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Report on resign and conversion of CFC-free products
At Moganshan Electrical Appliances Co.

To UNIDO:
The project of resign and conversion of CFC-free products at Zhongke Life Science & Technology Co., Ltd. (previously Moganshan Rongsheng Electrical Appliances Co.) has now been finished on design, manufacture and tests of BD-168, BCD-178, BD-308, YD-258 and SC-300 etc five freezers and refrigerators according to the basic condition frame put forward by UNIDO. The details are as follows:

1. Design of products
   Design of product: according to the new State standards on refrigeration and energy consumption and considering that the products shall comply with the requirements of CE, UL certification for export, we design the products on the following points:
   1.1 Design of product structure: calculation and design of polyester insulation;
   1.2 Design of system: re-calculation and design of condenser and evaporator;
   1.3 Calculation of refrigeration: calculation of R600a compressor capacity and type selection; calculation of charge of R600a;

2. Manufacture
   2.1 Manufacture of tooling
   According to the new design plan, we specially manufacture metal tooling and foaming tooling of the above five models so as to meet the demand of new product development.
   2.2 Manufacture of products
   We have nearly finished the manufacture of samples of the five models, details are: manufacture of metals, cyclopentane foaming of cabinets and doors, assembly of refrigeration system and charge of R600a refrigerant. Now those samples has passed tests in our model test room.

3. Investment of testing equipment
   In order to ensure the performances of the freezers/refrigerators with new system to meet the State standards, we purchased new intelligent testing instrument for testing the temperatures, energy consumption and other operation parameters of freezers/refrigerators. After the tests according to test procedure, we are sure the
designed products comply with the indexes of performances formulated by the Nation.

4. Final test of the products
According to the basic contract conditions proposed by UNIDO, we send the products which passed the test in model test room of our company to Guangzhou Inspection and Testing Institute for Electrical Appliances, the State authorized testing department for tests to confirm the designed products comply with requirements of standard.

Zhongke Life Science & Technology Co., Ltd. (previously Moganshan Rongsheng Electrical Appliances Co.) abide by the specific stipulations for design and conversion of freezers/refrigerators with new system provided for by UNIDO and now has finished the whole work.

It is hereby reported!

Zhongke Life Science & Technology Co., Ltd.
Jan 9, 2003
Transmission load calculation
Refrigerator Model SC-315
Dimensions (R600a)

<table>
<thead>
<tr>
<th>Dimension Mt</th>
<th>Area (sq. Mt)</th>
<th>Insulation Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side walls</td>
<td>1.3<em>0.55</em>2</td>
<td>1.43</td>
</tr>
<tr>
<td>back panel</td>
<td>0.595*1.3</td>
<td>0.715</td>
</tr>
<tr>
<td>door</td>
<td>0.595*1.3</td>
<td>0.734</td>
</tr>
<tr>
<td>Bottom floor</td>
<td>0.55*0.595</td>
<td>0.327</td>
</tr>
<tr>
<td>top floor</td>
<td>0.55*0.595</td>
<td>0.327</td>
</tr>
</tbody>
</table>

Insulation Type: Pu Foam

CP5. Foam Thermal Conductivity: 0.02 W/m²°C

Temperature Difference: 32 - 5 = 27°C
Ambient Temperature = 32°C
refrigerator Air Temperature = 5°C

Calculation:

\[ Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{Front} + Q_{DOOR} \]

\[ Q = U \times A \times (T_a - T_r) \]

\[ U = \frac{1}{X_l/K_1} \]

Where:
U = Heat Resistance Coefficient Factor
KI = Foam Thermal Conductivity

Xl = Foam Thickness

Note: Due to the short thickness of cabinet outside panel (0.5 mm) and aluminum inner liner (0.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

\[ Q_{\text{Side Walls}} = [UA(Ta - Tf)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_f = \text{refrigerator air Temperature} \]

\[ U = \frac{1}{(0.045/0.02)} = 0.44 \text{ W/ Sq. Mt. C} \]
\[ A = 1.43\text{Sq. Mt.} \]
\[ T_a = 32^\circ\text{C} \]
\[ T_f = 5^\circ\text{C} \]

\[ Q_{\text{Side Walls}} = 0.44 \times 1.43 \times 27 = 17 \text{ Watts} \]

\[ Q_{\text{Side Walls}} = 17\text{ Watts} \]

\[ Q_{\text{Back panel}} = [UA(Ta - T_f)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_f = \text{refrigerator air Temperature} \]

\[ U = \frac{1}{(0.045/0.02)} = 0.44 \text{ W/ Sq. Mt. C} \]
\[ A = 0.715\text{Sq. Mt.} \]
\[ T_a = 42^\circ\text{C} \]
\[ T_f = 5^\circ\text{C} \]
Q_{\text{back panel}} = 0.44 \times 0.715 \times 37 = 11.6\text{Watts}

Q_{\text{back panel}} = 11.6\text{Watts}

3 - \quad Q_{\text{door}} = [UA(Ta - Tf)]

\begin{align*}
T_a &= \text{Ambient Temperature} \\
T_f &= \text{refrigerator air Temperature}
\end{align*}

U = 1 / (0.003/0.65 + 0.004/0.65 + 0.026/0.06) = 2.25 \text{ W/Sq. Mt C}
A = 0.734\text{Sq. Mt.}
T_a = 32^\circ \text{C}
T_f = 5^\circ \text{C}

Q_{\text{door}} = 2.25 \times 0.734 \times 27 = 44.6\text{Watts}

Q_{\text{door}} = 44.6\text{Watts}

4 - \quad Q_{\text{bottom}} = [UA(Ta - Tf)]

\begin{align*}
T_a &= \text{Ambient Temperature} \\
T_f &= \text{refrigerator air Temperature}
\end{align*}

U = 1 / (0.05/0.02) = 0.4 \text{ W/Sq. Mt C}
A = 0.327\text{Sq. Mt.}
T_a = 32^\circ \text{C}
T_f = 5^\circ \text{C}

Q_{\text{bottom}} = 0.4 \times 0.327 \times 27 = 3.53\text{Watts}

Q_{\text{bottom}} = 3.53\text{ Watts}
5 - \[ Q_{\text{top floor}} = [UA(T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{refrigerator air Temperature} \]

\[ U = \frac{1}{(0.05/0.02)} = 0.4 \text{ W/Sq. Mt. C} \]
\[ A = 0.327 \text{Sq. Mt.} \]
\[ T_a = 32 \text{ °C} \]
\[ T_r = 5 \text{ °C} \]

\[ Q_{\text{top floor}} = 0.4 \times 0.327 \times 27 = 3.53 \text{Watts} \]

\[ Q_{\text{top floor}} = 3.53 \text{Watts} \]

Total Heat Leaks; 

\[ Q_{\text{Total}} = 17 + 11.6 + 44.6 + 3.53 + 3.53 = 80 \]

\[ Q_{\text{Total Heat Leaks}} = 80 \text{ Watts} \]

b) Product Loads;

\[ Q_{\text{product}} = 70\% Q_{\text{Total Heat Leaks}} = 56 \text{Watts} \]

\[ Q_{\text{Misc}} = 20\% \left( Q_{\text{Total Heat Leaks}} + Q_{\text{Product Loads}} \right) = 20\% (80 + 56) = 27.2 \text{Watts} \]

\[ Q_{\text{Misc}} = 27.2 \text{Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{Etc.}} \]

Total Cooling Capacity required is calculated as follows;
\( Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \)

\[ Q_{\text{Grand Total}} = 80 + 56 + 27.2 = 163 \text{ Watts} \]

\[ Q_{\text{Grand Total}} = 163 \text{ Watts} \]

\[ Q_0 = 1.1 \times Q_{\text{Grand Total}} = 180 \text{ Watts} \]

Type of Compressor suitable for this model is recommended Compressor BAIXUE Model QDHC126GA (\( Q_1 = 200 \text{ W} \))

二、CONDENSOR DESIGN:

\[ Q_K = 1.1 \times Q_0 = 1.1 \times 180 = 198 \text{ Watts} \]

condensor area: \( 198/ (18 \times 12) = 0.91 \text{ square meter} \)

condensing line area: \( 0.91/3.5 = 0.26 \text{ square meter} \)

length of double side condensing line: \( 0.26/(3.14 \times 0.00476) = 17 \text{ meter} \)

singal side 17 meter copper tube \( \varnothing 4.76 \times 0.7 \)

三、EVAPORATOR DESIGN:

evaporation area: \( 180/(13 \times 15) = 0.92 \text{ square meter} \)

length of evaporation copper tube: \( 0.92/(3 \times 3.14 \times 0.008) = 12.2 \text{ meter} \varnothing 8 \times 0.7 \)

四、Capillary tube:

\( \varnothing 2.1 \times 0.91 \times 2500 \text{ mm} \)

Refrigerant/Refrigerant charging: R600a/62g
Transmission load calculation

Chest Freezer Model BD-168

Dimensions (R600a)

<table>
<thead>
<tr>
<th></th>
<th>Dimension Mt</th>
<th>Area (sq. Mt)</th>
<th>Insulation Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side walls</td>
<td>2 X 0.58 X 0.55</td>
<td>0.638</td>
<td>60</td>
</tr>
<tr>
<td>back panel</td>
<td>0.895 X 0.58</td>
<td>0.519</td>
<td>60</td>
</tr>
<tr>
<td>door</td>
<td>0.895 X 0.55</td>
<td>0.49</td>
<td>40</td>
</tr>
<tr>
<td>Bottom floor</td>
<td>0.895 X 0.55</td>
<td>0.49</td>
<td>65</td>
</tr>
<tr>
<td>Front panel</td>
<td>0.895 X 0.58</td>
<td>0.519</td>
<td>60</td>
</tr>
</tbody>
</table>

Insulation Type: Pu Foam

CP5. Foam Thermal Conductivity: 0.02 W /mt.C

Temperature Difference: 32 - (-18) = 50 C

Ambient Temperature = 32 C

Freezer Air Temperature = -18 C

一、Calculation:

\[ Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{Front} + Q_{DOOR} \]

\[ Q = U \times A \times (T_a - T_f) \]

\[ U = \frac{1}{(X_i/K_i)} \]
Where:

\( U = \text{Heat Resistance Coefficient Factor} \)

\( K_f = \text{Foam Thermal Conductivity} \)

\( X_i = \text{Foam Thickness} \)

Note: Due to the short thickness of cabinet outside panel (0.5 mm) and aluminum inner liner (0.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

1. \( Q_{\text{Side Walls}} = [U \ A \ (T_a - T_f)] \)

\( T_a = \text{Ambient Temperature} \)

\( T_f = \text{Freezer air Temperature} \)

\( U = 1 \ (0.060/0.02) = 0.33 \ W/\text{Sq. Mt. C} \)

\( A = 0.638 \text{ Sq. Mt.} \)

\( T_a = 32 \ C \)

\( T_f = -18 \ C \)

\( Q_{\text{Side Walls}} = 0.33 \times 0.638 \times 50 = 10.5 \text{ Watts} \)

\( Q_{\text{Side Walls}} = 10.5 \text{ Watts} \)

2. \( Q_{\text{Back panel}} = [U \ A \ (T_a - T_f)] \)

\( T_a = \text{Ambient Temperature} \)

\( T_f = \text{Freezer air Temperature} \)
\[ U = \frac{1}{(0.060/0.02)} = 0.33 \text{ W/Sq. Mt. C} \]
\[ A = 0.519 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Back panel}} = 0.33 \times 0.519 \times 50 = 8.6 \text{ Watts} \]

\[ Q_{\text{Back panel}} = 8.6 \text{ Watts} \]

3 -

\[ Q_{\text{Front Panel}} = [U \times A \times (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{Freezer air Temperature} \]

\[ U = \frac{1}{(0.060/0.02)} = 0.33 \text{ W/Sq. Mt C} \]
\[ A = 0.519 \text{Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Front Panel}} = 0.33 \times 0.519 \times 50 = 8.6 \text{ Watts} \]

\[ Q_{\text{Front panel}} = 8.6 \text{ Watts} \]

4 -

\[ Q_{\text{Bottom}} = [U \times A \times (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{Freezer air Temperature} \]
U = 1 / (0.065/0.02) = 0.31 W/Sq. Mt C
A = 0.49 Sq. Mt.
Ta = 42°C
Tr = -18°C

\[ Q_\text{Bottom} = 0.31 \times 0.49 \times 60 = 9.7 \text{ Watts} \]

\[ Q_\text{Bottom} = 9.7 \text{ Watts} \]

\[ Q_\text{Door} = [U \, A \,(T_a - T_r)] \]

Ta = Ambient Temperature
Tr = Freezer air Temperature

U = 1 / (0.040/0.02) = 0.5 W/ Sq. Mt. C
A = 0.49 Sq. Mt.
Ta = 32°C
Tr = -18°C

\[ Q_\text{Door} = 0.5 \times 0.49 \times 50 = 12.25 \text{ Watts} \]

\[ Q_\text{Door} = 12.25 \text{ Watts} \]

Total Heat Leaks;

\[ Q_{\text{Total Heat Leaks}} = 10.5 + 8.6 + 8.6 + 9.7 + 12.25 = 49.65 \text{ Watts} \]

\[ Q_{\text{Total Heat Leaks}} = 49.65 \text{ Watts} \]

b) Product Loads;

We consider 8 Kg ice making capacity for this model per 24 hours. Therefore;
\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3, \]

where;

\[ Q_1 = mC_1 (T_i - T_f) = \text{energy required to freeze water from initial temperature to freezing point of 0 C} \]

\[ Q_2 = mC_2 (T_r - T_m) = \text{energy required to freeze ice from zero degree temperature to -18 C} \]

\[ Q_3 = mH = \text{heat gain from latent heat of fusion of water} \]

\[ Q_1 = 8 \times (24-0) = 192 \text{Kcal / 24 hours} \]

\[ Q_2 = 8 \times 1 \times [0 - (-18)] = 144 \text{Kcal / 24 hours} \]

\[ Q_3 = 8 \times 108 = 864 \text{Kcal / 24 hours} \]

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3 = 1350 \text{Kcal / 24 hours} = 58 \text{Watts} \]

\[ Q_{\text{Misc}} = 10\% \left( Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} \right) = 10\% (49.65 + 58) = 10.77 \text{Watts} \]

\[ Q_{\text{Misc}} = 10.77 \text{Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{Ex}}. \]

Total Cooling Capacity required is calculated as follows;

\[ Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \]

\[ Q_{\text{Grand Total}} = 49.65 + 58 + 10.77 = 118 \text{ Watts} \]
\[ Q_{\text{Grand Total}} = 118 \text{ Watts} \]

Type of Compressor suitable for this model is recommended Compressor BAIXUE Model QDHC79GA(Q \text{1.} = 122\text{W})

二、CONDENSOR DESIGN:
\[ Q_k = 1.2 \times Q_{\text{Grand Total}} = 1.2 \times 118 = 142\text{Watts} \]
condensor area: \(142/(17 \times 12) = 0.70\) square meter
condensing line area: \(0.70/3.5 = 0.20\) square meter
length of double side condensing line: \(0.20/(3.14 \times 0.00476) = 13\) meter
singal side 13 meter copper tube \(\phi 4.76 \times 0.7\)

三、EVAPORATOR DESIGN:
evaporation area: \(118/(13 \times 5.3) = 1.7\) square meter,
length of evaporation copper tube: \(1.7/(4 \times 3.14 \times 0.008) = 16.9\) meter \(\phi 8 \times 0.7\)

四、Capillary tube:
\(\phi 2.0 \times 0.71 \times 1800\text{mm}\)
Refrigerant/Refrigerant charging: R600a/54g
Transmission load calculation

Chest Freezer Model BD-308

Dimensions (R600a)

<table>
<thead>
<tr>
<th>DimensionMt</th>
<th>Area (sq.Mt)</th>
<th>Insulation Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side walls</td>
<td>(0.8<em>0.63)+(0.45</em>0.63)</td>
<td>0.79</td>
</tr>
<tr>
<td>back panel</td>
<td>0.8<em>1.12-(0.25</em>0.24)</td>
<td>0.89</td>
</tr>
<tr>
<td>door</td>
<td>1.12*0.63</td>
<td>0.7</td>
</tr>
<tr>
<td>Bottom floor</td>
<td>1.12*0.63</td>
<td>0.7</td>
</tr>
<tr>
<td>Front panel</td>
<td>0.8<em>1.12-(0.25</em>0.24)</td>
<td>0.89</td>
</tr>
</tbody>
</table>

Insulation Type: Pu Foam

CP5. Foam Thermal Conductivity: 0.02 W /mt.°C

Temperature Difference: 32 - (-18) = 50 C

Ambient Temperature = 32 C

Freezer Air Temperature = -18 C

Calculation:

\[ Q_{TL} = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{Front} + Q_{DOOR} \]

\[ Q = U A (T_a - T_r) \]

Where:

U = Heat Resistance Coefficient Factor
\[ K_1 = \text{Foam Thermal Conductivity} \]

\[ X_1 = \text{Foam Thickness} \]

Note: Due to the short thickness of cabinet out side panel (0.5 mm) and aluminum inner liner (0.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

1. \[
Q_{\text{Side Walls}} = [U \ A \ (T_a - T_r)]
\]
   \[
   T_a = \text{Ambient Temperature}
   \]
   \[
   T_r = \text{Freezer air Temperature}
   \]

   \[
   U = 1 \ (0.070 / 0.02) = 0.29 \text{ W/Sq. Mt. C}
   \]
   \[
   A = 0.79 \text{ Sq. Mt.}
   \]
   \[
   T_a = 32 \text{ C}
   \]
   \[
   T_r = -18 \text{ C}
   \]

   \[
   Q_{\text{Side Walls}} = 0.29 \times 0.79 \times 50 = 11.4 \text{ Watts}
   \]

2. \[
Q_{\text{Back panel}} = [U \ A \ (T_a - T_r)]
\]
   \[
   T_a = \text{Ambient Temperature}
   \]
   \[
   T_r = \text{Freezer air Temperature}
   \]

   \[
   U = 1 / (0.070 / 0.02) = 0.29 \text{ W/Sq. Mt. C}
   \]
   \[
   A = 0.89 \text{ Sq. Mt.}
   \]
   \[
   T_a = 32 \text{ C}
   \]
   \[
   T_r = -18 \text{ C}
   \]

   \[
   Q_{\text{Back panel}} = 0.29 \times 0.89 \times 50 = 12.9 \text{ Watts}
   \]
Q_{Back\ panel} = 12.9 \text{ Watts}

3 - \quad Q_{\text{Front\ Panel}} = [U \cdot A \cdot (T_a - T_f)]

\begin{align*}
T_a &= \text{Ambient Temperature} \\
T_f &= \text{Freezer air Temperature}
\end{align*}

\begin{align*}
U &= 1 / (0.070/0.02) = 0.29 \text{ W/Sq. Mt C} \\
A &= 0.89 \text{ Sq. Mt.} \\
T_a &= 32 \text{ C} \\
T_f &= -18 \text{ C}
\end{align*}

\begin{align*}
Q_{\text{Front\ Panel}} &= 0.29 \times 0.89 \times 50 = 12.9 \text{ Watts}
\end{align*}

\[ Q_{\text{Top}} = 12.9 \text{ Watts} \]

4 - \quad Q_{\text{Bottom}} = [U \cdot A \cdot (T_a - T_f)]

\begin{align*}
T_a &= \text{Ambient Temperature} \\
T_f &= \text{Freezer air Temperature}
\end{align*}

\begin{align*}
U &= 1 / (0.075/0.02) = 0.27 \text{ W/Sq. Mt C} \\
A &= 0.70 \text{ Sq. Mt.} \\
T_a &= 42 \text{ C} \\
T_f &= -18 \text{ C}
\end{align*}

\begin{align*}
Q_{\text{Bottom}} &= 0.26 \times 0.70 \times 60 = 11.4 \text{ Watts}
\end{align*}

\[ Q_{\text{Bottom}} = 11.4 \text{ Watts} \]

5 - \quad Q_{\text{Door}} = [U \cdot A \cdot (T_a - T_f)]

\begin{align*}
T_a &= \text{Ambient Temperature} \\
T_f &= \text{Freezer air Temperature}
\end{align*}
\[ U = \frac{1}{0.065/0.02} = 0.31 \text{ W/ Sq. Mt. C} \]
\[ A = 0.70 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_f = -18 \text{ C} \]

\[ Q_{\text{Door}} = 0.31 \times 0.70 \times 50 = 10.9 \text{ Watts} \]

\[ Q_{\text{Door}} = 10.9 \text{ Watts} \]

Total Heat Leaks;

\[ Q_{\text{TL}} = 11.4 + 12.9 + 10.9 + 11.4 + 12.9 = 59.5 \text{ Watts} \]

\[ \mathbf{Q_{\text{Total Heat Leaks}} = 59.5 \text{ Watts}} \]

\[ b) \text{ Product Loads;} \]

We consider 18 Kg ice making capacity for this model per 24 hours. Therefore;

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3, \]

where;

\[ Q_1 = mC_1 (T_i - T_i) = \text{energy required to freeze water from initial temperature to freezing point of 0 C} \]

\[ Q_2 = mC_2 (T_f - T_f) = \text{energy required to freeze ice from zero degree temperature to -18 C} \]

\[ Q_3 = mh = \text{heat gain from latent heat of fusion of water} \]

\[ Q_1 = 18 \times 4.2 \times 25 / (24 \times 3.6) = 21 \text{ Watt} \]

\[ Q_2 = 18 \times 2 \times 18 / (24 \times 3.6) = 7.5 \text{ Watt} \]
\[ Q_3. = \frac{18 \times 333}{(24 \times 3.6)} = 69.4 \text{Watt} \]

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3 = 97.9 \text{Watts} \]

\[ Q_{\text{Misc}} = 10\% \left( Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} \right) = 10\% \left( 59.5 + 97.9 \right) = 15.8 \text{Watts} \]

\[ Q_{\text{Misc}} = 15.8 \text{Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{etc.}} \]

Total Cooling Capacity required is calculated as follows;

\[ Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \]

\[ Q_{\text{Grand Total}} = 59.5 + 97.9 + 15.8 = 173.1 \text{ Watts} \]

\[ Q_{\text{Grand Total}} = 173. \text{ Watts} \]

Type of Compressor suitable for this model is recommended Compressor BAIXUE Model QDHC112GA (Q1=180W)

二、CONDENSOR DESIGN:

\[ Q_k = 1.3 \times Q_{\text{Grand Total}} = 1.2 \times 173 = 224.9 \text{ Watts} \]

condensor area: \[\frac{224.9}{(30 \times 8)} = 0.93 \text{ square meter}\]

三、EVAPORATION DESIGN:

evaporation area: \[\frac{173}{(13 \times 5.3)} = 2.5 \text{ square meter}\],

length of evaporation copper tube: \[\frac{2.5}{(4 \times 3.14 \times 0.008)} = 24.8 \text{ meter} \odot 8 \times 0.7\]

四、Capillary tube:

\[ \odot 2.1 \times 0.91 \times 3550 \text{mm} \]

Refrigerant/Refrigerant charging: R600a/92g
Transmission load calculation

Chest Freezer Model BCD-178

Dimensions (R600a)

<table>
<thead>
<tr>
<th></th>
<th>Dimension Mt</th>
<th>Area (sq.Mt)</th>
<th>Insulation Thickness mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side walls</td>
<td>2 × 0.58 × 0.55</td>
<td>0.638</td>
<td>60</td>
</tr>
<tr>
<td>back panel</td>
<td>0.895 × 0.58</td>
<td>0.519</td>
<td>60</td>
</tr>
<tr>
<td>refrigerating Bottom floor</td>
<td>0.395 × 0.55</td>
<td>0.217</td>
<td>60</td>
</tr>
<tr>
<td>freezing Bottom floor</td>
<td>0.50 × 0.55</td>
<td>0.275</td>
<td>70</td>
</tr>
<tr>
<td>door</td>
<td>0.895 × 0.55</td>
<td>0.49</td>
<td>40</td>
</tr>
<tr>
<td>Front panel</td>
<td>0.895 × 0.58</td>
<td>0.519</td>
<td>60</td>
</tr>
</tbody>
</table>

Insulation Type: Pu Foam

CP5. Foam Thermal Conductivity: 0.02 W/m²C

Temperature Difference: 32 - (-18) = 50°C

Ambient Temperature = 32°C

Freezer Air Temperature = -18°C

一、Calculation:
\[ Q_{TL} = Q_{SW} + Q_{BP} + Q_{\text{Freezing Bottom}} + Q_{\text{Refrigerating Bottom}} + Q_{\text{Front}} + Q_{\text{DOOR}} \]

\[ Q = U A (T_a - T_r) \]

\[ U = l/(X_1/K_1) \]

Where:

\( U \) = Heat Resistance Coefficient Factor

\( K_1 \) = Foam Thermal Conductivity

\( X_1 \) = Foam Thickness

Note: Due to the short thickness of cabinet outside panel (0.5 mm) and aluminum inner liner (0.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

\[ 1- Q_{\text{Side Walls}} = [U A (T_a - T_r)] \]

\( T_a \) = Ambient Temperature

\( T_r \) = Freezer air Temperature

\[ U = 1 \times (0.060/0.02) = 0.33 \text{ W/ Sq. Mt. C} \]

\( A = 0.638 \text{ Sq. Mt.} \)

\( T_a = 32 \text{ C} \)

\( T_r = -18 \text{ C} \)

\[ Q_{\text{Side Walls}} = 0.33 \times 0.638 \times 50 = 10.5 \text{ Watts} \]

\( Q_{\text{Side Walls}} = 10.5 \text{ Watts} \)

第 2 页
2 - \[ Q_{\text{Back\ panel}} = \left[ U \cdot A \cdot (T_a - T_r) \right] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{Freezer air Temperature} \]

\[ U = \frac{1}{(0.060/0.02)} = 0.33 \text{ W/ Sq. Mt. C} \]
\[ A = 0.519 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Back\ panel}} = 0.33 \times 0.519 \times 50 = 8.6 \text{ Watts} \]

\[ Q_{\text{Back\ panel}} = 8.6 \text{ Watts} \]

3 - \[ Q_{\text{Front\ Panel}} = \left[ U \cdot A \cdot (T_a - T_r) \right] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{Freezer air Temperature} \]

\[ U = \frac{1}{(0.060/0.02)} = 0.33 \text{ W/ Sq. Mt. C} \]
\[ A = 0.519 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Front\ Panel}} = 0.33 \times 0.519 \times 50 = 8.6 \text{ Watts} \]

\[ Q_{\text{Front\ panel}} = 8.6 \text{ Watts} \]
4 - \[ Q_{\text{Refrigerating Bottom}} = [U \ A \ (T_a - T_f)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_f = \text{Freezer air Temperature} \]

\[ U = \frac{1}{0.06/0.02} = 0.33 \text{ W/Sq. Mt C} \]
\[ A = 0.217 \text{ Sq. Mt.} \]
\[ T_a = 42^\circ C \]
\[ T_f = 5^\circ C \]

\[ Q_{\text{Refrigerating Bottom}} = 0.33 \times 0.217 \times 37 = 2.65 \text{ Watts} \]

\[ Q_{\text{Refrigerating Bottom}} = 2.65 \text{ Watts} \]

5 - \[ Q_{\text{Freezring Bottom}} = [U \ A \ (T_a - T_f)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_f = \text{Freezer air Temperature} \]

\[ U = \frac{1}{0.07/0.02} = 0.29 \text{ W/Sq. Mt C} \]
\[ A = 0.275 \text{ Sq. Mt.} \]
\[ T_a = 42^\circ C \]
\[ T_f = -18^\circ C \]

\[ Q_{\text{Freezring Bottom}} = 0.29 \times 0.275 \times 60 = 4.785 \text{ Watts} \]

\[ Q_{\text{Freezring Bottom}} = 4.785 \text{ Watts} \]

6 - \[ Q_{\text{Door}} = [U \ A \ (T_a - T_f)] \]

\[ T_a = \text{Ambient Temperature} \]
Freezer air Temperature

\[ U = \frac{1}{0.040/0.02} = 0.5 \text{ W/Sq. Mt. C} \]
\[ A = 0.49 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_f = -18 \text{ C} \]

\[ Q_{\text{Door}} = 0.5 \times 0.49 \times 50 = 12.25 \text{ Watts} \]

\[ Q_{\text{Door}} = 12.25 \text{ Watts} \]

Total Heat Leaks;

\[ Q_{\text{TL}} = 10.5 + 8.6 + 8.6 + 2.65 + 4.785 + 12.25 = 47.4 \text{ Watts} \]

\[ Q_{\text{Total Heat Leaks}} = 47.4 \text{ Watts} \]

b) Product Loads;

We consider 8 Kg ice making capacity for this model per 24 hours. Therefore;

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3, \]

where;

\[ Q_1 = mC(T_i - T_f) = \text{energy required to freeze water from initial temperature to freezing point of 0 C} \]

\[ Q_2 = mC_2(T_f - T_i) = \text{energy required to freeze ice from zero degree temperature to -18 C} \]

\[ Q_3 = mh = \text{heat gain from latent heat of fusion of water} \]

\[ Q_1 = 8*(24-0) = 192 \text{ Kcal / 24 hours} \]
\[ Q_2 = 8 \times 1 \times [0 - (-18)] = 144 \text{ Kcal/24 hours} \]

\[ Q_3 = 8 \times 108 = 864 \text{ Kcal/24 hours} \]

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3 = 1350 \text{ Kcal/24 hours} = 58 \text{ Watts} \]

\[ Q_{\text{Misc}} = 10\% \left( Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} \right) = 10\% (47.4 + 58) = 10.54 \text{ Watts} \]

\[ Q_{\text{Misc}} = 10.54 \text{ Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{Etc.}} \]

Total Cooling Capacity required is calculated as follows;

\[ Q_{\text{Grand Total}} = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \]

\[ Q_{\text{Grand Total}} = 47.4 + 58 + 10.54 = 115 \text{ Watts} \]

\[ Q_{\text{Grand Total}} = 115 \text{ Watts} \]

Type of Compressor suitable for this model is recommended: Compressor BAIXUE Model QDHC79GA (Q1 = 122 W)

二、CONDENSOR DESIGN:

\[ Q_k = 1.2 \times Q_{\text{Grand Total}} = 1.2 \times 115 = 138 \text{ Watts} \]

condenser area: \( \frac{138}{17 \times 12} = 0.68 \text{ square meter} \)

condensing line area: \( \frac{0.75}{3.5} = 0.19 \text{ square meter} \)
length of double side condensing line: \(0.19/(3.14*0.00476) = 12 \text{ meter}\)
singal side 12 meter copper tube \(\phi 4.76*0.7\)

三、EVAPORATOR DESIGN:
evaporation area=115/(13*10)=0.89 square meter,
length of evaporation copper tube: \(0.89/(3*3.14*0.008) = 11.8 \text{ meter} \phi 8*0.7\)

四、Capillary tube:
\(\phi 2.0*0.71*1800\text{mm}\)
Refrigerant/Refrigerant charging: R600a/50g
Transmission load calculation

Refrigerator Model YCD-258

Dimensions (R600a)

<table>
<thead>
<tr>
<th>Section</th>
<th>Dimension Mt</th>
<th>Area (sq.Mt)</th>
<th>Insulation Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side walls</td>
<td>1.10<em>0.5</em>2</td>
<td>1.10</td>
<td>60</td>
</tr>
<tr>
<td>Refrigerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>back panel</td>
<td>0.61*1.10</td>
<td>0.671</td>
<td>60</td>
</tr>
<tr>
<td>Refrigerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>door</td>
<td>0.61*0.9</td>
<td>0.549</td>
<td>80</td>
</tr>
<tr>
<td>Refrigerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom floor</td>
<td>0.5*0.61</td>
<td>0.305</td>
<td>70</td>
</tr>
<tr>
<td>Refrigerating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>top floor</td>
<td>0.5*0.61</td>
<td>0.305</td>
<td>60</td>
</tr>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side walls</td>
<td>0.78<em>0.5</em>2</td>
<td>0.78</td>
<td>90</td>
</tr>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>back panel</td>
<td>0.61*0.78</td>
<td>0.476</td>
<td>95</td>
</tr>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>door</td>
<td>0.61*0.7</td>
<td>0.427</td>
<td>80</td>
</tr>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom floor</td>
<td>0.5*0.61</td>
<td>0.305</td>
<td>105</td>
</tr>
</tbody>
</table>
Insulation Type: Pu Foam

CP5. Foam Thermal Conductivity: 0.02 W /mt.°C

Temperature Difference: 32 - 5 = 27°C
Ambient Temperature = 32°C
Refrigerator Air Temperature = 5°C

Temperature Difference: 32 - (-18) = 50°C
Ambient Temperature = 32°C
Freezer Air Temperature = -18°C

Calculation:

\[ Q_R = Q_{SW} + Q_{BP} + Q_{BOTTOM} + Q_{Front} + Q_{DOOR} \]

\[ Q = UA(T_a - T_f) \]

\[ U = \frac{1}{(X_l/K_f)} \]

Where:

- \( U \) = Heat Resistance Coefficient Factor
- \( K_f \) = Foam Thermal Conductivity
- \( X_l \) = Foam Thickness

Note: Due to the short thickness of cabinet outside panel (0.5 mm) and aluminum inner liner (0.5 mm) heat resistance of these materials have been considered negligible.

Therefore:

1. \[ Q_{Side Walls} = [UA(T_a - T_f)] \]

\( T_a \) = Ambient Temperature
\( T_f \) = Refrigerator air Temperature

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\[ U = 1 / (0.06/0.02) = 0.33 \text{W/Sq. Mt. C} \]
\[ A = 1.1 \text{Sq. Mt.} \]
\[ T_a = 42^\circ C \]
\[ T_r = 5^\circ C \]

\[ Q_{\text{Side Walls}} = 0.33 \times 1.1 \times 37 = 13.43 \text{ Watts} \]

\( Q_{\text{Side Walls}} = 13.43 \text{ Watts} \)

2 -

\[ Q_{\text{Back panel}} = [U \times A \times (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{refrigerator air Temperature} \]

\[ U = 1 / (0.06/0.02) = 0.33 \text{ W/Sq. Mt. C} \]
\[ A = 0.671 \text{Sq. Mt.} \]
\[ T_a = 32^\circ C \]
\[ T_r = 5^\circ C \]

\[ Q_{\text{Back panel}} = 0.33 \times 0.671 \times 27 = 5.98 \text{ Watts} \]

\( Q_{\text{Back panel}} = 5.98 \text{ Watts} \)

3 -

\[ Q_{\text{door}} = [U \times A \times (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{refrigerator air Temperature} \]

\[ U = 1 / (0.08/0.02) = 0.25 \text{ W/Sq. Mt C} \]
\[ A = 0.549 \text{Sq. Mt.} \]
\[ T_a = 32^\circ C \]
\[ T_r = 5^\circ C \]
4. \[ Q_{\text{Bottom}} = [U \cdot A \cdot (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{refrigerator air Temperature} \]

\[ U = \frac{1}{(0.07/0.02)} = 0.29 \text{ W/Sq. Mt C} \]
\[ A = 0.305 \text{ Sq. Mt.} \]
\[ T_a = 32°C \]
\[ T_r = 5°C \]

\[ Q_{\text{Bottom}} = 0.29 \times 0.305 \times 27 = 2.39 \text{Watts} \]

\[ Q_{\text{Bottom}} = 2.39 \text{ Watts} \]

5. \[ Q_{\text{Top floor}} = [U \cdot A \cdot (T_a - T_r)] \]

\[ T_a = \text{Ambient Temperature} \]
\[ T_r = \text{refrigerator air Temperature} \]

\[ U = \frac{1}{(0.06/0.02)} = 0.33 \text{ W/Sq. Mt C} \]
\[ A = 0.305 \text{ Sq. Mt.} \]
\[ T_a = 32°C \]
\[ T_r = 5°C \]

\[ Q_{\text{Top floor}} = 0.33 \times 0.305 \times 27 = 2.72 \text{Watt} \]

\[ Q_{\text{Top floor}} = 2.72 \text{Watts} \]
Total Heat Leaks:

\[ Q_{\text{Total}} = 13.4 + 5.98 + 3.7 + 2.39 + 2.72 = 28 \]

\[ Q_{\text{Total Heat Leaks}} = 28 \text{ Watts} \]

b) Product Loads;

\[ Q_{\text{product}} = 70\% Q_{\text{Total Heat Leaks}} = 19.6 \text{ Watts} \]

\[ Q_{\text{Misc}} = 20 \% (Q_{\text{Total Heat Leaks}} + Q_{\text{Product Loads}}) = 20\% (28 + 19.6) = 9.5 \text{ Watts} \]

\[ Q_{\text{Misc}} = 9.5 \text{ Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{Etc.}} \]

Total Cooling Capacity required is calculated as follows;

\[ Q_R = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \]

\[ Q_R = 28 + 19.6 + 9.5 = 57 \text{ Watts} \]

\[ Q_R = 57 \text{ Watts} \]

\[ Q_F = Q_{\text{SW}} + Q_{\text{BP}} + Q_{\text{BOTTOM}} + Q_{\text{DOOR}} \]

\[ Q = U A (T_a - T_r) \]

\[ U = 1/(X_1/K_1) \]

Where:

\[ U = \text{Heat Resistance Coefficient Factor} \]
$K_1 =$ Foam Thermal Conductivity \\
$X_1 =$ Foam Thickness \\

1 - 

$Q_{\text{Side Walls}} = [U \ A \ (T_a - T_r)]$ \\

$T_a =$ Ambient Temperature \\
$T_r =$ Freezer air Temperature \\

$U = 1 \ (0.09/0.02) = 0.22 \ W/ \ Sq. \ Mt. \ C$ \\
$A = 0.78 \ Sq. \ Mt.$ \\
$T_a = 42 \ C$ \\
$T_r = -18 \ C$ \\

$Q_{\text{Side Walls}} = 0.22 \times 0.78 \times 60 = 10.3 \ Watts$ \\

$Q_{\text{Side Walls}} = 10.3 \ Watts$

2 - 

$Q_{\text{Back panel}} = [U \ A \ (T_a - T_r)]$ \\

$T_a =$ Ambient Temperature \\
$T_r =$ Freezer air Temperature \\

$U = 1 / (0.095 /0.02) = 0.21 \ W/ \ Sq. \ Mt. \ C$ \\
$A = 0.476 \ Sq. \ Mt.$ \\
$T_a = 32 \ C$ \\
$T_r = -18 \ C$ \\

$Q_{\text{Back panel}} = 0.21 \times 0.476 \times 50 = 5 \ Watts$ \\

$Q_{\text{Back panel}} = 5 \ Watts$
3 - \[ Q_{\text{Bottom}} = [U \times A \times (T_a - T_r)] \]

- \( T_a \) = Ambient Temperature
- \( T_r \) = Freezer air Temperature

\[ U = \frac{1}{(0.105/0.02)} = 0.19 \text{ W/Sq. Mt C} \]
\[ A = 0.305 \text{ Sq. Mt.} \]
\[ T_a = 42 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Bottom}} = 0.19 \times 0.305 \times 60 = 3.48 \text{ Watts} \]

\[ Q_{\text{Bottom}} = 3.48 \text{ Watts} \]

4 - \[ Q_{\text{Door}} = [U \times A \times (T_a - T_r)] \]

- \( T_a \) = Ambient Temperature
- \( T_r \) = Freezer air Temperature

\[ U = \frac{1}{(0.080/0.02)} = 0.25 \text{ W/Sq. Mt C} \]
\[ A = 0.427 \text{ Sq. Mt.} \]
\[ T_a = 32 \text{ C} \]
\[ T_r = -18 \text{ C} \]

\[ Q_{\text{Door}} = 0.25 \times 0.427 \times 50 = 5.34 \text{ Watts} \]

\[ Q_{\text{Door}} = 5.34 \text{ Watts} \]

Total Heat Leaks;

\[ Q_{\text{TL}} = 10.3 + 5 + 3.48 + 5.34 = 24 \text{ Watts} \]
\[ Q_{\text{Total Heat Leaks}} = 24 \text{ Watts} \]

b) Product Loads;

We consider 8 Kg ice making capacity for this model per 24 hours. Therefore;

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3, \]

where;

\[ Q_1 = mC_1 (T_1 - T_f) = \text{energy required to freeze water from initial temperature to freezing point of 0 C} \]

\[ Q_i = 8 \times (24-0) = 192 \text{Kcal / 24 hours} \]

\[ Q_2 = mC_2 (T_f - T_{ff}) = \text{energy required to freeze ice from zero degree temperature to -18 C} \]

\[ Q_2 = 8 \times 1 \times [0-(-18)] = 144 \text{Kcal/24 hours} \]

\[ Q_3 = mh = \text{heat gain from latent heat of fusion of water} \]

\[ Q_3 = 8 \times 108 = 864 \text{Kcal/24 hours} \]

\[ Q_{\text{product}} = Q_1 + Q_2 + Q_3 = 1350 \text{Kcal/24 hours} = 58 \text{Watts} \]

\[ Q_{\text{Misc}} = 10\% \left( Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} \right) = 10\% (24 + 58) = 8.2 \text{Watts} \]

\[ Q_{\text{Misc}} = 10.77 \text{Watts} \]

\[ Q_{\text{Misc}} = Q_{\text{Electricity}} + Q_{\text{Infiltration}} + Q_{\text{Door Opening}} + Q_{\text{Etc.}} \]
Total Cooling Capacity required is calculated as follows:

\[ Q_F = Q_{\text{Heat Leaks}} + Q_{\text{Product Loads}} + Q_{\text{Misc.}} \]

\[ Q_F = 24 + 58 + 8.2 = 90 \text{ Watts} \]

\[ Q_F = 90 \text{ Watts} \]

\[ Q_{\text{Grand Total}} = Q_R + Q_F = 57 + 90 = 147ts \]

\[ Q_0 = 1.2 \times Q_{\text{Grand Total}} = 176 \text{ tts} \]

Type of Compressor suitable for this model is recommended Compressor BAIXUE Model QDHCI12GA(Q=180W)

二、CONDENSOR DESIGN:

\[ Q_k = 1.3 \times Q_0 = 1.3 \times 176 = 230 \text{ Watts} \]

condensor area: \( 230/(16 \times 12) = 1.2 \text{ square meter} \)
condensing line area: \( 1.2/3.5 = 0.35 \text{ square meter} \)
length of double side condensing line: \( 0.35/(3.14 \times 0.00476) = 24 \text{ meter} \)
singal side 24meter copper tube \( \varnothing 4.76 \times 0.7 \)

三、EVAPORATOR DESIGN:

evaporation area = \( 176/(13 \times 10) = 1.35 \text{ square meter} \),
length of evaporation copper tube: \( 1.35/(3 \times 3.14 \times 0.008) = 18 \text{ meter} \) \( \varnothing 8 \times 0.7 \)

四、Capillary tube:

Freezing: \( \varnothing 2.0 \times 0.71 \times 2000 \text{mm} \)
Refrigerating: \( \varnothing 2.1 \times 0.91 \times 4300 \text{mm} \)
Refrigerant/Refrigerant charging: R600a/52g
Testing records of refrigeration cabinets with R600a

1. **BD-308**
   Compressor model: QDHC112GA   Refrigerant/charge: R600a/92g
   Position of thermostat knob: strong cooling;
   Ambient temperature: 32°C   RH: 75%;
   Cooling speed: 52 minutes after switch on, the inside temperature reach \(-18\)^\circ C;
   63 minutes after switch on, the inside temperature reach \(-21.9\)^\circ C;
   The final temperature: \(-31\)^\circ C.

2. **BD-168**
   Compressor model: QDHC79GA   Refrigerant/charge: R600a/54g
   Position of thermostat knob: strong cooling;
   Ambient temperature: 32°C   RH: 75%;
   Cooling speed: 63 minutes after switch on, the inside temperature reach \(-21.9\)^\circ C;
   The final temperature: \(-26\)^\circ C.

3. **BCD-178**
   Compressor model: QDHC79GA   Refrigerant/charge: R600a/52g
   Position of thermostat knob:: 5
   Ambient temperature: 32°C   RH: 75%;
   Cooling speed: 92 minutes after switch on, the temperature in freezing chamber reach
   \(-23\)^\circ C; the temperature refrigeration chamber reach \(5.1\)^\circ C,

4. **SC-315**
   Compressor model: QDHC126GA   Refrigerant/charge: R600a/62g
   Position of thermostat knob:: 5
   Ambient temperature: 32°C   RH: 75%;
   Cooling speed: 45 minutes after switch on, the inside temperature reach \(3.73\)^\circ C,

5. **YCD-258**
   Compressor model: QDHC112GA   Refrigerant/charge: R600a/52g
   Position of thermostat knob: -20°C/5°C
   Ambient temperature: 32°C   RH: 75%;
   Cooling speed: 2 hours and 1 minutes after switch on, the temperature in refrigeration
   chamber reach \(2.1\)^\circ C, the temperature in freezing chamber: \(-18.8\)^\circ C.