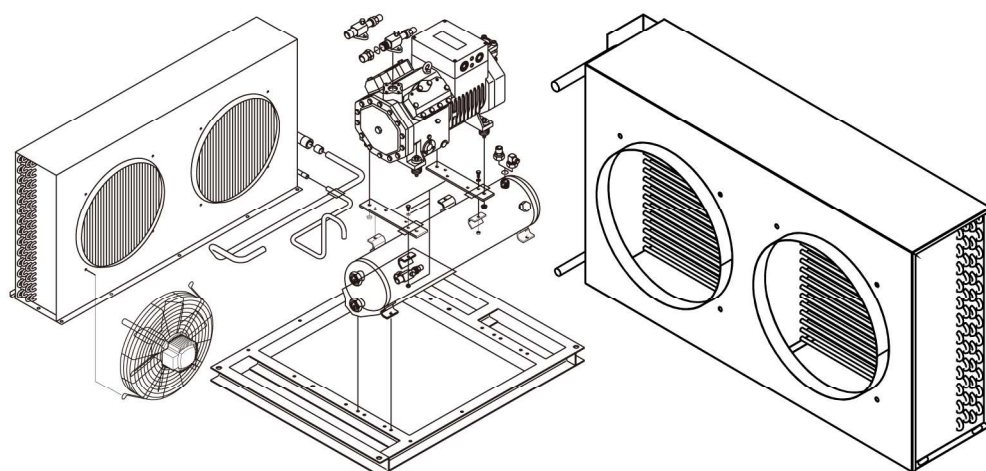
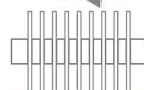
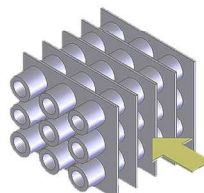
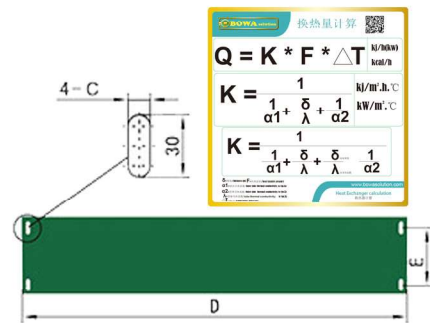
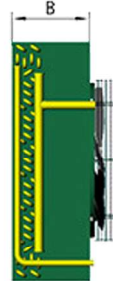
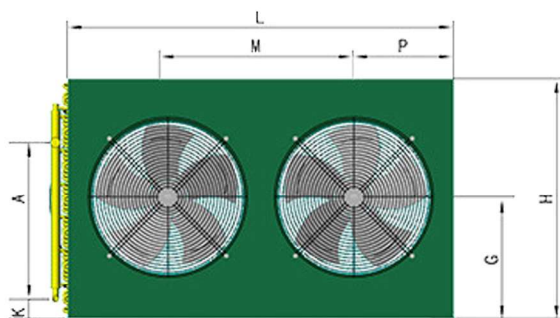
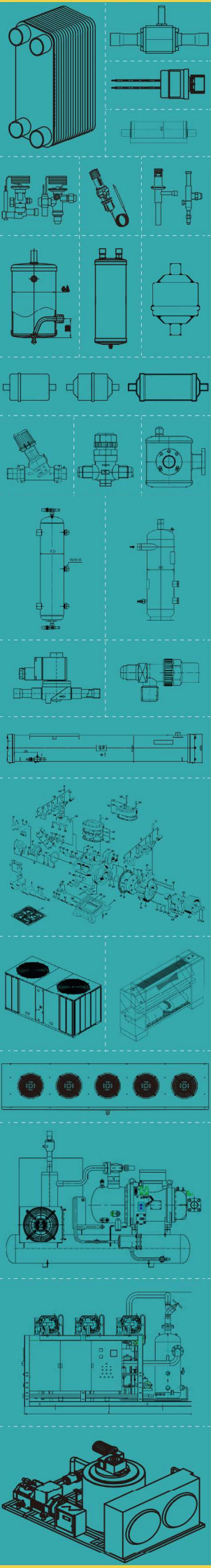




Finned Tube

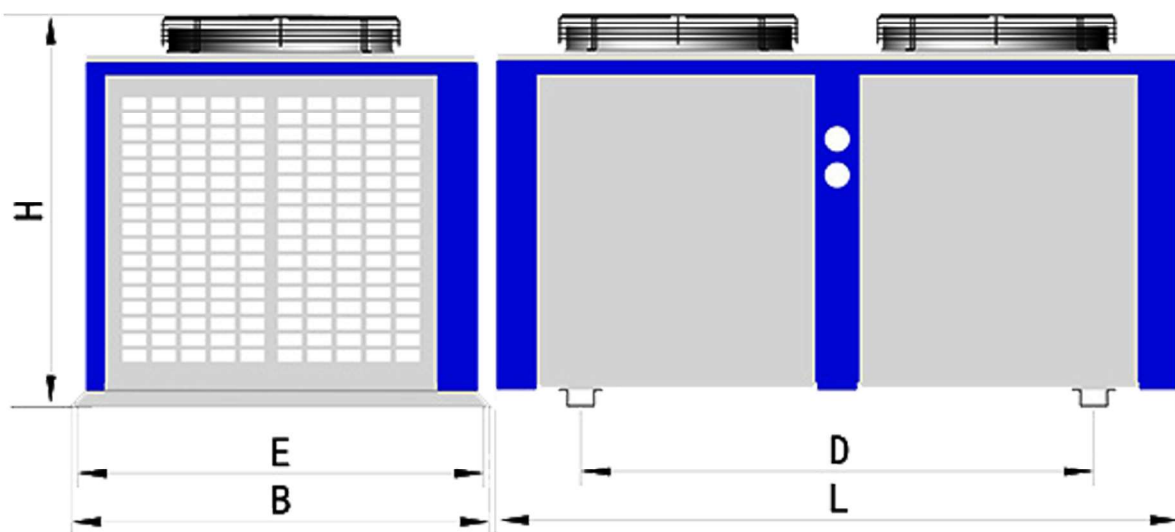


型号 Model	换热量 Heat transfer Capacity $\Delta t=15^\circ\text{C}$ W	换热面积 Heat Transfer Area m^2	风扇 Fan motor					连接尺寸 Connection Size	
			直径 Dia. mm	数量 Qty N	风量 volume m^3/h	功率 Input W	电压 Voltage V	进口 Inlet mm	出口 Outlet mm
FHN-0.7/2	710	2	200	1	430	35	220	10	10
FHN-1.2/3.4	1217	3.4	200	1	430	35	220	10	10
FHN-1.4/4.0	1440	4	200	1	430	35	220	10	10
FHN-1.6/4.4	1566	4.4	250	1	910	60	220	10	10
FHN-1.9/5.2	1856	5.2	300	1	1530	75	220	10	10
FHN-2.9/8	2864	7	300	1	1530	75	220	12	12
FHN-3.0/8.4	3007	8.4	300	1	1530	75	220	12	12
FHN-3.8/10.6	3816	10.6	300	1	1530	75	220	12	12
FHN-3.6/10	3550	10	350	1	1800	90	380	16	12
FHN-4.3/12	4296	12	350	1	1800	120	380	16	12
FHN-5.4/15	5355	15	350	1	1800	120	380	16	12
FHN-6.4/18	6408	18	400	1	3000	120	380	16	12
FHN-7.9/22A	7876	22	400	1	3000	120	380	16	12
FHN-10/27	9968	27	400	1	3000	120	380	19	16
FHN-7.9/22B	7876	22	350	2	3600	2×120	380	16	12
FHN-10/28	9968	28	350	2	3600	2×120	380	19	14
FHN-12/33	11880	33	400	2	6000	2×120	380	19	14
FHN-15/42	15036	42	400	2	6000	2×120	380	19	16
FHN-19/52	18668	52	400	2	6000	2×120	380	19	16
FHN-21/60	21360	60	450	2	9000	2×180	380	22	19
FHN-25/70	24640	70	450	2	9000	2×180	380	25	19
FHN-28/80	28240	80	450	2	9000	2×180	380	25	19
FHN-35/100	35400	100	500	2	13140	2×450	380	25	19
FHN-39/110	39050	110	500	2	13140	2×450	380	30	19
FHN-42/120	42240	120	550	2	17440	2×600	380	30	19
FHN-48/135	47799	135	550	2	17440	2×600	380	30	19
FHN-55/155	55025	155	600	2	21640	2×780	380	30	22
FHN-60/170	59500	170	600	2	21640	2×780	380	30	22



型号 Model	外形尺寸 Overall Dimension			安装尺寸 Mounting Size			接口尺寸 Connection		风扇排列尺寸 Fan Central Size		
	L	B	H	D	E	C	A	K	G	P	M
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
FHN-0.7/2	250	120	240	275	70	9	200	24	115	125	
FHN-1.2/3.4	250	120	240	275	70	9	200	24	115	125	
FHN-1.4/4.0	300	120	255	290	90	6	225	24	128	150	
FHN-1.6/4.4	325	120	280	290	70	6	250	24	140	162	
FHN-1.9/5.2	370	130	340	370	100	6	290	25	170	185	
FHN-2.9/8	370	150	340	370	120	6	290	25	170	185	
FHN-3.0/8.4	450	170	350	475	120	9	275	44	175	225	
FHN-3.8/10.6	450	170	350	475	120	9	275	44	175	225	
FHN-3.6/10	450	170	420	475	120	9	375	30	210	225	
FHN-4.3/12	440	180	420	430	130	9	320	50	210	220	
FHN-5.4/15	490	180	470	480	130	9	370	50	235	245	
FHN-6.4/18	530	180	520	520	130	11	420	50	260	265	
FHN-7.9/22A	530	200	520	520	150	11	420	50	260	265	
FHN-10/27	590	240	470	580	190	11	425	35	240	295	
FHN-7.9/22B	810	180	420	800	130	11	320	50	210	210	400
FHN-10/28	890	180	470	880	130	11	420	50	260	220	430
FHN-12/33	940	180	520	930	130	11	420	50	260	240	450
FHN-15/42	940	200	520	930	150	11	420	50	260	240	450
FHN-19/52	940	200	620	930	150	11	500	50	310	240	450
FHN-21/60	1160	240	620	1150	170	11	500	50	310	220	560
FHN-25/70	1160	240	720	1150	190	11	500	50	360	240	560
FHN-28/80	1160	240	820	1150	190	11	500	50	410	220	560
FHN-35/100	1350	260	870	1340	210	11	500	50	435	240	660
FHN-39/110	1350	260	920	1340	210	11	500	50	460	240	660
FHN-42/120	1350	260	1020	1340	210	11	500	50	510	240	660
FHN-48/135	1350	260	920	1340	210	11	500	50	460	240	660
FHN-55/155	1400	300	1020	1390	250	11	500	50	510	240	680
FHN-60/170	1400	300	1120	1390	250	11	500	50	560	240	680



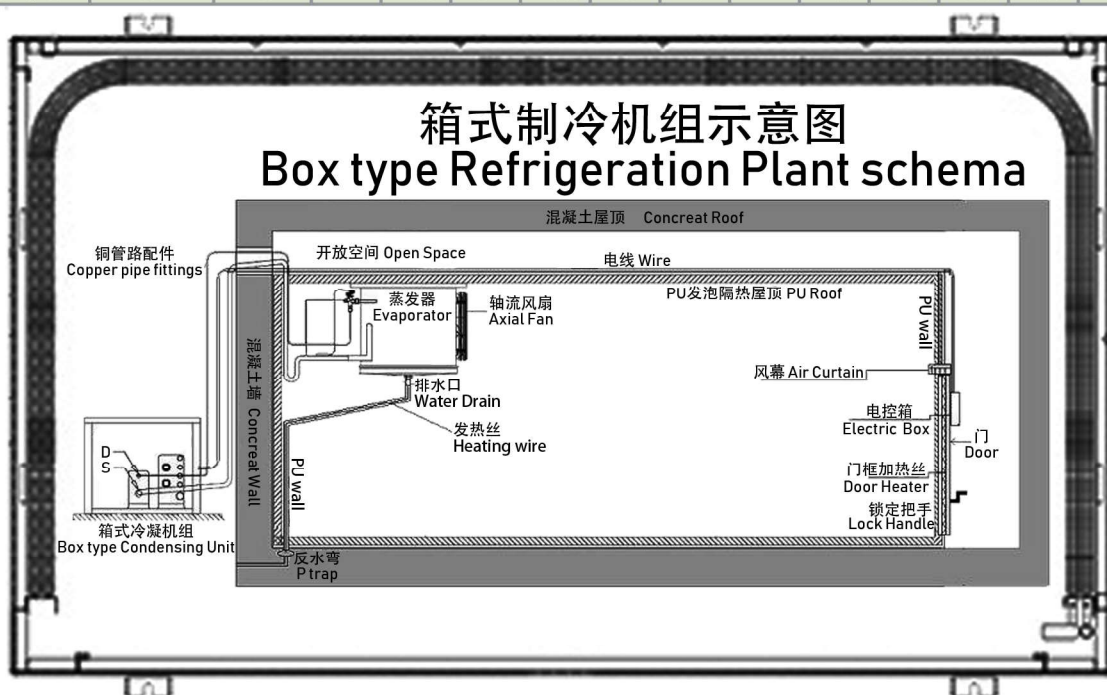


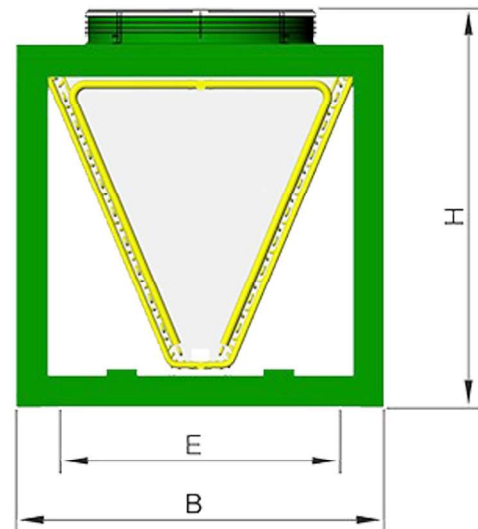
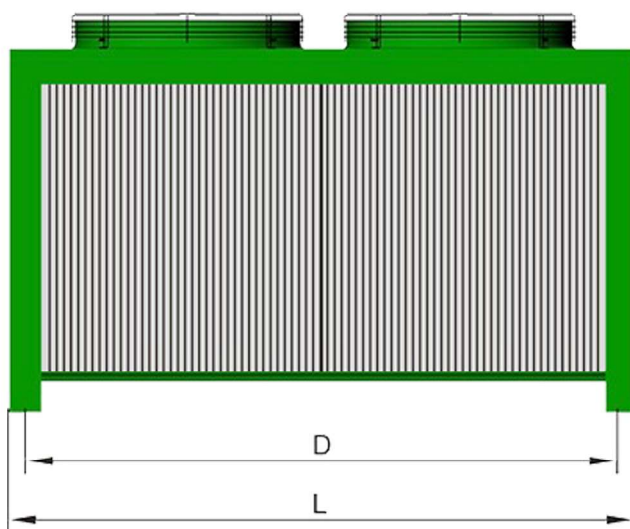
冷凝器性能参数表 Working as condenser performance

型号 Model	换热量 Heat transfer Capacity $\Delta t=15^{\circ}\text{C}$	换热面积 Heat Transfer Area	风机 Fan motor					连接尺寸 Connection Size		外型尺寸 Dimensions			安装尺寸 Mounting Size	
	W	m^2	数量 Qty	直径 Dia. mm	风量 volume m^3/h	功率 Input W	电压 Voltage V	进口 Inlet mm	出口 Outlet mm	L mm	B mm	H mm	D mm	E mm
FHU-10/28	9968	28	1	4D450	5000	290	380	19	14	870	670	690	510	840
FHU-12/33	11880	33	1	4D450	5000	290	380	19	14	870	670	690	510	840
FHU-15/42	15036	42	1	4D450	6570	380	380	19	16	920	770	690	610	890
FHU-18/50	17950	50	1	4D500	8720	600	380	22	16	900	770	900	610	870
FHU-21/60	21360	60	1	4D550	8720	600	380	22	16	900	770	900	610	870
FHU-25/70	24640	70	1	4D550	8720	600	380	22	16	900	770	1000	610	840
FHU-28/80	28240	80	2	4D450	2x5000	2x290	380	22	16	1330	850	800	900	820
FHU-31/90	30500	90	2	4D500	2x6570	2x380	380	22	16	1330	950	890	900	920
FHU-35/100	35400	100	2	4D500	2x6570	2x380	380	22	16	1330	950	990	900	920
FHU-39/110	39060	110	2	4D500	2x6570	2x380	380	22	16	1480	950	990	900	920
FHU-42/120	42240	120	2	4D550	2x8720	2x600	380	25	19	1730	1050	1000	1300	1020
FHU-46/130	46028	130	2	4D550	2x8720	2x600	380	25	19	1730	1050	1000	1300	1020

箱式制冷机组示意图

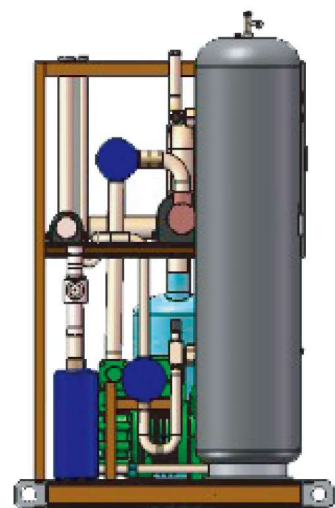
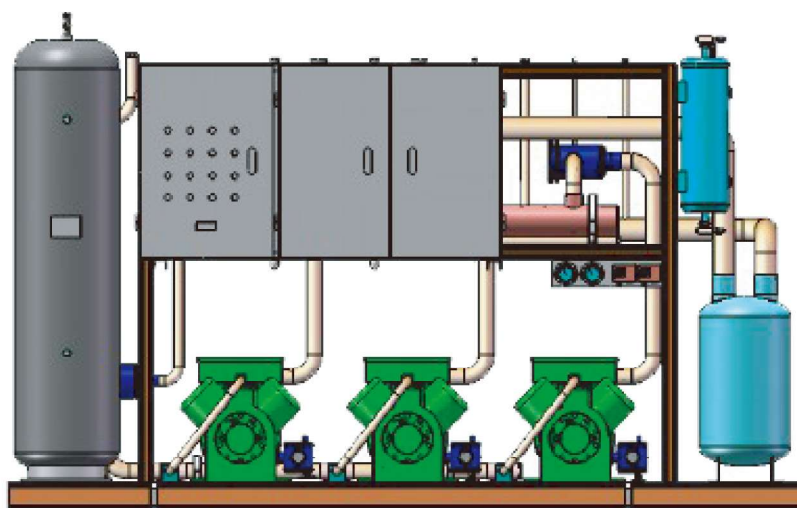
Box type Refrigeration Plant schema

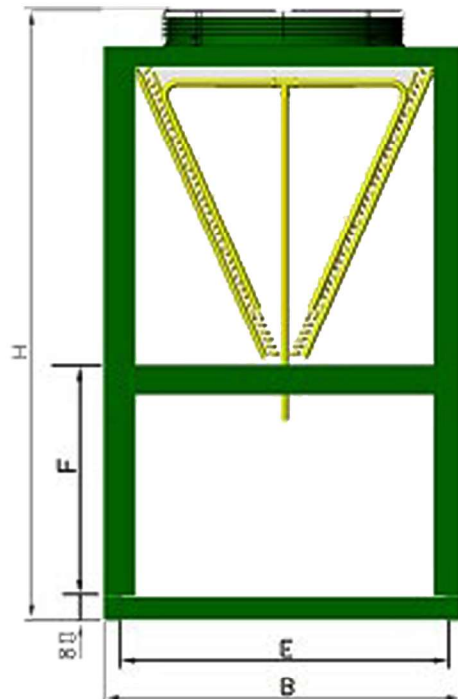
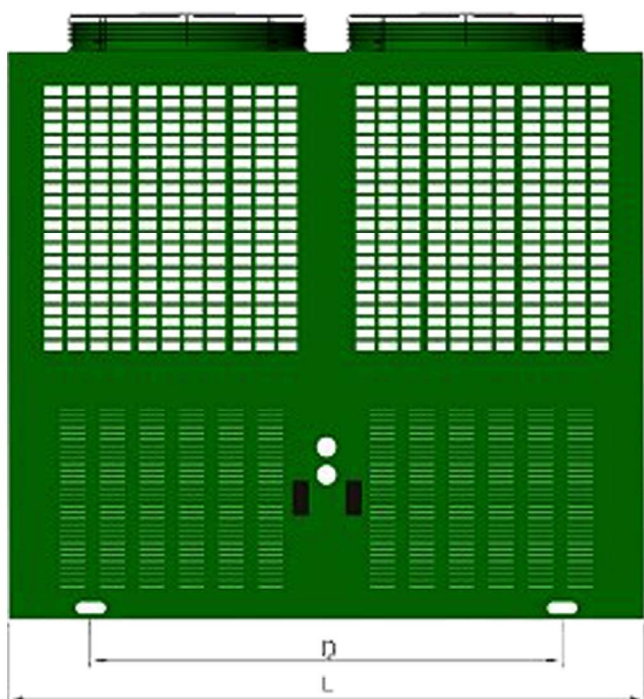




冷凝器性能参数表 Working as condenser performance

型号 Model	换热量 Heat transfer Capacity $\Delta t=15^{\circ}\text{C}$	换热面积 Heat Transfer Area	风机 Fan motor					连接尺寸 Connection Size		外型尺寸 Dimensions			安装尺寸 Mounting Size	
			数量 Qty	直径 Dia.	风量 volume	功率 Input	电压 Voltage	进口 Inlet	出口 Outlet	L	B	H	D	E
	W	m ²	N	mm	m ³ /h	W	V	mm	mm	mm	mm	mm	mm	mm
FHV-25/72	24840	72	1	4D550	8487	600	380	22	16	950	900	880	870	650
FHV-30/87	30102	87	1	4D600	10820	780	380	25	16	1100	1000	880	1020	650
FHV-39/110	39050	110	2	4D500	2×6246	2×450	380	25	16	1400	900	880	1320	650
FHV-45/130	44850	130	2	4D550	2×8487	2×600	380	28	19	1550	900	880	1470	650
FHV-55/155	55025	155	2	4D500	2×8487	2×600	380	28	19	1600	1000	980	1520	750
FHV-64/185	63825	185	2	4D600	2×12500	2×780	380	28	22	1700	1000	1080	1620	750
FHV-73/210	72660	210	2	4D630	2×13000	2×800	380	32	22	1750	1000	1180	1670	750
FHV-83/240	82800	240	2	φ700	2×15000	2×750	380	32	22	1900	1175	1260	1820	925
FHV-104/300	103800	300	2	φ750	2×19000	2×1100	380	35	25	2250	1175	1260	2170	925
FHV-111/320	111040	320	2	φ750	2×19000	2×1100	380	38	25	2350	1175	1260	2270	925
FHV-125/360	124560	360	3	φ650	3×13200	3×550	380	42	28	2650	1175	1260	2570	925
FHV-138/400	138400	400	3	φ700	3×15000	3×750	380	42	28	2950	1175	1260	2870	925
FHV-166/480	165600	480	3	φ750	3×19000	3×1100	380	54	28	3400	1175	1260	3320	925

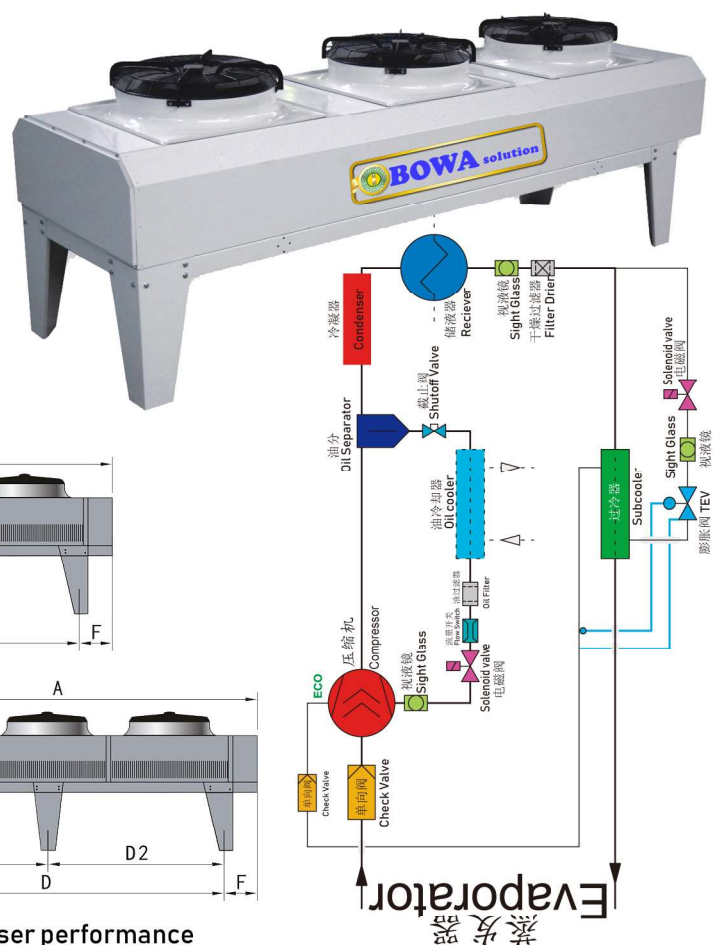
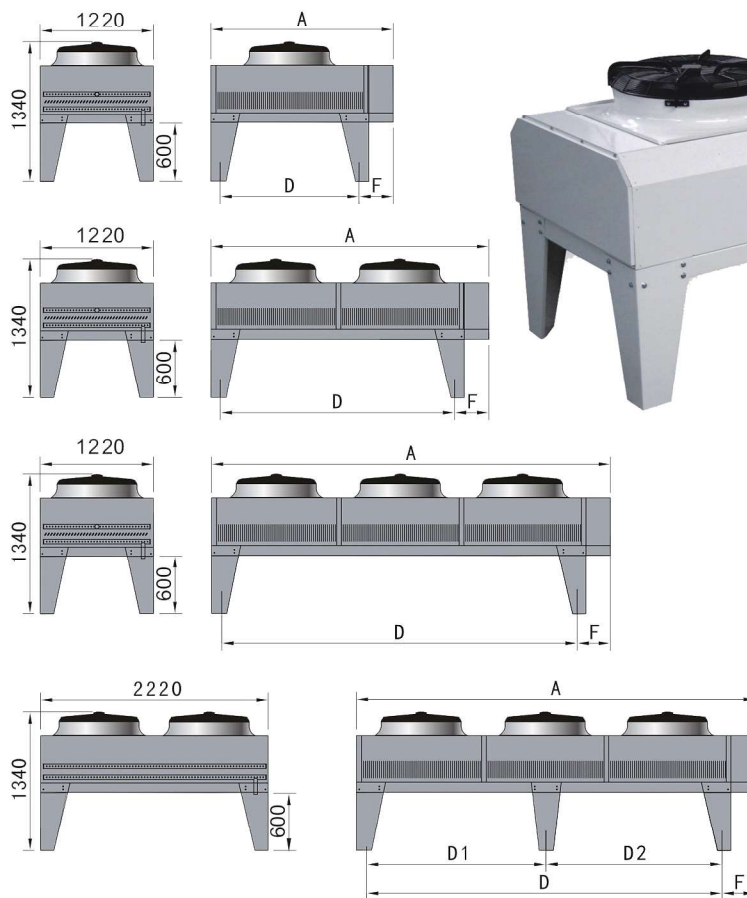




冷凝器性能参数表 Working as condenser performance

型号 Model	换热量 Heat transfer Capacity △t=15℃	换热面积 Heat Transfer Area	风机 Fan motor					连接尺寸 Connection Size		外型尺寸 Dimensions				Mounting Size	
			数量 Qty	直径 Dia.	风量 volume m³/h	功率 Input W	电压 Voltage V	进口 Inlet mm	出口 Outlet mm	L mm	B mm	H mm	F mm	D mm	E mm
	W	m²	N	mm	mm³/h	W	V	mm	mm	mm	mm	mm	mm	mm	mm
FHV(B)-25/72	24840	72	1	φ550	8720	600	380	22	16	950	900	1490	630	550	820
FHV(B)-30/87	30102	87	1	φ600	10820	780	380	25	16	1100	1000	1500	630	600	820
FHV(B)-39/110	39050	110	2	φ500	2x6570	2x450	380	25	16	1400	900	1490	630	900	820
FHV(B)-45/130	44850	130	2	φ550	2x8720	2x600	380	28	19	1550	900	1490	630	900	820
FHV(B)-55/155	55025	155	2	φ550	2x8720	2x600	380	28	19	1600	1000	1650	700	900	920
FHV(B)-64/185	63825	185	2	φ600	2x10820	2x780	380	28	22	1700	1000	1780	715	1000	920
FHV(B)-73/210	72660	210	2	φ630	2x12200	2x800	380	32	22	1750	1000	1880	715	1050	920
FHV(B)-83/240	82800	240	2	φ700	2x15000	2x750	380	32	22	1900	1175	1980	735	1200	1100
FHV(B)-104/300	103800	300	2	φ750	2x19000	2x1100	380	35	25	2250	1175	1980	735	1200	1100
FHV(B)-111/320	111040	320	2	φ750	2x19000	2x1100	380	38	25	2350	1175	1980	735	1650	1100
FHV(B)-125/360	124560	360	3	φ650	3x13200	3x550	380	42	28	2650	1175	1980	735	1950	1100
FHV(B)-138/400	138400	400	3	φ700	3x15000	3x750	380	42	28	2950	1175	1980	735	2250	1100
FHV(B)-166/480	165600	480	3	φ750	3x19000	3x1100	380	54	28	3400	1175	1980	735	2700	1100





冷凝器性能参数表 Working as condenser performance

类别 Category	单风机 Single Fan	双风机 Dual Fans		三风机 Three Fans		四风机 Four Fans		六风机 Six Fans	
型号 Model	FHF	08B/200	08B/330	08B/400	08B/500	08B/600	08B/800	08B/1000	08B/1200
电机接线 Motor Wiring		△	Y	△	Y	△	Y	△	Y
散热量 (KW) Heat Transfer Capacity	△t=15K	66	60	109	99	132	120	165	150
风量 Air Flow	m³/h	18660	14140	39000	29680	37320	28280	58500	44520
风机转速 Fan Speed		890	660	890	660	890	660	890	660
功率 Power	W	1800	1150	3600	2300	3600	2300	5400	3450
电流 Current	A	3.8	2.2	7.6	4.4	7.6	4.4	11.4	6.6
噪音 Noise10m	dB(A)	52	46	54	48	54	48	56	50
接口管 Connection(mm)	In/Out	42/35	42/35	54/42	54/42	54/42	54/42	67/54	67/54

型号 Model	FHF	08C/200	08C/330	08C/400	08C/500	08C/600	08C/800	08C/1000	08C/1200
电机接线 Motor Wiring		△	Y	△	Y	△	Y	△	Y
散热量 (KW) Heat Transfer Capacity	△t=15K	58	48	96	79	116	96	145	120
风量 Air Flow	m³/h	14770	12200	30120	24920	29540	24400	45180	37380
风机转速 Fan Speed		670	510	670	510	670	510	670	510
功率 Power	W	800	490	1600	980	1600	980	2400	1470
电流 Current	A	1.95	1	3.9	2	3.9	2	5.85	3
噪音 Noise10m	dB(A)	45	41	47	43	47	43	49	45
接口管 Connection(mm)	In/Out	42/35	42/35	54/42	54/42	54/42	54/42	67/54	67/54

常用数据 Main parameters									
风机直径 Fan Dia.		1×800	2×800	2×800	3×800	3×800	4×800	6×800	6×800
换热面积 Heat Transfer Area	m²	200	330	400	500	600	800	1000	1200
毛重 Gross Weight	kg	182	308	326	470	497	646	860	910
A	mm	1600	2900	2900	4200	4200	5500	4200	4200
D	mm	1250	2550	2550	3850	3850	5150	3850	3850
D1	mm							1925	1925
D2	mm							1925	1925

$$Q = K * F * \Delta T$$

kj/h(kw)
kcal/h

δ =厚度/thickness (m) F =传热面积/heat transfer area(m²)

$\alpha 1$ =管内导热系数/Inner tube thermal conductivity; w/(m.K)

$\alpha 2$ =管外导热系数/Outer tube thermal conductivity; w/(m.K)

λ =管壁导热系数/tube thermal conductivity; w/(m.K)

ΔT =温差/Temperature Difference

$$K = \frac{1}{\frac{1}{\alpha 1} + \frac{\delta}{\lambda} + \frac{1}{\alpha 2}}$$

kj/m².h.°C
kW/m².°C

$$K = \frac{1}{\frac{1}{\alpha 1} + \frac{\delta}{\lambda} + \frac{\delta_{\text{fin}}}{\lambda_{\text{fin}}} + \frac{1}{\alpha 2}}$$

fin thickness
fin thermal conductivity

Example: 35.9KW*2 风冷V型R22冷凝器设计
35.9KW*2 R22 Air cooled V Condenser design

Preliminary scheme / 初步规划

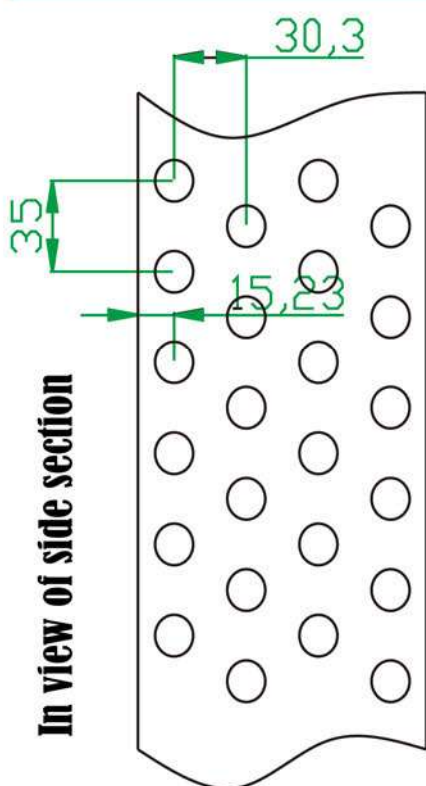
1. $\phi 16 \times 1.0\text{mm}$ copper tube 纯铜管
2. In-line triangular 正三角形排列
3. Tube Spacing 管间距 $S_1 = 35\text{mm}$
4. Row Spacing 排间距 $S_2 = 30.3\text{mm}$
5. Flat aluminum fins 平直铝肋片
6. Fin spacing 肋间距 $S_f = 2.5\text{mm}$
7. Rows quantity in flow direction 沿气流方向管排数 $n = 4$
8. Fin width 片宽 $L = n * S_2 = 121.2\text{mm}$

Given Parameters:

Condensing Temperature 冷凝温度: $t_k = 48^\circ\text{C}$

Inlet air temperature 进风温度: $t_{a1} = 35^\circ\text{C}$

Outlet air temperature 出风温度: $t_{a2} = 43^\circ\text{C}$



$$f_t = f_f + f_b$$

f_t = 肋管外总面积
total area of fins & Tubes

f_f = 肋片面积
area of fins

f_b = 肋片基管面积
area of tubes

$$\beta = \frac{f_t}{f_i}$$

β = 肋化系数
Rib effect coefficient

f_i = 肋管内表面积
tube inner area

$$f_f = \frac{2 * (S_1 * S_2 - \frac{\pi}{4} * d_b^2)}{S_f} = 0.6815\text{m}^2/\text{m}$$

$$f_b = \pi * d * (1 - \frac{\delta}{S_f}) = 0.04814\text{m}^2/\text{m}$$

$$= 3.14159 * 16.3 * 10^{-3} * (1 - \frac{0.20}{0.25})$$

$$f_t = 0.6815\text{m}^2/\text{m} + 0.04814\text{m}^2/\text{m} = 0.7296\text{m}^2/\text{m}$$

$$f_i = \pi * d_i = 0.04398\text{m}^2/\text{m} \quad \beta = 16.885$$

$$\Delta t_a = t_{a2} - t_{a1} = 8^\circ\text{C} \quad \Delta t_a = \text{Temperature Difference}$$

$$V_a = \frac{Q_k}{\rho_m \times c_{pa} \times t_a} = \frac{35.9 \times 2}{1.0995 \times 1.005 \times 8} \text{ m}^3 / \text{s} = 8.122 \text{ m}^3 / \text{s}$$

$$\rho_m = 1.0995 \text{ kg} / \text{m}^3$$

$$c_{pa} = 1.005 \text{ w} / (\text{kg} \cdot \text{k})$$

$A_{\min}$ = Minimum air flow area 空气最小流通面积

A_f = front face area 迎风面积

$$\frac{A_{\min}}{A_f} = \frac{(s_1 - s_b)(s_f - \delta_f)}{s_1 \times s_f} = \frac{(35 - 16.3) \times (25 - 0.15)}{35 \times 2.5} = 0.5022$$

$$W_{\max} = w_f \cdot \frac{A_f}{A_{\min}} = 5.575 \text{ m} / \text{s} \quad W_{\max} = \text{air velocity on minimum front face area}$$

$$A_f = 2.8 \text{ m}^2 / \text{s} \text{ (as setting)}$$

The value consider noise, energy saving and other factors

$$d_{eq} = \frac{2 \times (35 - 16.3) \times (2.5 - 0.15)}{35 - 16.3 + 2.5 - 0.15} = 4.17 \text{ mm} \quad d_{eq} = \text{Equivalent Diameter 当量直径}$$

$$\text{Re} = \frac{W_{\max} \times d_{eq}}{\nu_{f \text{ air viscosity}}} = \frac{5.575 \times 4.175}{17.5 \times 10^{-6}} = 1330.1663 \quad \text{Re} = \text{雷诺数 Reynolds number}$$

$$\frac{L}{d_{eq}} = \frac{121.2}{4.175} = 29.03 \quad A = 0.518 - 0.0231 \cdot \frac{L}{d_{eq}} + 0.000425 \left(\frac{L}{d_{eq}} \right)^2 - 3 \times 10^{-6} \left(\frac{L}{d_{eq}} \right)^3 = 0.1307$$

单元空气流道长径比

Aspect ratio of unit air passage

$$C = A \cdot (1.36 - \frac{0.24 \times \text{Re}_f}{1000}) = 0.1361$$

$$n = 0.45 + 0.0066 \cdot \frac{L}{d_{eq}} = 0.6416 \quad m = -0.28 + 0.08 \cdot \frac{\text{Re}_f}{1000} = -0.1736$$

流体横向流过肋片管簇的的整张平套片换热计算公式

$$a_2 = 1.1 \cdot \frac{\lambda_f}{d_{eq}} \cdot C \cdot \text{Re}_f^n \cdot \left(\frac{L}{d_{eq}} \right)^m = 53.32 \text{ w} / (\text{m}^2 \cdot \text{k})$$

$$\rho' = 1.27 \rho \sqrt{1 - 0.3}$$

$$\rho = \frac{s_1}{d_b} = 2.147$$

$$\text{So } \rho' = 2.282$$

staggered arrangement
叉排

$$h' = \frac{d_b}{2} \times (\rho' - 1) \times (1 + 0.35 \times \ln \rho')$$

$$= \frac{16.3}{2} \times (2.282 - 1) \times (1 + 0.35 \times \ln 2.282)$$

Fin equivalent height 肋片当量高度

$$m = \sqrt{\frac{2a_0}{\lambda_f \delta_f}}$$

$$= \sqrt{\frac{2 \times 53.3189}{203 \times 0.15 \times 10^{-3}}} m^{-1} = 59.1782 m^{-1}$$

肋片特性系数

$$\eta_f = \frac{th(mh)}{mh}$$

$$= \frac{th(59.1782 \times 13.46 \times 10^{-3})}{59.1782 \times 13.46 \times 10^{-3}} = 0.8312$$

肋片效率

$$\eta_s = \frac{f_f \eta_f + f_b}{f_t} = \frac{0.6815 \times 0.8312 + 0.04814}{0.7296} = 0.8423$$

冷凝器外表面效率
Outer condenser surface coefficient

$$\alpha_l = 0.683 r_s^{\frac{1}{4}} B_m d_i (t_r - t_w)^{\frac{1}{4}} = 2664.93 (t_r - t_w)^{\frac{1}{4}}$$

$$\text{Set } t_w^* = 47.03^\circ\text{C} \quad r_s^{\frac{1}{4}} = 19.87, B_m = 67.554$$

$$\alpha_i \pi d_i (t_k - t_w)^{\frac{3}{4}} = \eta_s \alpha_0 f_t (t_w - t_{am})$$

管壁温度的计算

$$= 2664.93 \times 0.04398 \times (t_k - t_w)^{\frac{3}{4}} = 0.8423 \times 53.32 \times 0.7296 \times (t_w - 39)$$

$$= 117.21 (50 - t_w)^{\frac{3}{4}} = 32.77 \times (t_w - 39)$$

用试凑法 cut-and-trial
 $t_w = t_w^* = 47.03^\circ\text{C}$

$$k_{of} = \frac{1}{\frac{1}{\alpha_i} \beta + \frac{\delta_f}{\lambda_f} \beta_i + \gamma_0 + \frac{1}{\alpha_0 \eta_s}} = 28.38 \text{ W}/(\text{m}^2 \cdot \text{K})$$

$$\alpha_i = 2664.93 \times (50 - 47.03)^{\frac{1}{4}} = 2030$$

$$\gamma_0 = 0.048, \quad \sigma_j = 1.0 \times 10^{-3} \text{ m}$$

$$\beta_i = \frac{f_t}{f_m} = \frac{0.7296 \times 2}{(0.7296 + 0.04398)} = 1.286$$

$$\Delta t_m = \frac{(t_{a1} - t_{a2})}{\ln \frac{t_k - t_{a1}}{t_k - t_{a2}}} = \frac{8}{\ln \frac{50 - 35}{50 - 43}} ^\circ\text{C} = 8.4^\circ\text{C}$$

Mean temperature difference
平均温差

$$F_0 = \frac{Q_K}{k_{of} t_m} = \frac{35900}{28.38 \times 8.4} m^2 = 150 m^2$$

管外传热面积 Outer pipe heat transfer area

$$L = \frac{F_0}{f_t} = \frac{150}{0.7296} m = 205.6 m$$

Copper Length Calculate
铜管长度计算

$$\Delta p = 1.2 g A \frac{L}{d_{eq}} (\rho \times w_{max})^{1.7}$$

$$= 1.2 \times 9.8 \times 0.0133 \times 29.3 \times (1.0955 \times 5.575)^{1.7} pa$$

$$= 99 pa$$

空气的流动阻力计算
Air flow resistance

$$H = H_{st} + H_{dg}$$

$$= 99 + \frac{\rho_w + w_f^2}{2}$$

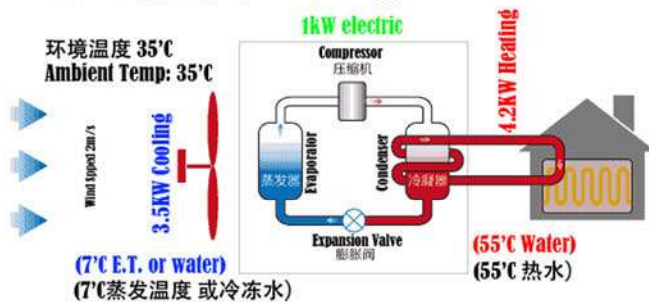
$$= (99 + \frac{1.0955 + 2.8^2}{2}) pa$$

$$= 105 pa$$

风机全压的计算
Total pressure of the fan

空调、热泵 Air conditioner, Heat Pump

Follow the laws of Conservation of energy
遵循能量守恒定律 (热力学第一定律)



Heating Capacity = Cooling capacity + Compressor indicated power
制热量 = 制冷量 + 压缩机指示功率

$$q_k = i - i$$

冷进 冷进

kj/kg
kcal/kg

$$Q_k = G * q_k$$

kj/h
kcal/h

$$Q_k = Q_0 + N_i$$

kw

q_k = 冷凝器单位理论散热量
 Q_k = 冷凝器总理论散热量
 Q_0 = 制冷量
 G = 制冷剂流量
 N_i = 压缩机指示功率