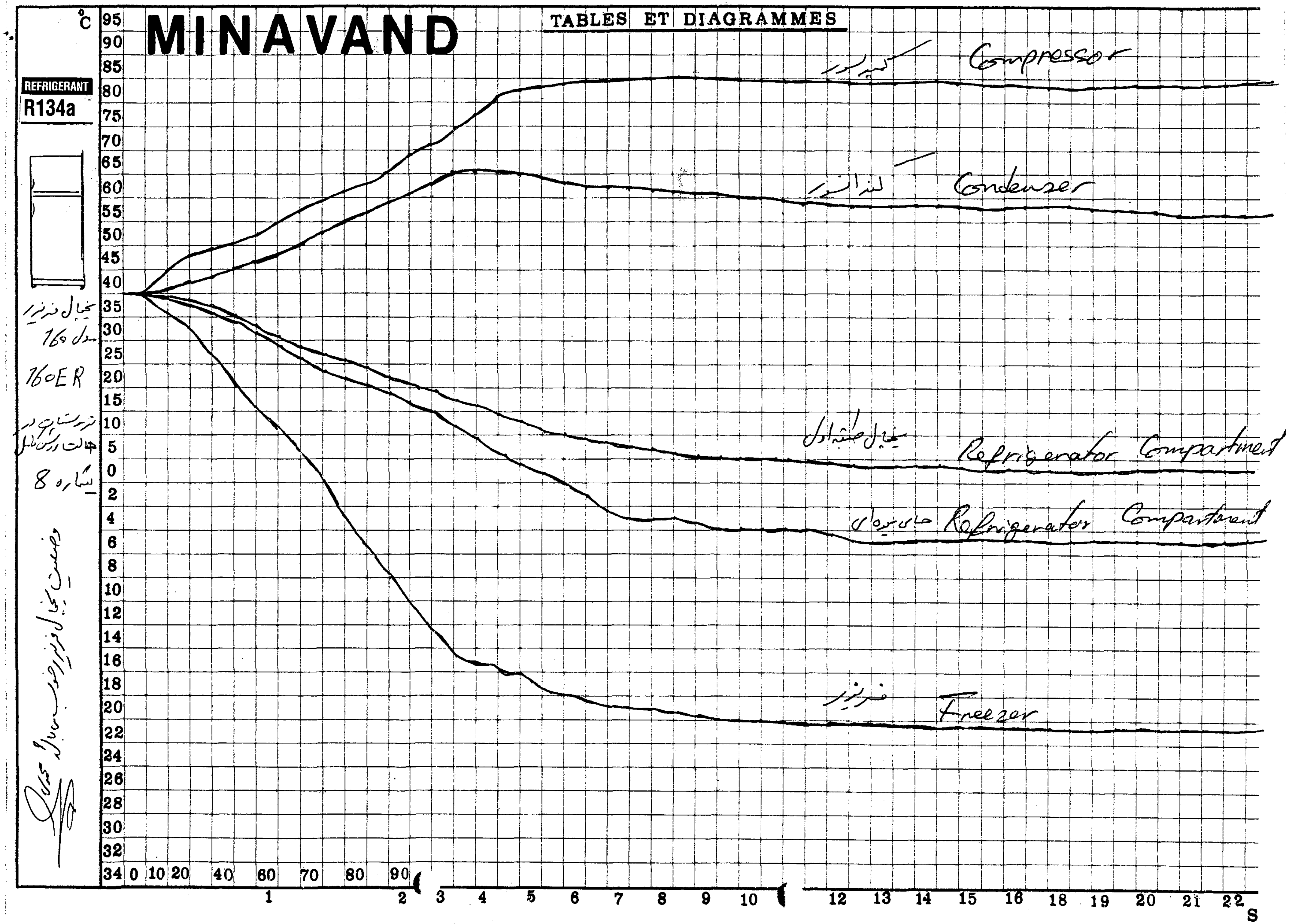


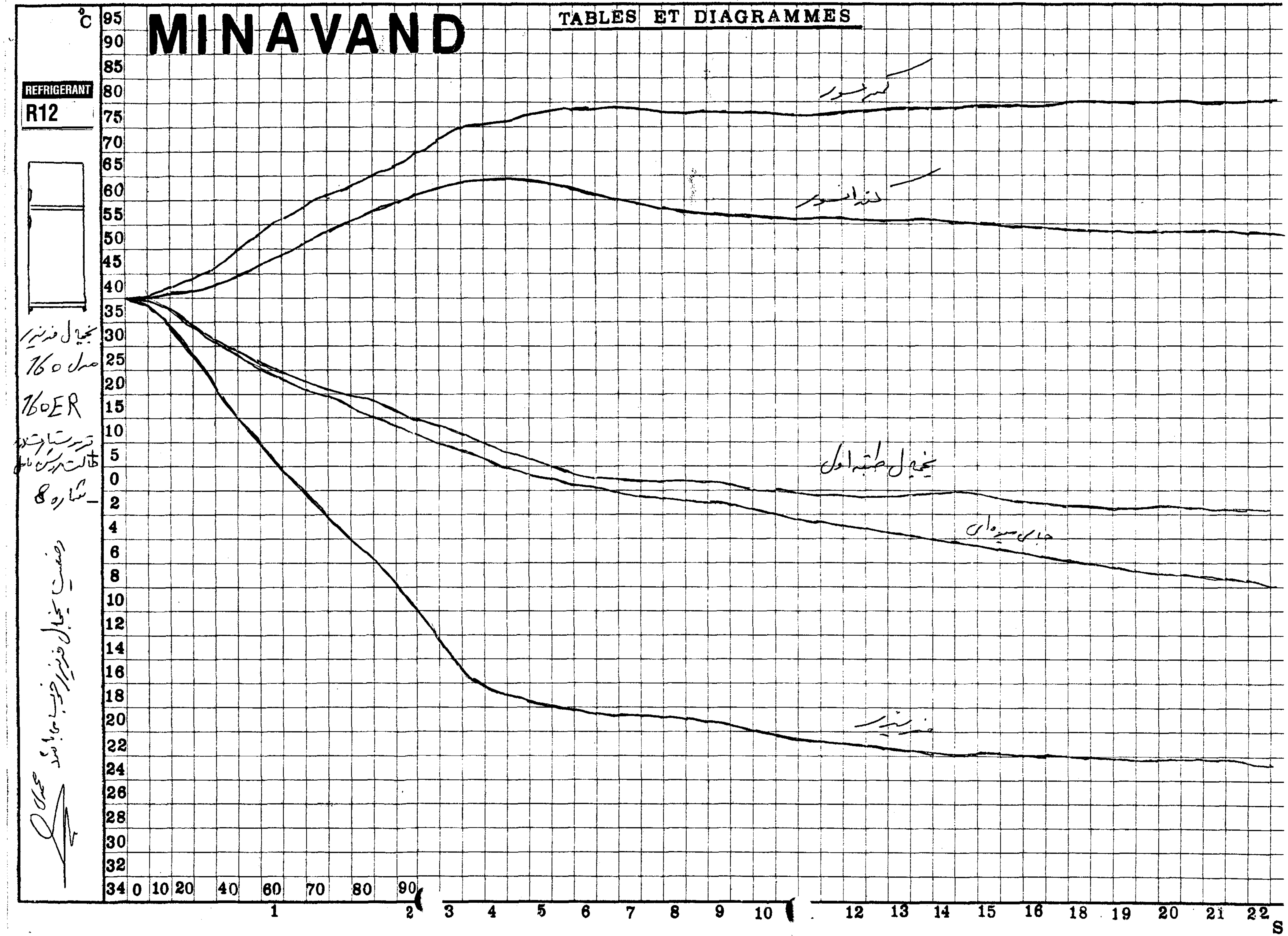
MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R12
°C
95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 + 5 0 − 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
0 10 20 40 60 70 80 90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22
S
یخچال مدل 120
120ED
رطوبت 85%
ترموستات در حال روشن کامل
شماره 8 ترموستات
وضعیت یخچال خوب می‌باشد
کمپرسور
کندانسور
جای میوه‌ای یخچال
قسمت منجمد شده یخچال


MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R134a
°C
95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34
0 10 20 40 60 70 80 90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 19 20 21 22
S
120ER



MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R12
°C
فریزر مدل 12
رطوبت 85 درجه
120ER
ترموستات در
حالت روشن کامل
شماره 8 ترموستات
وضعیت فریزر خوب می باشد
کمپرسور
کندانسور
طبقه پایین فریزر
طبقه اول فریزر
S


MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R134a
°C
Compressor
Condenser
Refrigerator Compartment
Refrigerator Compartment
Freezer
160ER
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
0 10 20 40 60 70 80 90
1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 18 19 20 21 22
S



MINAVAND
TABLES ET DIAGRAMMES
REFRIGERANT
R12
°C
S
یخچال فریزر
مدل 160
160ER
شماره 8
یخچال طبقه اول
جای میوه ای
فریزر