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UNIDO's Contract NO. 98/023 Conversion of Prototype into Ozone Friendly R134a Refrigerant

FINAL REPORT

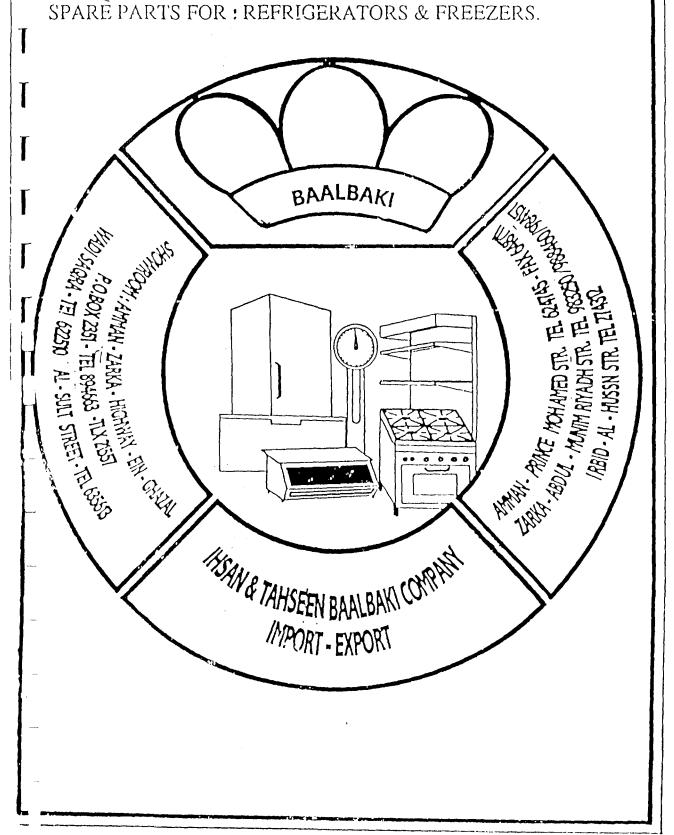
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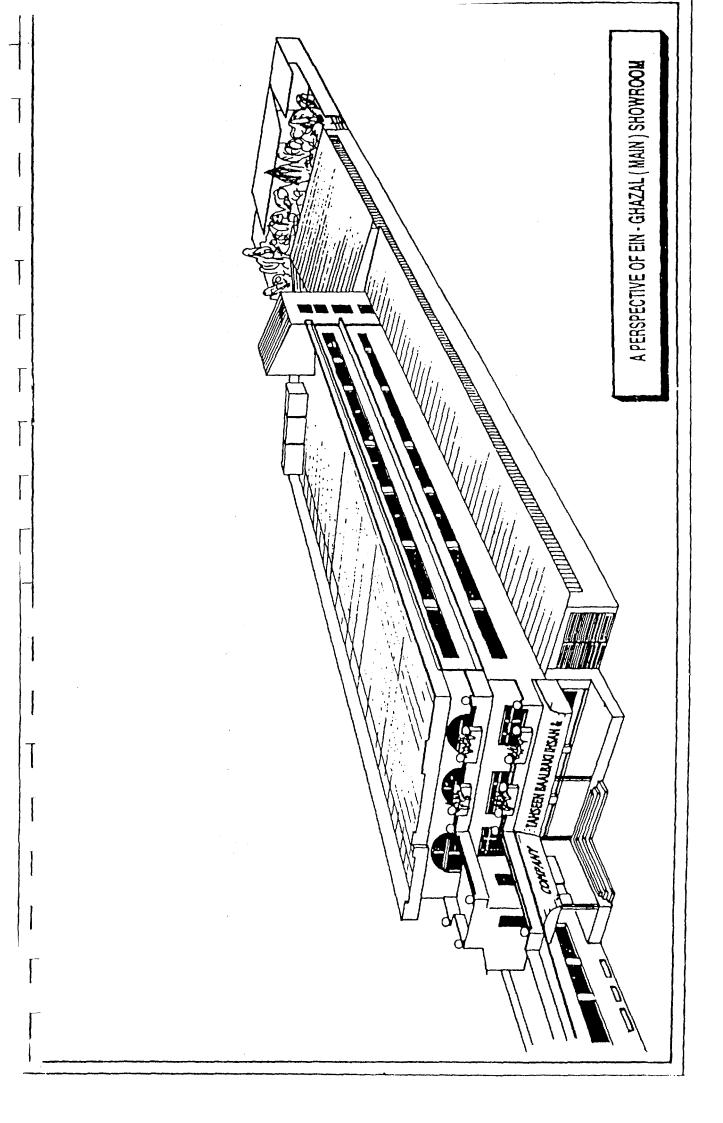
OCTOBER 1998

1HSAN & TAHSEEN BAALBAKI COMPANY

EQUIPMENT FOR: HOTELS - RESTAURANTS KITCHENS - SUPERMARKETS, SNAK BARS - CAFETERIAS - DEPARTMENT STORES:

WE ALSO HANDLE: WALK - IN COLD ROOMS TO CONSERVE MEAT, FRUITS AND FOODSTUFFS - SHELVING SYSTEMS - SHOPFITTINGS - SHOW STANDS FOR BOOKSHOPS, BOTIQUES AND SHOE STORES.





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Activities

we have achieved the following activities during implementation of the project:

Calculation for Refrigeration Load

- 1. Collecting necessary data for model redefinition
- 2. Dimensional Evaluation of each prototype
- 3. Refrigeration Load Calculation
- 4. Definition for prototype specification

Redesign of the Prototypes.

- 1. Redefinition of Refrigeration Circuit
- 2. Drafting for Refrigeration System Changes
- 3. Evaluation of Refrigeration System Components for implementation of necessary changes

Making Prototypes

- 1. Selection of components
- Assessing new R134a Compressor technical Specification in order to compare with R12 compressor technical specification
- Contacting several compressor manufactures to receive samples for testing prototypes
- 4. Investigating the existing filter direr suppliers in order to assure purchasing filter diers from local market
- 5. Supplying R134a for charging prototypes
- 6. Making prototypes in accordance with ISO standards and preliminary design of prototypes
- 7. Perform necessary adjustment on refrigeration system specially on Capillary tube
- Perform necessary adjustment on Refrigerant Charge Weight of R134a

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Testing prototypes

- 1. Achievement of performance test on R12 prototype in order to get enough data to compare with future R134a prototypes performance test.
- 2. Evaluation of R12 Sample Prototype test results
- 3. Performing necessary changes to the R12 Refrigeration System Components in order to optimize refrigeration circuits
- 4. Achievement of performance on eight R134a prototypes
- 5. Necessary adjustment of Capillary tubes were done with respect to the performance test results
- 6. Changing R134a charge weight with respect to the performance test results evaluation
- 7. Prototype test results evaluation

Conclusion

- 1. Performance test results revealed that in small water cooler there is no need to do any significant changes to the refrigeration circuit components.
- 2. In products that the internal volume of the refrigeration system is more than two litters we had to increase the length of capillary tube
- Reducing refrigerant charge weight in high cooling capacity is not practicable, therefore keeping refrigerant charges same as R12 refrigeration system is more practical.
- 4. In some prototypes we had to re-adjust the thermostat setting in order to get good test results.
- 5. In some prototype we had to change the position of the thermostat bulb position in order to get efficient attachment of thermostat bulb to the evaporators.

<u>Acknowledgment</u>

We would like to thank UNIDO, for giving us the opportunity to research on efficiency of our products and improve them to respond our customers requirement and also follow ISO standards and improve our design and quality of work. We would like also to thank the back stopping officer of the project for his sincere cooperation with us in implementing the project.

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Our company is proud of being one of Montreal Protocol candidates to phase out Ozone Depletion Substances in its products.

We will do our best effort to improve our products to use ozone friendly substances and will continue our technical co-operation with UNIDO in the future.

The company is proud that has invested a lot of capital investment to refurbish existing facilities in Al-Zarga to extend its activities to use modern and ozone friendly equipment in order to adopt with advance technology and keep our environment green and safe.

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Section I

INTRODUCTION

Based on UNIDO's request for proposal no. P. 98/14/VK and contract no. 98/023 between UNIDO and Mohammed Tahseen Baalbaki & Partner co. Provision of services relating to the design, calculation and drafting of 10 Prototype Models of Commercial Refrigerators and Freezers.

The project has been assigned to UNIDO in an agreement with the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, in response to a request from the Government of the Hashemi Kingdom of Jordan. The project was entitled as Conversion of Commercial Refrigerator Production Facilities to Phase-out CFC-12 of the above mentioned companies.

Mohammed Tahseen Baalbaki & Partner co. as the pioneer of executing UNIDO's CFC Phase-out project in Jordan was selected by UNIDO to implement a part of the project for the Jordanian Commercial Refrigerator Manufacturers. The missions that originally were assigned to Mohammed Tahseen Baalbaki & Partner are mainly referring to achieve the following activities;

- 1) Making Prototypes;
- 2) Testing Prototypes;
- 4) Calculating Heat Leaks;
- 5) Selecting Components for each models;
- 6) Preparing Technical Specifications and Characteristics;
- 7) and other services as mentioned in the subject contracts;

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SYNOPSIS

1 - General Background

- a) This report was prepared based on the UNIDO's contract no 98/023 between UNIDO and Mohammed Tahseen Baalbaki & Partner Co. for the provision of services related todesign, calculation and drafting of 10 prototype models of Commercial Refrigerators and Freezers and relevant terms of reference prepared by UNIDO and the requirement of Hashemi Kingdom of Jordan indicated in the country program.
- b) The project will phase out the use of CFC11 and CFC12 for the production of Commercial refrigerators in Jordan.

Company Background

This is a family-owned concern that traces its origin to the founding of a trading company in Damascus by the grandfather of the present proprietor. In the 1950's the Syrian business was nationalized and the family moved their operations to Jordan.Our involvement in refrigeration dates from this time when a cooperation with Linde GmbH was inaugurated.

The factories of Ihsan and Tahseen Baalbaki is based in Amman, Zargha and Sahab and manufactures, imports and markets a complete range of catering supplies which includes refrigeration equipment. A service operation with 13 mobile refrigerator technician is working throughout the Jordan.

In addition to display cases and cabinets, the company manufactures modular coldroom panels and engineers complete cold stores. The company produces; Reach in freezers, water coolers, Chest freezers, reach in chillers, dual temperature reach in tank type case for dairy production, tank type display for fishes, salad bar, cabinet for meat for supermarket, cabinet for fish and vegetables for supermarkets, and upright display cases.

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Section II

Refrigeration Load Calculation for Upright and Chest Freezer and Display cases

Refrigeration load consist of three individual components:

- 1- Transmission load;
 Heat transfer through side walls by conduction
- 2 Product load;Heat Removed from and produced by the products which are stored.
- 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 and door opening and etc.;

In this section, the above mentioned components will be discussed separately to analyze and extract the most useful and practical equipment's.

Transmission Load

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

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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 related equations is.

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

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

Where:

x = Insulation Thickness, mm

K = Insulation Conductivity, $\frac{Wmm}{m^2}$.

 $A = Outside Area, m^2$

 ΔT = Temperature difference (T_a - T_c), C

If the insulation thickness of sidewalls, back panels, top, bottom and door are different. Heat transfer for each part can be calculated separately and then summed for freezer and refrigerator compartments as necessary, 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;

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$$Q_{rs} = \dot{M}C (T_i - T_{rs})$$

Where:

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

C = Specific heat of product, Kcal / Kg

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

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

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;

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

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 $(Tf - Tfs)$

Where:

C_{bf} = Specific heat of products below freezing temperature.

For upright freezers or chest freezer, total product load is

$$O_{pl} = O_{af} + O_l + O_{bf}$$

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

Qpl = Qrs

Internal Load

Electrical energy dissipated in the refrigerated space such as lights, fan motors, heaters, should be calculated as appropriate depending on type of display cases and other products.

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 and /or open top freezer of show cases. Infiltration load is one of the most important load components.

Total Refrigeration load

As it was mentioned before, transmission load (Q_{II}), product load (Q_{PI}) and internal load (Q_{IL}) can be calculated separately. For infiltration load (air exchange through doorways or gasket leakage), we have to take into account that depending on the type of models we have to consider different amount of heat gain, or a percentage of amount of the above mentioned components. (Transmission load, product load and internal load). For example;

$$Q_{TL} = 1.25 (Q_{TL} + Q_{PL} + Q_{IL})$$

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

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one or more sides may be easily removed to gain access to the interior. The basin of the water cooler is generally made ofporcelain-coated cast iron, porcelaicoated-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.

There-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 ½ 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 bubblers 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.

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

- 1- Heat gain by heat transmission from, main water storage tank wall insulation.
- 2- 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.
- 3- 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.

$Q_1 = m C\Delta T$

Where:

- **Q**₁ 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
- **T** Temperature difference (Ti Tc), where, Ti is inlet water temperature, and Tc is final cooled water.

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$\mathbf{Q}_2 = \dot{M} \quad \mathbf{C} \ \Delta \mathbf{T}$

- Q₂ Total heat removed from total drinking water flow (lit.) during specific period, 16 hours. In Kcal.
- M total weight of water flow during 16 hours. in 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 temperature.

$Q_3 = UA \Delta T$

Where:

- **Q**₃ 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.

MOHAMMED TAHSEEN BAALBAKI & PARTNERS'CO. Importer, Exporter, Manufacturer, Commercial & Domestic Refrigerators

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Section III

Load Calculation of Prototypes

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:

$$Qc = \frac{Q_{7L \times 24}}{16} = 1.5Q \ 7L$$

Where:

Qc = required cooling capacity

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Saturation Properties Comparison

| | R12 | | | | | R134a | | | | |
|-----------|----------|-------------------|-------------------|------------------|------------------|----------|-------------------|-------------------|------------------|------------------|
| Temp C | P Kpa | Entholpy Kj/Kg | Entholpy Kj/Kg | Sp.Vol Lit/Kg | Sp.Vol Lit/Kg | P Kpa | Entholpy Kj/Kg | Entholpy Kj/Kg | Sp.Vol Lit/Kg | Sp.Vol Lit/Kg |
| | | hf | hg | Vf | Vg | | hf | hg | Vf | Vg |
| -30 | 100.41 | 172.81 | 338.14 | 0.672 | 159.37 | 84.36 | 61.51 | 277.208 | 0,7100 | 0,2219 |
| -26 | 118.72 | 176.38 | 339.96 | 0.677 | 136.28 | 101.65 | 66,56 | 212.96 | 0.7171 | 0.1868 |
| -22 | 139,53 | 179,96 | 341,78 | 0.682 | 117.16 | 121.62 | 71,63 | 281,86 | 0.7243 | 0,1570 |
| -18 | 163,04 | 183.56 | 343,58 | 0.688 | 101.24 | 144.56 | 76.72 | 284.19 | 0.7318 | 0,1313 |
| -14 | 189,50 | 187.18 | 345.36 | 0,694 | 87.89 | 170.76 | 81.84 | 286.52 | 0.7396 | 0.1138 |
| -10 | 219.12 | 190.82 | 347.13 | 0.700 | 76.64 | 200.51 | 86.98 | 288.85 | 0.7475 | 0.0941 |
| -6 | 252,14 | 194,47 | 348,88 | 0,706 | 67.11 | 234.13 | 92,162 | 291.18 | 0.7558 | 0.0843 |
| -4 | 270.01 | 196.31 | 349.75 | 0.709 | 62.89 | 252.49 | 94,76 | 292,35 | 0.7600 | 0.0784 |
| -2 | 288.82 | 198,15 | 350.61 | 0.712 | 58.99 | 271.94 | 97.377 | 293.522 | 0.7643 | 0.0730 |
| 0 | 308.61 | 200,00 | 351.47 | 0.715 | 55.38 | 292.52 | 100,00 | 294.68 | 0.7687 | 0.0681 |
| 2 | 329.40 | 201.85 | 352.33 | 0.719 | 52.04 | 314.27 | 102.63 | 295.35 | 0.7732 | 0.0635 |
| 4 | 351.24 | 203.71 | 353.17 | 0.722 | 48.94 | 337.24 | 105.28 | 297.01 | 0.7777 | 0.0594 |
| 6 | 374.14 | 205.57 | 354.02 | 0.726 | 46.07 | 361.47 | 107.93 | 298017 | 0.7823 | 0.0555 |
| 8 | 398.15 | 207.44 | 354.85 | 0.729 | 43.40 | 387.01 | 110,60 | 299.33 | 0.7870 | 0.0520 |
| 10 | 423.30 | 209.32 | 355.68 | 0.733 | 40.91 | 413,90 | 113.29 | 300.49 | 0.7918 | 0.0487 |

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Load Calculation for Bottle Water Cooler Model WB.6.

1-

$$Q_1 = m C \Delta T$$

Where:

- **Q**₁ 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 24 C.
- **m** total weight of original water in the water cooler storage tank in Kg. Considering that one litter of water at 24 C is equal to approximately one Kg.

$$M = 22$$
 liter = 22 Kg.

- C Specific heat factor of water in Kcal/Kg ?C = 1
- **\Delta T** Temperature difference (Ti Tc), where, Ti is inlet water temperature, and Tc is final cooled water.

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

$$Q_1 = m C T = 22 \times 1 \times 14 = 308 \text{ Kcal} = 308 \times 1.163 = 358 \text{ Watts/24 hrs}$$

 $Q_1 = 358 / 24$ water cooler operating time per day = 14.9 Watts

$Q_1 = 14.9 \text{ Watts}$

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2-

$$Q_2 = \dot{M} C\Delta T$$

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

M total weight of water flow during 16 hours. in Kg. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 20

M = Kg weight of water in one Glass of Water = 0.2 Kg

$$M = 16 \times 20 \times 0.2 = 64 \text{ lit.} + 20\% \text{ Waste Water} = 76.8$$

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

 $Q_2 = m C T = 76.8 \times 1 \times 14 = 1075 \text{ Kcal} = 1075 \times 1.163 = 1250 \text{ Watts/16 hrs}$

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 $Q_2 = 1250/12.8$ compressor operating time per day = 97.7 Watts

$$Q_1 = 97.7$$
 Watts

3-

$$Q_3 = UA \Delta T$$

Where:

- **Q**₃ Total Leak, gained through side wall of drinking water storage tank by conduction in Kcal..
- U Heat Resistance CoefficFactor in Kcal/Sq. mt. C

$$U = \frac{1}{x/K} = \frac{1}{0.025/0.0174} = 0.696 \frac{Kcal}{m^2} \circ C$$

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

$$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$$

Where; $A_1 = A_2 =$ bottom and top surface area of the storage tank are the same, and side walls are the same size

Storage Tank Width x Length = $25 \times 25 \text{ Cm}$.

Storage Tank Height = 35 Cm

$$A_1 = A_2 = 25 \times 25 = 625 \text{ Sq. Cm} = 0.0625 \text{ Sq. Mt.}$$

$$A_3 = A_4 = A_5 = A_6 = 35 \times 25 = 875 \text{ Sq. Cm.} = 0.0875 \text{ Sq. Mt.}$$

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$$A = (2 \times 0.0625) + (4 \times 0.0875) = 0.475 \text{ Sq. M}.$$

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

$$Ta = 30 C$$
 and $Tc = 10 C$

$$Ta - Tc = 30-10 = 20 C$$

$$Q_3 = UA \Delta T = 0.696 \times 0.475 \times 20 = 6.612 \text{ Kcal} = 7.69 \text{ Watts}$$

$$Q_3 = 7.69 \text{ Watts}$$

$$Q_1 = Q_1 + Q_2 + Q_3 = 14.9 + 97.7 + 7.69 = 120$$
 Watts

Compressor R134a, Model AZ 1358 Y (total cooling capacity 144 watts) manufactured by L'uniteh Hermatic, Tecumseh, is selected as a suitable compressor to replace R12 compressor model AZ 1358 Y.

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Load Calculation for Two Top Tap Water Cooler Model WC12

1-

$$Q_1 = m C \Delta T$$

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 24 C.

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

$$M = 45$$
 liter = 45 Kg.

C Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

$$Q_1 = m CT = 45 \times 1 \times 14 = 630 \text{ Kcal} = 630 \times 1.163 = 732.7 \text{ Watts/24 hrs}$$

 $Q_1 = 732.7 / 24$ water cooler operating time per day = 30.5 Watts

$Q_1 = 30.5 \text{ Watts}$

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2-

$$\mathbf{Q}_{2} = \dot{M} \mathbf{C} \Delta \mathbf{T}$$

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

M total weight of water flow during 16 hours. in Kg. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 25

M = Kg weight of water in one Glass of Water = 0.2 Kg

$$M = 16 \times 25 \times 0.2 = 80 \text{ lit.} + 20\% \text{ Waste Water} = 96$$

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

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$$Q_2 = m C T = 96 x 1 x 14 = 1344 Kcal = 1344 x 1.163 = 1563 Watts/16 hrs$$

 $Q_2 = 1563/12.8$ compressor operating time per day = 122 Watts

$Q_1 = 122 \text{ Watts}$

3-

$$Q_3 = UA \Delta T$$

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

$$U = \frac{1}{x_K} = \frac{1}{0.025} = 0.696 \frac{Kcal}{m^2}$$

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

$$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$$

Where; $A_1 = A_2 =$ bottom and top surface area of the storage tank are the same, and side walls are the same size

Storage Tank Width x Length = $26 \times 26 \text{ Cm}$.

Storage Tank Height = 66 Cm

$$A_1 = A_2 = 26 \times 26 = 676 \text{ Sq. Cm} = 0.0676 \text{ Sq. Mt.}$$

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$$A_3 = A_4 = A_5 = A_6 = 66 \times 26 = 1730 \text{ Sq. Cm.} = 0.1730 \text{ Sq. Mt.}$$

$$A = (2 \times 0.0676) + (4 \times 0.1730) = 0.827 \text{ Sq. Mt.}$$

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

$$Ta = 30 C$$
 and $Tc = 10 C$

$$Ta - Tc = 30-10 = 20 C$$

$$Q_3 = UA T = 0.696 \times 0.827 \times 20 = 6.612 \text{ Kcal} = 11.5 \text{ Watts}$$

$$Q_3 = 11.5 \text{ Watts}$$

$$Q_1 = Q_1 + Q_2 + Q_3 = 30.5 + 122 + 11.5 = 164$$
 Watts

Compressor R134a, Model AZ 136 (total cooling capacity 177 watts) manufactured by L'uniteh Hermatic, Tecumseh, is selected as a suitable compressor to replace R12 compressor model AZ 1360 Y.

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Load Calculation for Big Top Tap Water Cooler Model WC18

1-

$$Q_1 = m C\Delta T$$

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 24 C.

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

$$M = 66$$
 liter = 66 Kg.

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

$$Q_1 = m C ?T = 66 x 1 x 14 = 924 Kcal = 924 x 1.163 = 1075 Watts/24 hrs$$

 $Q_1 = 1075 / 24$ water cooler operating time per day = 30.5 Watts

$Q_1 = 44.7 \text{ Watts}$

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2-

$$Q_2 = \dot{M} C \Delta T$$

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

M total weight of water flow during 16 hours. in Kg. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 30

M = Kg weight of water in one Glass of Water = 0.2 Kg

$$M = 16 \times 30 \times 0.2 = 64 \text{ lit.} + 10\% \text{ Waste Water} = 105.6$$

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

 $Q_2 = m C T = 105.6 \times 1 \times 14 = 1478 \text{Kcal} = 1478 \times 1.163 = 1719 \text{ Watts/16 hrs}$

 $Q_2 = 1719/12.8$ compressor operating time per day = 134 Watts

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$Q_1 = 134 \text{ Watts}$

3-

$$Q_3 = UA \Delta T$$

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

$$U = \frac{1}{x/K} = \frac{1}{0.025/0.0174} = 0.696 \frac{Kcal}{m^2} \circ ($$

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

$$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$$

Where; $A_1 = A_2 =$ bottom and top surface area of the storage tank are the same, and side walls are the same size

Storage Tank Width x Length = $40 \times 40 \text{ Cm}$.

Storage Tank Height = 42 Cm

$$A_1 = A_2 = 40 \text{ x } 40 = 1600 \text{ Sq. Cm} = 0.1600 \text{ Sq. Mt.}$$

$$A_3 = A_4 = A_5 = A_6 = 42 \times 40 = 1680 \text{ Sq. Cm.} = 0.1680 \text{ Sq. Mt.}$$

$$A = (2 \times 0.1600) + (4 \times 0.1680) = 0.992 \text{ Sq. Mt.}$$

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

$$Ta = 30 C$$
 and $Tc = 10 C$

$$Ta - Tc = 30-10 = 20 C$$

$$Q_3 = UA \Delta T = 0.696 \times 0.992 \times 20 = 6.612 \text{ Kcal} = 13.8 \text{ Watts}$$

$$Q_3 = 13.8 \text{ Watts}$$

$$Q_1 = Q_1 + Q_2 + Q_3 = 44.7 + 134 + 13.8 = 192$$
 Watts

Compressor R134a, Model AEZ 1365 (total cooling capacity 177 watts) manufactured by L'uniteh Hermatic, Tecumseh, is selected as a suitable compressor to replace R12 compressor model AEZ 1380.

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Load Calculation for Two Front Tap Water Cooler Model WC12L

1-

$$Q_1 = m C \Delta T$$

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 24 C.

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

$$M = 45 \text{ liter} = 45 \text{ Kg}.$$

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

 $Q_1 = m C T = 45 \times 1 \times 14 = 630 \text{ Kcal} = 630 \times 1.163 = 732.7 \text{ Watts/24 hrs}$

 $Q_1 = 732.7 / 24$ water cooler operating time per day = 30.5 Watts

$Q_1 = 30.5 \text{ Watts}$

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2-

$$\mathbf{Q}_2 = \dot{M} \ \mathbf{C} \ \mathbf{?T}$$

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

M total weight of water flow during 16 hours. in Kg. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 30

M = Kg weight of water in one Glass of Water = 0.2 Kg

$$M = 16 \times 25 \times 0.2 = 96 \text{ lit.} + 20\% \text{ Waste Water} = 96$$

C Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $T = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

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$$Q_2 = m C T = 96 x 1 x 14 = 1344 Kcal = 1344 x 1.163 = 1563 Watts/16 hrs$$

 $Q_2 = 1563/12.8$ compressor operating time per day = 122 Watts

$Q_1 = 122$ Watts

3-

$$Q_3 = UA \Delta T$$

Where:

- **Q**₃ 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

$$U = \frac{1}{x_K} = \frac{1}{0.025/0.0174} = 0.696 \frac{Kcal}{m^2} \circ C$$

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

$$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$$

Where; $A_1 = A_2 =$ bottom and top surface area of the storage tank are the same, and side walls are the same size

Storage Tank Width x Length = $40 \times 40 \text{ Cm}$.

Storage Tank Height = 42 Cm

$$A_1 = A_2 = 40 \text{ x } 40 = 1600 \text{ Sq. Cm} = 0.1600 \text{ Sq.Mt.}$$

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$$A_3 = A_4 = A_5 = A_6 = 42 \times 40 = 1680 \text{ Sq. Cm.} = 0.1680 \text{ Sq. Mt.}$$

$$A = (2 \times 0.1600) + (4 \times 0.1680) = 0.992 \text{ Sq. Mt.}$$

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

$$Ta = 30 C$$
 and $Tc = 10 C$

$$Ta - Tc = 30-10 = 20 C$$

$$Q_3 = UA \Delta T = 0.696 \times 0.992 \times 20 = 6.612 \text{ Kcal} = 13.8 \text{ Watts}$$

$$Q_3 = 13.8 \text{ Watts}$$

$$Q_1 = Q_1 + Q_2 + Q_3 = 30.5 + 122 + 13.8 = 166.3$$
 Watts

Compressor R134a, Model AZ 136 (total cooling capacity 177 watts) manufactured by L'uniteh Hermatic, Tecumseh, is selected as a suitable compressor to replace R12 compressor model AZ 1360 Y.

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Load Calculation for Tow Medium Front Tap Water Cooler Model WC18L

1-

$$Q_1 = m C \Delta T$$

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 24 C.

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

$$M = 66$$
 liter = 66 Kg.

C Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 ?C$$
 and $Tc = 10 ?C$

$$Ti - Tc = 24-10 = 14 ?C$$

$$Q_1 = m C T = 66 x 1 x 14 = 924 Kcal = 924 x 1.163 = 1075 Watts/24 hrs$$

 $Q_1 = 1075/24$ water cooler operating time per day = 30.5 Watts

$Q_1 = 44.7 \text{ Watts}$

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2-

$$Q_2 = \dot{M} C \Delta T$$

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

M total weight of water flow during 16 hours. in Kg. = H x N x M where:

H = Total Water Cooler Usage Time (Hours) = 16

N = Number of Glass of Drinking Water per Hour = 30

M = Kg weight of water in one Glass of Water = 0.2 Kg

$$M = 16 \times 30 \times 0.2 = 64 \text{ lit.} + 15\% \text{ Waste Water} = 110.4$$

 \mathbf{C} Specific heat factor of water in Kcal/Kg C = 1

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

$$Ti = 24 C$$
 and $Tc = 10 C$

$$Ti - Tc = 24-10 = 14 C$$

 $Q_2 = m C T = 110.4 \times 1 \times 14 = 1546 \text{Kcal} = 1546 \times 1.163 = 1797.5 \text{ Watts/16 hrs}$

 $Q_2 = 1797.5/12.8$ compressor operating time per day = 140.4 Watts

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$Q_1 = 140.4 \text{ Watts}$

3-

$$Q_3 = UA \Delta T$$

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

$$U = \frac{1}{x/K} = \frac{1}{0.025/0.0174} = 0.696 \frac{Kcal}{m^2} ^{\circ} C$$

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

$$A = A_1 + A_2 + A_3 + A_4 + A_5 + A_6$$

Where; $A_1 = A_2 =$ bottom and top surface area of the storage tank are the same, and side walls are the same size

Storage Tank Width x Length = $40 \times 40 \text{ Cm}$.

Storage Tank Height = 42 Cm

$$A_1 = A_2 = 40 \text{ x } 58 = 2320 \text{ Sq. Cm} = 0.2320 \text{ Sq. Mt.}$$

$$A_3 = A_5 = 40 \text{ x } 28 = 1120 \text{ Sq. Cm.} = 0.1120 \text{ Sq. Mt.}$$

$$A_4 = A_6 = 58 \times 28 = 1624 \text{ Sq. Cm.} = 0.1624 \text{ Sq. Mt.}$$

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$$A = (2 \times 0.2320) + (2 \times 0.1120) + (2 \times 0.1624) = 1.013 \text{ Sq. Mt.}$$

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

$$Ta = 30 C$$
 and $Tc = 10 C$

$$Ta - Tc = 30-10 = 20 C$$

$$Q_3 = UA \Delta T = 0.696 \times 1.013 \times 20 = 6.612 \text{ Kcal} = 14.1 \text{ Watts}$$

$$Q_3 = 14.1 \text{ Watts}$$

$$Q_1 = Q_1 + Q_2 + Q_3 = 44.7 + 140.4 + 14.1 = 199$$
 Watts

Compressor R134a, Model AEZ 1365 (total cooling capacity 177 watts) manufactured by L'uniteh Hermatic, Tecumseh, is selected as a suitable compressor to replace R12 compressor model AEZ 1380.

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Show Case Model Kyoto 180 Heat Load Calculation

Heat Load

Total heat load consists of the amount of heat to be removed from cabinet during a certain period. This is dependent on two main factors:

- 1- Heat Leakage Load
- 2- Heat usage or Product load.

The heat leakage load or heat transfer load is total amount of heat that leaks through the walls, windows, ceiling, and floor of the cabinet.

The Heat usage or product load, is the sum of the heat load of cooling the contents to cabinet temperature, cooling of air changes, removing respiration heat from fresh or live vegetables, meat, removing heat released by electric lights, electric motors and the like, and heat given off by people entering and/or working in the cabinet.

Heat Leakage Variables

There are five factors, which affect heat leakage.

- 1- Time. The longer the period of time, the more heat will leak through a certain wall. The standard time unit used for computation is the 24 hour period in refrigeration situation.
- 2- Temperature difference. The temperature difference is an important factor in heat leakage into the cabinet.
- 3- Insulation Thickness. The thicker the insulation, the less heat flow through it.

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- 4- Kind of Insulation. The kind of insulation or the material used, is an important consideration in the construction of the cabinet.
- 5- Area of the Cabinet. Just as size of a pipe determination how much water will flow through it. So the more the area through which heat may leak the greater the heat flow will be. The common unit used for determining the heat flow is square meter of area.

Determination Usage Load, Product Load

The total heat load of refrigerator cabinet, in addition to being dependent upon the heat leaking through walls and windows is also affected by the heat to be removed from articles in the cabinet, the air change and other sources of heat. This heat is called heat usage, or product load, and it is caused by changes of air in the cabinet, by products to be cooled, by lights and motors which may be used inside the box, and by the occupancy of the box.

Refrigerator equipment manufacturers have developed a standard where by you may obtain a fairy accurate estimate of the usage heat load. The method is as follows;

The cabinet is classified as the type of service to be performed. Under this classification come florist's cabinets, grocery boxes, normal market coolers, fresh meat cabinets, and restaurant and short order boxes. This load depends in detail upon the following basic factors:

- 1- Temperature difference between exterior and interior of cabinet.
- 2- Volume of cabinet (internal).
- 3- Type of Service.
- 4- Time.

It is impossible to calculate, using a typical installation and determine the amount of food put into the refrigerator, how many times the door is opened, and for how long a period of time the employees are inside the cabinet. This is a laborious

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process and, unless carefully performed, discrepancies are bound to appear in the results.

The usual procedure to determine the usage heat load is as follows:

- 1- The temperature difference is the same value as that used for heat leakage into the cabinet.
- 2- Volume of the cabinet is computed from inside diameters.
- Next determine under what type service the cabinet is being used, such as average, heavy or long storage. The service load is also dependent on cabinet size, the smaller the cabinet the more heat load is caused by products. A meat market, for instance, may be one in either a small neighborhood store or it may be in a supermarket.
- 4- Time, 24 hour. There would, of course, be considered variation in the amount of heat to be removed from the cabinet content. From the table we can find the load for three conditions.

After the total volume of the box has been calculated, the load for each cubic foot is determined by referring to the table, if the cabinet appears to have average product with a temperature difference of 60 F., and has a volume of 300 cu. ft. the amount of heat to be removed from each cubic feet will be 78 BTU per 24 hours. We multiply this value by the total volume in cubic feet, and a fairy accurate estimate of the product load may be obtained. The table gives the heat usage over a period of 24 hours as this time is the established standard.

Heat Usage = Usage BTU x Volume in cu. ft.

Through our knowledge, experience and facts and figures we believe that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;

- 3- Next determine under what type service the cabinet is being used, such as average, heavy or long storage. The service load is also dependent on cabinet size, the smaller the cabinet the more heat load is caused by products. A meat market, for instance, may be one in either a small neighborhood store or it may be in a supermarket.
- 4- Time, 24 hour. There would, of course, be considered variation in the amount of heat to be removed from the cabinet content. From the table we can find the load for three conditions.

After the total volume of the box has been calculated, the load for each cubic foot is determined by referring to the table, if the cabinet appears to have average product with a temperature difference of 60 F., and has a volume of 300 cu. ft. the amount of heat to be removed from each cubic feet will be 78 BTU per 24 hours. We multiply this value by the total volume in cubic feet, and a fairy accurate estimate of the product load may be obtained. The table gives the heat usage over a period of 24 hours as this time is the established standard.

Heat Usage = Usage BTU x Volume in cu. ft.

Through our knowledge, experience and facts and figures we believe that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin anete.;

Transmission load calculation

Dimensions

| | Dimension Cm. | Area (sq. mt.) | Insulation Thickness mm. |
|------------------|---------------|----------------|-----------------------------|
| Side Walls | 110x85x2 | 1.87 | 50 |
| Back Panel | 180x85 | 1.53 | 50 |
| Front Top Window | 180x130 | 2.34 | 600+0.5 |
| Bottom Floor | 135x75 | 1.012 | 50 |
| Front Panel | 180x85 | 1.53 | 50 |

Insulation Type: Pu Foam

R141b. Foam Thermal Conductivity: 0.0178 W/mt.C

Air Thermal Conductivity at \pm 2 °C = 0.00128 W /mt.C Glass Thermal Conductivity at \pm 2 °C = 5 W /mt.C

Temperature Difference: (Δ/) = 30 - 2 - 28 C

Ambient Temperature = 30 C Freezer Air Temperature - + 2 C

Calculation:

 $Q_{\mathrm{TL}} \equiv Q_{\mathrm{SW}} + Q_{\mathrm{BP}} + Q_{\mathrm{BOTTOM}} + Q_{\mathrm{TOP}}$ Glass, $+Q_{\mathrm{Front}}$ Panel

$$Q = U A (T_a - T_t)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \dots}$$

Where:

U - Heat Resistance Coefficient Factor

Ki - Foam Thermal Conductivity

Xi = Foam Thickness

Note: Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

1- $Q_{\text{Bide Walls}} = [U \land (Ta - Tr)]$

 T_a - Ambient Temperature

Tr Freezer air Temperature

U = 1∕ (0.050/0.0178) = 0.36 W/ Sq. Mt. C

A 11.87Sq. Mt.

Ta 30 C

 $T_f = \pm \ 2 \ C$

Q side walls $\approx 0.36 \times 1.87 \times 28 = 18.85$ Walts

Q side works = 18.85 Watts

2 - Q Back panel = [UA (Ta - Tr)]

Ta - Ambient Temperature

Tr Freezer air Temperature

U-11/(0.050/0.0178) 10.36 W/ Sq. Mt. C

 $\Lambda = 1.53$ Sq. Mt.

 $T_u = 30 \text{ C}$

Tr == +2 C

 $Q_{\rm Back\ panel} = 0.36\ x\ 1.53\ x\ 28 = 15.42\ Watts$

$Q_{Buck punel} \simeq 15.42 Watts$

 $3 - Q_{Top glaza} = [U \wedge (Ta - Tr)]$

Ta - Ambient Temperature

Tr - Freezer air Temperature

U = 1 / [(0.005/5) + (0.6/0.00128)] = 0.002 W/ Sq. Mt C

4 1

A - 2.38 Sq. Mt.

Ta = 30 C

Te = 12 C

 $Q_{\rm Top\,glass} \simeq 0.36 \ x \ 2.38 \ x \ 0.002 \simeq 0.133$ Watts

Q Top glass 0.133 Watts

4 - Q Bottom > [UA (Ta - Tf)]

Ta - Ambient Temperature

Tr. Freezer air Temperature

 $U=1/\left(0.050/0.0178
ight)\simeq0.36~W/Sq.~Mt.~C$

A =1.012 Sq. Mt.

 $T_a = 30 C$

Tr = +2 C

 $Q_{\rm Bollom} = 0.36 \times 1.012 \times 28 \simeq 10.93 \text{ Watts}$

Q Boltom = 10.93 Watts

5 - Q trontponel = [UA (Ta - Tr)]

Ta = Ambient Temperature

Tre-Freezer an Temperature

 $\begin{array}{l} U=1 \ / \ (0.050 / \ 0.0178) \cong 0.36 \ W / \ Sq. \ Mt. \ C \\ A=1.53 Sq. \ Mt. \\ T_a=30 \ C \\ T_f \cong \pm 2 \ C \end{array}$

Q broot panels $\simeq 0.36 \times 1.53 \times 28 \times 15.42$ Watts

Q Front punct 15.42 Watts

Total Heat Leaks;

 $Q_{TL} = 18.85 \pm 15.42 \pm 0.133 \pm 10.93 \pm 15.42 \pm 60.75$

 ${\cal Q}$ Total Best Leaks +60.75 Watts

Product Load Calculation.

1- Heat removed from about 350 Kg Fresh Lamb Meat—from initial temperature of 32 C to final temperature of + 2 C can be calculated from the following formula.

$$Q = m C \Delta T$$

Where:

Q = Total heat removed from fresh lamb meat Kj

m = total mass of lamb meat put in the refrigerator about 350 Kg.

C = Specific heat of fresh lamb meat at 30 C = 3 Kj/Kg

$$\Delta T = T_i - T_f = 32 - 2 = 30 \text{ C}$$

 $Q = 350 \times 3 \times 30 = 31500 \times 0.008 = 252$ watts.

Infiltration and Door opening

Total Internal Volume = 500 lit.

No. of air changes per day = 70

Heat removed per cubic meter of air load = 75 Kj

Air change load = $0.5 \times 70 \times 75 / 86400 = 0.0303$ Kwatt = 30.4

$$Q_{\text{Misc}} = 0.25 \%$$
 Q Heat Leaks $+Q_{\text{Product Loads}}$

$$Q_{\text{Misc}} = 0.25(60.75 \pm 252) = 78$$

Total Cooling Capacity required is calculated as follows;

$$Q_{\text{Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}} + Q_{\text{Lighting}}$$

$$Q_{Total} = 60.75 + 252 + 30.4 + 78 = 421 \text{ Watts}$$

QGrand Total 421 Watts

Q Compressor Cooling Capacity = $421 \times 24 / 16 = 631$ watt

Section I Refrigeration Load Calculation

Chest Freezer Model BCF-100

- a) Transmission Load Calculation

Dimension

| | Dimension Cm. | Area (sq. mt.) | Insulation Thickness mm |
|---------------------|------------------|-------------------|----------------------------|
| Side Walls | 2 x (55x86) | 0.95 | 55 |
| Front & Back Panel | 2 x (55x86) | 0.95 | 55 |
| Chest Door | 55 x 55 | 0.3 | 55 |
| Bottom Floor | 55 x 55 | 0.3 | 55 |

nsulation Type: Pu Foam R141b expanded blowing PU foam

R141b Foam Thermal Conductivity: 0.017 W /mt.C

Temperature Difference: $(\Delta T) = 43 - (-18) = 61 \text{ C}$

mbient Temperature = 43 C

rreezer Air Temperature = - 18 C

_alculation:

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$$Q_{TL} = Q_{side\ Walls} + Q_{Bottom} + Q_{Top}$$

Q = U A (
$$T_a - T_f$$
)
U = $\frac{1}{X_1/K_1 + X_2/K_2 + \dots}$

Where:

U = Heat Resistance Coefficient Factor

K₁ = Foam Thermal Conductivity

X₁ = Foam Thickness

Note: Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

$$Q_{SideWalls} = [UA(T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Freezer air Temperature

$$U = 1 / (0.055/0.017) = 0.31 \text{ W/ sq.m C}$$

 $A = 0.95 \text{ Sq. Mt.}$
 $T_a = 43 \text{ C}$
 $T_f = -18 \text{ C}$

Q sideWalls = $0.31 \times 0.95 \times 61 = 17.96$ Watts

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Q sideWalls = 17.96 Watts

2 - Q Front & Back Walls = [U A (Ta - Tf)]

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.055/0.017) = 0.31 W/ sq.m C A = 0.95 Sq. Mt. $T_a = 43 \text{ C}$ $T_f = -18 \text{ C}$

Q Front & Back Walls = $0.31 \times 0.95 \times 61 = 17.96$ Watts

Q Front & Back Walls = 17.96 Watts

 $3 - Q_{Top} = [U A (T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1 / (0.055/0.017) = 0.31 W/ sq.m C A = 0.3 Sq. Mt. $T_a = 43 C$ $T_f = -18 C$

 $Q_{\text{Top}} = 0.31 \times 0.3 \times 61 = 5.67 \text{ Watts}$

 $Q_{Top} = 5.67 Watts$

 $Q_{Bottom} = [UA(T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.055/0.017) = 0.31 W/ sq.m C A = 0.3 Sq. Mt. $T_a = 55 \text{ C}$ $T_f = -18 \text{ C}$

Q Bottom = $0.31 \times 0.3 \times 73 = 6.79$ Watts

Q Bottom = 6.79 Watts

Total Heat Leaks;

$$\mathbf{Q}_{\text{TL}} = 17.96 + 17.96 + 5.76 + 6.79 = 48.47 \text{ watts}$$

$$Q$$
 Total Heat Leaks = 48.47 Watts

b) Product Loads;

Through our knowledge, experience and facts and figures of calculation of Ihsan and Tahseen al-Baalbaki products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;

- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we calculate our product load as follows;

$$Q$$
 Product = (40% to 65%) Of Q Total Heat Leaks

Product load calculation for Ihsan and Tahseen al-Baalbaki Freezer Model
 BOF 700 V, that an average internal volume of about 102 liter could be 50 percent of heat leak of equal amount of about 100 kg of fresh meat of 24 C
 that should be frozen to - 18 degree of making 6 kg ice for 24 hours;

Ice Making Capacity = $6 kg \times 1 \times (15-0) \times 1.163 = 104.67$ Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 10 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = $0.1 \times (total heat leaks)$

Heat gain by infiltration = $0.1 \times (48.47) = 4.8 \text{ Watts}$

Total Cooling Capacity Required for Model BCF 100 V are calculated as – follows:

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Ice Making}} + Q_{\text{Infiltration}}$$

 $Q_{Grand\ Total} = 48.47 + 104.67 + 4.8 = 158\ Watts$

Q_{Grand Total} = 158 Watts

The Suitable Compressor selected for this Model is OF 700 V with a total 150 watts cooling capacity, the Evaporator and Condenser sizes were _:emained un-changed.

Chest Freezer Model BCRY-380

-a) Transmission Load Calculation

Dimension

| | Dimension Cm. | Area (sq. mt.) | Insulation Thickness mm |
|---------------------|------------------|-------------------|----------------------------|
| Side Walls | 2 x (64x95) | 1.22 | 60 |
| _Front & Back Panel | 2 x (95x118) | 2.24 | 60 |
| Chest Door | 64 x 118 | 1.12 | 60 |
| Bottom Floor | 64 x 118 | 1.12 | 60 |

isulation Type: Pu Foam R141b expanded blowing PU foam

R141b Foam Thermal Conductivity: 0.017 W /mt.C

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Temperature Difference: $(\Delta T) = 43 - (-18) = 61 \text{ C}$

Ambient Temperature = 43 C

Freezer Air Temperature = - 18 C

Calculation:

$$Q_{TL} = Q_{side Walls} + Q_{Bottom} + Q_{Top}$$

Q = U A (
$$T_a - T_f$$
)
U = $\frac{1}{X_1 / K_1 + X_2 / K_2 + \dots}$

Where:

U = Heat Resistance Coefficient Factor

K₁ = Foam Thermal Conductivity

X₁ = Foam Thickness

Note: Due to the short thickness of cabinet out side panel (0.6 mm) and plastic inner liner (1.5 mm) heat resistance of these materials have been considered negligible.

_*herefore:

$$Q_{\text{SideWalls}} = [UA(T_a - T_f)]$$

T_a = Ambient Temperature
T_f = Freezer air Temperature

$$U = 1 / (0.06/0.017) = 0.28 W/ sq.m C$$

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A = 1.22 Sq. Mt.

 $T_a = 43 C$

 $T_f = -18 C$

Q $_{\text{SideWalls}} = 0.28 \times 1.22 \times 61 = 19.35 \text{ Watts}$

Q sideWalls = 119.35 Watts

2 - Q Front & Back Walls =
$$[UA(Ta - Tf)]$$

T_a = Ambient Temperature

Tf = Freezer air Temperature

U = 1 / (0.060/0.017) = 0.28 W/ sq.m C

A = 2.24 Sq. Mt.

 $T_a = 43 C$

 $T_f = -18 C$

Q Front & Back Walls = 0.28 x 2.24 x 61 = 38.6 Watts

Q Front & Back Walls = 38.26 Watts

$$3 - Q_{Top} = [U A (T_a - T_f)]$$

Ta = Ambient Temperature

Tr = Freezer air Temperature

U = 1 / (0.060/0.017) = 0.28 W/ sq.m C

A = 1.12 Sq. Mt.

 $T_a = 43 C$

 $T_f = -18 C$

 $Q_{Top} = 0.28 \times 1.12 \times 61 = 19.13 \text{ Watts}$

 $Q_{Top} = 19.13 \text{ Watts}$

 $4 - Q_{Bottom} = [UA(T_a - T_f)]$

T_a = Ambient Temperature
T_f = Freezer air Temperature

U = 1/(0.060/0.017) = 0.28 W/ sq.m C A = 0.1.12 Sq. Mt. $T_a = 55 \text{ C}$ $T_f = -18 \text{ C}$

Q Bottom = $0.28 \times 1.12 \times 73 = 22.89$ Watts

Q Bottom = 22.89 Watts

- Total Heat Leaks;

$$Q_{TL} = 19.35 + 38.6 + 19.13 + 22.89 = 99.97$$
 watts

<u>b) Product Loads;</u>

Through our knowledge, experience and facts and figures of calculation of Ihsan and Tahseen al-Baalbaki products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;

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- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore considering 40% to 65% of total heat leaks for total – product load depending on size of model and internal volume of the product could be reasonable and practical to calculate. With respect to this fact we _ calculate our product load as follows;

$$Q$$
 Product = (40% to 65%) Of Q Total Heat Leaks

Product load calculation for Ihsan and Tahseen al-Baalbaki Freezer Model

BCRY 380, that an average internal volume of about 102 liter could be 50 percent of heat leak of equal amount of about 300 kg of fresh meat of 24 C that should be frozen to - 18 degree of making 15 kg ice for 24 hours;

lce Making Capacity = $15 kg \times 1 \times (15-0) \times 1.163 = 261.68$ Watts

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 10 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = $0.1 \times (total heat leaks)$

Heat gain by infiltration = $0.1 \times (99.97) = 10 \text{ Watts}$

Total Cooling Capacity Required for Model BCRY 380 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Ice Making}} + Q_{\text{Infiltration}}$$

$$Q_{Grand\ Total} = 99.97 + 261.68 + 10 = 371.65\ Watts$$

The Suitable Compressor selected for this Model is Aspera B1118Z with a – total **410** watts cooling capacity, the Evaporator and Condenser sizes were remained un-changed.

Bottle Show Case Model BNOR-S122

a) Transmission load calculation

<u>Table I</u> Dimensions

| T | Dimension Cm. | Area (sq. mt.) | Insulation Thickness |
|-------------------|------------------|----------------|-------------------------|
| Side Walls | 2 x (71.5x159) | 2.27 | 44 |
| Back Panel | 108 x 159 | 1.72 | 44 |
| Top Roof | 71.5 x 108 | 0.77 | 70 |
| ■ Bottom Floor | 71.5 x 108 | 0.77 | 70 |
| Double Door Glass | 108 x 159 | 1.72 | 15 |

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Insulation Type: Pu Foam

R141b Expanded PU Foam Thermal Conductivity: 0.017 W /mt.C

Still Air Thermal Conductivity: 0.00128 W /mt.C

With regard to the thickness of the glass comparing to the 15 mm still air thickness between double glass door we neglect the glass thermal conductivity

Temperature Difference: $(\Delta T) = 32 - (10) = 22 \text{ C}$

Ambient Temperature = 32 C

Show Case Air Temperature = 10 C

Calculation:

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \dots}$$

Where:

U = Heat Resistance Coefficient Factor

K₁ = Foam Thermal Conductivity

 $X_1 = Foam Thickness$

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Note: Due to the short thickness of cabinet out side panel (0.6 mm) and inner liner, heat resistance of these materials have been considered negligible.

Therefore:

1-
$$Q_{SideWalls} = [UA(T_a - T_f)]$$

Ta = Ambient Temperature
Tf = Inside Air Temperature

$$U = 1/(0.044/0.017) = 0.39 \text{ W/ sq.m C}$$

 $A = 2.27 \text{ Sq. Mt.}$
 $T_a = 32 \text{ C}$
 $T_f = 10 \text{ C}$

Q
$$_{\text{SideWalls}} = 0.39 \times 2.27 \times 22 = 19.48 \text{ Watts}$$

Q SideWalls = 19.48 Watts

$$2 - Q_{Back panel} = [UA(Ta - Tf)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

$$U = 1/(0.044/0.017) = 0.39 \text{ W/ sq.m C}$$

 $A = 1.72 \text{ Sq. Mt.}$
 $T_a = 32 \text{ C}$
 $T_f = 10 \text{ C}$

Q Back panel =
$$0.39 \times 1.72 \times 22 = 14.76$$
 Watts

Q Back panel = 14.76 Watts

$$3 - Q_{Top} = [UA(T_a - T_f)]$$

T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.070/0.017) = 0.24 W/ sq.m C A = 0.77 Sq. Mt. $T_a = 45 \text{ C}$ $T_f = 10 \text{ C}$

 $Q_{Top} = 0.24 \times 0.77 \times 35 = 6.47 \text{ Watts}$

 $Q_{Top} = 6.47 \text{ Watts}$

4 -
$$Q_{Bottom} = [UA(T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.070/0.017) = 0.24 W/ sq.m C A = 0.77 Sq. Mt. $T_a = 32 \text{ C}$ $T_f = 10 \text{ C}$

Q $_{\text{Bottom}} = 0.24 \times 0.77 \times 22 = 4.07 \text{ Watts}$

Q Bottom = 4.07 Watts

$$5 - Q_{Door} = [UA(T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

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U = 1/(0.015/0.00128) = 0.09 W/ sq.m C A = 0.1.72 Sq. Mt. $T_a = 32 \text{ C}$ $T_f = 10 \text{ C}$

 $Q_{Door} = 0.09 \times 1.72 \times 22 = 3.41 \text{ Watts}$

Q Door = 3.41 Watts

Total Heat Leaks;

$$Q_{TL} = 19.76 + 14.76 + 6.47 + 4.07 + 3.41 = 48.47$$
 watts

$$Q_{\text{Total Heat Leaks}} = 48.47 \text{ Watts}$$

<u>b) Product Loads;</u>

Through our knowledge, experience and facts and figures of Ihsan and Tahseen al-Baalbaki products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore this type of Bottle Commercial Refrigerator we calculated as follow;

Total inside net volume is 1.085 x 1.59 x .59 = 1.02 Cubic Meter

Total internal volume = 1020 lit.

$$Q_{\text{Product}} = mxC(T_{\text{bottle}} - T_{\text{inside}})$$

Where:

m = Mass of total bottle kept in the refrigerator = 500 bottle of 1/3 litter C= Specific heat of Soft Drink Liquid, which is slightly bigger than pure water, (because of the more density sugar and additives)

$$m = 500x 1/3 = 166$$

 $Q_{Product load} = 166 x 1.1 x 5 x 1.163 = 916$

c) Heat gain through infiltration;

Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = $0.2 \times (\text{total heat leaks} + \text{product loads})$

Heat gain by infiltration = $0.2 \times (48.47 + 916.65) = 193 \text{ Watts}$

Total Cooling Capacity Required for Model BNOR-S122 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{Grand\ Total} = 48.47 + 916.65 + 193.02 = 1158\ Watts$$

Bottle Show Case Model BNOR-S88

a) Transmission load calculation

<u>Table I</u> Dimensions

| | Dimension Cm. | Area (sq. mt.) | Insulation Thickness |
|-------------------|------------------|----------------|-------------------------|
| Side Walls | 2 x (59x159) | 1.88 | 44 |
| Back Panel | 80 x 159 | 1.27 | 44 |
| Top Roof | 59 x 80 | 0.47 | 70 |
| Bottom Floor | 59 x 80 | 0.47 | 70 |
| Double Door Glass | 80 x 159 | 1.27 | 15 |

Insulation Type: Pu Foam

R141b Expanded PU Foam Thermal Conductivity: 0.017 W /mt.C

Still Air Thermal Conductivity: 0.00128 W /mt.C

With regard to the thickness of the glass comparing to the 15 mm still air thickness between double glass door we neglect the glass thermal—conductivity

Temperature Difference: $(\Delta T) = 32 - (10) = 22 \text{ C}$

\mbient Temperature = 32 C

Show Case Air Temperature = 10 C

_alculation:

$$Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{TOP} + Q_{DOOR}$$

$$Q = U A (T_a - T_f)$$

$$U = \frac{1}{X_1 / K_1 + X_2 / K_2 + \dots}$$

_'here:

U = Heat Resistance Coefficient Factor

 K_1 = Foam Thermal Conductivity

X₁ = Foam Thickness

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 Note: Due to the short thickness of cabinet out side panel (0.6 mm) and inner liner, heat resistance of these materials have been considered negligible.

Therefore:

1-
$$Q \text{ SideWalls} = [U A (T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.044/0.017) = 0.39 W/ sq.m C A = 1.88 Sq. Mt. $T_a = 32 \text{ C}$ $T_f = 10 \text{ C}$

Q
$$_{\text{SideWalls}} = 0.39 \times 1.88 \times 22 = 16.13 \text{ Watts}$$

Q SideWalls = 16.13 Watts

$$= 2 - Q_{Back panel} = [UA(T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.044/0.017) = 0.39 W/ sq.m C A = 1.27 Sq. Mt. $T_a = 32 \text{ C}$ $T_f = 10 \text{ C}$

$$Q_{Back panel} = 0.39 \times 1.27 \times 22 = 10.9 Watts$$

Q Back panel = 10.9 Watts

$$3 - Q_{Top} = [UA(T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.070/0.017) = 0.24 W/ sq.m C A = 0.47 Sq. Mt. $T_a = 45 \text{ C}$ $T_f = 10 \text{ C}$

 $Q_{Top} = 0.24 \times 0.47 \times 35 = 3.95 \text{ Watts}$

 $Q_{Top} = 3.95 Watts$

4 -
$$Q_{Bottom} = [U A (T_a - T_f)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

U = 1/(0.070/0.017) = 0.24 W/ sq.m C A = 0.47 Sq. Mt. $T_a = 32$ C $T_f = 10$ C

Q $_{\text{Bottom}} = 0.24 \times 0.47 \times 22 = 2.48 \text{ Watts}$

Q Bottom = 2.48 Watts

$$5 - Q_{Door} = [UA(Ta - Tf)]$$

 T_a = Ambient Temperature T_f = Inside Air Temperature

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U = 1/(0.015/0.00128) = 0.09 W/ sq.m C A = 0.1.27 Sq. Mt. $T_a = 32 \text{ C}$ $T_f = 10 \text{ C}$

 $Q_{Door} = 0.09 \times 1.27 \times 22 = 2.51 \text{ Watts}$

Q Door = 2.51 Watts

Total Heat Leaks;

 $Q_{TL} = 16.13 + 10.9 + 3.95 + 2.48 + 2.51 = 35.97$ watts

Q Total Heat Leaks = 35.97 Watts

b) Product Loads;

Through our knowledge, experience and facts and figures of Ihsan and Tahseen al-Baalbaki products we found out that calculation of product loads for each individual model depends upon many factors that we could mention briefly as follows:

- Product design;
- Product style;
- Company policy;
- Useful internal volume;
- Type of evaporator;
- Type of cellar compartment;
- Freezer volume;
- Culture of customer;
- Country of origin and etc.;

Therefore this type of Bottle Commercial Refrigerator we calculated as follow;

Total inside net volume is $0.80 \times 1.59 \times 0.59 = 0.750$ Cubic Meter

Total internal volume = 750 lit.

$$Q_{Product} = mxC(T_{bottle} - T_{inside})$$

- Where:

m = Mass of total bottle kept in the refrigerator = 300 bottle of 1/3 litter C= Specific heat of Soft Drink Liquid, which is slightly bigger than pure water, (because of the more density sugar and additives)

$$m = 300x 1/3 = 100$$

 $Q_{Product load} = 100 x 1.1 x 5 x 100 x 1.163 = 639.65$

- c) Heat gain through infiltration;
- Total heat gain through infiltration (door opening, and gasket) are considered to 20 % of total heat gain by conduction and heat removed from products, therefore;

Heat gain by infiltration = $0.2 \times (total heat leaks + product loads)$

Heat gain by infiltration = $0.1 \times (35.97 + 639.65) = 135.12 \text{ Watts}$

Total Cooling Capacity Required for Model BNOR-S188 are calculated as follows;

$$Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{infiltration}}$$

$$Q_{Grand\ Total} = 35.97 + 639.65 + 135.12 = 810\ Watts$$

The compressor Model CAE4460 manufactured by TECOMSEH of France with a cooling capacity of 920 watt was chosen as a replacement of existing R12 compressor. The other components remained un-changed, They will be adjusted respectively as required during trial test.

Section II

Calculation Methods Analysis

In preparation of the first progress report, we have chosen an appropriate method for our refrigeration load calculation. To respond our design and configuration requirements, choosing an appropriate method of refrigeration load calculation is the aim of selecting compatible components.

The method of refrigeration load calculation for a new design refrigerator could be completely different, in comparison with converting the existing Commercial refrigerators in production, because, in this case, we are not looking for the new nature of each refrigerator component or parts. In contemporary with designing new refrigerator model, we have to consider many parameters, such as heat leaks from outside through, wedge, orners, door gasket, door infiltration, door openings, heat radiation dissipated from condenser and compressor shell and etc.

A number of heat load parameters for cabinet loads in addition to the vall conduction loads could be considered. These include: electric defrost, enetrations, heaters and controls, fan heat, refrigerant line heat, in-wall evaporator, in-mullion evaporator, and in-wall condenser.

- The total values shown for the cabinet type refrigerator are the hourly average loads, which must be removed by refrigeration system.

For the purpose of determination of energy consumption, two cooling

capacities should be considered:

- 1) Evaporator load,
- 2) Net capacity.

Normally these two quantities are the same. If a cold-plate evaporator is used, however, the total evaporator load will be higher than the net capacity due to the heat going directly to the back of the evaporator through the insulation.

In our case, which the main consideration is selecting compatible components with existing refrigeration components, the method of refrigeration load calculation is different from the refrigeration load calculation of the new design products.

We will discuss three different methods of refrigeration load calculations, from following sources;

- 1) EPA Refrigerator Analysis Programme (ERA).
- 2) Ariston Co.'s methods of refrigeration load calculation.
- 3) ASHRAE standards of refrigeration load calculation.

EPA (Environmental Protection Agency) Refrigerator Analysis

For this method, following data are required for cabinet loads:

- 1) Cabinet Type and Dimension, as follows;
- Cabinet height is measured from the bottom to top of the cabinet, not the floor.
- Depth includes the cabinet door. This dimension measures the distance from the outside (front) surface of doors to the back of the cabinet
- Width of the gasket and the door edge thickness. The effects of door thickness on the internal volume are taken into account.
- Wedge dimensions, the cabinet wedge is the section of the cabinet near the door. In all cabinet types, except the chest freezer, the thickness of the insulation is reduced near the door to accommodate the door geometry.
- 2) Refrigerated volume;

ERA considers calculation of internal volume of the cabinet compartment based on the input data for the cabinet dimensions. The calculated volume is used in the simulation of the contribution to the cabinet loads from door openings.

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Normally, the compressor will be located in a space at the near, bottom of the cabinet, where it is cooled by air blown over the condenser or by natural convection. This space requirement will reduce the storage volume of the cabinet located above, and will also affect the net external surface area available for heat exchange with the room.

3) Freezer and Fresh Food Cabinets;

The wall and door thickness and also insulation resistively for each wall element and door are required to calculate the sum of thermal resistivities. The resistivity and thickness determine the net resistance of each cabinet element.

The specified thickness of wall containing a sandwich of a foam and vacuum insulation panel should be the total thickness (neglecting the thickness of the liner). When a composite insulation system is used, an average resistivity for the wall should be specified. The general case assumes a vacuum insulation panel located between inner and outer foam panels and surrounded foam along all four edges.

4) Air and Cabinet Temperature

The room air and cabinet temperatures establish the heat loads of each compartment on the refrigeration system. For DOE closed door test simulation a room air temperature of 32.2 C° is ordinary specified, along with a freezer temperature of -15 C° and fresh food cabinet temperature of 3.3 C°. Temperatures must also be specified for under cabinet (where the compressor is normally located) and for "air entering the condenser."

5) Door Opening Schedule

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The schedule of door opening is defined here to establish the net sensible and latent heat inputs to the cabinet during the hour. The controlling parameters are, the room relative humidity, the number of times each door is opened during the hour, and the average duration of each opening.

Parameters controlling the sensible and latent loads are, room temperature, cabinet temperature, room relative humidity, number of openings/hour, average duration of each door opening, and type of defrosting (manual or automatic). The typical schedule for door openings might be;

| Commercial Fresh food door | Opening/hr. Duration (sec) | 5 20 |
|----------------------------|-------------------------------|---------|
| Freezer door | Opening/hr. Duration (sec) | 1 15 |

6) Gasket Heat Leak

The gasket areas around the cabinet doors are sources of heat due to conduction loads from the room air along the cabinet and door flanges, and through the gasket itself. Correct estimates of the heat leaks must take into consideration the geometry and materials used in the wall panels and doors.

All gasket heat leaks are expressed in units of conductance per length of the gasket. The net leak is determined by the program, from the total door perimeter and from the outside-inside air temperature difference.

7) Others such as: defrost and control's energy use, electrical anti-sweat heat, refrigerant line anti-sweat heat, and penetration heat input.

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- Refrigerator side areas.
- Drops retainer.
- · Back panel rear areas.
- · Refrigerator gasket.
- Freezer side areas.
- · Freezer gasket.
- 1) Determination of thermal conductivity for following materials.
 - Expanded polyurethane.
 - Magnetic gasket

Note. In order to make calculation easier, select the average thickness of sloping surfaces, assuming that the whole insulation thickness is of one single material in polyurethane, expanded polystrol PVC.

The total thermal loss in Kcal/hr. are those necessary to face all dispersions at 43 °C. Then, the heat in Kcal/hr. obtained at temperature of 32 °C are to be found and must be then added to those necessary to freeze 3 kg of water in 24 hr. In order to obtain functionality relation of the compressor at 43°C, we divide total thermal loss at 32 °C by total thermal loss at 43 °C ambient temperature.

Method of Heat Leak Load Calculation Established by ASHRAE Standard

- 1) Heat gain by conduction, in Kcal/hr. Through;
 - Refrigerator side areas.
 - Refrigerator gaskets.
 - Refrigerator door.

Method of Heat Load Calculation by Ariston Home Appliance Manufacturing Company of Italy

In this method, the whole refrigerator circuit is designed in such manners to face the possible leakage deriving from working under stand by conditions, with an ambient temperature of 43 degree centigrade, granting at the same time the freezing at least 3 kg/24hrs. of water at temperature of 48 °C or 5 kg/24hrs of water at 32 °C.

Determination of total heat loads;

- 1) In conservation at 43 °C of outside temperature.
- 2) In freezing at 32 °C of outside temperature.
- Measuring all the thermal loss surfaces and thickness thereof.
- 4) Calculate the (t) relevant to the single surfaces at following conditions;
 - 43 °C outside temperature, except 60 °C compressor shell area
 - 55 °C Condenser side.
 - 0 °C refrigerator medium temp.
 - -23 °C freezer air temp.
 - -26 °C evaporator temp.
- Determination of thermal loss for following areas;
 - Refrigerator door.
 - Crisper support area.
 - Crisper back area.
 - Crisper side area.
 - Compressor upper area.

- Crisper side areas.
- Freezer side areas.
- Mullion area, positive to freezer compartment.
- Back panel
- 2) Determination of thermal conductivity of following materials;
 - Cabinet carbon steel.
 - Polyurithane of foam.
 - Door and freezer gasket.
 - Inner liner plastic
 - Air, between mullion and evaporator.
- 3) The heat resistance of coefficient factor, with regard to average thickness of each substance.
- 4) Determination of product heat load as follows;
- Heat removed from products above freezing point in fresh food compartment.

Note: The amount of product weight kept in fresh food compartment depends upon. Internal volume and different products selected by the manufacturer.

- Heat removed from products from initial temperature to freezing point in Freezer compartment.
- Heat removed from freezing point to final temperature below freezing point in Freezer compartment.
 - Heat removal to freeze products (latent heat), in freezer compartment.

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Note: The amount of product weight kept in Freezer compartment depends upon. Internal volume and different products selected by the manufacturer.

5) Calculation of total heat gain through refrigerator, evaporator, and heat removal per hour form product.

Note: The amount of heat removal from product are in 24 hrs. daily, in order to obtain total heat removal per hour we divide it by desired Compressor operating time in 24 hr.

- 6) To determine the grand total of the heat load, we add ten percent of the total heat gain. This ten to twenty percent additional load is for door openings, infiltration, and wedge and edge thermal loss, depending type of refrigerator and freezer.
- Component Selection

Section III

Conclusion;

With respect to the calculations and our experience we made following prototypes with selected components suitable components for R134a refrigeration system.

Two models of water cooler prototypes will be tested for performance and functionality as soon as we can have our HOT CHAMBER operational. The hot chamber is not suitable for testing R134a prototypes due to the lack of test equipment such as temperature adequate sensors and suitable software and data logging system.

1- Bottle Water Cooler Model WB.6

- Compressor model AZ 4412YH Techomseh
- Cooling Capacity 157 watts at 10 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 10% reduced
- Capillary 15 % increased
- Other Components remained un-changed.

2- Two Taps Water Cooler Model W12

- Compressor model AZ 4412 YH Techomseh
- Cooling Capacity 157 watts at 10 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 10% reduced
- Capillary 15 % increased
- Other Components remained un-changed.

3- Two Big Top Tap Water Cooler Model W18

- Compressor model AZ 3414YH Techomseh
- Cooling Capacity 187 watts at 10 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 10% reduced
- Capillary 15 % increased
- Other Components remained un-changed.

4- Two Front Tap Water Cooler Model WB 12L

• Compressor model AZ 3414 YH Techomseh

FAX.00962-6-4648711 TEL. 4624745 AMMAN-JORDAN

- Cooling Capacity 187 watts at 10 C evaporating Temp.
- Drier type XH9
- R134a Refrigerant charge 10% reduced
- Capillary 15 % increased
- Other Components remained un-changed.

5- Two Medium Front Tap Water Cooler Model WB 18L

- Compressor model AZ 3414 YH Techomseh
- Cooling Capacity 187 watts
- Drier type XH9
- R134a Refrigerant charge 10% reduced
- Capillary 10 % increased
- Other Components remained un-changed

6- Dairy Refrigerator Model BNOR-S122

- Compressor model CAJ4492 HR Techomseh
- Cooling Capacity 1742 watts at 0 C evaporating Temp.
- Drier type Commercial.
- R134a Refrigerant charge 445 gr.
- Other Components remained un-changed.

7- Dairy Refrigerator Model BNOR-S88

- Compressor model CAE4440 841 HR Techomseh
- Cooling Capacity 1179 watts at 0 C evaporating Temp.
- Drier type Commercial.
- R134a Refrigerant charge 260 gr.
- Other Components remained un-changed.

8- Small Show Case Refrigerator Model BRS5-WN

- Compressor model Danfoss TC 48
- Cooling Capacity 179 watts at 10 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 125 gr.
- Other Components remained un-changed.

9- Chest Freezer model BCF-100

- Compressor model OF 700V
- Cooling Capacity 150 watts at 23 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 65 gr.
- Other Components remained un-changed.

10- Chest Freezer model BCRY-380

- Compressor model ASPERA B1118Z
- Cooling Capacity 550 watts at 23 C evaporating Temp.
- Drier type XH7
- R134a Refrigerant charge 210 gr.
- Other Components remained un-changed.

| Product Technical Detail Specification | | | |
|--|------------------------------------|--|--|
| Proto Type No, | 1 | | |
| Description | | | |
| Product Name, | Bottel Watter Coolerمبرد ماء قنينة | | |
| Product Model, | WB.6. | | |
| Body finish, | Stainless Steel. | | |
| U.S.G/Liter Tank Capacity, | (6 Gallons/Hr.) or. (22 Lir/Hr.) | | |
| Water Inlet Temperature, C | 24 C | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 110 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 136 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle R12, | AZ 1355 D. | | |
| Comp. Cooling Capacity Watt, R134a | 144 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle R134a, | AZ 1358 Y. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Tank Capacity, lit, | 1 Ltr. | | |
| Net Weight: Kg. | 35 Kg. | | |
| Overall Dimension: HXWXL: cm. | 30 cm X 30 cm X 140 cm. | | |
| Water Flow Rate, Lit./S | (0.36 Ltr./rn). | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Tank Dim. mm. | 1 ltr. | | |
| Water inlet Pipe Dim. mm. | No. Conection. | | |
| Evaporator Type, | Cylender. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 150 g. | | |
| Refrigerant Charge Gr. R134a, | 155 g. | | |
| Drier Type and Weight, | 10 g. | | |
| Foam Type, | Polesterin. | | |
| Wall Thickness/ Foam thickness, mm. | 2.5 cm. | | |

مانف ص.ب ۱ ه برقیاً : د فریز » تلکس ۱۹۵۷ کا ایفاجو

شركة احسان و تحسين البعلبكي مصنع الثلاجات وغرف التبريد والمطابخ الامريكية والاثاث المعدني

الحل الوئيسي شارع الامير محد عمان الارمىت

Water Coolers

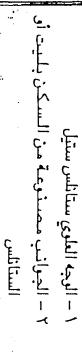


للركلة احمسان وتحسيلن البعلبكي

مببردات مساء قنينسسة

| Product Technical Detail Specification | | | |
|--|-----------------------------------|--|--|
| Proto Type No, | 2 | | |
| Description | | | |
| Product Name, | TWO TOP TAP WATER COOLER | | |
| | مبرد ماء حنفيتين كبس من الأعلى | | |
| Product Model, | WC12. | | |
| Body finish, | Stainless Steel. | | |
| U.S.G/Liter Tank Capacity, | (12 Gallons/Hr.) or. (45 Lir/Hr.) | | |
| Water Inlet Temperature, C | 24 C | | |
| Designated Comp. Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 150 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 154 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R12 | AZ 1360 D. | | |
| Comp. Cooling Capacity Watt, R134a | 177 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R134a. | AZ 136. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Tank Capacity, lit, | 15 Ltr. | | |
| Net Weight: Kg. | 40 Kg. | | |
| Overall Dimension: HXWXL: cm. | 32 cm X 32 cm X 120 cm. | | |
| Water Flow Rate, Lit./S | (0.36 Ltr./n·). | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Tank Dim. mm. | 15 ltr. | | |
| Water inlet Pipe Dim. mm. | 1/2 Inc. | | |
| Evaporator Type, | Cylender. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 170 g. | | |
| Refrigerant Charge Gr. R134a, | 180 g. | | |
| Drier Type and Weight, | 10 g. | | |
| Foam Type, | Polesterin. | | |
| Wall Thickness/ Foam thickness, mm. | 2.5 cm. | | |

المواصفات



٢ - حنفيتين كبس عى الوجه العلوي

- مجهز بثرموستات للتحكم في درجة البرودة

معزول من الداخل بمادة السفوم
 العمل على موتور أحسى من أفضل الإنواع

٧- القدرة الانتاجية يعطي من ١٠٠ - ١٠ جلن ماء
 ١٠٠ بادر في الساعة تقريباً
 ٨ - المواسير الداخلية من أفضل الانواع

أ - يعمل هذا المبرد في النوائر الحكومية
 والستشفيات والجامعات والدارس والمطاعم

١٠ - القياس حسب ماهو موضيح بالرسم

١١ – من أنتاج شركة أحسان وتحسين البعلبكي

| مشسركة اجدسان قيسين ليبييي | القوم | منعق لميت بستانده مساعطا زاد | 32 X 32 X 👵 cm | مندوم ورين. | واضفادت |
|---|-------|------------------------------|----------------|-------------|---------|
| 01. 12. 12. 12. 12. 12. 12. 12. 12. 12. 1 | إسازل | 250 | المنباد | ہنوے | 1 |

| Product Technical Detail Specification | | | |
|--|------------------------------------|--|--|
| Proto Type No, | 3 | | |
| Description | | | |
| Product Name, | TWO BIG TOP TAP WATER COOLER | | |
| | مبرد ماء حنفيتين كبيركبس من الأعلى | | |
| Product Model, | WC18. | | |
| Body finish, | Stainless Steel. | | |
| U.S.G/Liter Tank Capacity, | (18 Gallons/Hr.) or. (66 Lir/Hr.) | | |
| Water Inlet Temperature, C | 24 C | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 185 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 194 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R12 | AEZ 1380. | | |
| Comp. Cooling Capacity Watt, R134a | 177 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R134a. | AEZ 1365. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Tank Capacity, lit, | 20 Ltr. | | |
| Net Weight: Kg. | 47 Kg. | | |
| Overall Dimension: HXWXL: cm. | 42 cm X 42 cm X 120 cm. | | |
| Water Flow Rate, Lit./S | (0.65 Ltr./m). | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Tank Dim. mm. | 15 ltr. | | |
| Water inlet Pipe Dim. mm. | 1/2 Inc. | | |
| Evaporator Type, | Cylender. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 175 g. | | |
| Refrigerant Charge Gr. R134a, | 180 g. | | |
| Drier Type and Weight, | 15 g. | | |
| Foam Type, | Polesterin. | | |
| Wall Thickness/ Foam thickness, mm. | 2.5 cm. | | |

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المواصفات

اليجه العلوي ستائلس ستيل ٢ - الجوانب مصنوعة من

الستانلس

٢ - حنفيتين كبس عي الوجه العلوي

٤ - مجهز بثرموستات للتحكم في درجة البرودة

ه - معزول من الداخل بمادة الفوم

٦ - يعمل على موتور } مِنبرع من أفضل الأنواع
 ٧ - القدرة الأنتاجية يعطي من ١٠ - ١٣ جلن ماء

بادر في الساعة تقريباً

٨ - المواسير الداخلية من أفضل الانواع

٩ - يعمل هذا المبرد في النوائر الحكومية
 والستشفيات والجامعات والمدارس والمطاعم

١٠ – القياس حسب ماهو موضع بالرسم

١١ - من أنتاج شركة أحسان وتحسين البعلبكي

| مشسركة احسسان قيسين لبيليي | القوم | برشائده مسيا نصكارُلِهِ | 42×42×102 cm | صبروم اورشان به | واصفات |
|----------------------------|-------|-------------------------|--------------|-----------------|--------|
| El El | اعمزن | ارة إعباء | يرباد | ابوع | F |

| Product Technical Detail Specification | | | |
|--|-----------------------------------|--|--|
| Proto Type No, | 4 | | |
| Description | | | |
| Product Name, | TWO FRONT TAP WATER COOLER | | |
| | مبرد ماء حنفيتين كبس أمامية | | |
| Product Model, | WC12L. | | |
| Body finish, | Stainless Steel. | | |
| U.S.G/Liter Tank Capacity, | (12 Gallons/Hr.) or. (45 Lir/Hr.) | | |
| Water Inlet Temperature, C | 24 C | | |
| Designated Comp Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 150 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 154 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R12 | AEZ 1360. | | |
| Comp. Cooling Capacity Watt, R134a | 177 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R134a. | AZ 136. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Tank Capacity, lit, | 15 Ltr. | | |
| Net Weight: Kg. | 43 Kg. | | |
| Overall Dimension: HXWXL: cm. | 42 cm X 42 cm X 105 cm. | | |
| Water Flow Rate, Lit./S | (0.36 Ltr./m). | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Tank Dim. mm. | 15 ltr. | | |
| Water inlet Pipe Dim. mm. | 1/2 Inc. | | |
| Evaporator Type, | Cylender. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 170 g. | | |
| Refrigerant Charge Gr. R134a, | 180 g. | | |
| Drier Type and Weight, | 10 g. | | |
| Foam Type, | Polyurethane 38kg/mc. | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | |

المواصفات

١ - مادة الصنع ستانلس ستيل + سكن بليت ٢ – يعمل بصورة أتوماتيكية

۲ - مجهز بحنفیتین کروم

٤ – يتحمل الصدمات

ه - يعبأ الماء بصورة أتوماتيكية

٢ - يعطي ١٤ جلن ماء بارد في الساعة تقريباً
 ٧ - خاص بالمستشفيات والمدارس والبنوك

F F

والمطاعم الكبيرة

٨ - يعمل على موتور فرنس من أفضل الأنواع ٩ – مادة العازلة فوم

Θ

١١ – مجهز بثرموستات للتحكم في البرودة ١٠ - المواسير الداخلية من أفضل الأنواع

١٢ - القياس كما هو موضع بالرسم

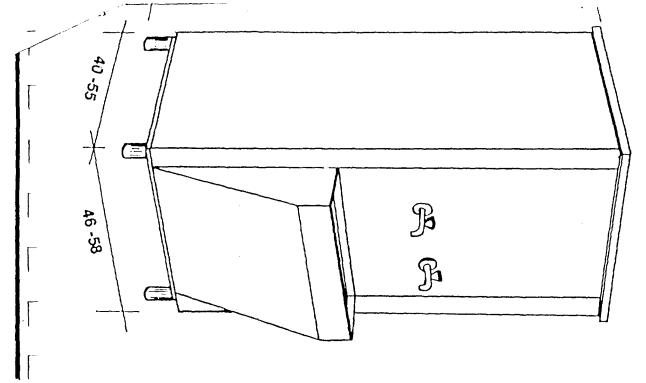
١٢ – من أنتاج شركة أحسان وتحسين البعلبكي

متسرنعاميها رس ماسين البعيلي المحديث مركائس معادلالرثوم 40 X 46 X 102 cm 55 X 58 X 130 cm ブルノ 130 ر عن-. Je.

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46-58

| Product Technical Detail Specification " | | | |
|--|-------------------------------------|--|--|
| Proto Type No, | 5 | | |
| Description | | | |
| Product Name, | TWO MEDUM FRONT TAP WATER COOLER | | |
| , , , , , , , , , , , , , , , , , , , | مبرد ماء حنفيتين كبس أمامية حجم وسط | | |
| Product Model, | WC18L. | | |
| Body finish, | Stainless Steel. | | |
| U.S.G/Liter Tank Capacity, | (18 Gallons/Hr.) or. (66 Lir/Hr.) | | |
| Water Inlet Temperature, C | 24 C | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 185 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 194 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R12 | AEZ 1380. | | |
| Comp. Cooling Capacity Watt, R134a | 177 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, R134a. | AEZ 1365. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Tank Capacity, lit, | 20 Ltr. | | |
| Net Weight: Kg. | 48 Kg. | | |
| Overall Dimension: HXWXL: cm. | 42 cm X 60 cm X 105 cm. | | |
| Water Flow Rate, Lit./S | (0.65 Ltr./m). | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Tank Dim. mm. | 25 ltr. | | |
| Water inlet Pipe Dim. mm. | 1/2 Inc. | | |
| Evaporator Type, | Cylender. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 175 g. | | |
| Refrigerant Charge Gr. R134a, | 180 g. | | |
| Drier Type and Weight, | 15 g. | | |
| Foam Type, | Polyurethane 38kg/mc. | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | |



المواصفات

١ - مادة الصنع ستانلس ستيل + سكن بليت

٢ – يعمل بصورة أتوماتيكية

۲ - مجهز بحنفیتین کروم

٤ – يتحمل الصدمات

ه - يعبأ الماء بصورة أتوماتيكية

٦ - يعطي ١٤ جلن ماء بارد في الساعة تقريباً
 ٧ - خاص بالمستشفيات والمدارس والبنوك

والمطاعم الكبيرة

٨ - يعمل على موتور فرنس من أفضل الأنواع

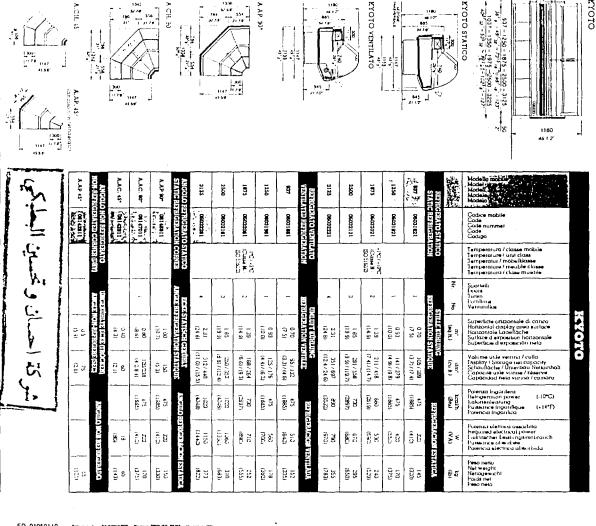
١١ – مجهز بثرموستات للتحكم في البرودة ٩ - مادة العازلة فوم
 ١٠ - المواسير الداخلية من أفضل الأنواع

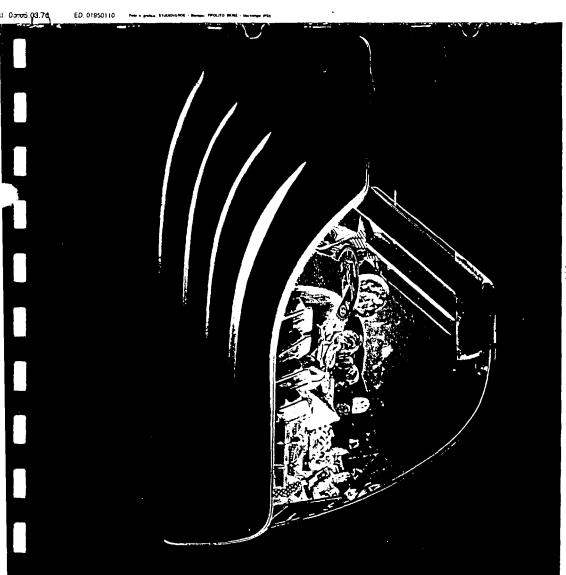
١٢ – القياس كما هو موضيح بالرسم

رًا ١٠ من أنتاج شركة أحسان وتحسين البعلبكي

| | | 7 | Table 1 | |
|------------------------------|-----------------------------|--------------------------------------|----------------|---------|
| مشسركة احسارت وكسيزن البعيكي | كمعربية مركانس معاهلالإرثوم | 40 X 46 X 102 cm 55 X 58 X 130 cm | ر مادم | وإص فات |
| 3: 2 | المجنور | لعبا و | اليوع | F |

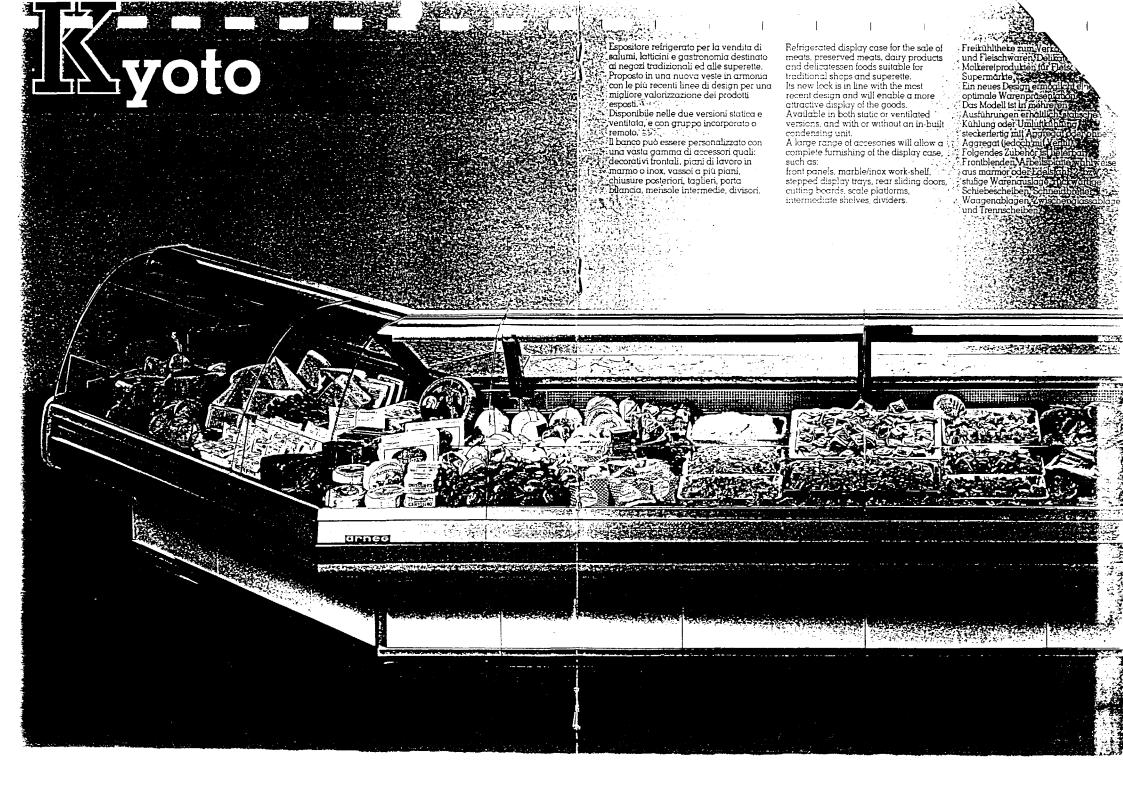
| Product Technical Detail Specification | | | |
|--|--------------------------------|--|--|
| Proto Type No, | 6 | | |
| Description | | | |
| Product Name, | Show Case 180 cm. | | |
| | ثلاجة عرض ١٨٠ سم . | | |
| Product Model, | Kyoto 180 cm. | | |
| Body finish, | Stainless Steel/ Skin plate | | |
| Internal Volume, lit. | 500 ltr. | | |
| Glass Type and Thickness. | Round, 1 layer 6 mm. | | |
| Cabinet Temperature, C. | 5 C. | | |
| Freezer, Temperature, C. | 2 C. | | |
| Air Flow, CFM/Cubic Meter, | Static. | | |
| Electrical Heat, Lamp, Fan, / Watt | 250 Watt Heater, 25 Watt Lamp. | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 600 Watt - 700 WATT. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 620 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, | CAJ 2 T 12. | | |
| Comp. Cooling Capacity Watt, R134a | 611 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, | AEZ 3425 Y | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Net Weight: Kg. | 450 Kg. | | |
| Overall Dimension: HXWXL: cm. | 180 cm X 135 cm X 80 cm. | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Evaporator Type, | Fins. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 1500 g. | | |
| Refrigerant Charge Gr. R134a, | 1500g. | | |
| Drier Type and Weight, | 15 g. | | |
| Foam Type, | Polyurethane | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | |







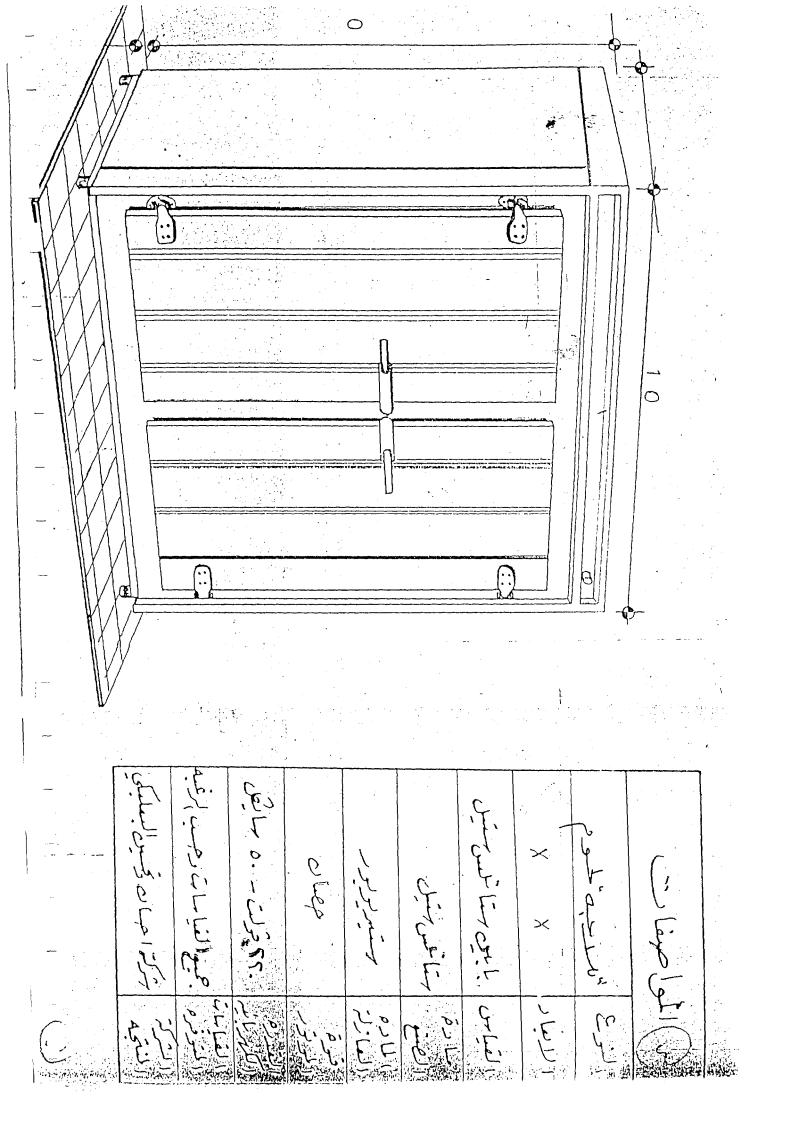
| Product Technical Detail Specification | | | | |
|--|--------------------------------|--|--|--|
| Proto Type No, | 7 | | | |
| Description | | | | |
| Product Name, | Show Case 250 cm. | | | |
| · | ثلاجة عرض ٢٥٠ سم . | | | |
| Product Model, | Kyoto 250 cm. | | | |
| Body finish, | Stainless Steel/ Skin plate | | | |
| Internal Volume, lit. | 900 ltr. | | | |
| Glass Type and Thickness. | Round, 1 layer 6 mm. | | | |
| Cabinet Temperature, C. | 5 C. | | | |
| Freezer, Temperature, C. | - 10 C. | | | |
| Air Flow, CFM/Cubic Meter, | Static. | | | |
| Electrical Heat, Lamp, Fan, / Watt | 500 Watt Heater, 50 Watt Lamp. | | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | | |
| Appliance Calcultaed, Cooling | 650 Watt. | | | |
| Capacity Watt, | | | | |
| Comp. Cooling Capacity Watt, R12 | 1028 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | TAH 2445 A. | | | |
| Comp. Cooling Capacity Watt, R134a | 1245 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | CAE 4448 Y | | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | | |
| Net Weight: Kg. | 650 Kg. | | | |
| Overall Dimension : HXWXL : cm. | 250 cm X 135 cm X 80 cm. | | | |
| Operating Ambient Temperature, C. | 30 C. | | | |
| Evaporator Type, | Fins. | | | |
| Condenser Type, | Fins. | | | |
| Refrigerant Charge Gr. R12, | 1800 g. | | | |
| Refrigerant Charge Gr. R134a, | 1800 g. | | | |
| Drier Type and Weight, | 60 g. | | | |
| Foam Type, | Polyurethane | | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | | |



| Product Technical Detail Specification | | | |
|--|----------------------------------|--|--|
| Proto Type No, | 8 | | |
| Description | | | |
| Product Name, | One door Refrigerator | | |
| | ثلاجة لحوم ستانلس ستيل باب واحد. | | |
| Product Model, | ODR700. | | |
| Body finish, | Stainless Steel | | |
| Internal Volume, lit. | 700 ltr. | | |
| Glass Type and Thickness. | CLOSED NO WINDOWS. | | |
| Cabinet Temperature, C. | 5 C. | | |
| Freezer, Temperature, C. | - 10 C. | | |
| Air Flow, CFM/Cubic Meter, | Static. | | |
| Electrical Heat, Lamp, Fan, / Watt | 0 Watt Heater, 0 Watt Lamp. | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | |
| Appliance Calcultaed, Cooling | 300 - 400 Watt. | | |
| Capacity Watt, | | | |
| Comp. Cooling Capacity Watt, R12 | 311 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle, | AZ 4414 Y. | | |
| Comp. Cooling Capacity Watt, R134a | 344 Watt. | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | |
| Comp. Modle , | CAE 2412 Y. | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | |
| Net Weight: Kg. | 350 Kg. | | |
| Overall Dimension: HXWXL: cm. | 70 cm X 70 cm X 220 cm. | | |
| Operating Ambient Temperature, C. | 30 C. | | |
| Evaporator Type, | Fins. | | |
| Condenser Type, | Fins. | | |
| Refrigerant Charge Gr. R12, | 550 g. | | |
| Refrigerant Charge Gr. R134a, | 550 g. | | |
| Drier Type and Weight, | 25 g. | | |
| Foam Type, | Polyurethane | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | |

| Product Technical Detail Specification | | | | |
|--|-------------------------------|--|--|--|
| Proto Type No, | 9 | | | |
| Description | | | | |
| Product Name, | Two Door Refrigerator | | | |
| | ثلاجة لحوم ستانلس ستيل بابين. | | | |
| Product Model, | ODR1400. | | | |
| Body finish, | Stainless Steel | | | |
| Internal Volume, lit. | 1400 ltr. | | | |
| Glass Type and Thickness. | CLOSED NO WINDOWS. | | | |
| Cabinet Temperature, C. | 5 C. | | | |
| Freezer, Temperature, C. | - 10 C. | | | |
| Air Flow, CFM/Cubic Meter, | Static. | | | |
| Electrical Heat, Lamp, Fan, / Watt | 0 Watt Heater, 0 Watt Lamp. | | | |
| Designated Comp. Working Hr/Day, | 20 Hr/Day | | | |
| Appliance Calcultaed, Cooling | 980 Watt - 1200 Watt | | | |
| Capacity Watt, | | | | |
| Comp. Cooling Capacity Watt, R12 | 1028 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | TAH 2445 A. | | | |
| Comp. Cooling Capacity Watt, R134a | 1022 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | CAE 4448 Y | | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | | |
| Net Weight: Kg. | 550 Kg. | | | |
| Overall Dimension: HXWXL: cm. | 140 cm X 70 cm X 220 cm. | | | |
| Operating Ambient Temperature, C. | 30 C. | | | |
| Evaporator Type, | Fins. | | | |
| Condenser Type, | Fins. | | | |
| Refrigerant Charge Gr. R12, | 900 g. | | | |
| Refrigerant Charge Gr. R134a, | 900 g. | | | |
| Drier Type and Weight, | 30 g. | | | |
| Foam Type, | Polyurethane | | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | | |

| Product Technical Detail Specification # | | | | |
|--|-------------------------------|--|--|--|
| Proto Type No, | 10 | | | |
| Description | | | | |
| Product Name, | Two Door Freezer | | | |
| | فريزر لحوم ستانلس ستيل بابين. | | | |
| Product Model, | ODR1400 F. | | | |
| Body finish, | Stainless Steel | | | |
| Internal Volume, lit. | 1400 ltr. | | | |
| Glass Type and Thickness. | CLOSED NO WINDOWS. | | | |
| Cabinet Temperature, C. | -18 C. | | | |
| Freezer, Temperature, C. | -27 C. | | | |
| Air Flow, CFM/Cubic Meter, | VENTILATED. | | | |
| Electrical Heat, Lamp, Fan, / Watt | 0 Watt Heater, 0 Watt Lamp. | | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | | |
| Appliance Calcultaed, Cooling | 1600 WATT - 1700 Watt. | | | |
| Capacity Watt, | | | | |
| Comp. Cooling Capacity Watt, R12 | 1617 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle , | TAH 2466 A | | | |
| Comp. Cooling Capacity Watt, R134a | 1561 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | TAJ 4461 Y. | | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | | |
| Net Weight: Kg. | 550 Kg. | | | |
| Overall Dimension: HXWXL: cm. | 140 cm X 70 cm X 220 cm. | | | |
| Operating Ambient Temperature, C. | 30 C. | | | |
| Evaporator Type, | Fins. | | | |
| Condenser Type, | Fins. | | | |
| Refrigerant Charge Gr. R12, | 1650 g. | | | |
| Refrigerant Charge Gr. R134a, | 1650 g. | | | |
| Drier Type and Weight, | 40 g. | | | |
| Foam Type, | Polyurethane | | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | | |

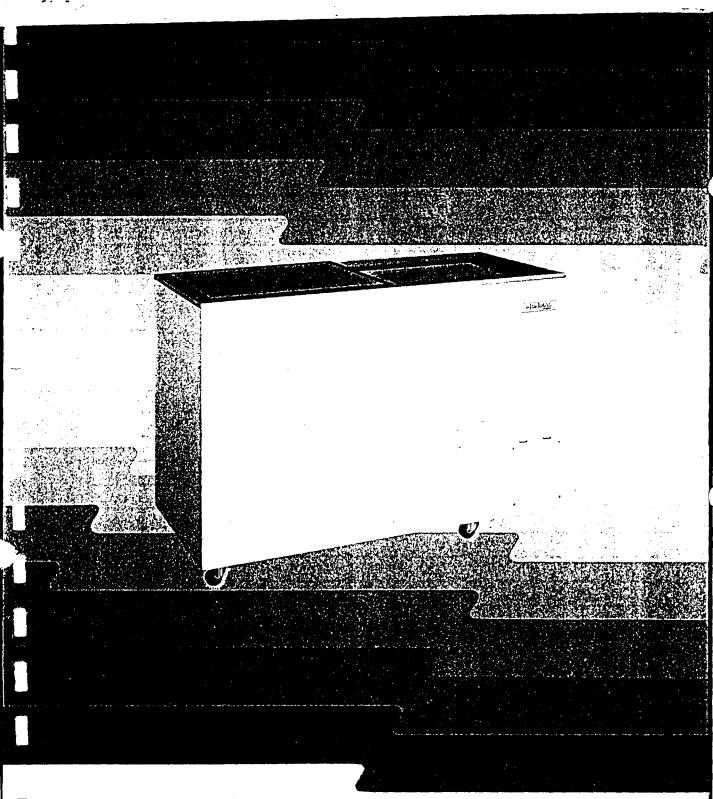


| Product Technical Detail Specification | | | | |
|--|------------------------------|--|--|--|
| Proto Type No, | 11 | | | |
| Description | | | | |
| Product Name, | New Chest frezzer 750 ltr. | | | |
| | فريزر أرضي بطح جديد ٧٥٠ سم. | | | |
| Product Model, | F 750 L. | | | |
| Body finish, | Skin Plate | | | |
| Internal Volume, lit. | 750 ltr. | | | |
| Glass Type and Thickness. | Sliding Door, 3 mm. | | | |
| Cabinet Temperature, C. | -20 C. | | | |
| Freezer, Temperature, C. | -30 C. | | | |
| Air Flow, CFM/Cubic Meter, | Static. | | | |
| Electrical Heat, Lamp, Fan, / Watt | 0 Watt Heater, 0 Watt Lamp. | | | |
| Designated Comp . Working Hr/Day, | 20 Hr/Day | | | |
| Appliance Calcultaed, Cooling | 235 Watt - 300 WATT. | | | |
| Capacity Watt, | | | | |
| Comp. Cooling Capacity Watt, R12 | 311 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | CAE 2412 A. | | | |
| Comp. Cooling Capacity Watt, R134a | 344 Watt. | | | |
| Comp. Manufacture, | L'uniteh Hermatic, Tecumseh. | | | |
| Comp. Modle, | AEZ 3414 Y. | | | |
| Voltage Rate/Hz,Amp, | 220 Volt, 50 Hz. | | | |
| Net Weight: Kg. | 120 Kg. | | | |
| Overall Dimension : HXWXL : cm. | 173 cm X 70 cm X 85 cm. | | | |
| Operating Ambient Temperature, C. | 30 C. | | | |
| Evaporator Type, | Coil. | | | |
| Condenser Type, | Fins. | | | |
| Refrigerant Charge Gr. R12, | 650 g. | | | |
| Refrigerant Charge Gr. R134a, | 650 g. | | | |
| Drier Type and Weight, | 25 g. | | | |
| Foam Type, | Polyurethane | | | |
| Wall Thickness/ Foam thickness, mm. | 5 cm. | | | |

مانف ہے ص.ب ۱ ہے برقیاً : « فریز ر نلکس ۱۵۵۷ کا ایفاجو

شركة احسان و تحسين البعلبكي مصنع الثلاجات وغرف التبريد والمطابخ الامريكية والاثاث المعدني

الحل الوئيسي شارح الامير بحد حمان الارميث



CONSERVATORE A BASSA TEMPERATURA GLASS TOP CONSERVATEUR A BASSE TEMPERATURE GLASS TOP GLASS TOP CABINET AT LOW TEMPERATURE GLASS TOP TRUHE FÜR TIEFE TEMPERATUR

المواصفات

١ - الوجه العلوي ستانلس ستيل
 ٢ - الجوانب مصنوعة من السكن بليت أو الستانلس

٣ - حنفيتين كبس عي الوجه العلوي
 ٤ - مجهز بثرموستات للتحكم في درجة البرودة
 ٥ - معزول من الداخل بمادة الكريول
 ٢ - يعمل على موتورا جبل من أفضل الأنواع
 ٧ - القدرة الانتاجية يعطي من ١٠ - ١٢ جلن ماء
 بادر في الساعة تقريباً

بادر هي الساعه لعريب ۸ - المواسير الداخلية من أفضل الانواع ۹ - يعمل هذا المبرد في الدوائر الحكومية والمستشفيات والجامعات والمدارس والمطاعم ١٠ - القياس حسب ماهو موضع بالرسم

102

R-CFC-134A

| 1 | بنوع | بمربباد | | ्रो. जि.स | सिर्दे निकुष्ट |
|---------|--------------|------------------|---------------------------|--------------|-------------------------|
| واض_فاد | فبيوم ويشاند | 32 X 32 X 102 cm | مكن بيت بستاندمسا دهلازاء | الفوم | مشركة احسان قيبين لبيني |

المواصفات

۱ – مادة الصنع ستانلس ستيل + سكن بليت
 ٢ – يعمل بصورة أتوماتيكية
 ٢ – مجهز بحنفيتين كروم

ع – يتحمل الصدمات ٥ – بين الماء بصبي ة أتومات

٥ – يعبُّ الماء بصورة أتوماتيكية

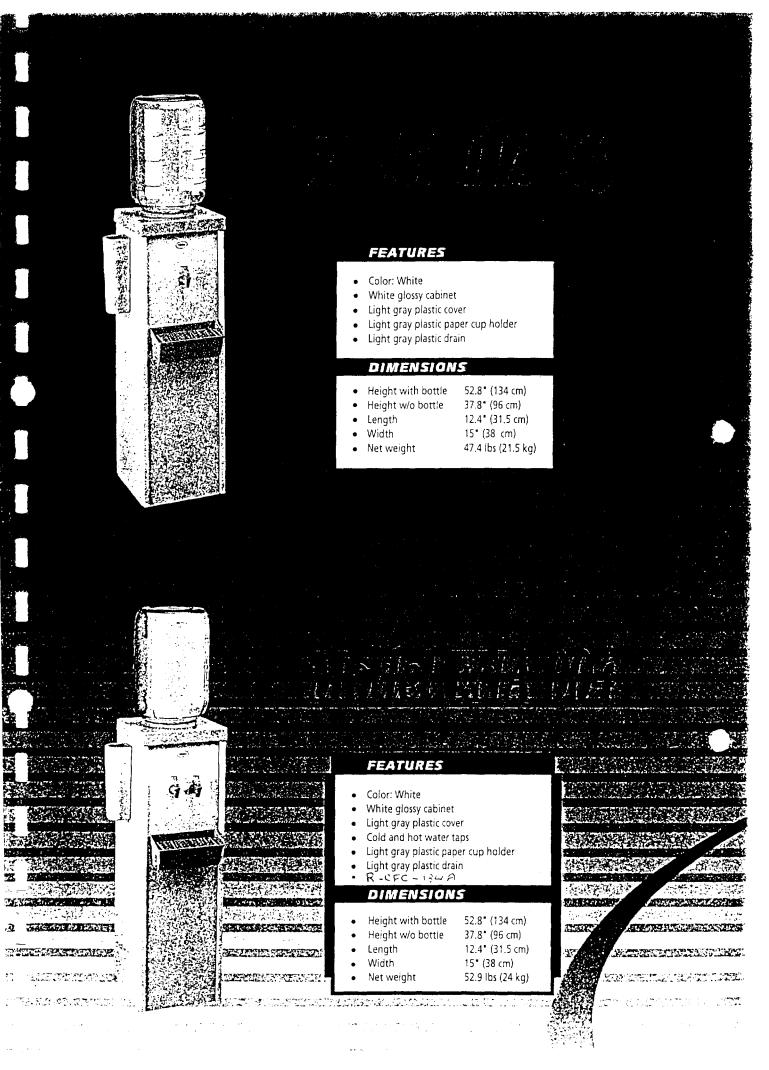
7 – يعطي ١٤ جلن ماء بارد في الساعة تقريباً ٧ – خاص بالمستشفيات والمدارس والبنوك والطاعم الكبيرة

٩ - مادة العازلة قوم
 ١٠ - المواسير الداخلية من أفضل الأنواع
 ١١ - مجهز بثرموستات للتحكم في البرودة

80

11 - 0 مجهن بثر موستات للتحكم في البرودة 11 - 11 القياس كما هو موضع بالرسم 11 - 11 من أنتاج شركة أحسان وتحسين البعلبكي 11 - 11 11 - 11 11 - 11

| | 17, | 7. | 4.6 | 3,3 |
|----------|------------|-------------|-----------------------------|-------------------|
| وأص فار- | - برد مر د | 45X55X108cm | بكعدبية بهرانس برماض لإرقوا | شركةامسات وكبزاله |
| J | | | * | \रं! |







SUNG AN WATER COOLER

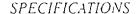
MODEL: CHW -3020

SUPPLIED COLD WATER & HOT WATER FOR COFFEE, TEA & SOUP IN ONE UNIT!!!

- © DUAL FUNCTION USE OF HOT/COLD WATER YOU CAN HAVE HOT WATER AS WELL AS COLD WATER ALSO IS SIMULTANEOUSLY PREPARED IN ONE UNIT TO BE INSTALLED EVEN IN SMALL SPACE
- © SANITIZED WATER TANK
 TO BE MOUNTED SANITIZED WATER TANK
 WHICH MADE FROM STAINLESS STEEL
- © AUTOMATIC TEMP. CONTROL OF COLD WATER COLD WATER TEMP. IS AUTOMATICALLY CONTROLLED BY THERMO PILLAR AT A RANGE OF 2°C TO 10°C
- © ENOUGH SAFETY DEVICES

 AN ENOUGH SAFETY DEVICES WILL PREVENT IT

 FROM THE CONCERN OF ACCIDENTS WHEN OVERHEATED



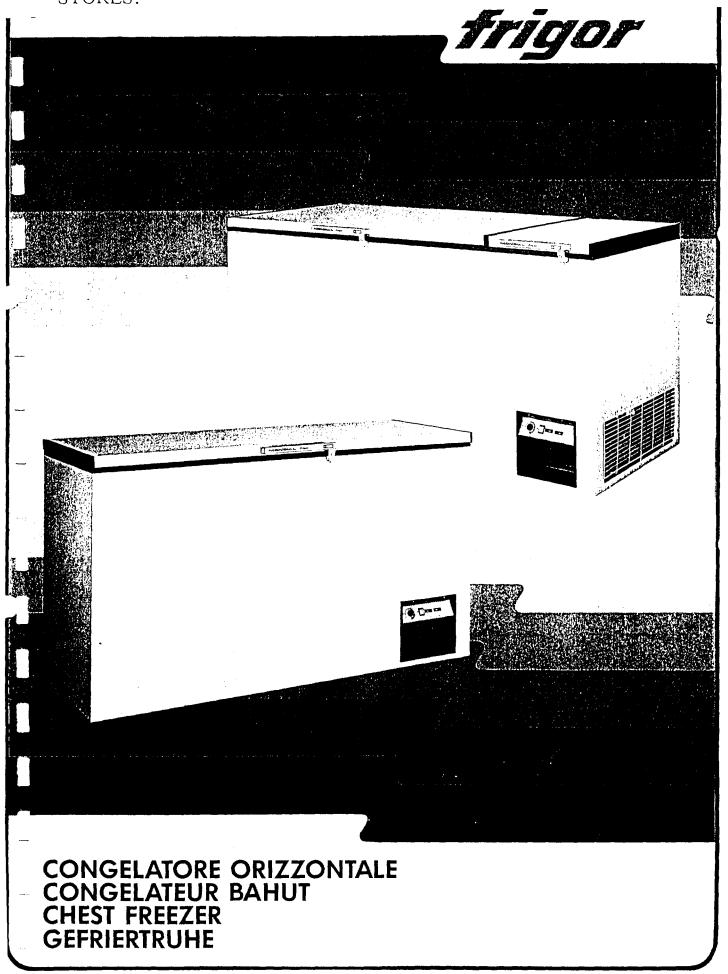
| ITEMS | | SPECIFICATIONS | |
|------------------------|---------------------|---|--|
| RATED VOI | TAGE | SINGLE PHASE, AC220 ~ 24CV 50HZ 6CHZ, AC12CV 6CH2 | |
| RATED CURRENT | | 6A(120V). 3A(220~240V) | |
| POWER CO | NSUMPTION | COLD WATER: 100W. HOT WATER: 450W | |
| | COMPRESSOR | RESISTANCE START NOUCTION RUN MOTOR | |
| | FREEZER | COIL BUILT IN OUTER WALL OF TANK | |
| 00.0 | CONDENSER | WIRES: TUBES TYPE | |
| COLD | REFRIGERANT | R CFC-134a | |
| NATER | TEMP. CONTROLLER | THERMO PILLAR | |
| | TEMP. CONTROL RANGE | 2.0 ~ 10.0 | |
| | TANK CAPACITY | 3.0. | |
| | HEATER | 450W | |
| | SAFETY DEVICES | CUT-OFF BI-METAL | |
| HOT WATER | TEMP. CONTROLLER | THERMO BI-METALION/CFF | |
| WATER | TEMP, CONTROL RANGE | 30°C ~90°C | |
| | TANK CAPACITY | 2.0 1 | |
| DRAINIAGE | CONTAINER | 1.0 : | |
| INSULATION | HOT WATER | SURFACE MOUNTING | |
| MOULATION | COLD WATER | FOAM-PU(LOWER - BODY | |
| UNIT WEIGHT | | APPROX.2CKCS | |
| UNIT DIMENSIONS(W*D*H) | | 315 × 320 × 960(mm) | |
| CORK TYPE(VALVE) | | PUSH LEVER TYPE | |
| STUFFING | 20ft | 192 SETS | |
| O' TY 40ft | | 396 SETS | |

Notes: design and specifications subject to change sudfout prior notice for product improvement.





IHSAN & TAHSEEN BAALBAKI COMPANY



CONSERVATORI ORIZZONTALI PER GELATI E SURGELATI

CONSERVATEURS HORIZONTAUX POUR GLACES ET SURGELÉS

TIEFKUELTRUHEN FUER EIS UND TIEFKUELKOST

ICE CREAM AND FROZEN CABINETS

CONSERVADORES HORIZONTALES PARA HELADOS Y SURGELADOS





– Da 200 a 540 litri con vasca standard, adatti a tutte le esigenze

De 200 à 540 litres, avec cuve standard, adaptés à tous les besoins

V n 200 bis 540 Liter mit standard Wanne, geeignet fuer alle Beduerfnisse

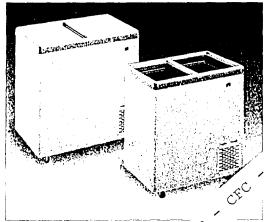
From 200 to 540 litres, with standard standard tanks, suitable for every requirement

L 200 a 540 litros con cuba standard, adaptados a todas las exigencias

olamento in poliuretano iniettato SENZA CFC *
bile in lamiera d'acciaio trattata anti-corrosione *
Vasca in lamiera d'acciaio zincata a caldo * Termometro * Termostato meccanico regolabile * Quattro
ute pivottanti * Compressore ermetico con protete * Sistema condensante a pacco (alettato) con
motoventilatore * Evaporatore statico avvolto sulla
vasca con mastice termoconduttore *

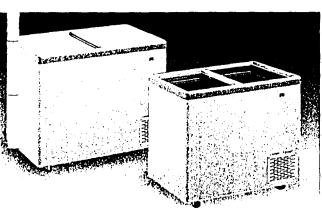
V/Hz/1:220-240/50 (a richiesta altri voltaggi o frequenze).

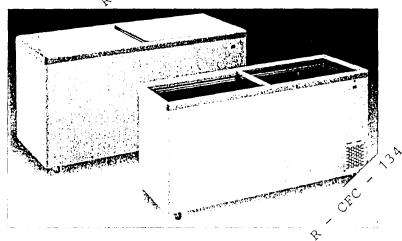
T-GTL": con coperchi scorrevoli vetrati **T-STL**": con coperchi scorrevoli ciechi



IGLOO GT 20 - IGLOO ST 200

| L x P x H : 760 x 592 x 860 | |
|-----------------------------|---------------|
| L. lordi : 200 | L.netti : 145 |
| °C.: -18°-25° | Watt: 130 |
| Cestelli : no | Gaz : R 134a |



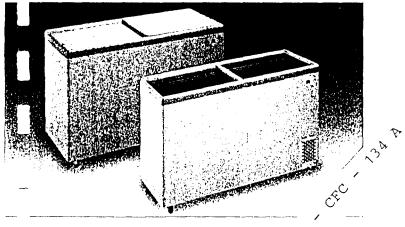


IGLOO GT 30 - IGLOO ST 300

| LxPxH: 1040 x 592 x 860 | |
|-------------------------|---------------|
| L. lordi : 300 | L.netti : 218 |
| °C.: -18°-25° | Watt : 160 |
| Cestelli : no | Gaz : R 134a |



| LxPxH: 17 | 50 x 630 x 860 |
|----------------|----------------|
| L. lordi : 540 | L.netti : 442 |
| °C.:-18°-25° | Watt: 230 |
| Cestelli : no | Gaz : R 134a |
| | |



IGLOO GT 40 - IGLOO ST 400 %

| LxPxH: 1320 x 592 x 860 | |
|-------------------------|---------------|
| L. lordi : 400 | L.netti : 294 |
| °C.:-18°-25° | Watt : 215 |
| Cestelli : no | Gaz : R 134a |

*Insulation in polyurethane injected without CFC * Cabinet in anticorrosion treated steel sheet * Thank in hot-galvanised steel sheet * Thermometer * Adjustable mechanic thermostat * Four pivot wheels * Air-tight compressor with protection * Packed condensation system (finned) with powered ventilator * Static evaporator wrapping the tank with thermo-conducting mastic*

V/Hz/1:220-240/50 (other voltages/frequencies by request).

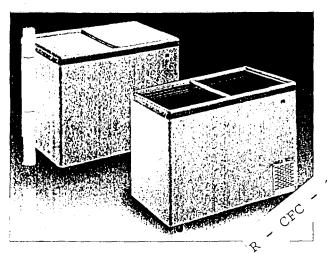
"GT-GTL": with glazed sliding top
"ST-STL": with insulated closed
sliding top

Da 370 a 470 litri con vasca larga, adatti per il "gelato sfuso" De 370 à 470 litres, avec cuve large, adaptés pour le "service vrac"

Von 370 bis 470 Liter, mit spezialen Wanne, geeignet fuer "eis service"

From 370 to 470 litres, with large tank, suitable for "ice cream service"

D 370 a 470 litros con cuba ancha, especifica para el "helado a granel"



*Aistamento en poliuretano inyectado SIN CFC *Mueble en chapa de acero tratada con anti-oxidante *Cuba en chapa de acero zincada en caliente *Termometro *Termostato mecanico regulable *Cuatro ruedas pivotantes *Compresor de condensacion con motoventilador *Evaporador estatico envuelto en la cuba con masilla termo-conductora

V/Hz/1:220-240/50 (Bajo pedido otros voltajes o frecuencias).

"GT - GTL": con tapas correderas acristaladas "ST - STL": con tapas correderas ciegas solation en mousse de polyuréthane injectée SANS CFC Meuble en tôle d'acter frantée anti-corrosion Cuve en tôle d'acter frantée à chaud Thermomètre Régulation mécanique Quatre roues pi-votantes Compresseur hermétique avec projecteur Condenseur ventilé à ailettes placé dans le logement compresseur Evaporateur statique enroulé sur la cuve avec mastic thermoconducteur

V/Hz/1:220-240/50 (sur demande g'autres voltages/fréquences).

GTL": à couvercles coulissants vitrés

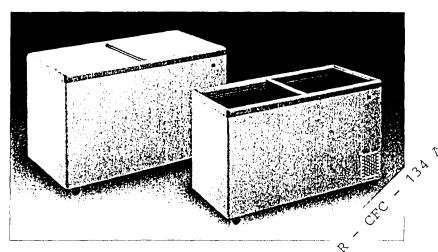
IGLOO GTL 37 - IGLOO STL 37

| L x P x H : 1105 x 680 x 860 | | |
|------------------------------|---------------|--|
| L. lordi : 370 | L.netti : 340 | |
| °C.:-18°-25° | Watt : 230 | |
| Cestelli : no | Gaz : R 134a | |

Polyurethaninsolierung eingenspritz OHNE FCKW * Mobel aus Stahlblech mit Korrosionsschutz * Wanne aus feuerverzinktem Stahlblech * Thermometer * Regulierbarer mechanicher Thermostat * Vier schwenkbare Rader * Hermetischer Kompressor mit Schutzvornchtung * Geripptes Verfluessgersystem mit Motoentilator * Staticher Verdampfer, an den Waenen der Wanne mit thermoleitender Dichtmasse

V/Hz/1:220-240/50 (auf Anfrage andere Spannung/Frequenz).

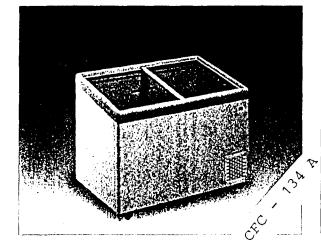
"GT - GTL": mit Glasschiebedeckeln
"ST - STL": mit isolierten, blinden Deckeln



IGLOO GTL 47 - IGLOO STL 47

| LxPxH:14 | 35 x 680 x 860 |
|----------------|----------------|
| L. lordi : 470 | L.netti: 392 |
| °C.:-18°-25° | Watt: 370 |
| Cestelli : no | Gaz : R 134a |

NOVITÀ, NOUVEAUTÉ, NEW, NEUEN, NOVIDAD



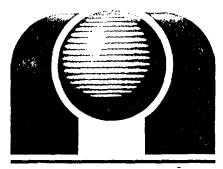


GLOO 37 VISION

| Ex P x H : 1125 x 700 x 860 | | |
|-----------------------------|---------------|--|
| L. lordi : 290 | L.netti : 250 | |
| ° : -18°-25° | Watt : 230 | |
| Citelli : no | Gaz : R 134a | |

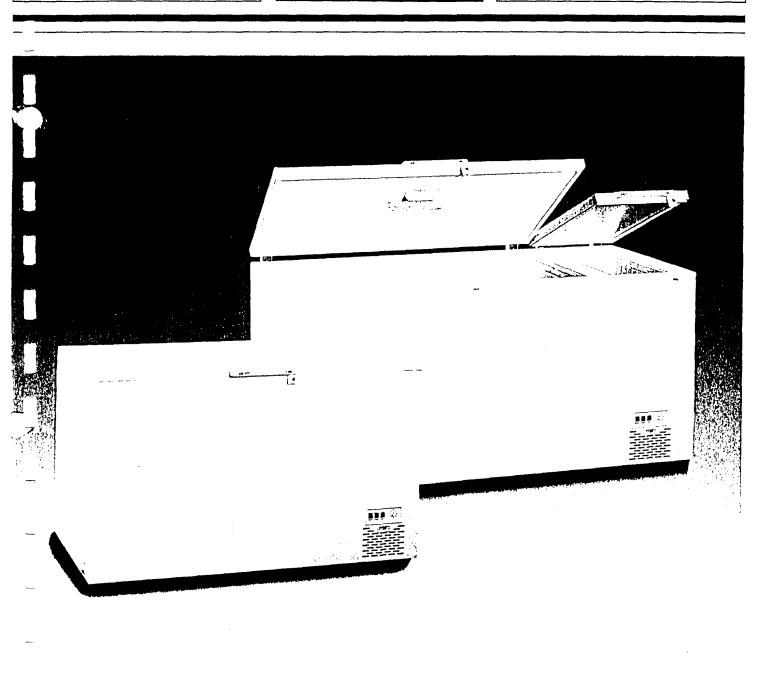
JONGELATORI ORIZZONTALI JERIE COM"

CONGELATEURS
3AHUT"
"SERIE COM"

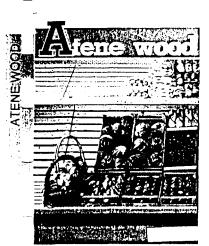


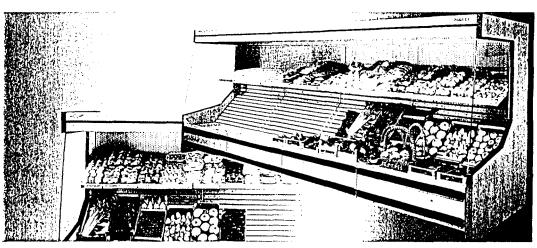
BAALBAKI FRIGOR CHEST FREEZERS "COM SERIES"

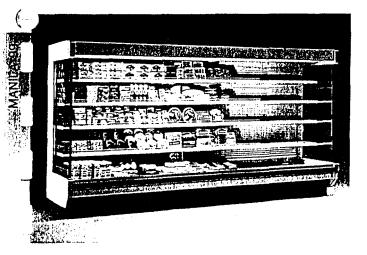
CONGELADORES HORIZONTALES "SERIE COM"

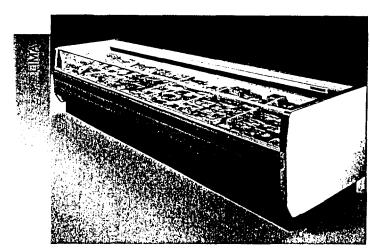


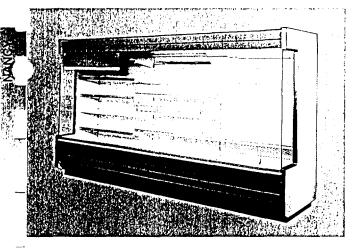
THURN & TARBUUN BAALBAKI CUMPANY

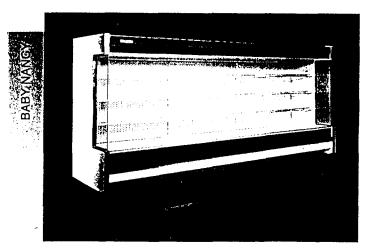


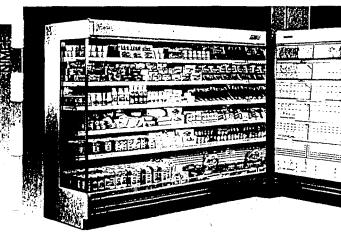


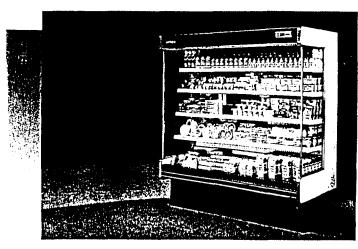


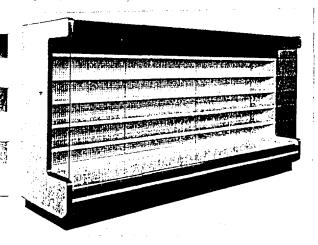


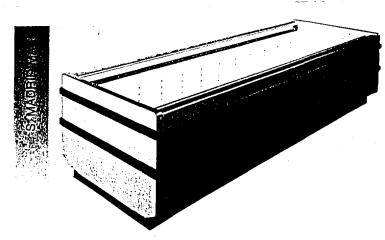


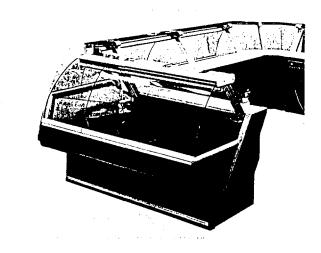


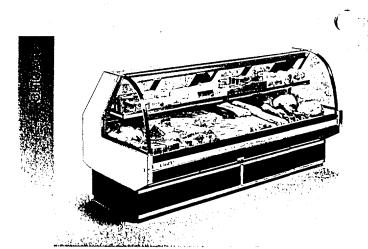


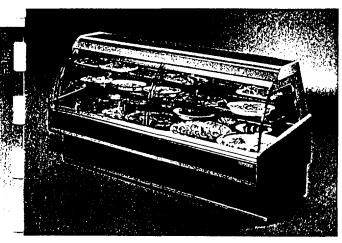


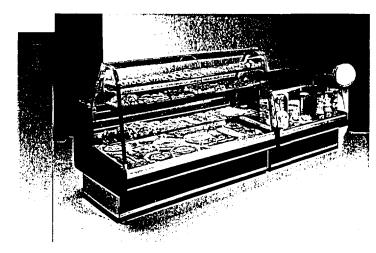


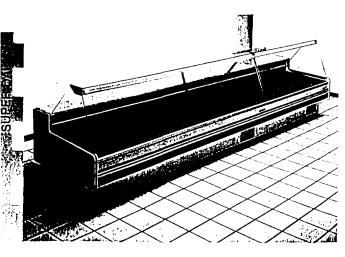


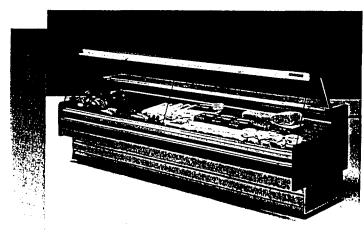




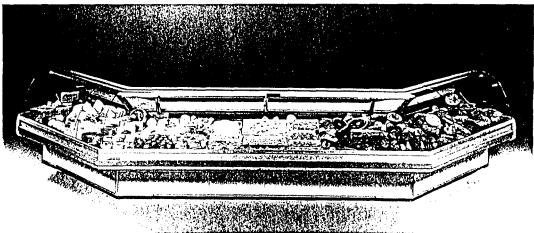


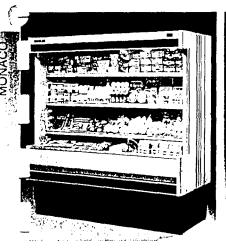


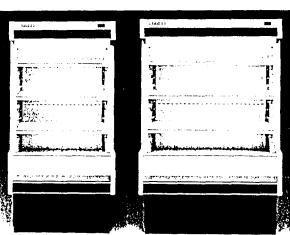






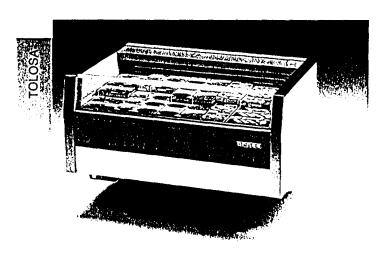


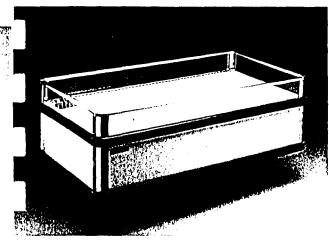


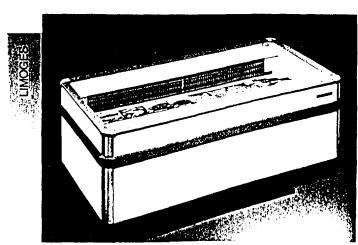


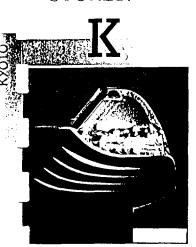


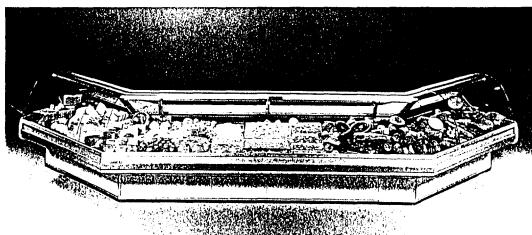


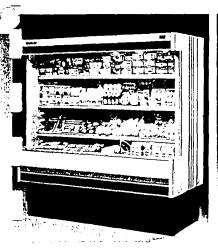


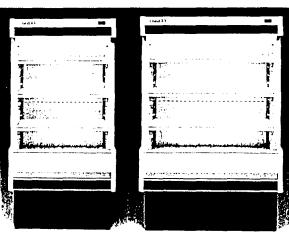






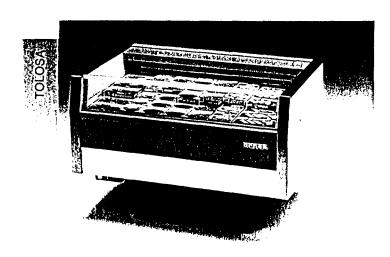


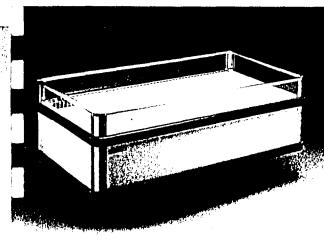


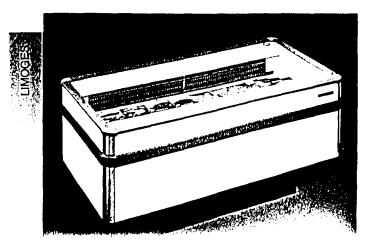


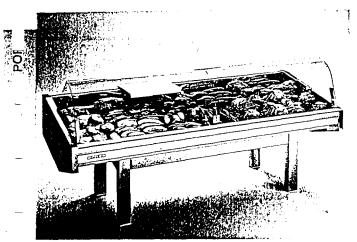


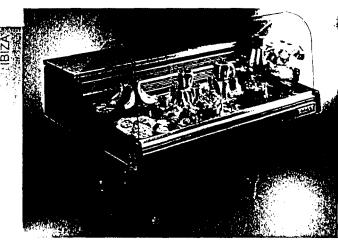


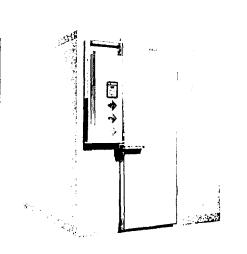


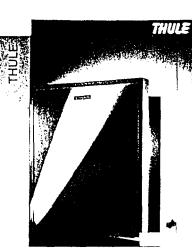


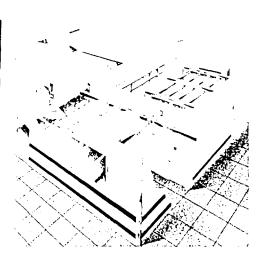




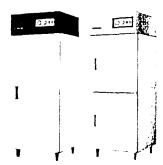






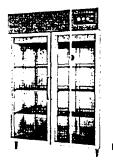






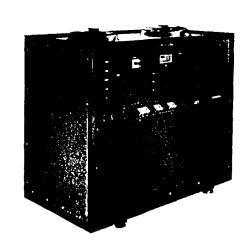


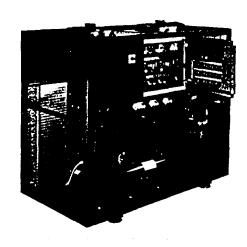


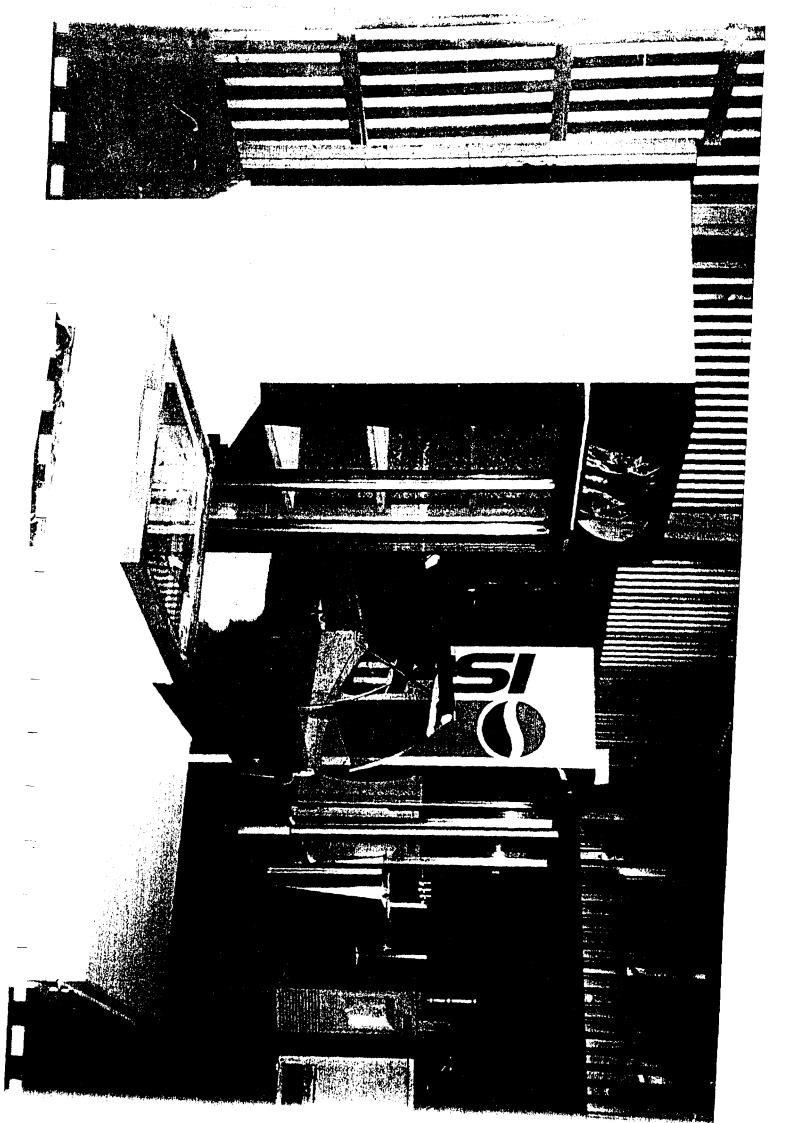


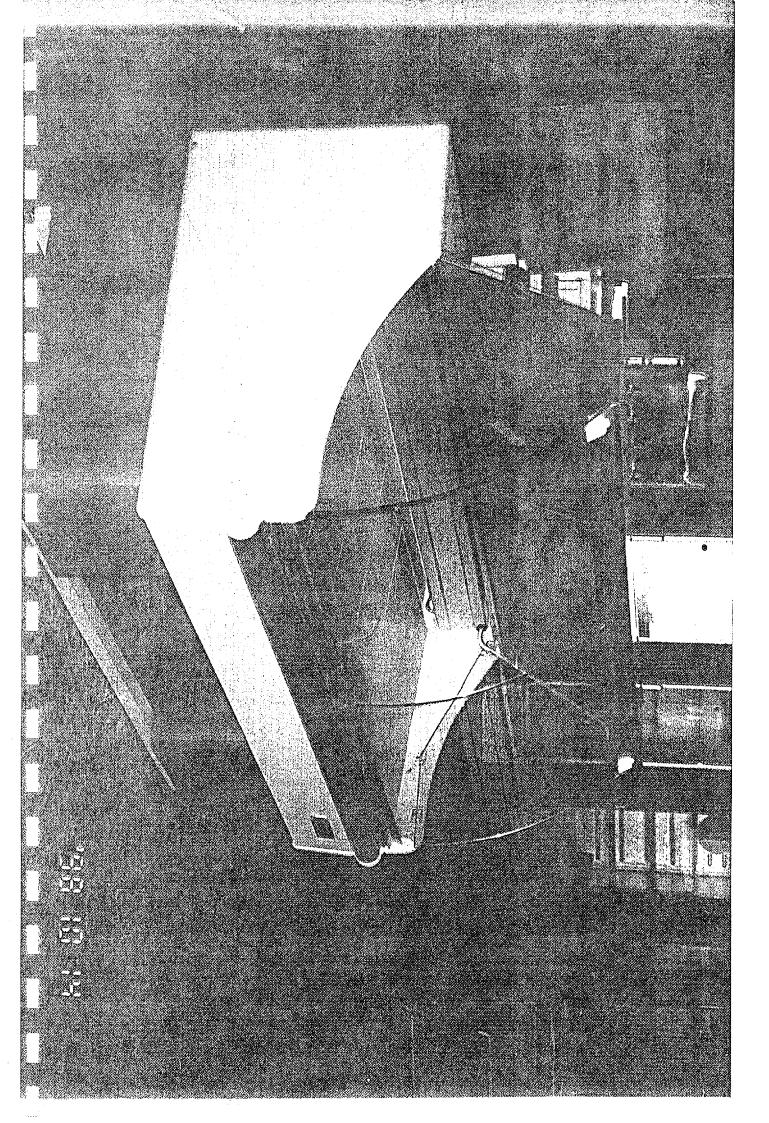


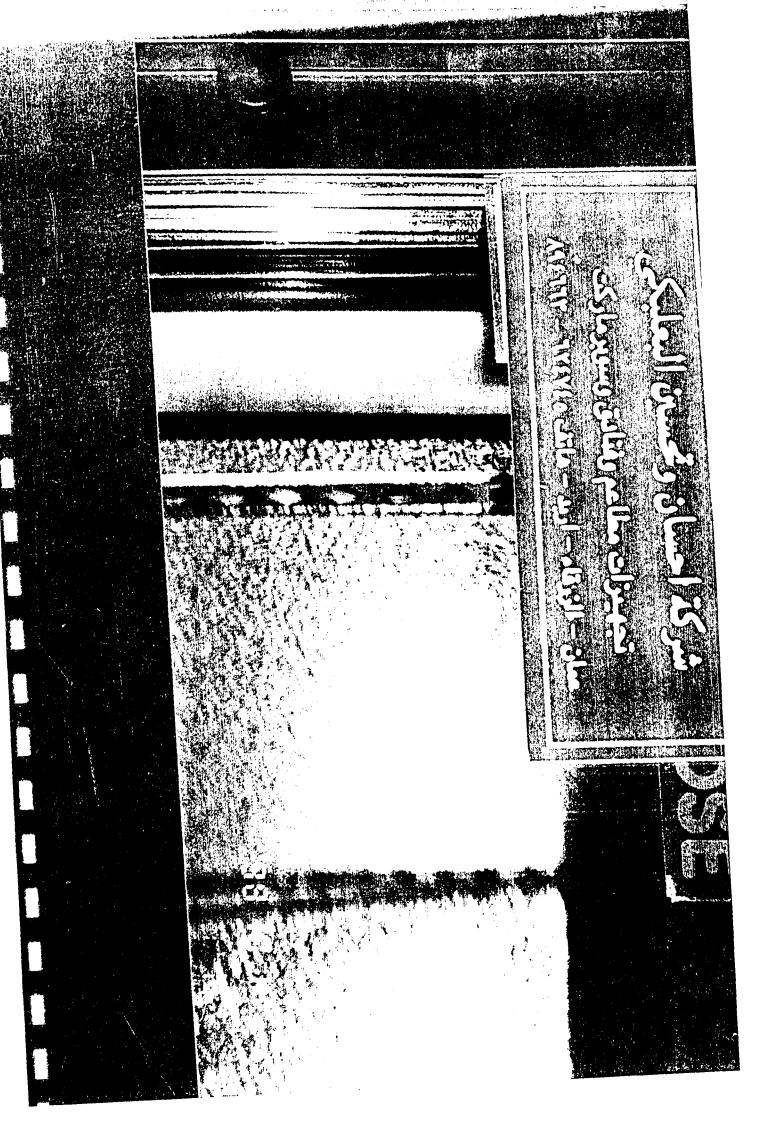












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