Chapter 7

CALCULATION OF CONDENSER DEVICES

7.1 ANALYSIS AND SELECTION OF CONDENSER DEVICES

7.1.1 Condenser Evaporation:

The air moving from the bottom up on the axial fan set above the condenser or puts the bottom. Part of the water is evaporated and is carried by air flow. So the water temperature is in and out of constant condenser. Water supplements are controlled by valves that float to give the system.

Pros Point:

- Save a lot of extra water.
- No additional cooling equipment is required.

Downside Point:

- The relatively small thermal transmission coefficient, a lot of metals.
- Temperature condenser varies by weather.

Usually used in hot and dry climates.
7.1.2 Condenser Tank:

Water cooling is pumped into the tank, going into the distributed trough the triangular appearance on each beam. So the water is watered evenly on the tube and flows to the bottom tank. Part of the hot water will be discharged away, a rest after the mixing of cold water will be refunded back. To save the heat-saving water needed next to the condenser water cooling equipment.

Pros Point:

- Consume low heat and metal.
- Easy to build and trust in operators.

Downside Point:

- Bulky, occupying many area.
- Regularly hygiene water distribution and heat transfer surfaces.
- Cooling water is prone to dirt.

We Now The condenser type is not to be produced in the market
7.1.3 Air Cooling Condenser

This type of condenser has 2 Type: It is a compulsive and natural cooling. This type of condensing air-cooled radiator is usually composed of many winged beams with wings, associated with the donated tubes. Cold agent goes on down and out at the bottom. This type of need to use the ventilator, which is the cause of the noise.

The natural object that is composed of a flat beam of aluminum or bronze, the impeller is the steel wire which is welded to the spiral beam. This type is often used in family refrigerators.

7.1.4 Condenser Panel :

The primary part of the condenser is the panel made of two rolled steel plates that are stamping into each other. In panel formed a sequence of vertical grooves, where cold lips would condenser. Water cooling passes through the duct of the distribution hole, which in turn crosses the panel and goes out through the exhaust.

Pros Point: Can be easily removed for testing, cleaning and lightning-resistant.

Downside Point: The size and weight of the condenser is quite large.

This kind of little is used in reality.
7.1.5 discontinuation of sheet type:

The main part of this type of sheet condenser is the metal plate that is wavy-shaped. Each wavy plate comes into contact with 2 Work One side is the cold agent one side is a thermal solution. Horizontal ripples have the effect of making the motion flow of the working environment and enhancing the likelihood of thermal transmission of condenser.

7.1.6 Condenser Pipe Upright:

This type of body and heat transfer tubes upright. Slightly the agent enters the beam from the upper side of the tank, the liquid agent of the tube flows downwards and is led out. The water is led to the top from the upper twisted groove on the tube which flows into the membrane along the surface in the tube.

Heat line density at about $4.7 \div 5.2$ KW/M$^2$

The advantage is easy to do hygiene on the water.
7.1.7 Condenser Horizontal Plumbing

The condenser is a cylindrical, horizontal fuselage. Two heads have two screens on the trunk. The plumbing forms a thermal transfer surface which is formed in two sieve surfaces. The two first relatives had two caps that were firmly inserted in the face of bolts.

The water is cooling away in the heat transmission tube from the bottom up. Slightly the agent goes from the top of the tank and condensation at intervals between the tubes, the liquid agent is collected into the bottom. For Freon condenser, people usually make the wings toward Freon.

The condenser type has a compact size, a higher cooling coefficient than other types. It is widely used in the market.

7.2 OPTIONS

The type of panel and plate condenser is in the research phase of the development so little is tolerated in the present moment. The type of irrigation and evaporation is needed to have a wide space as they are large in size. Due to its narrow design space, it also does not use two types.

There are only 3 types Is: Stop the hose upright, horizontally and with air heat. Depending on the conditions of space, design conditions, economic conditions if appropriate to use air-cooled atmosphere, use the air-cooled condenser type, while using a more suitable thermal water, use a tube of water condenser.

Using a straight-back tube of water, the cooling water is set directly at the condenser, above the tank. Requires proper space. The air-cooled condenser can be arranged on the rooftop machine, the heat is less bulky, and economic conditions also allow.

Through the analysis we choose the type of cooling condenser Water. Because of the horizontal tube, we can heat the water from the remote, flexible in the arrangement of the thermal water tank. For comfort Air Conditioning This is a very rewarding factor for less Time available
7.3 CALCULATING CONDENSER

-Heat filler for vase Stop: \( Q_k \)

\[ Q_k = G(i_2 - I_3), \text{ KW pages 151 TL [1]} \]

G – The intake of cold agent enters condenser, kg/s

\[ G = 4.8 \text{ Kg/s} \]

The planetary cycle

\[ I_2 - I_3 - \text{Entanpi's writings Human cold When in and out of condenser, KJ/kg} \]

\[ QK = I_2 - I_3 = 451.1427 - 261.5 = 189.6427 \text{ KJ/kg} \]

\[ \Rightarrow Q_k = 48. (451.1427 - 261.5) = 910.3 \text{ Kw} \]

-Heat Speed Water in, Condenser: Tw1, Tw2

-Discontinued temperature Capacitor: \( T_k = 37^\circ\text{C} \), the cycle calculator.

-Cold Agent History Use R410A

-The thermal surface of the condenser is a beam that has a arranged wing.

-Digital parameters Art:

\[ \text{Diameter in steel tube} \quad d_p = 0.0115 \text{ M} \]

\[ \text{Wing diameter} \quad D = 0.0165 \text{ M} \]

\[ \text{diameter of the wing} \quad d_{Ng} = 0.0133 \text{ M} \]

\[ \text{Step Wings} \quad S_c = 0.00127 \text{ M} \]

\[ \text{Exterior area of 1m tube} \quad F = 0.1444 \text{ M}^2/\text{m} \]

\[ \text{Surface area of 1m tube} \quad F_P = 0.0361 \text{ M}^2/\text{m} \]

\[ \text{Wing coefficient} \quad \beta = \frac{F}{R_{tr}} = 4 \]

-Average temperature of water in condenser

\[ t_w = \frac{t_1 + t_2}{2} = \frac{31 + 35}{2} = 33^\circ\text{C} \]

-Medium Temperature difference Logarithm

\[ \theta_m = 4^\circ\text{C} \]

-Water flow needed for cooling Stop:
Choose water velocity \( \omega = 1.5 \text{ m/s} \)

\[
\begin{align*}
\bar{G}_w &= \frac{Q_k}{C \Delta t_w} = \frac{910.3}{4171.4} = 54.56 \text{ kg/s} \\
\end{align*}
\]

- Number of tubes in a water line

\[
\begin{align*}
n_z &= \frac{4G_w}{\pi \rho_w \cdot \frac{d_{tr}^2}{2} \cdot \omega} = \frac{4.5456}{3.14994 \cdot 65.0 \cdot 0.0115 \cdot 1.5} = 352 \\
\end{align*}
\]

Recharging water velocity by \( n_1 \) TA has \( \omega = 1.5 \text{ m/s} \)

\[
\begin{align*}
\Re &= \frac{\omega \cdot d_{tr}}{\nu} = \frac{1.5 \cdot 0.0115}{0.7612 \cdot 10^{-6}} = 22661.5 \\
\nu ; \text{ Dynamic viscosity of a water m}^2/\text{s}
\end{align*}
\]

This is the puppet regime for

\[
\begin{align*}
\Nu &= 0.021 \cdot \Re^{0.8} \cdot \Pr^{0.43} \cdot \varepsilon_1 = 0.021 \cdot 22661.5^{0.8} \cdot 5.087^{0.43} = 128.9 \\
\end{align*}
\]

With \( \varepsilon_1 = 1 \) Vl L \( d_{tr} > 50 \)

- The thermal coefficient Water: \( \alpha_w \)

\[
\begin{align*}
\alpha_w &= \frac{\Nu \cdot \lambda}{d_{tr}} = \frac{128.9 \cdot 0.623}{0.0115} = 6983 \text{ W/m}^2 \cdot \text{K}
\end{align*}
\]

- Select Total Heat \( \sum \delta_i \cdot \lambda_i = 2.6 \cdot 10^{-4} \text{ M}^2. \text{K/w} \) is the equation for determining the density of thermal lines to the country:

\[
\begin{align*}
q_w &= A(\theta_m - \theta) = \frac{\theta_m - \theta}{\alpha_w + \sum \frac{\delta_i}{\lambda_i}} = \frac{4 - \theta}{6983 + 2.6 \cdot 10^{-4}} = 2480(4 - \theta)
\end{align*}
\]

To be able to determine the temperature line density \( Q_p \) Need to preliminary the texture selection of the condenser. We want to first select the value of \( Q_p \) Then We'll check again. It is difficult to choose exactly the value \( q_p \), which can only be selected approximate by the following:

- Choose \( \theta = 0.3 \theta_m \) Then:

\[
\begin{align*}
q'_{tr} &= A(\theta_m - 0.3 \theta_m) = 0.7 \cdot 2480.4 = 6944 \text{ W/m}^2
\end{align*}
\]

If the tube is arranged on a triangular floor and according to hexagonal edges, the parameter \( m \) can be determined by the formula

\[
\begin{align*}
m = 0.75 \sqrt{\frac{Q_k}{q'_{tr} \cdot 5 \cdot d_{tr} \cdot k}}
\end{align*}
\]
Select \( S = 1, \ 3d = 1.3 \cdot 0.0165 = 0.02145 \) \( M = L/D = 5.5 \)

Note: \( D \) in the \( S \) formula is the wing diameter, and \( D \) in the formula \( K \) is the diameter of the condenser fuselage.

At that \( m = 0.75 \cdot \frac{910.3 \cdot 10^6}{694.0 \cdot 0.02145 \cdot 0.0115 \cdot 5.5} = 34.4 \)

So the row number of vertical tubes \( n_x = m = 35 \) and \( N_x/2 = 17 \)

Heat-generating coefficient for condenser R410a is calculated by the surface in the tube will determine the formula

\[
\alpha_a = 0.72 \left\{ \frac{\Delta t \cdot \rho \cdot \lambda^3 \cdot g}{v \cdot d_{ng} \cdot \left( \frac{n_x}{2} \right)^{0.157} \cdot \beta \cdot \theta^{-0.25} \cdot \Psi_c} \right\}
\]

\( \Delta t = q_K = 189.6427 \text{ KJ/kg} = 189.6427 \cdot 10^3 \text{ J/kg} \)

Coefficient of calculation of different condensation conditions on the vertical sections (Superficial The impeller) and the horizontal (surface of the tube) of the surface condenser.

\[
\Psi_c = 1.3 \cdot \frac{F_{x}}{F} \cdot B_{0.75} \left( \frac{d_{ng}}{h'} \right)^{0.25} + \frac{F_{x}}{F}
\]

Vertical wing area with 1m pipe length

\[
F_d = \frac{\pi \left( D^2 - d_{ng}^2 \right)}{2 \cdot S_c \cdot \cos \frac{\alpha}{2}} = \frac{3.14 \left( 0.0165^2 - 0.0133^2 \right)}{2 \cdot 0.00127 \cdot \cos 10^2} = 0.12 \text{ m}^2
\]

\( \alpha = 20°C \) Winghead Angle

The surface area of the horizontal canal of 1m

\[
F_h = F - F_d = 0.1444 - 0.12 = 0.0244 \text{ m}^2
\]

\( h' \) height effect of wings

\[
h' = \frac{\pi \left( D^2 - d_{ng}^2 \right)}{D} = \frac{3.14 \left( 0.0165^2 - 0.0133^2 \right)}{0.0165} = 0.0045 \text{ m}
\]

With \( e \) is the wing coefficient, for low-wing \( E = 1 \)

\[
\Psi_c = 1.3 \cdot \frac{0.12}{0.1444} \cdot \left( \frac{0.0133}{0.0045} \right)^{0.25} + \frac{0.0244}{0.1444} = 1.585
\]

So we have

\[
\alpha_a = 0.72 \left\{ \frac{189.6427 \cdot 10^3 \cdot 993.46 \cdot 0.0825 \cdot 9.81}{0.1008 \cdot 10^{-6} \cdot 0.0133} \cdot \left( 28 \right)^{-0.167} \cdot 4 \cdot \theta^{-0.25} \cdot 1.585 = 270222 \cdot \theta^{-0.25} \right\}
\]
Thermal line density in R410a

\[ q_a = \alpha_a \cdot \theta = 10481.6 \cdot \theta^{-0.25}, \theta = 270222. \theta^{0.75} \]

We have a system of determining \( Q_P \)

\[ q_w = 2480(4 - \theta) \]

\[ q_a = 270222. \theta^{0.75} \]

\[ q_{tr} = \frac{(x-1)q^X_{tr} + \theta_m.B^X}{x.q^X_{tr} + \theta_m.B^X/A} \]

where \( x = 1/k = 1/0.75 = 1.333, A = 2480, B = 270222 \)

\( \theta_m = 4, q'_{tr} = 6944 \ W/m^2 \)

The first time we have

\[ q_{tr1} = \frac{(1.333 - 1 \cdot 6944^{1.333} + 4.270222^{1.333})}{1.333 \cdot 6944^{1.333} - 1 + 270222^{1.333} \cdot 2480} = 9858.73 \ W/m^2 \]

The second similar value \( q'_{tr} \) be replaced by \( q_{tr1} \)

\[ q_{tr2} = \frac{(1.333 - 1 \cdot 9858^{1.333} + 3.270222^{1.333})}{1.333 \cdot 9858^{1.333} - 1 + 270222^{1.333} \cdot 2480} = 9858.05 \ W/m^2 \]

Relative error

\[ \delta_e = \frac{q_{tr1} - q_{tr2}}{q_{tr2}} = \frac{9858.73 - 9858.05}{9858.05} = 0.07 \cdot 10^{-3} = 0.007\% \]

Select Preliminary at first \( m = 35 \) So the total pipe is

\( n = 0.75 \cdot (m^2 - 1) + 1 = 0.75 \cdot (35^2 - 1) + 1 = 919 \)

Number of roads

\[ z = \frac{n}{n_1} = \frac{919}{352} = 2.61 \text{ chn } z = 3 \]

At that \( n = 352.3 = 1056 \)

if \( M = 35 \) and \( n = 919 \) Then Number of tubes will be less 1056. We must reselect the value \( m \), for example, select \( m = 38 \)

\( n = 0.75 \cdot (m^2 - 1) + 1 = 0.75 \cdot (38^2 - 1) + 1 = 1083 \)

Often must be diminished 2 The lower tube to hold the liquid condenser, so the number of left away is
\[ n' = \frac{m + 1}{2} + [1 + 2 + \ldots + (i - 1)] = 2 \frac{38 + 1}{2} + 1 + 2 = 42 \]

With \( i \) The row of pipe removed

Number of tubes left

\[ n'' = n - n' = 1083 - 42 = 1041 \]

So missing 15 Tubes to suffice 1056. We can arrange them at the ph. top of the condenser.

Floor diameter

\[ D = m.S = 38.0.02145 = 0.8151 \text{ m} \]

The external diameter of the condenser fuselage can 850MM and body thickness are 10Mm

Surface heat transfer area of condenser

\[ F_{tr} = \frac{Q_k}{q_{tr}} = \frac{910.3 .10^3}{9858.05} = 92.3 \text{ m}^2 \]

The length of a tube is

\[ l = \frac{F_{tr}}{n. d_{tr}. n} = \frac{92.3}{3.14.0.0115.1056} = 2.5 \text{ m} \]

Ratio \( \kappa = \frac{l}{D} = \frac{2.5}{0.8151} = 3 \) Not Within the limit allows \((4 \div 8)\) so we choose \( L = 3\text{M} \) To comfortably limit the Allow

**7.4 ENDURANCE CONDENSER:**

**7.4.1 Body:**

The average body thickness must satisfy Sue:

\[ S \geq \frac{P_R \times D_{tr}}{2 \times [\delta] \times \varphi_d - P_R} + C \text{ mm. CT10.1/TR 364 [TL4]} \]

In it:

\[ P_R = 20 \text{ Bar} = 2 \text{ Mpa} \text{-pressure calculation of the device. Table 10.1 [TL4]} \]

\[ [\delta] = 139 \text{ Application Allowed by Steel CCT38. Table 10.2 [TL4]} \]

\[ D_P = 0.8151\text{M}: \text{the diameter in the trunk.} \]

\[ \varphi_d = 0.9: \text{Strength of vertical welding coefficient. Table 10.3 [TL4]} \]

\[ C = C1 + C2 - \text{additional thickness.} \]
C1 = 3 mm-section of extra thickness to compensate for corrosion when exposed to toxic substances that cause high wear.

C2 = 1 mm: is a thickness of the complement to the thickness offset.

C = 3 + 1 = 4 mm

So we finally Be:

\[ S \geq 4 \text{ mm} \]

Select \( S = 5 \text{ mm} \)

### 7.2.2 Bottom curve and lid:

Choose an ellipse-shaped curved bottom.

Curved bottom Thickness, \( d \) Deal 2 conditions Following:

\[
\left\{ \begin{array}{l}
0.2 \leq \frac{H_p}{D_u} \leq 0.5 \\
0.002 \leq \frac{S_d - C}{D_u} \leq 0.1
\end{array} \right. \quad \text{Pages 370 [TL4]}
\]

With:

\( H_p \) - The inner height of the curved bottom is not

\( H_p = 0.25, D_p = 0, 15.5, 8151 = 0.2 \text{ M. Page 375 [TL4]} \)

\( S_d \) Determined by the Knowledge

\[
S = \frac{P_R \times R}{2 \times \delta \times \varphi_d - P_R} + C \quad \text{mm. CT10.9)/tr 374 [TL4]}
\]

\( R \) – Radius of curved bottom. \( R = D_p \) With the bottom \( H_p = 0.25, D_p \)

So \( S_d = 4 \text{ mm} \)

Select \( S_d = 5 \text{ mm} \)

Check Back

\[ \frac{H_{tr}}{D_{tr}} = \frac{0.014}{0.057} (0.2 < 0.25 < 0.5) \text{ fulfills} \]

\[ \frac{S_d - C}{D_{tr}} = 5 - 4 = 0.0625 (0.002 < 0.0625 < 0.1) \text{ fulfills} \]

So the length of the curved bottom, \( d \) Also in 5 mm.

Choosing the vase lid is the type of an ellipse that should be calculated as well as the cover for the curved bottom. Similar, The lid is 5 mm.
7.2.3 Availability:

Heat transfer tubes are mounted in the sieve of the Naustralian method. Sieve surface $S_m$ To satisfy Sue:

$$S_m \geq 0.5 \times D_e \times \sqrt{\frac{P_0 - P_R}{\sigma}} + C \quad CT (10.20)/page 382 [TL4]$$

$D_e = 0.1$: The diameter of the circle can be contained on the area with no largest tube on the floor.

$P_R = 2$ Mpa - Voltage Calculation (10.1) [TL4]).

$P_0 = 1.5$ Bar = 0.15 MPa-pressure calculation in the tube [TL4].

$[\delta] = 139$ - Allowed pressure of steel CCT38. Table 10.2 [TL4].

$C = 4$ mm-thickness added.

So: $S_m \geq 4$

Select Ensure $S_m = 5$ mm.