DESIGN GUIDE
XVV

Contents

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GENERAL DESCRIPTION OF THE XVV SYSTEM

The air to air heat recovery unit type XVV is a compact air handling unit with built-in diagonal flow recuperators, condensate tray and filters, with the facility for fitting pre-heating coils, after heating coils, by-pass, heat pump and other options.

The Dantherm Diagonal Flow Recuperator is unique, being the only system with removable, modular heat recuperators, thus providing a realistic facility for cleaning the units.

The fan section type W is designed for direct connection to the XXV unit. The two fans are available with motors and r.p.m.s capable of overcoming both the internal pressure drop and most requirements for external duct resistance.

These two cabinet sections form a complete air handling unit with built-in heat recovery, which can satisfy most individual requirements.

If recirculation is required, a mixing type BL can be added to the system section.

When additional heat recovery is required, the unit can be supplied with a built-in air heat pump type WP. When using a heat pump type WP it is usually possible to obtain a supply air temperature which is equal to or higher than the exhaust air temperature.

The units are available in eight different sizes, covering a range of 1550 to 14,000 m^3/h. (0.4 to 3.9 m^3/s).

Normally, based on required efficiency and pressure, there is a choice between several sizes for a given air volume.

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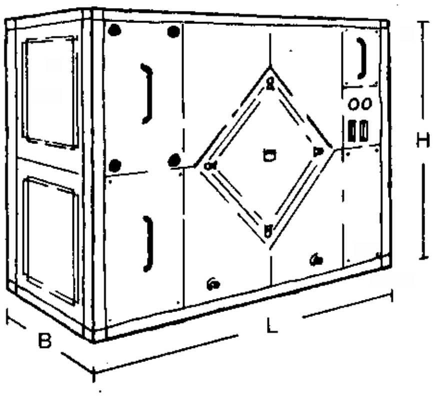
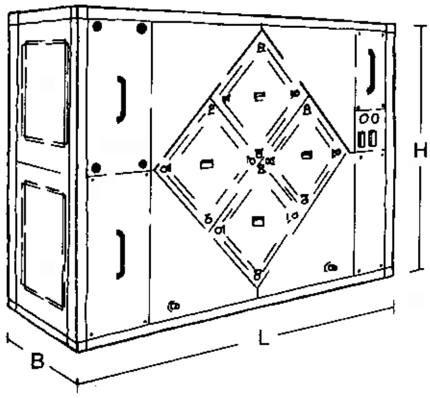
RECUPERATOR MODULE XVV

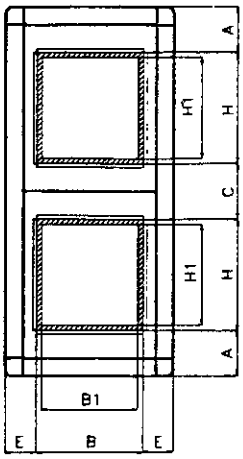
TECHNICAL INFORMATION





TYPE		XVV-11	XVV-12	XVV-13	XVV-14	XVV-41	XVV-42	XVV-43	XVV-44
Air volume max.	m³/h	2500	5000	7500	10000	3500	7000	10500	14000
Dimensions:	H mm	1285	1285	1285	1285	1750	1750	1750	1750
	B mm	476	880	1284	1684	476	880	1284	1684
	L mm	1730	1730	1730	1730	2490	2490	2490	2490
Weight:*	kg	150	220	285	360	345	570	780	1000

*For guidance only.



Dimensions of duct connections

	B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
XVV 11	300	270	400	370	200	85	88
XVV 12	600	570	400	370	200	85	140
XVV 13	1000	970	400	370	200	85	142
XVV 14	1200	1170	400	370	200	85	242
XVV 41	300	270	600	570	145	260	88
XVV 42	600	570	600	570	145	260	140
XVV 43	1000	970	600	570	195	160	142
XVV 44	1200	1170	600	570	230	90	242

B + H = Duct connection
B1 + H1 = Internal dimensions

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RECUPERATOR UNIT XVV

DESIGN

The recuperator unit type XVV is built up of profiles and cover panels which are constructed from hot galvanized sheet steel.

The cover panels are doubled skinned and apart from the triangular plates and the top cover panel at the by-pass, which have an insulation of 15 mm mineral wool, all other cover panel have a 30 mm thick insulation.
A bag filter is built into the return air side as standard.
The access panels for servicing are provided with handles and quick release fasteners.

In the standard version the recuperator unit contains a stainless steel condensate tray with a plastic drain through the side of the unit.
Depending to size the XVV plant is supplied with 1-16 diagonal flow recuperator units. The seals used in the standard version are suitable for temperatures up to 80°C. Seals for temperatures up to 140°C, are available as an option.
The XVV plant is open on one end and prepared for connection to the fan unit by means of four assembly fittings. The opposite end is provided with two flanged spigots for connection to ducts. The spigots have a 15 mm thick internal insulation.

The units are supplied with the inspection side in position right or left, i.e. when looking in the direction of the fresh air stream the service access can be ordered to be on the left or on the right hand side.

SIZES

The XVV is available with two different recuparator configurations. In one type cabinet the air is led through only one cross-flow recuperator and in the other it is led through four cross-flow recuperators, where four module frames are joined together as one unit. Both executions are available with up to four modules next to each other. This is how we get the size designation, the first figure being the number of modules seen from the access side and the last figure being the number of modules across.
Example:

XVV-42 means four modules on the side and two module sets across, i.e. a total of 8 modules.

The choice of size will be dependent on air volume and desired efficiency - see section 7.

ACCESSORIES

The XVV units can be supplied with various accessories such as heat pump, by-pass, heating coils, eliminator plates and the like. In section 4 these components are described further.

ELECTRIC CONNECTION

The XVV units can be supplied with connections for the electrical components to multi pin plugs on the service side of the unit. Alternatively the XVV unit can be supplied with screwed cable connections and terminal strips in both the control panel and the unit.

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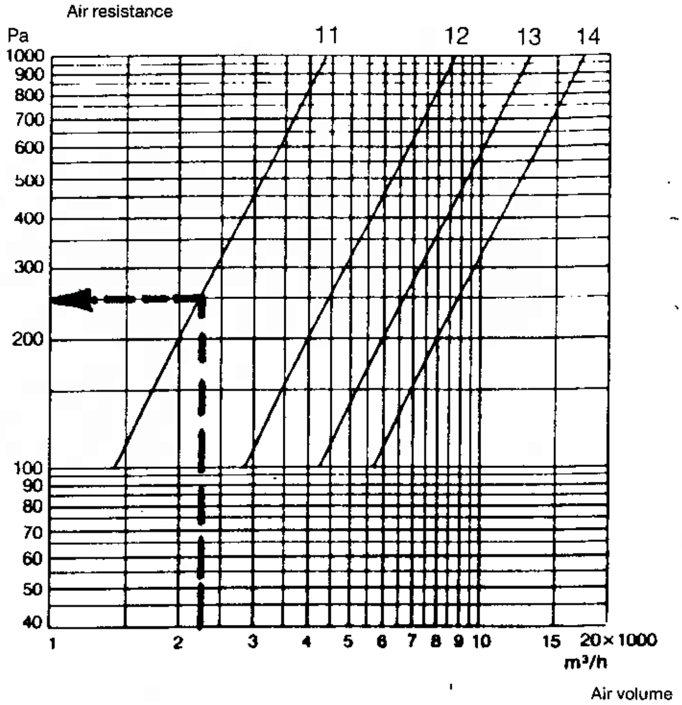
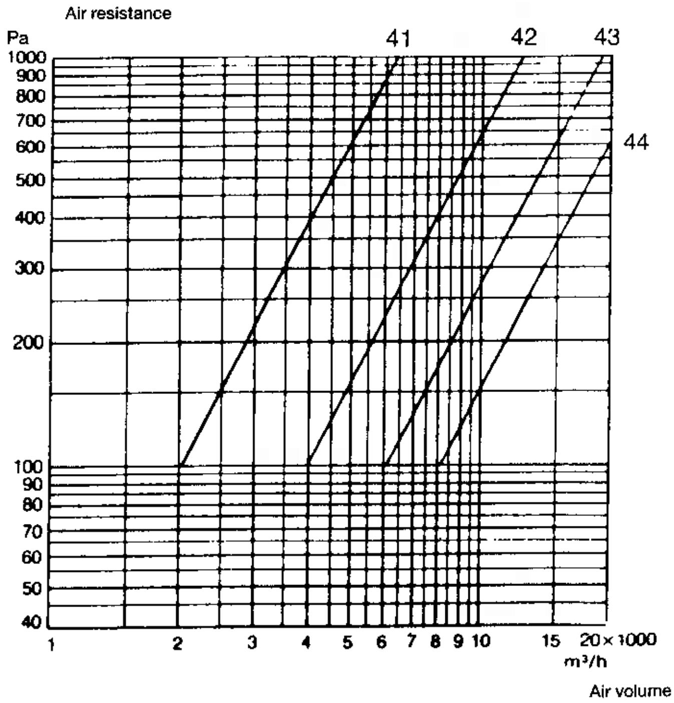


Ex.: XVV-11, 2250 m³/h
Air resistance = 250 Pa



The air resistance across the cross-flow recuperator module depends on the air volume.

The graphs show the air resistance for different module configurations, in relation to air volume.

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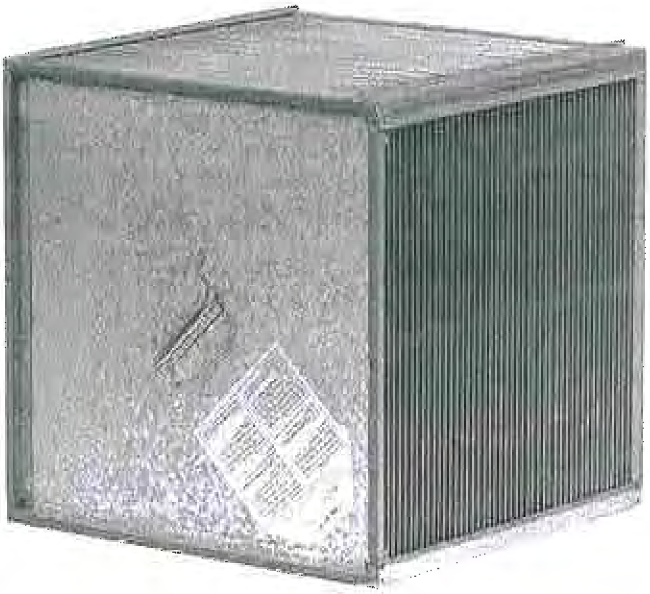
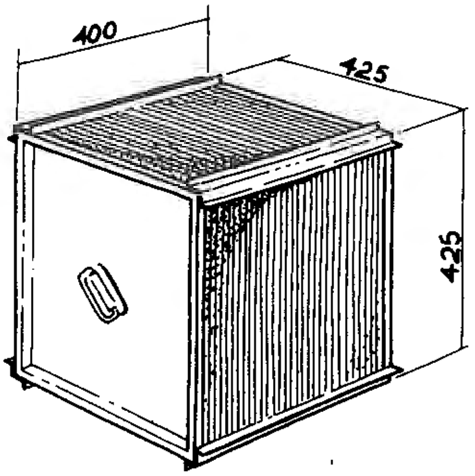
RECUPERATOR MODULE MV-A





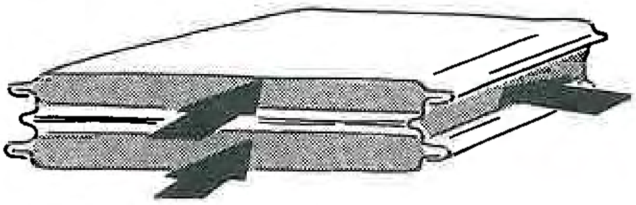
CONSTRUCTION AND FUNCTION

A series of aluminium plates are clamped together with precise spacings which are intended to ensure turbulence of the air streams.

The plates are sealed at two opposite sides and open at two others, and thereby a narrow spacing is created. This alternation between sealed and open spaces at each side of the recuperator unit creates a series of narrow spaces at 90°C to each other. When two air streams of different temperatures are connected to each side of the recuperator, the heat contained in the warm air stream is transmitted to the cold air stream through the plates. The two air streams are completely separated and there is no risk at all that contaminated air is mixed with clean supply air.

The plates are held together by four angle rails and two end plates of hot galvanized steel sheet. The end plates are supplied with handles for removal and a profiled rubber seal. The plate corners are sealed by a silicone compound which is temperature resistant up to 80°C and resistant to most kinds of corrosive atmospheres. Seals, suitable for temperatures up to 140°C, can be supplied.

The plates are of aluminium and standard plates are given a thin coating of anodised epoxy that gives a surface which is highly resistant to corrosive air streams and high temperatures.



DATA:

Type	: MV-A
Dimensions	: 425x425x400 mm
Weight	: 25 kg
Temperatur std.	: 80°C
No. of plates	: 92
Sheet thickness	: 0,4 mm
Sheet spacing	: 3,65 mm

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MODULE FRAMES

MAX. PRESSURE DIFFERENCE

Normally, there is positive pressure in the direction of the fresh air and negative pressure in the exhaust air direction, consequently there is a big difference in pressure, affecting each single plate in the recuperator.

Allowance has been made for this fact during construction, and the recuperator is guaranteed a max. pressure difference of 1500 Pa (~ 150 mm WG).

AIR TIGHTNESS AND PRESSURE DIFFERENCE

Standard requirements
The air tightness of a duct system can be defined as the air quantity (leakage air quantity), which escapes through unintentional leakages per time unit at a pressure difference of 400 Pa.
Leakage air quantity per sec. divided by the area of the internal surface is called leakage factor.

A module recuperator built into a duct system naturally must comply with the same demands as imposed to the whole plant.

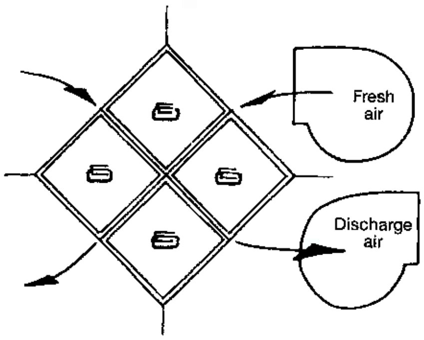
In Denmark the requirements for tightness are stated either with A or B.

As small deviations may occur during the manufacturing process Dantherm guarantees classification A for tightness with a good safety margin.

POLLUTED AIR

In case of polluted or unhealthy exhaust air, even small leakages - caused by wear and damage - if no precautions are taken against it, may result in the return air containing an unacceptable quantity of pollution.

This must and can be avoided by observing the following rule:



In case of heat recovery from polluted exhaust air, there must be a positive pressure on the fresh air system and a negative pressure on the exhaust air system.

When this rule is observed, any small leaks will cause small amounts of fresh air to leak to the exhaust air.

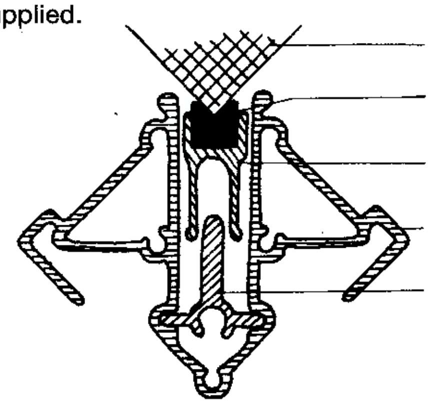
MODULE FRAMES

MODULE FRAMES

The cross-flow recuperator units are positioned in standard module frames which are part of the cabinet thus giving a rigid and sturdy construction.

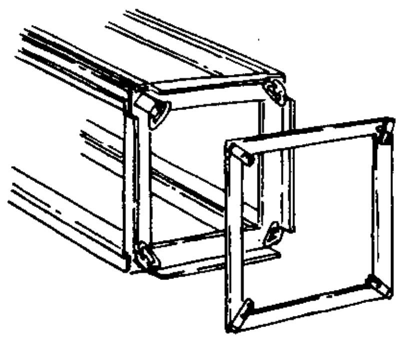
Module frames are made in four sizes and can accomodate either one, two, three or four modules.

The frames are made of extruded aluminium profiles and their sealing system is unique. The four corner seals can be individually loosened or tightened over their full length by means of a slide system. This system ensures maximum tightness and allows removal of the module recuperator without damaging the seals. The seals are made of a silicone-product which is resistant to oil and to temperatures up to 80°C.
Seals, suitable for temperatures up to 140°C, can be supplied.



The moving rail can be moved in the frame profile by means of a handle on the access side of the module frame. When pulling the handle outwards the slide profile with its seal will move away from the module, which can then be withdrawn.
The movement is produced by studs in the moving rail which moves in oblique rails in the slide profile. Correspondingly the seal is pressed against the module when pushing the handle inwards.

In order to create a tightness in the opening of the module frame where the modules are pushed in, a separate front sealing frame is kept in position by a quick release lock in each corner. The front sealing frame itself is on the inside covered by a sealing material.



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SIZING THE FAN MOTOR

Each size W fan unit incorporates a specific size and type of fan, which is always used for that size "W" unit. The fan motor and the belt drive will be selected for it's specific requirements.
The basis for the calculation of the motor size is related to the actual air volume, as well as the necessary air pressure for each of the air streams.

FAN DATA SHEET

In order to obtain a quick section of necessary r.p.m. and motor power the fan data sheet below, valid for nominal air volumes, can be used.
The criteria for seeking the necessary information in the data sheet is:

a) demand for available external pressure - either 100, 200, 300 Pa.

b) Number of rows in the heating coil - either 0R (no heating coil in exhaust), 1, 2 or 3 rows of tubes in supply.

The values from the data sheet take the air resistance over the recuperator element, flat plate filter and heating coil, if any, into consideration.

FAN UNIT TYPE W

Pt = total pressure Pa (recuperator + 80/25 filter + heating coil + system effect + external pressure).
n = fan rotations r.p.m.
N = motor size kW

Fan unit type				W-11	W-12	W-13	W-14	W-41	W-42	W-43	W-44
Nom. air volume m^3/h				2250	4500	6750	9000	3200	6400	9600	12800
Fan type AT-				9/7	12/12	12/12	2 x 12/12	9/7	12/12	15/15	18/18
100 Pa available eksternal pressure	Exhaust 0 R	Pt	Pa	510	455	570	455	605	545	585	530
		n	r.p.m.	1440	1040	1080	1040	1500	1070	910	740
		N	kW	0,75	1,1	2,2	2,2	1,1	2,2	3,0	4,0
	Supply 1 R	Pt	Pa	587	509	637	507	678	606	619	588
		n	r.p.m.	1540	1100	1160	1100	1590	1140	950	790
		N	kW	0,75	1,5	3,0	3,0	1,5	2,2	4,0	4,0
	Supply 2 R	Pt	Pa	650	556	680	548	742	655	664	632
		n	r.p.m.	1625	1150	1200	1150	1680	1200	990	820
		N	kW	0,75	1,5	3,0	3,0	1,5	2,2	4,0	4,0
	Supply 3 R	Pt	Pa	690	587	720	588	782	687	706	672
		n	r.p.m.	1675	1200	1240	1200	1750	1220	1020	850
		N	kW	0,75	1,5	3,0	3,0	1,5	3,0	4,0	4,0
200 Pa available eksternal pressure	Exhaust 0 R	Pt	Pa	610	555	670	555	705	645	685	630
		n	r.p.m.	1570	1150	1200	1160	1620	1190	1000	820
		N	kW	0,75	1,5	3,0	3,0	1,5	2,2	4,0	4,0
	Supply 1 R	Pt	Pa	687	609	737	607	778	706	719	688
		n	r.p.m.	1675	1230	1275	1210	1750	1240	1050	870
		N	kW	0,75	1,5	3,0	3,0	1,5	3,0	4,0	5,5
	Supply 2 R	Pt	Pa	750	656	780	648	842	755	764	732
		n	r.p.m.	1775	1280	1310	1260	1800	1300	1080	900
		N	kW	1,1	2,2	3,0	4,0	1,5	3,0	4,0	5,5
	Supply 3 R	Pt	Pa	790	687	820	688	882	787	806	772
		n	r.p.m.	1810	1310	1340	1300	1840	1330	1110	930
		N	kW	1,1	2,2	3,0	4,0	1,5	3,0	4,0	5,5
300 Pa available eksternal pressure	Exhaust 0 R	Pt	Pa	710	655	770	655	805	745	785	730
		n	r.p.m.	1720	1280	1300	1260	1770	1290	1090	900
		N	kW	1,1	2,2	3,0	4,0	1,5	3,0	4,0	5,5
	Supply 1 R	Pt	Pa	787	709	837	707	878	806	819	788
		n	r.p.m.	1810	1340	1360	1320	1840	1350	1130	940
		N	kW	1,1	2,2	3,0	4,0	1,5	3,0	5,5	5,5
	Supply 2 R	Pt	Pa	850	756	880	748	942	855	864	832
		n	r.p.m.	1920	1375	1400	1360	1925	1400	1170	970
		N	kW	1,1	2,2	3,0	4,0	1,5	3,0	5,5	5,5
	Supply 3 R	Pt	Pa	890	787	920	788	982	887	906	872
		n	r.p.m.	1980	1400	1430	1390	1970	1420	1200	1060
		N	kW	1,1	2,2	4,0	4,0	2,2	3,0	5,5	5,5

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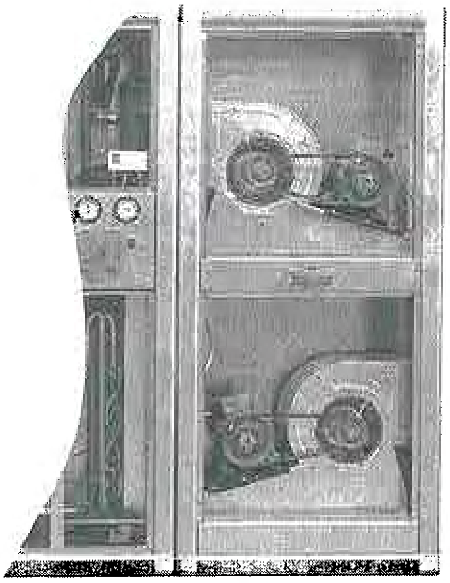
FAN UNIT TYPE W

To provide the necessary air volume and pressure for the two air streams in the XVV-system a Dantherm fan unit type W is normally used.



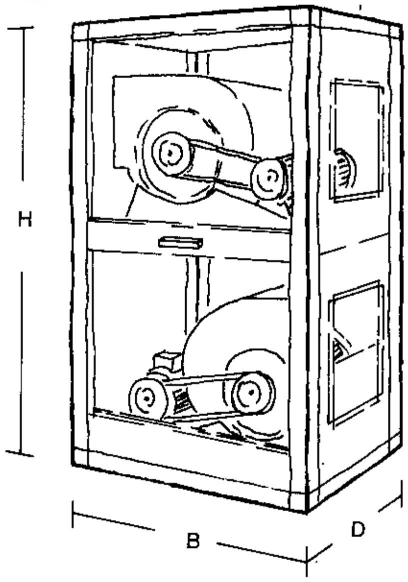
The fan units are matched the XVV-cabinet. The cabinet is built up in the same way as described for the XVV.

The built in centrifugal fans have hot galvanized casings and are forward curved. In connection with especially high pressure loss fans with backward curved fans can be built in. Due to the larger physical size of these fans, however, they cannot be built into fan units type W11 and W41.

The fans are mounted on two transverse rails which are isolated from the frame by anti-vibration pads.

On these rails is mounted an adjustable motor base which allows the belt tension to be easily adjusted.

The transmission between motor and fan consists of a V-belt drive, a fixed fan pulley and a Taperlock-pulley on the motor.



The motors can be supplied to the voltage required, but usually only three phase. Where required, star/delta starting can be supplied, as well as 2-speed motors, which gives a wide range of options and cover most requirements.

The electrical connections to the motors are joined via a multi pin plug on the acces side of the unit.
Alternatively the unit can be supplied with terminal connections on the acces side.

On the open end the cabinet is equipped with flanged duct connections, and the ductwork is connected by means of assembly rails.
Alternatively the fresh air duct can be connected into the top of the fan.
Dimensions of duct connections are as stated for XVV (see page 2.02 or DIMENSIONS, section 8).

TYPE		W-11	W-12	W-13	W-14	W-41	W-42	W-43	W-44
Air Volume	m³/h	2500	5000	7500	10000	3500	7000	10500	14000
Dimensions	H mm	1285	1285	1285	1285	1750	1750	1750	1750
	B mm	476	880	1285	1685	476	880	1285	1685
	L mm	815	940	940	940	815	940	1130	1230
Weight*	kg	120	160	190	280	150	190	250	320

*Nominal only.

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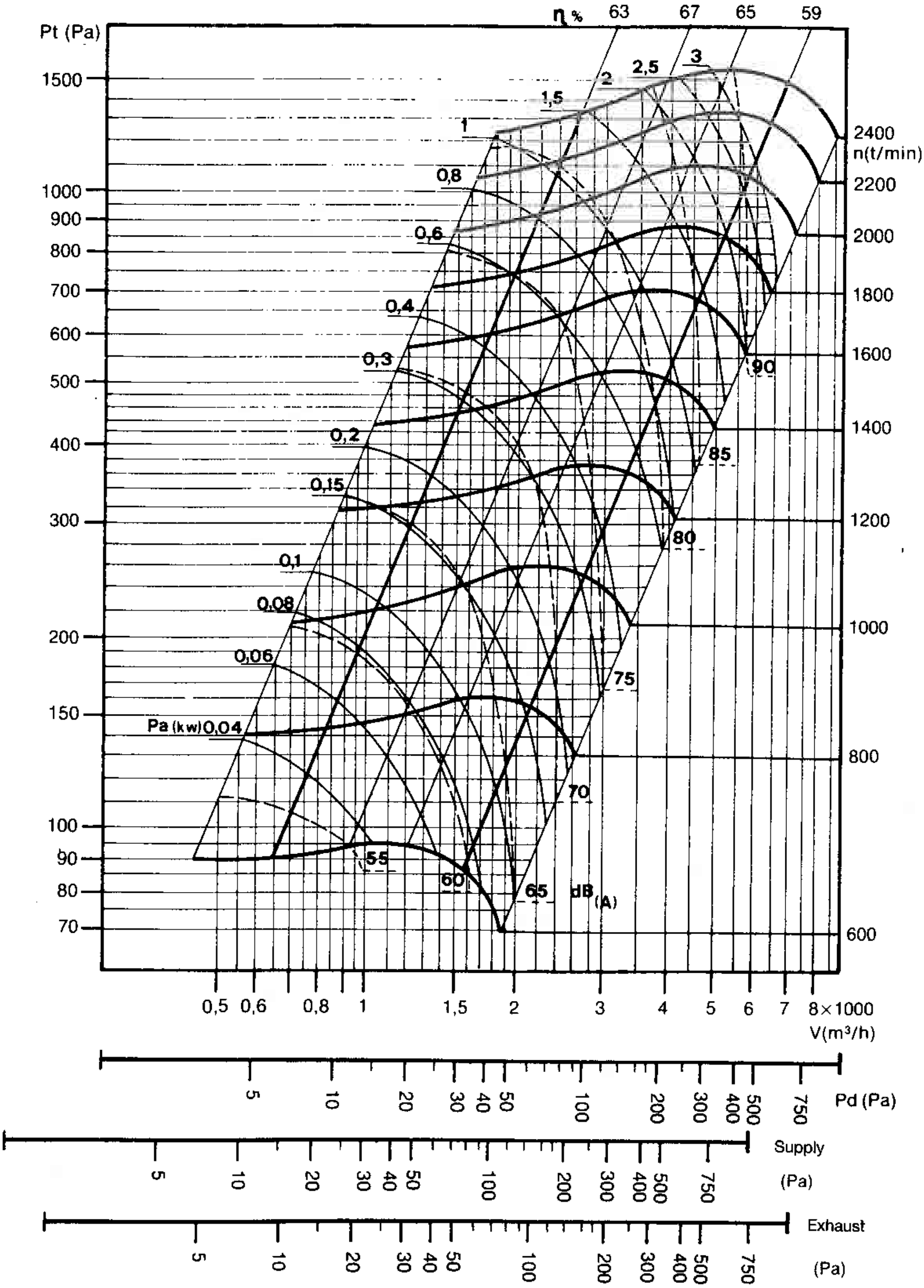
W11 - AT 9/7



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FAN CURVES

In those cases where the conditions on the fan data sheet do not apply, a more detaliled fan calculation must be done, where air volumes which differ from the nominal values can also be taken into consideration.

The necessary air pressure will normally be the sum of the resistances through the following:

- inlet grilles
- outlet grilles
- ducts and dampers
- recuperator elements
- filters
- heating coils (for water or electricity)
- condenser and evaporator (for WP)
- dynamic pressure

When the actual air volumes required for the two systems are known, the air resistance values for the individual components can be found in the resistance curves in the section about component description. The pressure needed to overcome the resistances in the external systems must be calculated on the basis of the systems design.

When the air volume and the sum of the air resistances in both supply and exhaust air streams are known, the necessary r.p.m. of the fans, as well as the corresponding motor power can be read in the fan curves on the following pages. Due to friction loss in the V-belt pulley the fan shaft power should be multiplied by a factor 1.2 to find necessary motor size.

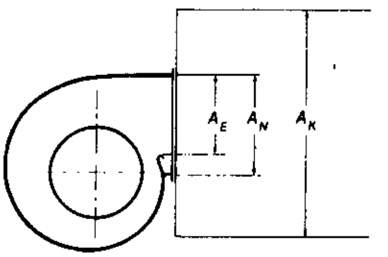
VELOCITY PRESSURE AND SYSTEM EFFECT

The total pressure increase in the air stream (P_t) obtained through the fan is the sum of the static pressure (P_s) and the velocity pressure (P_d). The velocity pressure is in reality dynamic or kinetic energy and is proportional with the square of the air velocity in the fan discharge.
Whereas the static portion is always effective, the velocity pressure is only converted to useful static pressure if the fan discharge dimension is transformed gradually to the final duct dimension, together with a length of straight ducting at least three times the duct diameter. Only then will the velocity profile be symmetric.

Such conditions are not normally found outside the test laboratory, and the velocity pressure is therefore not counted as useful pressure. When using the fan curves, where the vertical axis is the total pressure, the input value must therefore be the sum of the various static pressures together with the velocity pressure which can be found on the scale below for air volume axis.
As the air flow pattern in the XVV/W are not optimal, account must be taken of the system effect, which is not covered by the above. The supply air fan in particular has a significant element of system effect, because the fan discharges into a chamber with dimensions considerably larger than the fan discharge opening. For the exhaust fan the dimensional differences are smaller and the system effect therefore also smaller.

On the inlet side to the fan there is no significant system effect, because the openings are free and the distance to the cabinet cover panels is large.

The system effect is in each case calculated as the velocity pressure in the fan discharge opening, multiplied by a system effect factor determined by the relative areas.



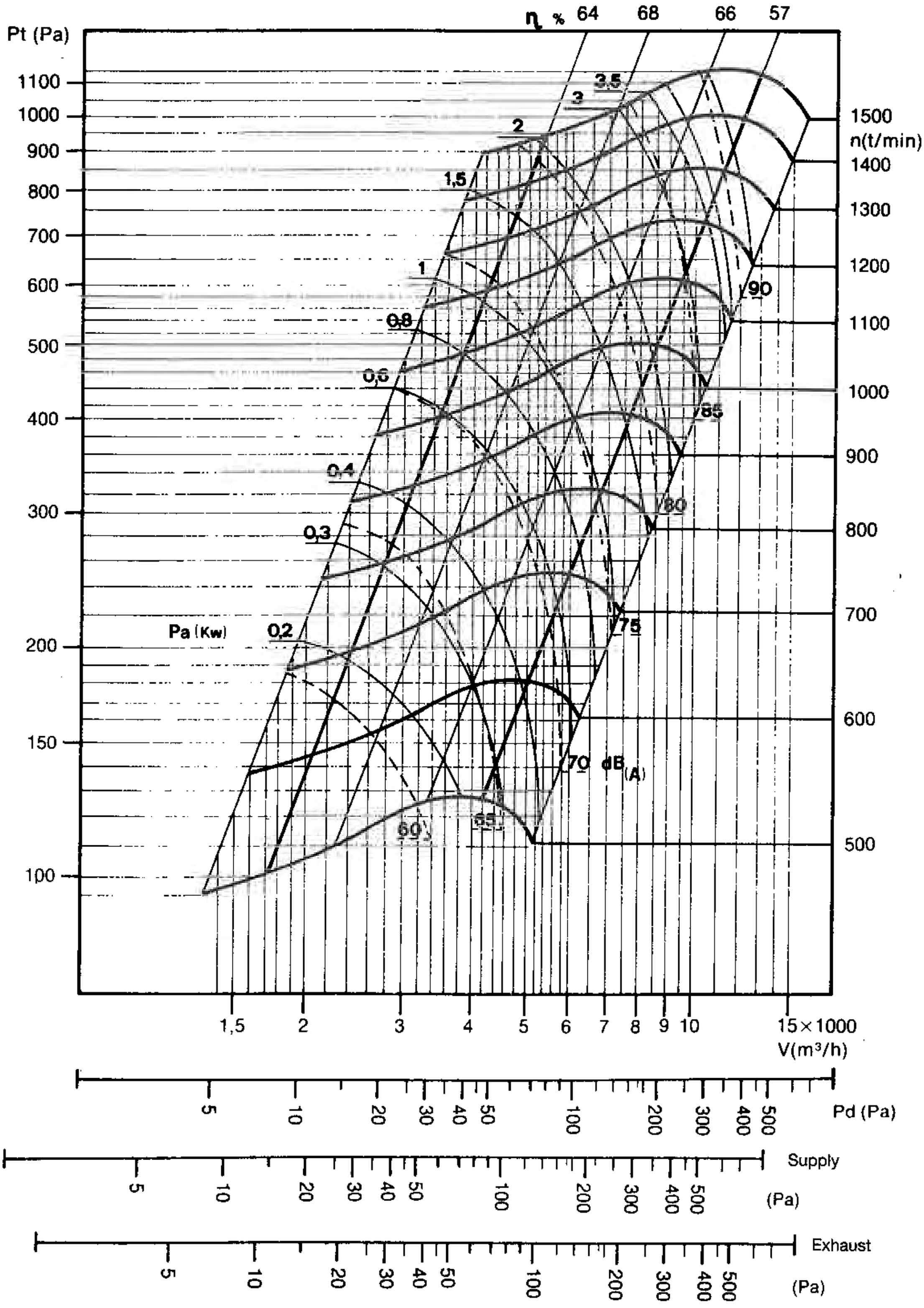
A_E/A_N	A_K/A_N				
	1	1,5	2,0	2,5	3,0
0,5	—	0,8	1,3	1,6	1,8
0,6	—	0,6	0,9	1,2	1,4
0,7	—	0,4	0,7	0,9	1,0
0,8	—	0,3	0,5	0,7	0,8
0,9	—	0,2	0,4	0,5	0,6
1,0	—	0,1	0,25	0,4	0,5

System effect factor for fan connected to ducts larger than the fan discharge area.

In the fan graphs on the following pages the system effect is calculated and incorporated in the two bottom scales, for supply and exchaust fan respectiverly.

The value read off these scales must therefore be added to the sum of the static pressures and the resultant value used as input for P_t on the vertical axis.

W13 - AT 12/12



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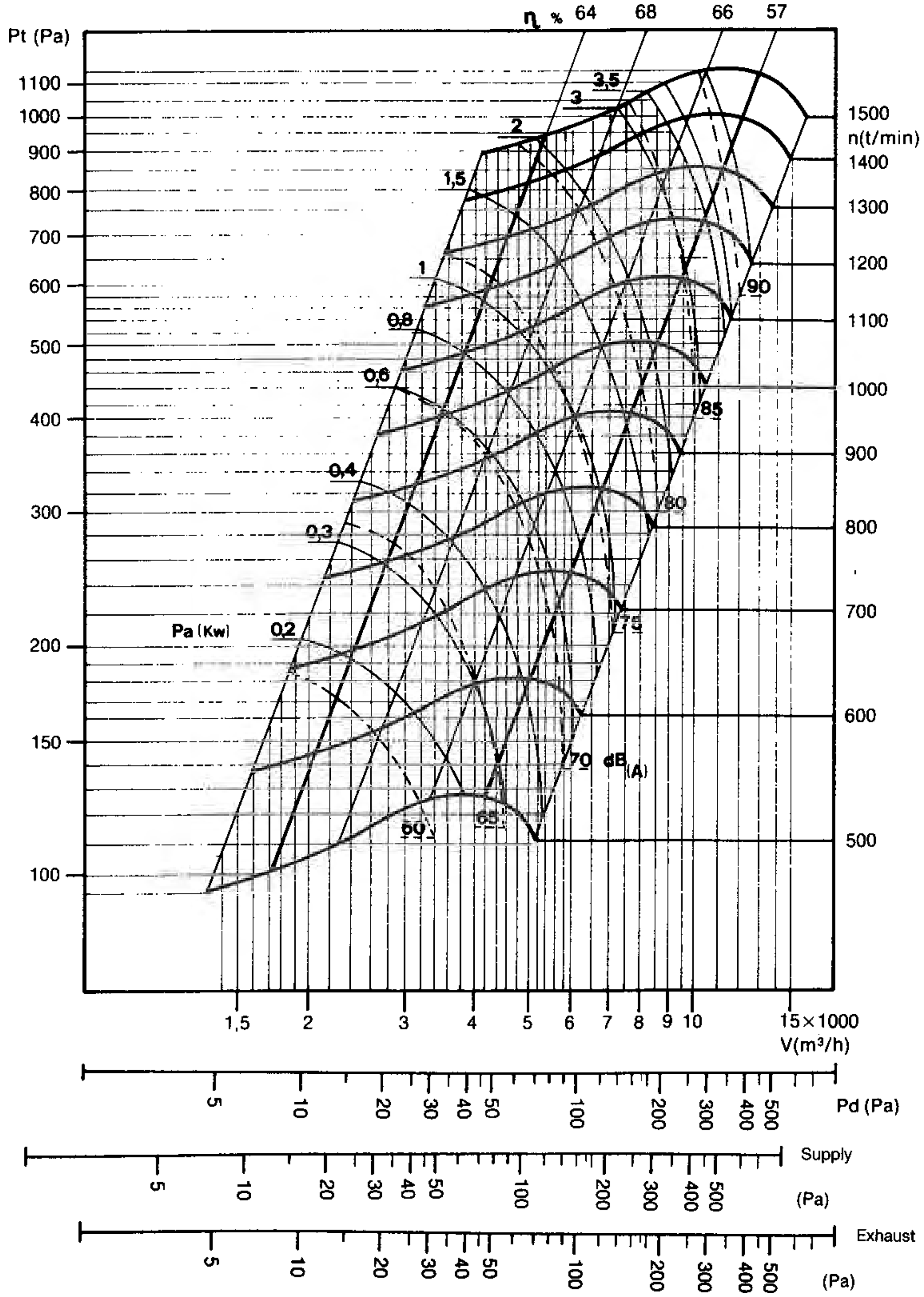
W12 - AT 12/12



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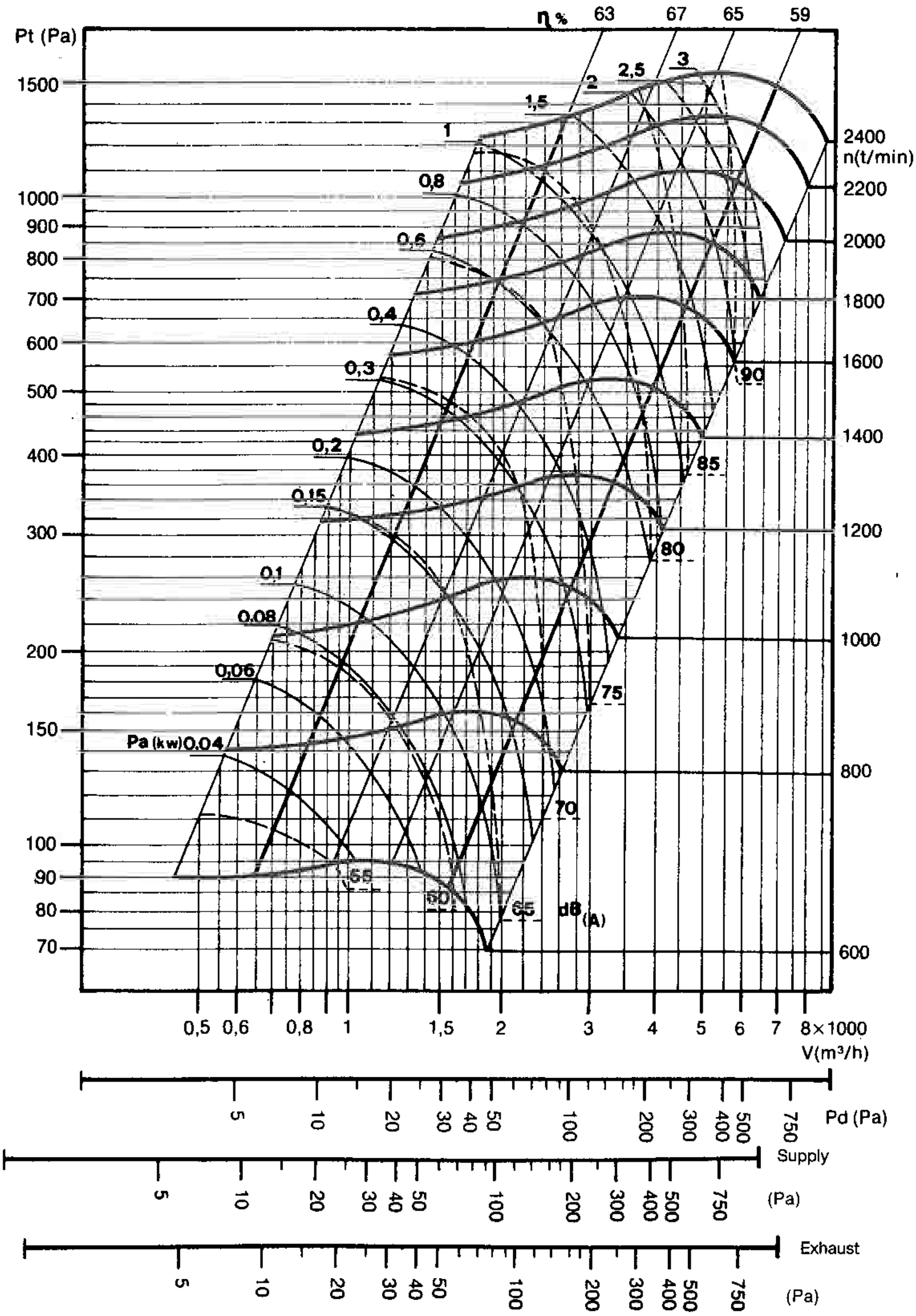
W41 - AT 9/7



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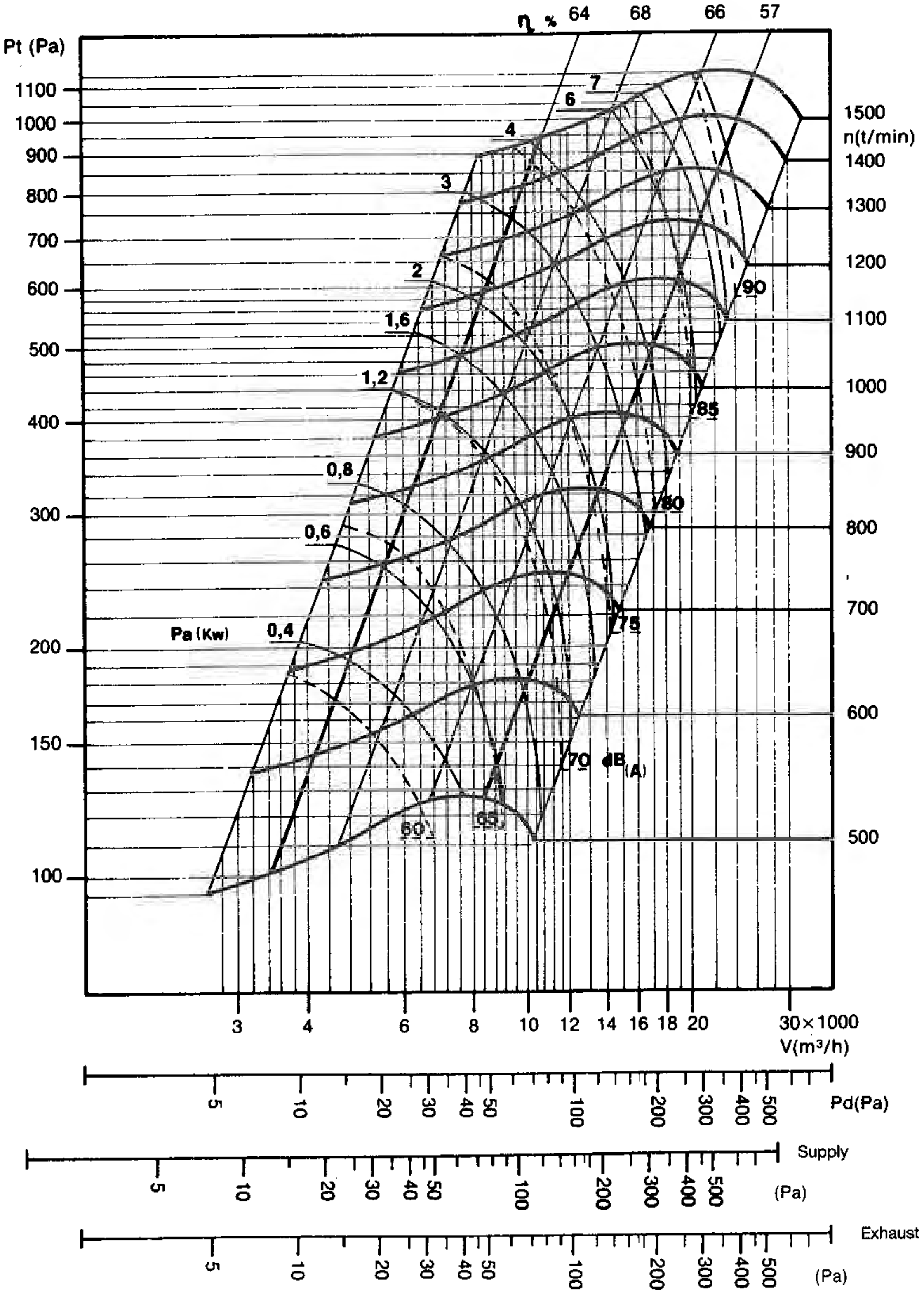
W14 - AT 12/12 TWIN



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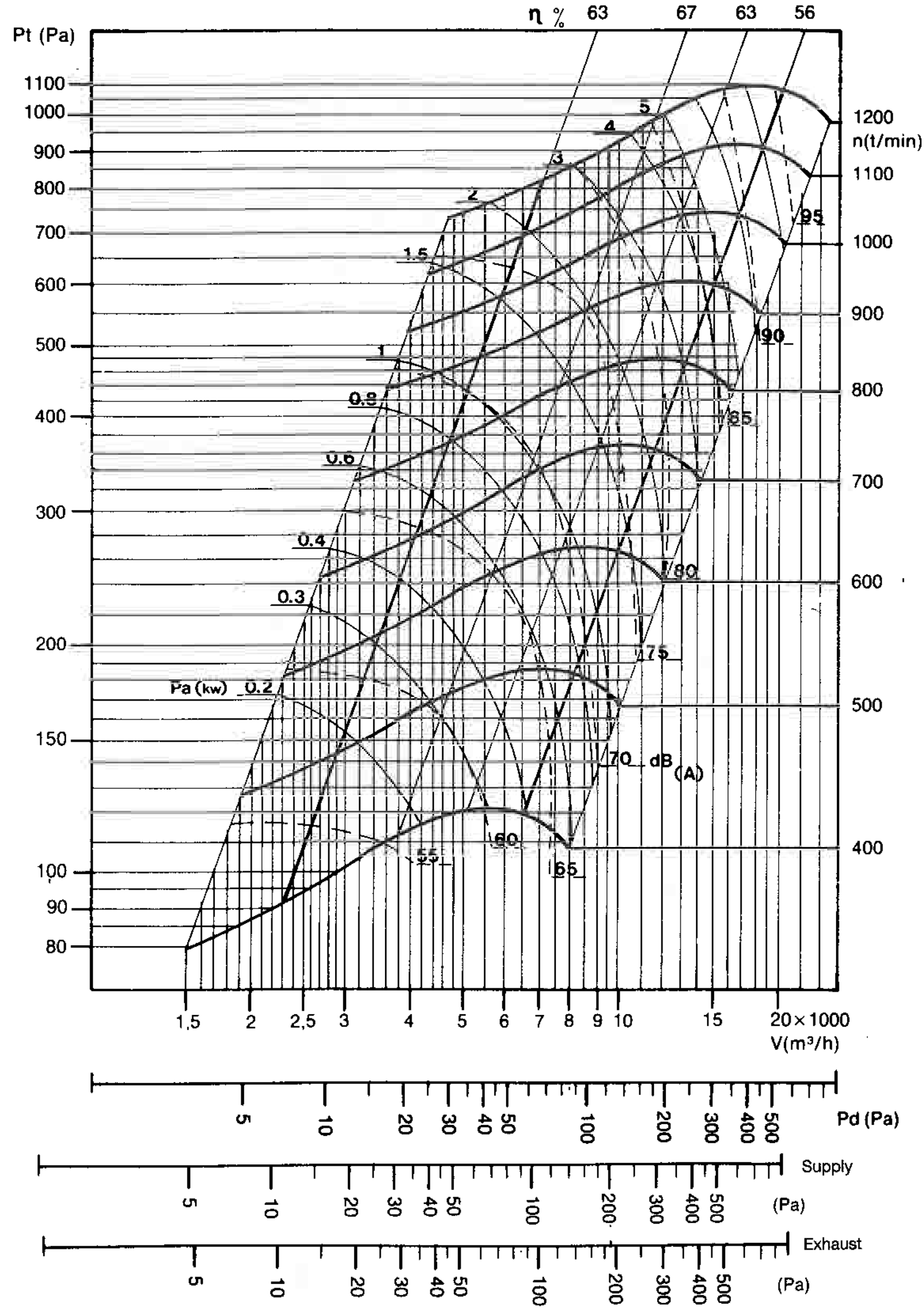
W43 - AT 15/15



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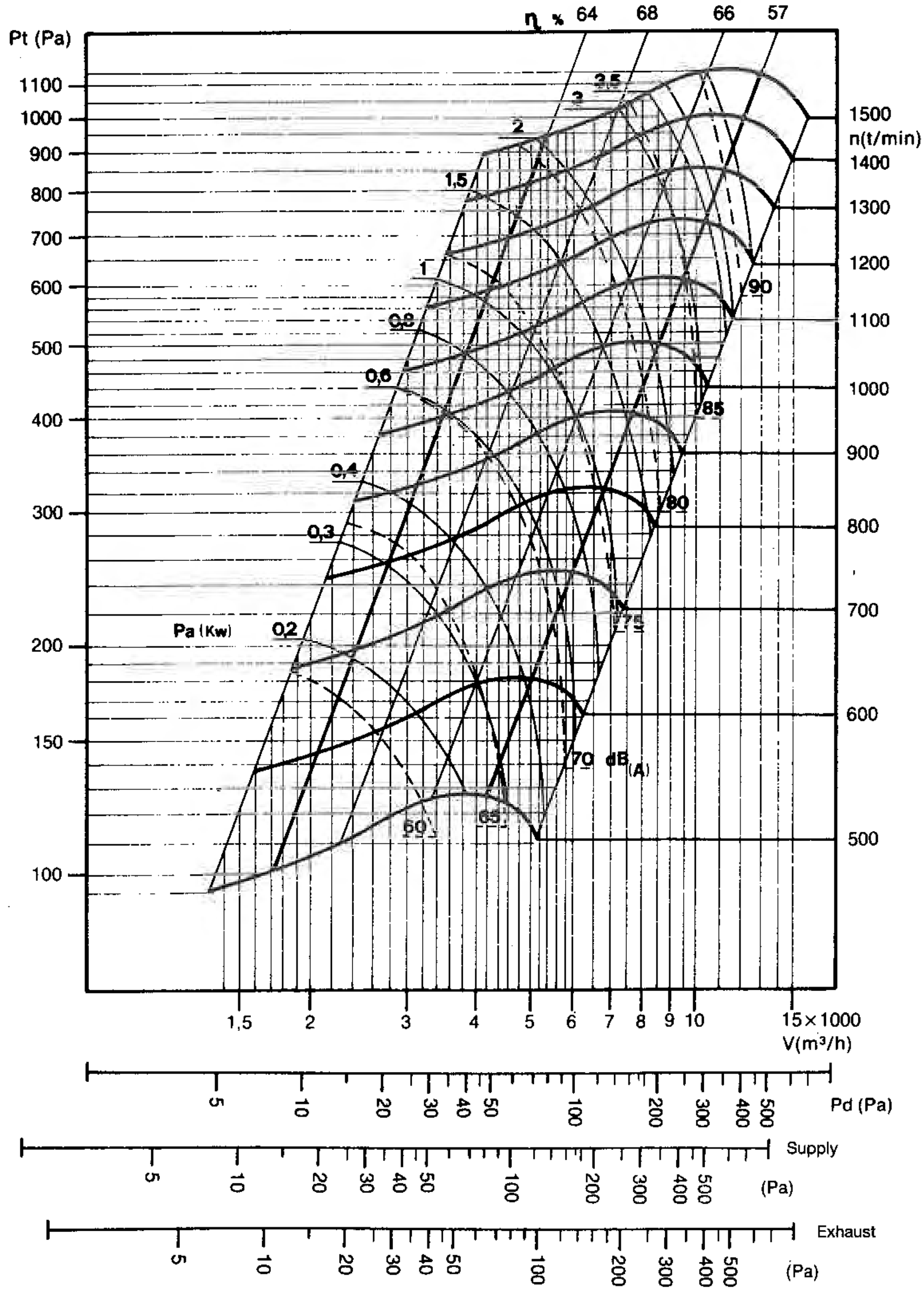
W42 - AT 12/12



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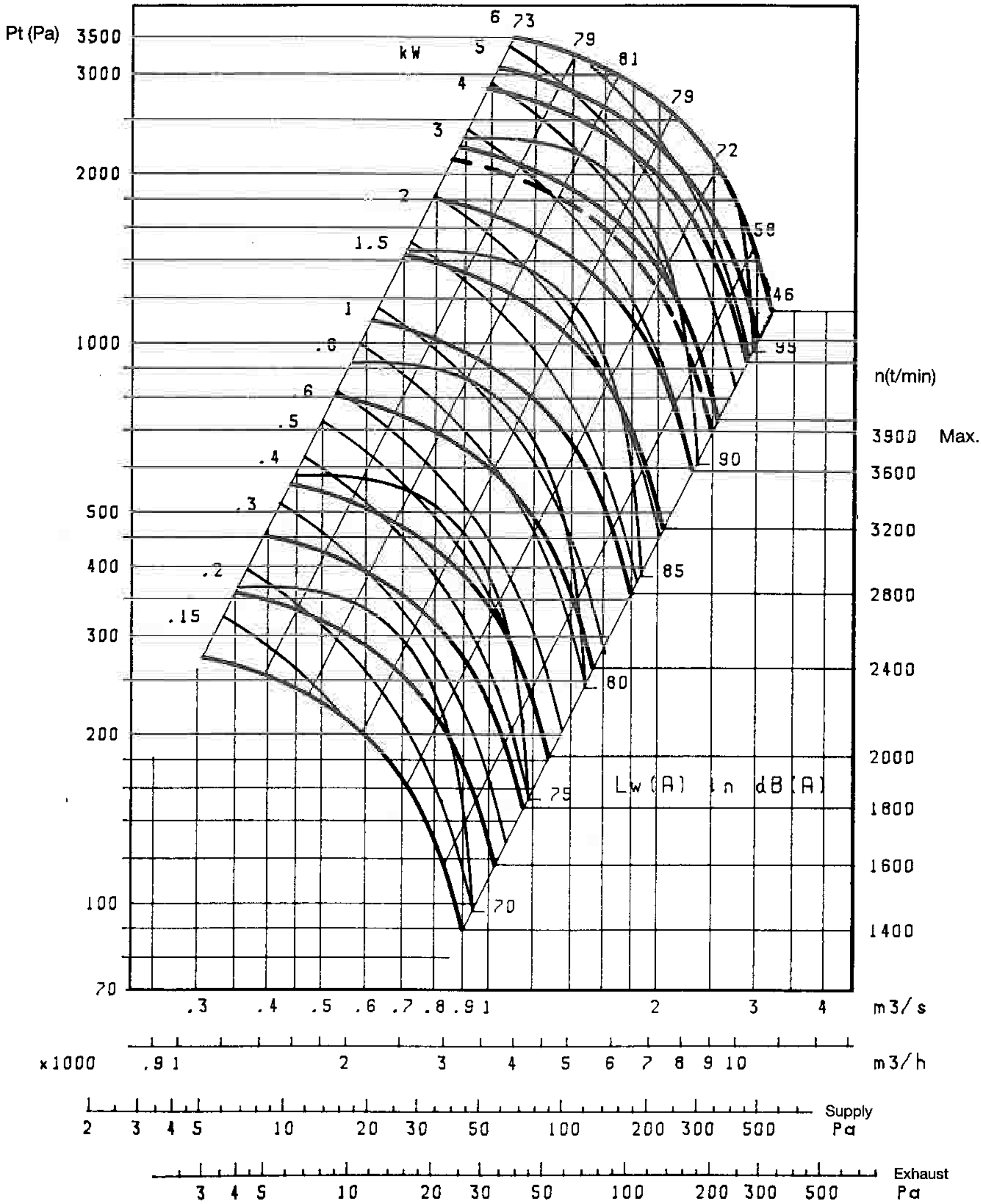
FAN CURVES

W12

W12 - RDZ 280



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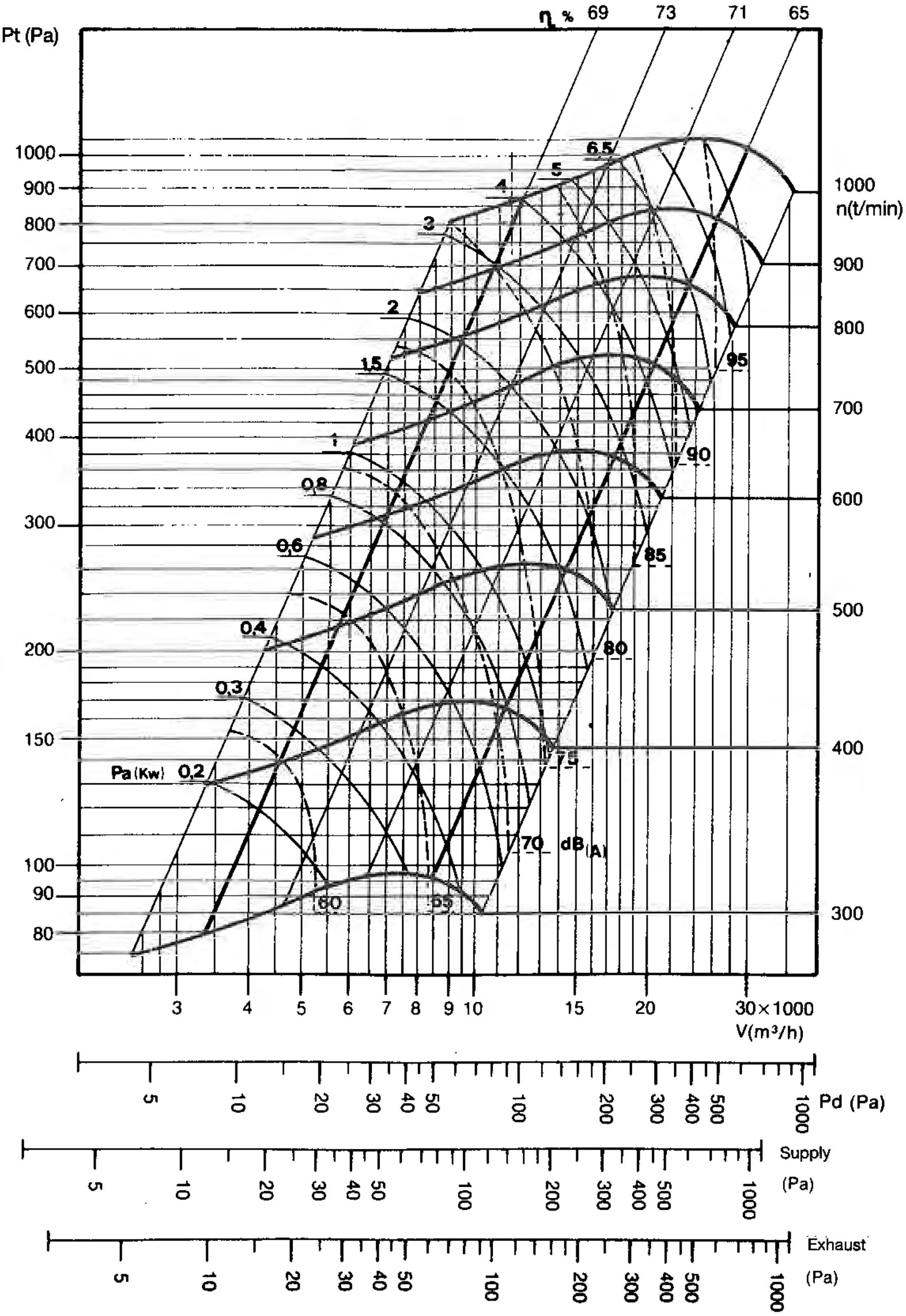
W44 - AT 18/18



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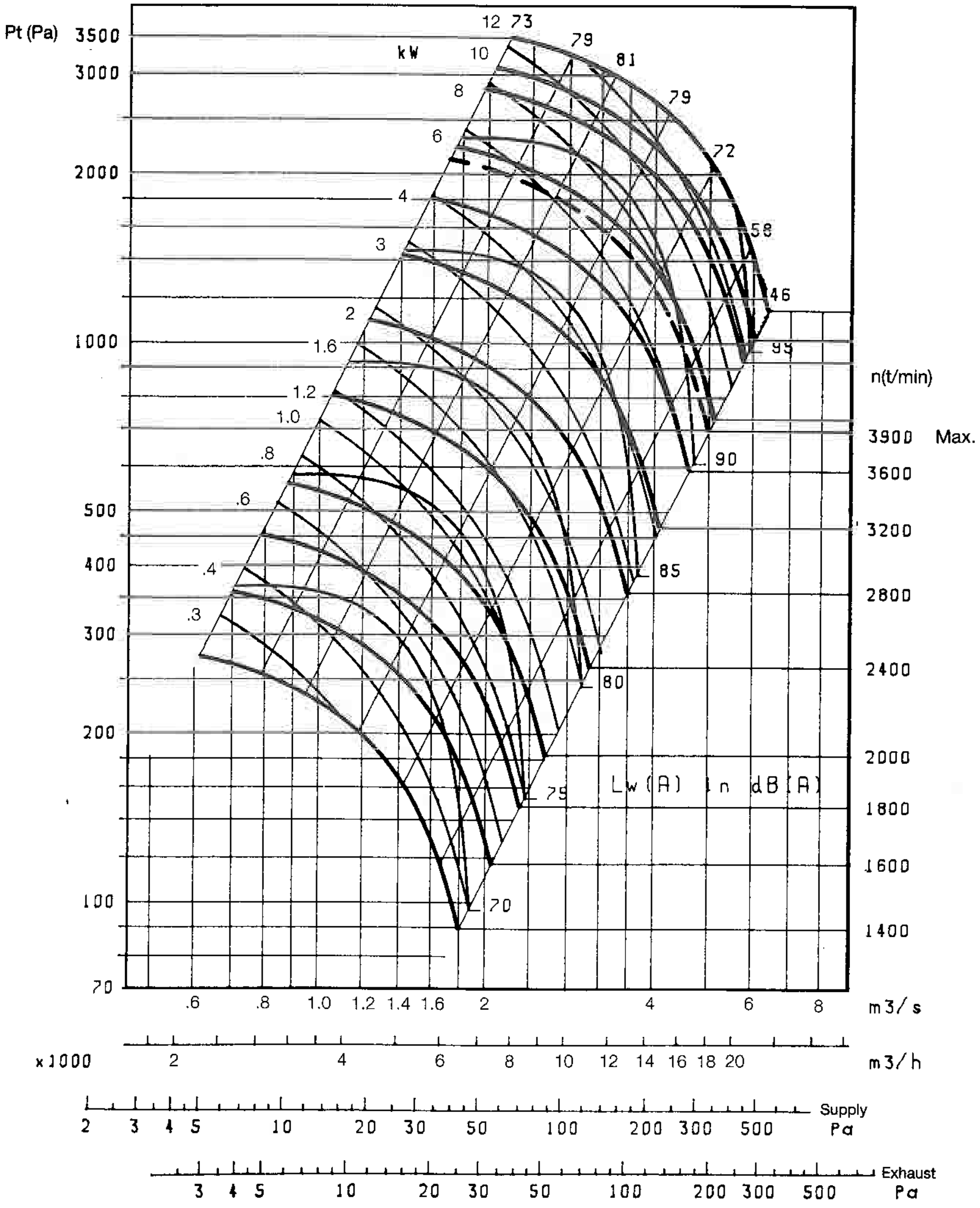
W14 - RDZ 280 TWIN



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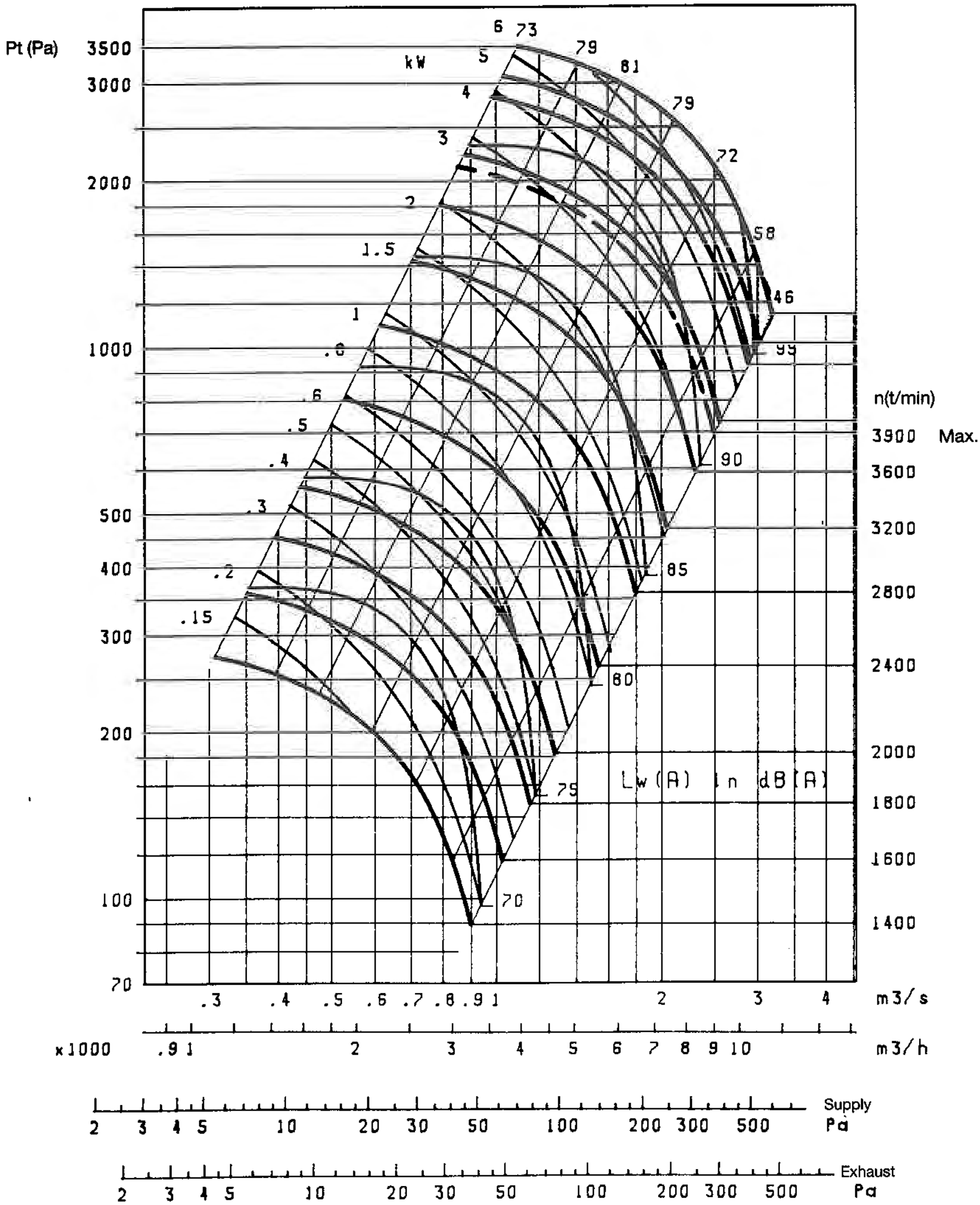
W13 - RDZ 280



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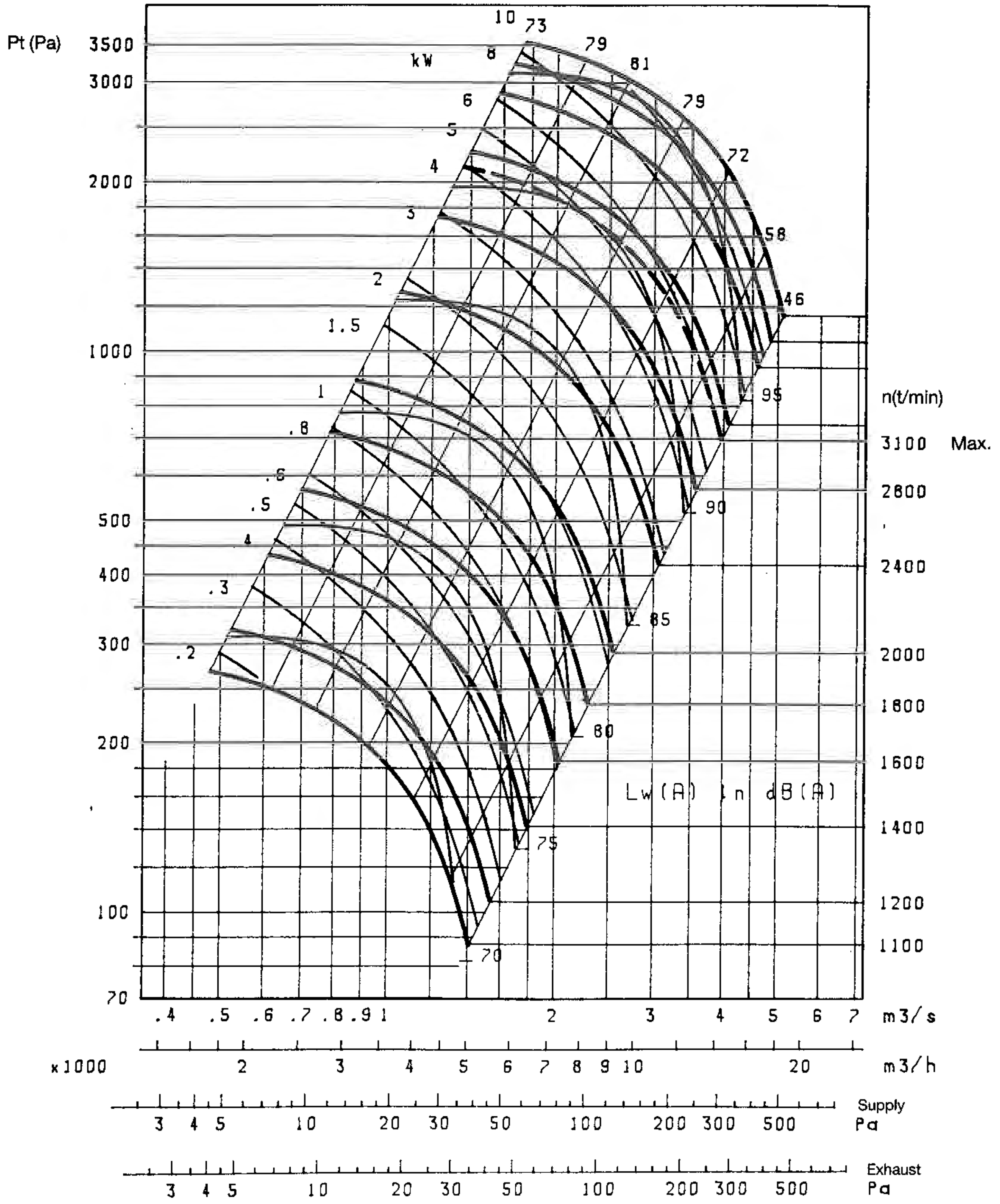
W43 - RDZ 355



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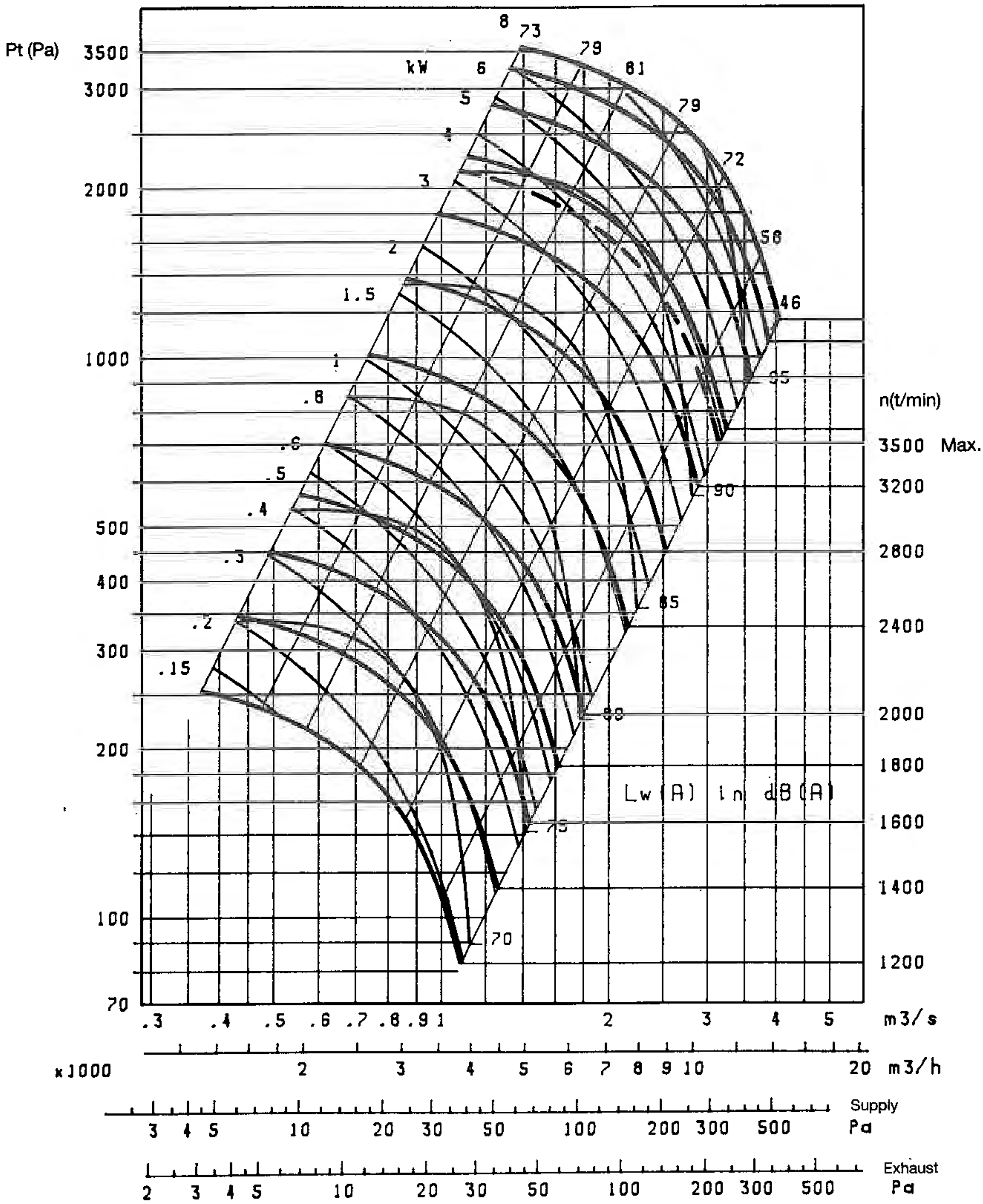
W42 - RDZ 315



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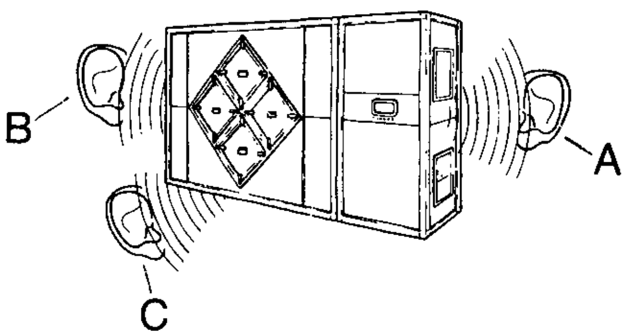


Sound level

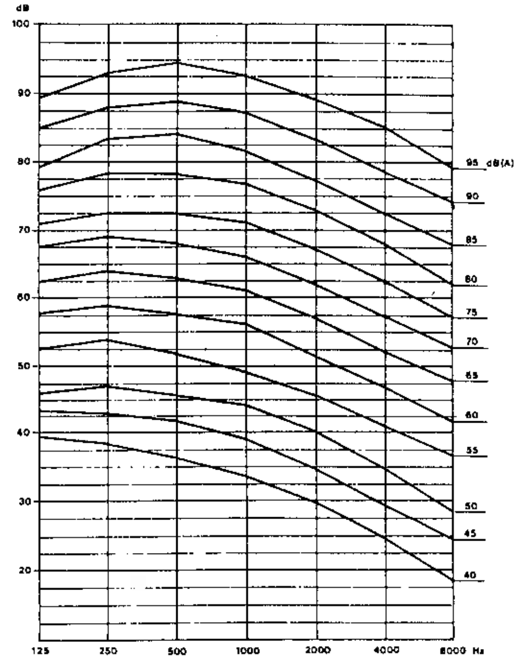
ΔP Pa	100			200			300		
dB (A)	A	B	C	A	B	C	A	B	C
XVV 11	73	68	63	74	69	64	75	70	65
XVV 12	72	67	62	74	69	64	75	70	65
XVV 13	77	72	67	79	74	69	80	75	70
XVV 14	75	70	65	77	72	67	78	73	68
XVV 41	76	70	66	77	71	67	78	72	68
XVV 42	76	70	66	78	72	68	79	73	69
XVV 43	76	70	66	78	72	68	79	73	69
XVV 44	78	72	68	80	74	70	81	75	71

Readings are dB(A).

Sound level measurements have been made at a distance of 1 m at the respective r.p.m., giving the three different external pressures Δp.

Sound Pressure Graph

By means of the following curves it is possible to convert the sound level dB(A) value found in the table or in the fan curves into Sound Pressure (dB) for all octaves in the frequency spectrum. This is of important when selecting a silencer.



Add 11 dB to left hand scale for SOUND POWER PEVEL. All readings taken at 45°, one metre from equipment, for frequency spectrum.

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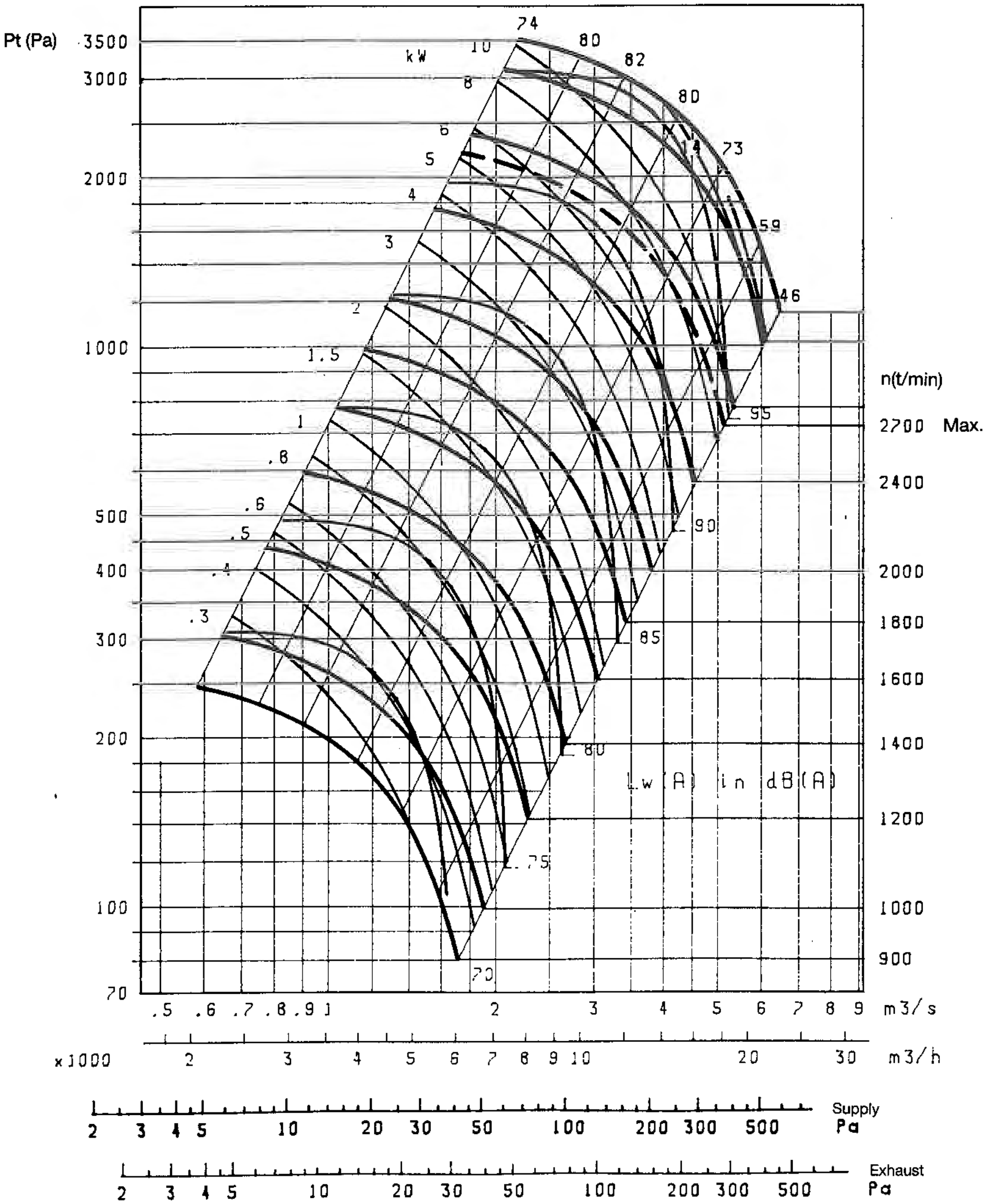
W44 - RDZ 400



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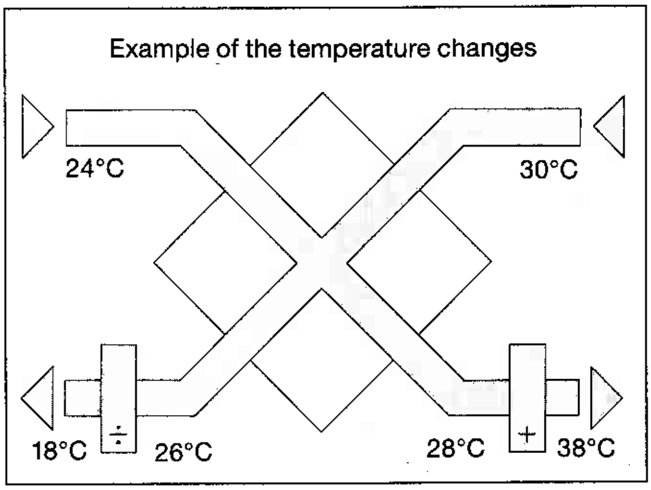
SUMMER OPERATION

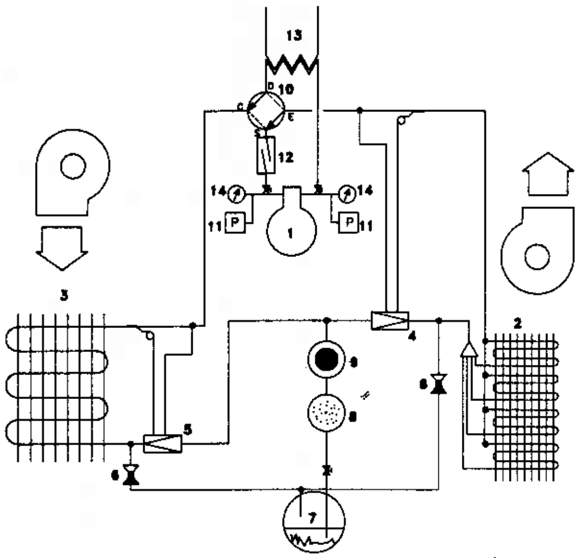


The heat pump circuit

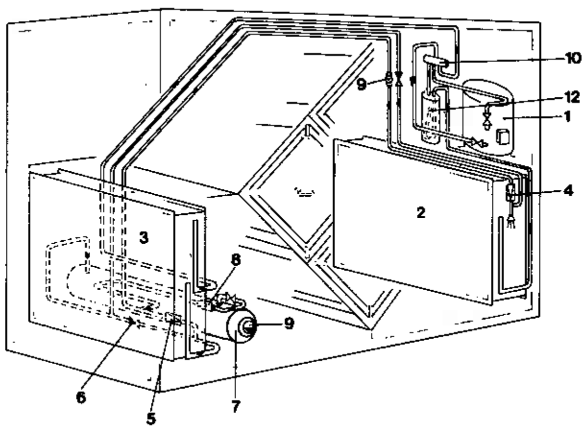
Under very cold conditions the air, which is drawn through the evaporator, can be cold and humid, which means that the evaporator can ice up.
In order to avoid ice gradually stopping the air passage, the cooling cycle is automatically reversed and is therefore able to melt the ice after a short period of reverse cycle operation.
For the automatic control of the time and duration of the defrosting process, a well tested electronic control device is used, which ensures that the evaporator is kept ice-free and the same time takes only as little time for the defrosting as absolutely necessary.

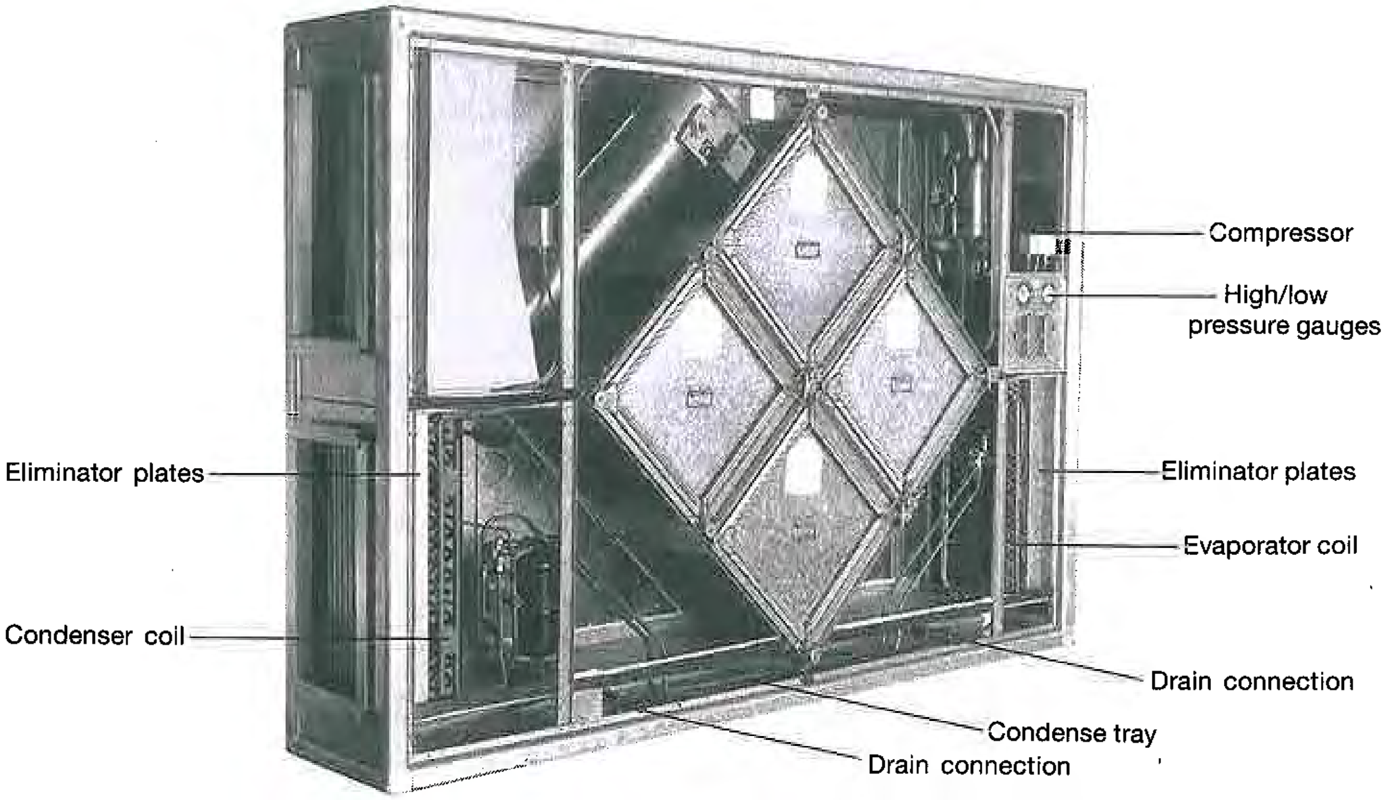
The cooling plant is of cource equipped with a high/low pressure stat as well as high and low pressure gauges placed in such a way that the working conditions can immediately be read off.
Further details can be found in the instruction manual.
The heat pump can be provided with a further water cooled condenser, if desired.
During summer time the heat pump is not needed for heat recovery and the cooling cycle can be reserved in such a way that the WP works as a cooling plant. In this way the period of operation is prolonged, and in addition to this the invested capital is better utilized, and at the same time better comfort conditions are obtained.
From the example it can be seen that even with an outside temperature of 30°C it is possible to blow air of approx 18°C into the room. If the exhaust from the room takes place at the ceiling the temperature may be 24°C or more while the temperature in the occupied area may be 20-22°C.

The operation of the heat pump is controlled automatically - according to the preset room temperature - changes between cooling, heating or neutral. The function is described in section 6 (controls).



1. Hermetic compressor
2. Evaporator (normal operation)
3. Condenser (normal operation)
4. Primary thermostatic expansion valve
5. Secondary thermostatic expansion valve
6. Back pressure valve
7. Receiver
8. Drying filter
9. Inspection glass
10. Switch valve
11. High pressure switch
12. Suction accumulator
13. Water cooled condense (extra equipment)
14. High/low pressure gauge





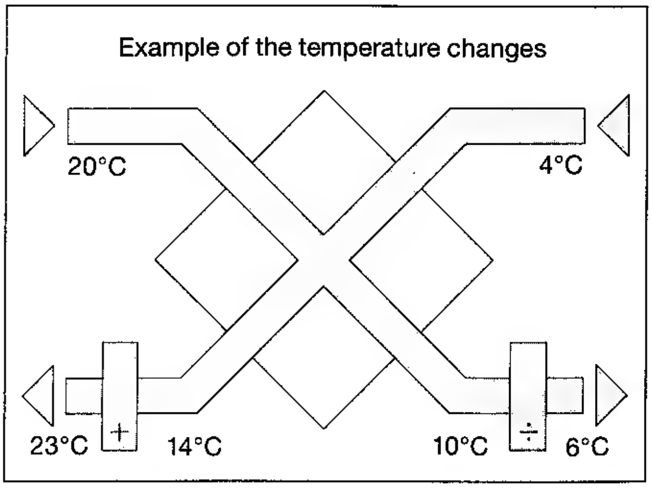
HEAT PUMP TYPE WP

When choosing a suitable recuperator size in relation to air volume and temperature difference, temperature efficiencies up to 70% can be obtained.
This is usually accepted as an optimum, but if it is desired to recover the remaining 30% a heat pump type WP can be supplied - as an option built into the XVV unit.
In practice this means that a cooling circuit with a cooling coil (evaporator) is built into the exhaust air and takes up the remaining heat content, which is then via a compressor delivered at a higher temperature to a condenser coil in the supply air stream.
In addition the electric power used for the operation of the compressor is converted into heat and released in the inlet air stream, which in this way is heated to approximately the same temperature as the exhaust air.

Conversely, the system can also operate in reverse cycle, cooling the incoming air in hot weather. This greatly increases the application of the unit. Although not a full air conditioning system it will in most cases cover the vast majority of both heating and cooling demand.
When a pump is built into the unit the compressor etc. is placed in the top right hand compartment. If therefore a pre-heating coil is required it has to be mounted externally before the supply fan.

When a heat pump is built into the unit the compressor etc. is placed in the top right hand compartment. If, therefore, a pre-heating coil is required, it has to be mounted externally before the supply fan.
Eliminator plates are fitted as standard in both supply and exhaust air streams.

WINTER OPERATION



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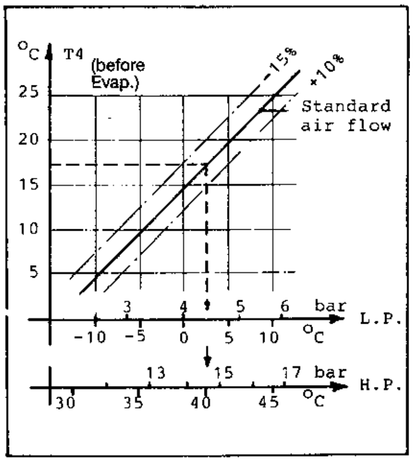


In the following table the capacity of the heat pump can be found at T4 temperatures stepwise from 5 to 25°C at a standard air flow. At the intermediate operating conditions found in the above diagram the values can be interpolated.

XVV/WP Type	Inlet temp. evaporator T4-°C	Working conditions Tf/Tc °C	Cooling capacity kW	Power consumption kW	Heat output kW	Temp. increase Δt-k	Effect factor
11	25	10/45	7,2	2,3	9,5	12.6	4,1
12	25	10/45	11,5	3,0	14,5	9,6	4,8
13	25	10/45	20,1	5,2	25,3	11,2	4,8
14	25	10/45	25,2	6,6	31.8	10.5	4.8
41	25	10/45	11,5	3,0	14,5	13,5	4,8
42	25	10/45	20,1	5,2	25,3	11,8	4,9
43	25	10/45	25,2	6,6	31,8	9,9	4,8
44	25	10/45	32.1	8,3	40,4	9,4	4,9
11	20	5/40	6,4	1,8	8,2	10,1	4,5
12	20	5/40	9,7	2,7	12,4	7,6	4,6
13	20	5/40	17,1	4,6	21,7	8,9	4,7
14	20	5/40	21,5	5,9	27,4	8,4	4,6
41	20	5/40	8,3	2,5	10,8	9,3	4,3
42	20	5/40	17,1	4,6	21,7	9,4	4,7
43	20	5/40	21,5	5,9	27,4	7,9	4,6
44	20	5/40	27,2	7,5	34,7	7.5	4,6
11	15	0/40	5,3	1,6	6,9	8,5	4,3
12	15	0/40	7,6	2,5	10,1	6,2	4,0
13	15	0/40	13,3	4,3	17,6	7,2	4,1
14	15	0/40	17,0	5,5	22,5	6,9	4,1
41	15	0/40	7,0	2,3	9,3	8,1	4,0
42	15	0/40	13,3	4,3	17,6	7,6	4,1
43	15	0/40	17,0	5,5	22,5	6,5	4,1
44	15	0/40	21,4	7,0	28,4	6,2	4,1
11	10	-5/35	4,4	1,5	5,8	7,2	3,9
12	10	-5/35	6,6	2,2	8,8	5,4	4,0
13	10	-5/35	11,6	3,8	15,4	6,3	4,1
14	10	-5/35	14,7	4,8	19,5	6,0	4,1
41	10	-5/35	6,1	2,1	8,2	7,1	3,9
42	10	-5/35	11,6	3,8	15,4	6,7	4,1
43	10	-5/35	14,7	4,8	19,5	5,6	4,1
44	10	-5/35	18,6	6,2	24,8	5,4	4,0
11	5	-10/35	3,3	1,3	4,6	5,7	3,5
12	5	-10/35	5,2	2,0	7,2	4,4	3,6
13	5	-10/35	8,2	3,4	11,6	4,8	3,4
14	5	-10/35	11,6	4,5	16,1	5,0	3,6
41	5	-10/35	4,9	1,9	6,8	5,9	3,6
42	5	-10/35	8,2	3,4	11,6	5,0	3,5
43	5	-10/35	11,6	4,5	16,1	4,7	3,6
44	5	-10/35	14,7	5,6	20,3	4,4	3,6

CALCULATION OF COOLING (Δt):

Example: XVV-14, 9000 m^3/h, T4 = 15°C/80% RH

Cooling capacity from table: 17,0 kW x 3600 ~ 61214 kJ.

Cooling in °C is calculated by means of a Mollier (h,x) diagram.

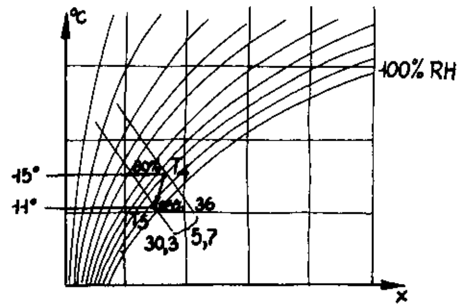
Enthalpy difference Δi = 61214 /(9000 x 1,2)
= 5,7 kJ/kg

Inlet enthalpy i4 = 36 kJ/kg

Outlet enthalpy i5 = 36 - 5,7 = 30,3 kJ/kg

Outlet temperature T5 = 11°C/95% RH

The outlet humidity is normally calculated at 95% RH)



CALCULATION OF HEATING (Δt):

Example: XVV-14, 9000 m^3/h (= 2,5 m^3/s)

T4 = 15°C/80% RH

T3 = 10°C/40% RH

Heat output from table (T4 = 15°C): 22,5 kW

$$\Delta t = \frac{E}{Q2 \times 1{,}2 \times 1{,}006} = \frac{22{,}5}{2{,}5 \times 1{,}2 \times 1{,}006} = 7{,}5°C$$

where:

E = Heat output (kW)

Q2 = Supply air flow rate (m^3/s)

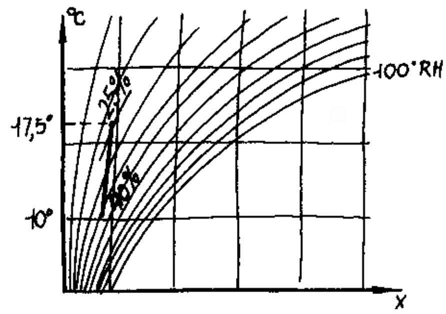
1,2 = Density at 20°C (or another actual value) (kg/m^3)

1,006 = Spec. heat capacity (kJ/kg x °C)

Temperature after condenser: 10°C + 7,5°C = 17,5°C

The corresponding %RH can be found in the Psychrometric chart as the point of intersection between a horizontal line for 17,5°C and a vertical line from 10°C/40% RH.

Relative humidity = 25% RH.



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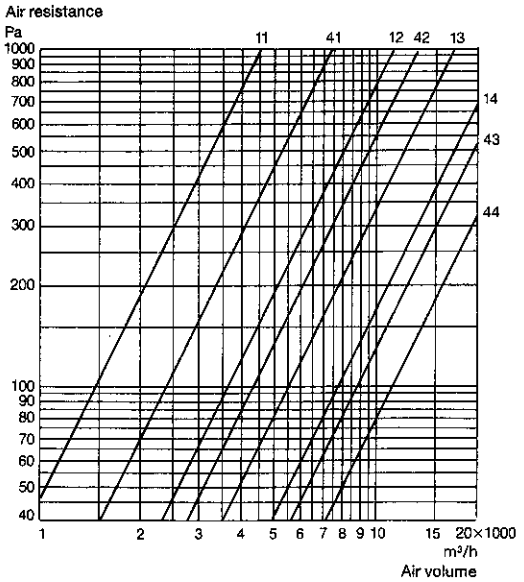
For the calculation of the necessary power and r.p.m. of the fans the air resistance over evaporator coil and condenser coil respectively should be taken into consideration - in accordance with the graphs below.

Air resistance over evaporator/condenser coil



Heat pump capacity

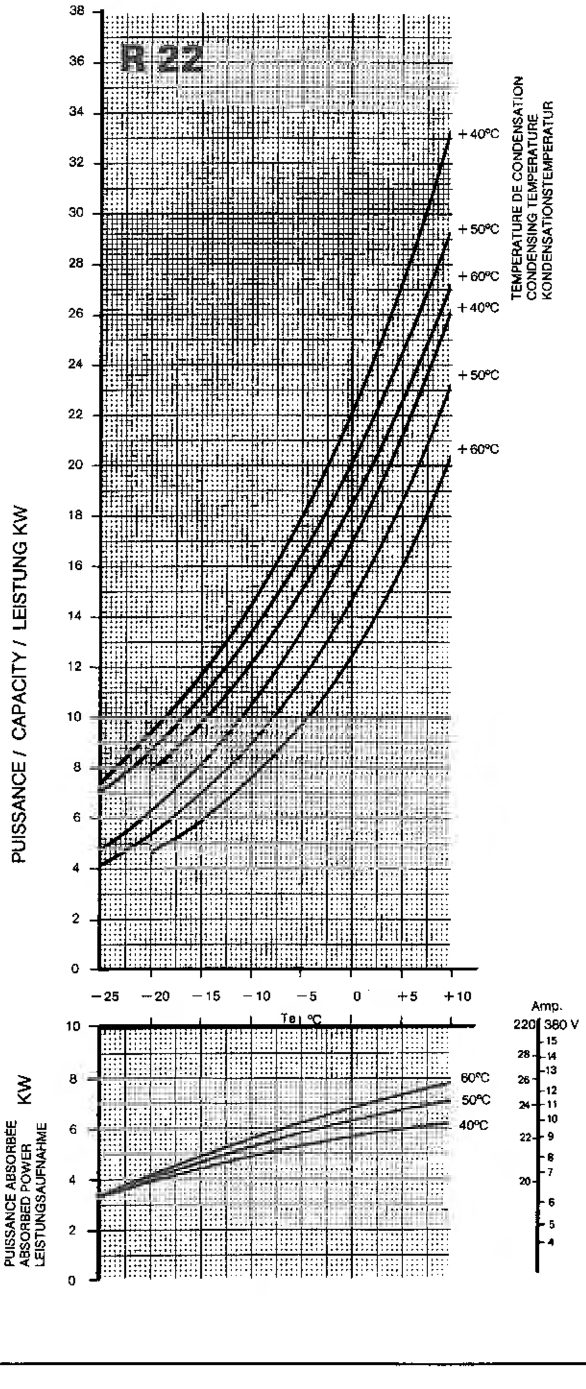
The capacity of the heat pump and consequently the compressor is partly dependent on the air volume and the air temperature when entering the evaporator and condenser.
Generally, it can be said that the higher the air volume and the inlet temperature at the evaporator, the higher the capacity will be.
As far as the condenser is concerned, the capacity will be increased with higher air volumes and with *lower* inlet air temperatures, as this results in a lower condensation temperature and thus a lower power consumption.
Example of a compressor-capacity diagram, which based on a specific evaporation temperature and condensing temperature will give the capacity on the left scale (kW) and the power consumption on the scale below. (Compressor MT 80 in XVV-14 and XVV-43).

From the diagram it can be seen that:

a) The cooling capacity will increase with an increasing evaporation temperature and with a falling condensation temperature.
b) The power consumption will increase with an increasing evaporation- and condensation temperature.

In the following diagram the approximate evaporation temperature and the corresponding pressure (LP) can be found - as well as the condensation temperature and pressure (HP) being a function of the air temperature before the evaporator (T4) and the standard or alternative air flow.
The condenser resistance is calculated in the supply air system and the evaporator resistance is calculated in the exhaust air system.

MT 80 JH

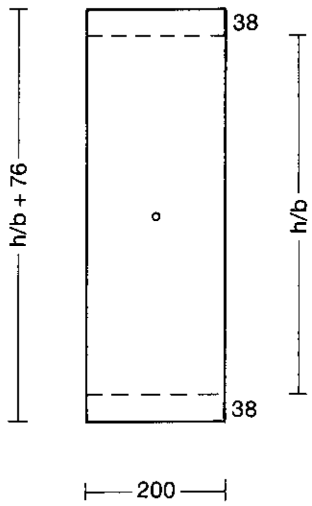


ELIMINATOR PLATES

The air velocity is normally high, so that in cases with wet systems (high humidity), droplets will be carried forward in the air flow.
To avoid this problem it is recommended that standard eliminator plates are fitted. The eliminator plates consist of S-shaped aluminium profiles, forcing the air through a labyrinth, where the droplets are collected and run off into the tray.
The pressure drop across the eliminator plate is insignificant and it ensures that the droplets are not carried into the fan unit.
When considering the necessity for eliminator plates, the highest temperature and relative humidity that can occur in the exhaust air as well as the lowest fresh air temperature, should be used as the basis (see section about wet/dry operation).
When the unit is provided with a heat pump eliminator plates are mounted in both the return air side and the air intake side as standard.

MULTI-LEAF DAMPER

Multi-leaf dampers for mounting on the recuperator unit or the fan unit are used as shut-off-dampers. Frame and fins are made from galvanized steel. The bearings are black leaded steel bearings.
The dampers can be provided with hand quadrant or motor.



	b mm	h mm
XVV 11	270	370
XVV 12	570	370
XVV 13	970	370
XVV 14	1170	370
XVV 41	270	570
XVV 42	570	570
XVV 43	970	570
XVV 44	1170	570

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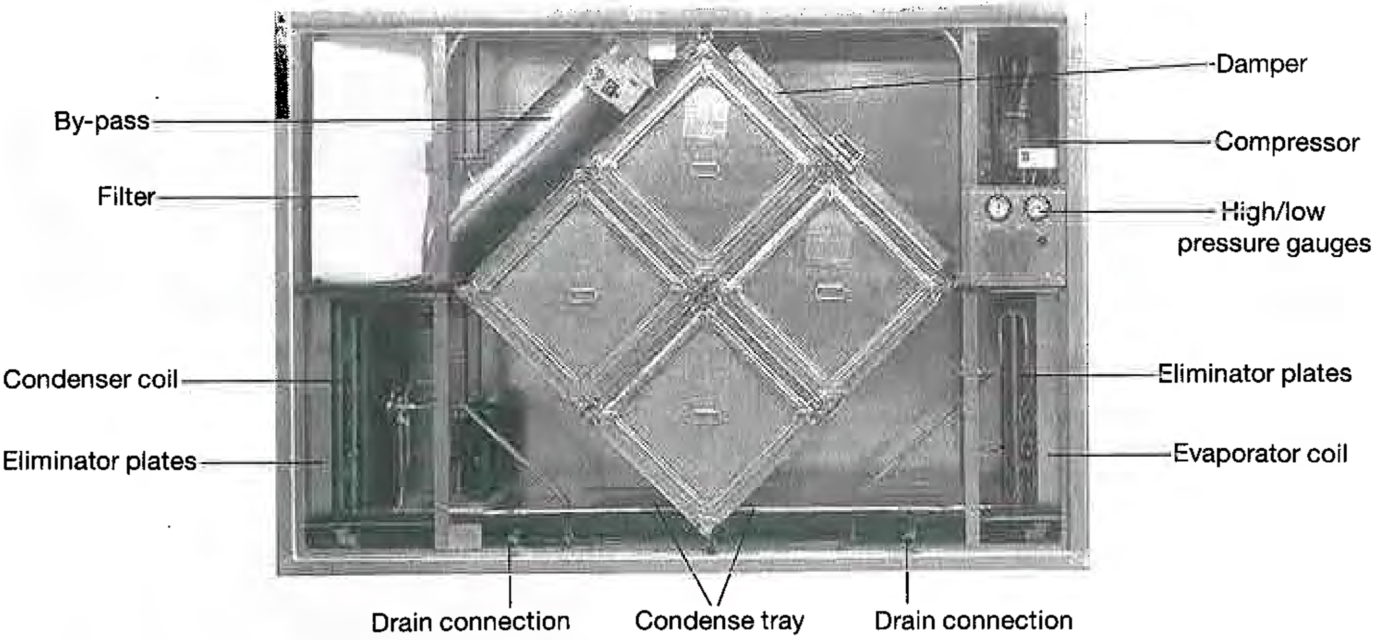
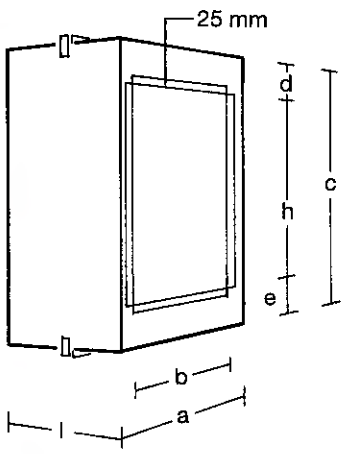
ACCESSORIES

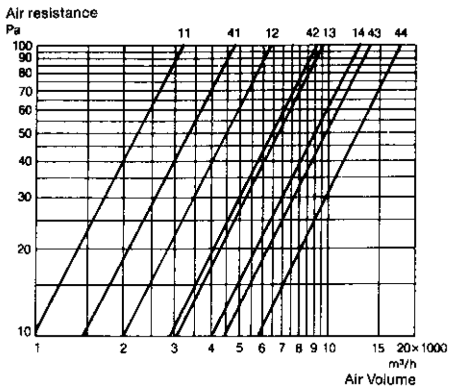


ACCESSORIES of various kinds can be built into or onto the units.

FILTERS
As standard the XVV unit is supplied with bag filter 80/25 in the return air side. Pressure loss over the filter appears from the diagram.

FILTER FL
If a filter in the fresh air side is desired the separate filter unit FL is mounted on the inlet spigot.
The filter cabinet is made from hot galvanized double skinned plates with 15 mm thick insulation. Internally bag filters type 80/25 of the same size as the built-in filters in the return air side are mounted. The sides of the filter unit are fastened by means of snap locks.





	b mm	h mm	a mm	c mm	d mm	e mm	l mm
XVV 11	300	400	404	574	114	60	410
XVV 12	600	400	810	574	132	42	410
XVV 13	1000	400	1190	574	132	42	410
XVV 14	1200	400	1420	574	132	42	410
XVV 41	300	600	404	804	127	77	410
XVV 42	600	600	810	804	127	77	410
XVV 43	1000	600	1190	804	127	77	410
XVV 44	1200	600	1420	804	162	42	410

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BY-PASS

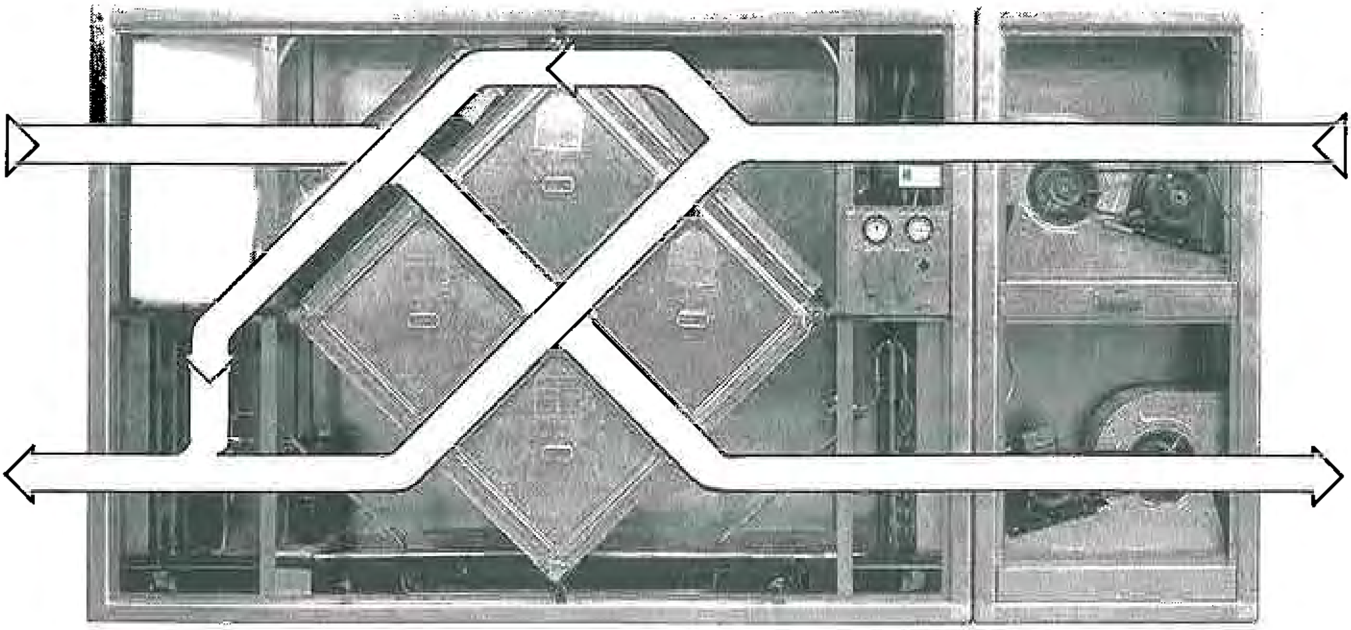
In order to lead the fresh air stream past the recuperator, completely or partly, the XVV unit can be supplied with a built-in by-pass duct.

Before the recuperator unit a motorized damper is mounted. This damper closes when the damper in the by-pass duct opens.

For the 11-14 series it is possible to lead 100% fresh air through the by-pass. For space reasons it is only possible to lead 80% of the fresh air past the recuperator in the XVV 41-44 series.

If 100% by-pass is necessary an external by-pass duct can be connected at the top of recuperator unit, but this cannot be used if a heat pump is fitted.

The electric connections for the motorized dampers are connected to multiple plugs or terminal strips in the acces side of the XVV unit.



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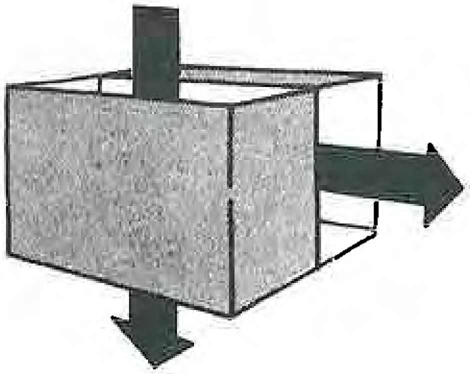
ALUMINIUM GRILLE

For use on the duct spigots of the unit or as terminal devices in duct or wall aluminium grilles with profiled blades. They offer good weather protection and a good visual finish.
The grills are supplied in various sizes, dependent on the air velocity, which must not exceed 3 m/sec.

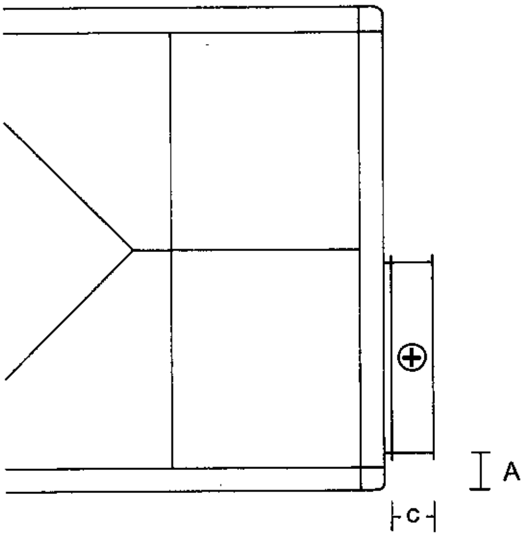
SUMMER MODULE

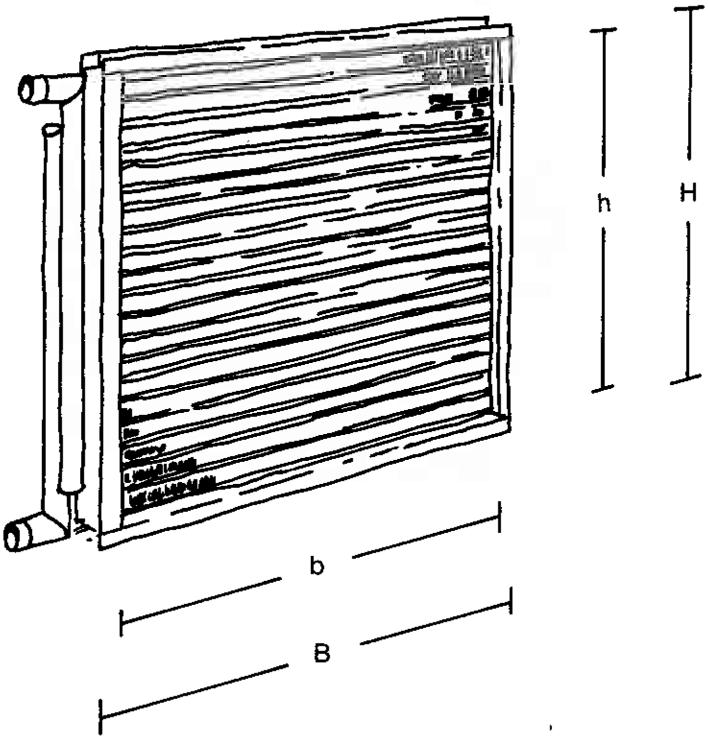
During summer operation it is often necessary to avoid heating up the supply air.
If the unit has no built-in by-pass the recuperator unit can be replaced with a summer module during the warm period to avoid heating of the air supply.



ROOF COVER

For protection against rain, units which are placed under open air conditions, can be supplied with a roof cover.





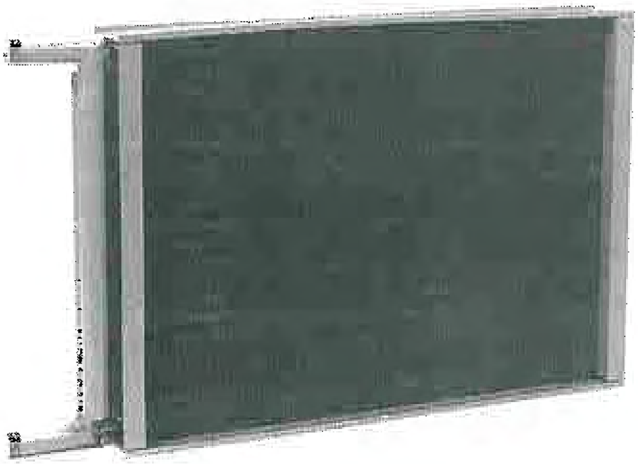
Dimensions of after heating coils mounted externally on the unit.

	(c) 1 RR	(c) 2 RR	(c) 3 RR	A
XVV 11	120	120	170	200
XVV 12	120	120	170	200
XVV 13	120	120	170	200
XVV 14	120	120	170	200
XVV 41	120	120	170	145
XVV 42	120	120	170	145
XVV 43	120	120	170	195
XVV 44	120	170	170	230

	B	b	H	h
XVV 11	350	300	450	400
XVV 12	650	600	450	400
XVV 13	1050	1000	450	400
XVV 14	1250	1200	450	400
XVV 41	350	300	650	600
XVV 42	650	600	650	600
XVV 43	1050	1000	650	600
XVV 44	1250	1200	650	600

ACCESSORIES

HEATING COILS, WATER



After heating coils for further increase of the supply air temperature after the recuperator unit can easily be accomodated in the unit.

The heating coils are made of copper tubes with aluminium fins and threaded steel headers.

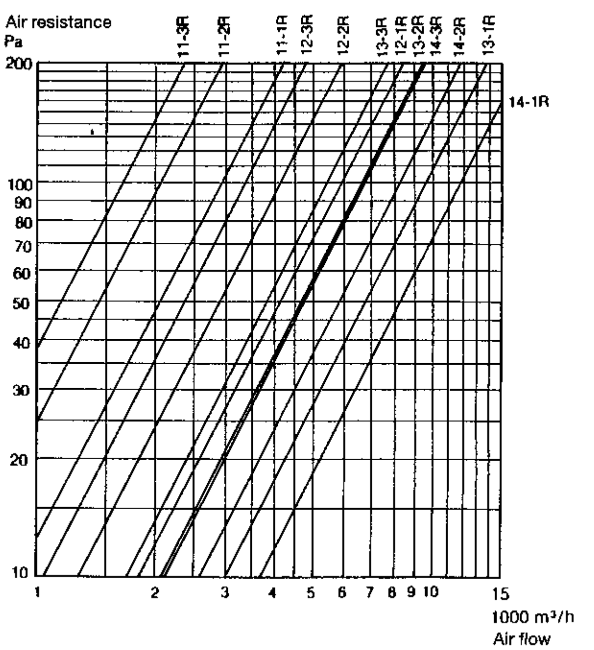
The air resistance for heating coils shown in the graphs below can be used when sizing the fan motors.

If the XVV plant is equipped with heat pump type WP the heating coils have to be mounted outside the unit, directly on the pressure connection. In that case the after heating coil is mounted directly on the XVV.

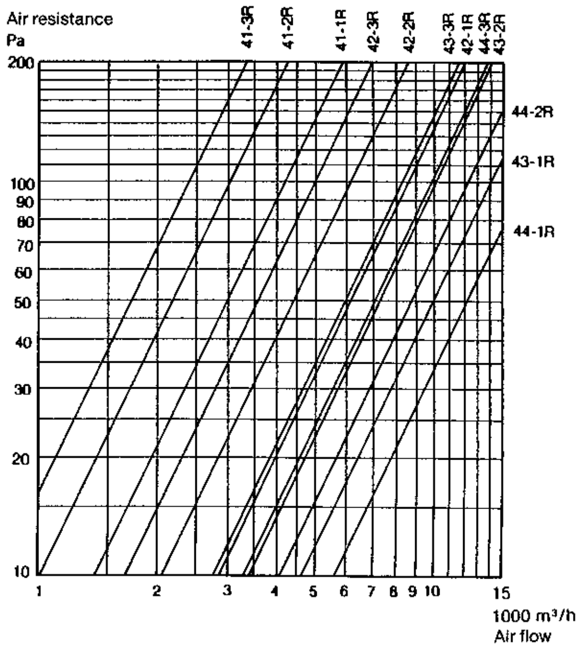
Capacities
Heating coils are available with 1, 2 and 3 rows of tubes, making it possible to match most output requirements. The charts below gives the relevant information on standard air volumes and air temperatures of 5°C and 15°C.

The figures are calculated for hot water with different inlet/outlet temperatures.

Air resistance across heating coils XVV 11-14



Air resistance across heating coils XVV 41-44



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ACCESSORIES

HEATING COILS FOR XVV **INTERNAL** **DATA FOR WATER 82/71°C**

Type XVV	Air Volume m^3/s - m^3/h	Number of rows		1 R		2 R		3 R	
		Inlet temperature	°C	5	15	5	15	5	15
11	0,625	Outlet temperature	°C	22	29	34	40	45	49
		Heat output	kW	13	11	23	19	31	26
	2250	Water consumption	l/h	1030	860	1800	1520	2420	2060
		Water reisitance	mVS	1.3	0.9	1.0	0.7	1.2	0.8
12	1,25	Outlet temperature	°C	23	30	37	42	43	47
		Heat output	kW	29	24	50	43	60	51
	4500	Water consumption	l/h	2230	1890	3940	3350	4690	3950
		Water resistance	mVS	1.3	0.9	2.0	1.5	2.5	1.9
13	1,875	Outlet temperature	°C	23	30	38	43	48	52
		Heat output	kW	43	36	77	66	101	87
	6750	Water consumption	l/h	3390	2870	6080	5170	8000	6820
		Water resistance	mVS	1.0	0.7	1.7	1.2	2.2	1.5
14	2,5	Outlet temperature	°C	24	31	38	43	48	52
		Heat output	kW	60	51	104	88	136	116
	9000	Water consumption	l/h	4690	3990	8120	6910	10640	9060
		Water resistance	mVS	2.5	1.8	1.8	1.3	1.4	1.0
41	0,88	Outlet temperature	°C	22	29	35	40	45	49
		Heat output	kW	19	16	34	28	45	38
	3200	Water consumption	l/h	1490	1260	2640	2240	3490	2960
		Water resistance	mVS	1.8	1.3	2.1	1.5	1.3	0.9
42	1,77	Outlet temperature	°C	23	30	37	42	48	52
		Heat output	kW	41	35	72	61	96	82
	6400	Water consumption	l/h	3230	2730	5670	4820	7530	6420
		Water resistance	mVS	1.6	1.1	2.2	1.5	2.3	1.7
43	2,66	Outlet temperature	°C	23	30	37	42	49	52
		Heat output	kW	62	52	107	91	146	124
	9600	Water consumption	l/h	4870	4110	8390	7090	11400	9730
		Water resistance	mVS	1.1	0.7	0.7	0.5	2.1	1.5
44	3,55	Outlet temperature	°C	24	31	38	43	48	52
		Heat output	kW	85	72	149	127	194	166
	12800	Water consumption	l/h	6660	5640	11640	9900	15200	12940
		Water resistance	mVS	0.9	0.7	1.9	1.4	1.4	1.0

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ACCESSORIES

HEATING COILS FOR XVV **INTERNAL** **DATA FOR WATER 80/60°C**

Type XVV	Air Volume m^3/s - m^3/h	Number of rows		1 R		2 R		3 R	
		Inlet temperature	°C	5	15	5	15	5	15
11	0,625	Outlet temperature	°C	19,0	26,5	31,8	36,7	40,7	44,3
		Heat output	kW	11	9,0	21	17	28	23
	2250	Water consumption	l/h	470	380	900	730	1200	980
		Water resistance	mVS	0,2	0,1	0,2	0,1	0,3	0,2
12	1,25	Outlet temperature	°C	21,6	28,4	34,3	39,2	44,5	47,5
		Heat output	kW	26	21	46	38	62	51,0
	4500	Water consumption	l/h	1110	900	1970	1630	2660	2190
		Water resistance	mVS	0,3	0,2	0,5	0,3	0,6	0,4
13	1,875	Outlet temperature	°C	21,6	28,6	34,7	40,5	45,3	48,1
		Heat output	kW	39	32	70	60	95	78
	6750	Water consumption	l/h	1670	1370	3010	2580	4080	3350
		Water resistance	mVS	0,2	0,1	0,4	0,3	0,6	0,4
14	2,5	Outlet temperature	°C	22,5	29,3	35,3	40,4	44,8	48,4
		Heat output	kW	55	45	95	80	125	105
	9000	Water consumption	l/h	2360	1930	4080	3440	5370	4510
		Water resistance	mVS	0,7	0,4	0,5	0,3	0,4	0,2
41	0,88	Outlet temperature	°C	20,2	27,5	32,8	37,4	41,7	45,5
		Heat output	kW	17	14	31	25	41	34
	3200	Water consumption	l/h	730	600	1330	1070	1760	1460
		Water resistance	mVS	0,4	0,3	0,5	0,3	0,3	0,2
42	1,77	Outlet temperature	°C	20,7	28,4	34,6	39,6	45,3	48,6
		Heat output	kW	35	30	66	55	98	75
	6400	Water consumption	l/h	1500	1290	2830	2360	3870	3220
		Water resistance	mVS	0,3	0,2	0,6	0,4	0,5	0,4
43	2,66	Outlet temperature	°C	20,8	27,8	32,8	38,9	43,8	48,7
		Heat output	kW	53	43	93	80	130	113
	9600	Water consumption	l/h	2270	1840	3990	3440	5580	4850
		Water resistance	mVS	0,2	0,1	0,1	0,1	0,5	0,4
44	3,55	Outlet temperature	°C	22,5	28,9	35,2	40,8	45,3	48,6
		Heat output	kW	78	62	135	115	180	150
	12800	Water consumption	l/h	3350	2660	5800	4940	7740	6440
		Water resistance	mVS	0,2	0,1	0,5	0,4	0,4	0,2

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ACCESSORIES

HEATING COILS FOR XVV **EXTERNAL** **DATA FOR WATER 82/71°C**

Type XVV	Air Volume m^3/s - m^3/h	Number of rows		1 R		2 R		3 R	
		Inlet temperature	°C	5	15	5	15	5	15
11	0,625	Outlet temperature	°C	24	31	39	44	49	53
		Heat output	kW	14	12	26	22	34	29
	2250	Water consumption	l/h	1180	1000	2160	1830	2770	2340
		Water resistance	mVS	0.7	0.5	2.0	1.5	1.7	1.2
12	1,25	Outlet temperature	°C	24	31	38	42	48	51
		Heat output	kW	29	25	50	42	66	56
	4500	Water consumption	l/h	2370	1980	4060	3420	5300	4460
		Water resistance	mVS	0.5	0.3	0.5	0.4	0.6	0.4
13	1,875	Outlet temperature	°C	26	33	41	46	51	55
		Heat output	kW	49	42	84	71	108	92
	6750	Water consumption	l/h	3960	3380	6730	5720	8670	7410
		Water resistance	mVS	1.6	1.2	1.5	1.1	1.6	1.2
14	2,5	Outlet temperature	°C	25	32	40	45	50	54
		Heat output	kW	63	54	108	92	141	120
	9000	Water consumption	l/h	5070	4320	8710	7410	11300	9650
		Water resistance	mVS	2.7	2.0	2.3	1.7	2.1	1.6
41	0,88	Outlet temperature	°C	25	32	40	45	50	54
		Heat output	kW	22	19	38	32	50	42
	3200	Water consumption	l/h	1830	1540	3100	2628	4030	3420
		Water resistance	mVS	1.8	1.3	1.6	1.2	1.5	1.1
42	1,77	Outlet temperature	°C	25	31	38	43	41	52
		Heat output	kW	43	36	74	62	96	81
	6400	Water consumption	l/h	3500	2920	5940	5000	7700	6520
		Water resistance	mVS	0.5	0.3	0.5	0.4	0.6	0.4
43	2,66	Outlet temperature	°C	27	33	42	46	52	55
		Heat output	kW	71	61	121	103	156	133
	9600	Water consumption	l/h	5760	4900	9720	8280	12520	10656
		Water resistance	mVS	1.5	1.1	1.5	1.1	1.7	1.2
44	3,55	Outlet temperature	°C	26	33	41	46	51	55
		Heat output	kW	93	79	158	135	205	175
	12800	Water consumption	l/h	7490	6370	12700	10830	16400	14040
		Water resistance	mVS	2.8	2.0	2.8	2.0	3.0	2.2

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HEATING COILS FOR XVV **EXTERNAL** **DATA FOR WATER 80/60°C**

Type XVV	Air Volume m³/s - m³/h	Number of rows		1 R		2 R		3 R	
		Inlet temperature	°C	5	15	5	15	5	15
11	0,625 / 2250	Outlet temperature	°C	19	27	33	38	42	46
		Heat output	kW	11	9	22	18	29	24
		Water consumption	l/h	500	400	970	800	1300	1040
		Water resistance	mVS	0.1	0.1	0.5	0.3	0.4	0.3
12	1,25 / 4500	Outlet temperature	°C	20	27	31	46	40	43
		Heat output	kW	23	19	40	32	53	43
		Water consumption	l/h	1000	830	1760	1440	2340	1900
		Water resistance	mVS	0.1	0.1	0.1	0.1	0.1	0.1
13	1,875 / 6750	Outlet temperature	°C	22	29	35	40	45	48
		Heat output	kW	41	33	70	58	92	76
		Water consumption	l/h	1800	1470	3100	2560	4070	3350
		Water resistance	mVS	0.4	0.3	0.4	0.3	0.4	0.3
14	2,5 / 9000	Outlet temperature	°C	22	29	35	40	44	47
		Heat output	kW	53	44	92	76	121	100
		Water consumption	l/h	2340	1940	4070	3350	5330	4430
		Water resistance	mVS	0.6	0.4	0.6	0.4	0.5	0.4
41	0,88 / 3200	Outlet temperature	°C	22	29	34	39	43	46
		Heat output	kW	18	15	32	26	42	34
		Water consumption	l/h	820	680	1400	1150	1870	1550
		Water resistance	mVS	0.4	0.3	0.4	0.3	0.4	0.3
42	1,77 / 6400	Outlet temperature	°C	20	27	32	36	40	43
		Heat output	kW	34	27	59	47	77	63
		Water consumption	l/h	1510	1190	2600	2090	3420	2770
		Water resistance	mVS	0.1	0.1	0.1	0.1	0.1	0.1
43	2,66 / 9600	Outlet temperature	°C	23	30	36	40	45	48
		Heat output	kW	59	49	102	84	133	110
		Water consumption	l/h	2630	2160	4500	3700	5870	4830
		Water resistance	mVS	0.4	0.2	0.4	0.3	0.4	0.3
44	3,55 / 12800	Outlet temperature	°C	23	28	35	40	45	48
		Heat output	kW	78	64	135	112	176	146
		Water consumption	l/h	3460	2850	5940	4890	7780	6440
		Water resistance	mVS	0.7	0.5	0.7	0.5	0.7	0.5

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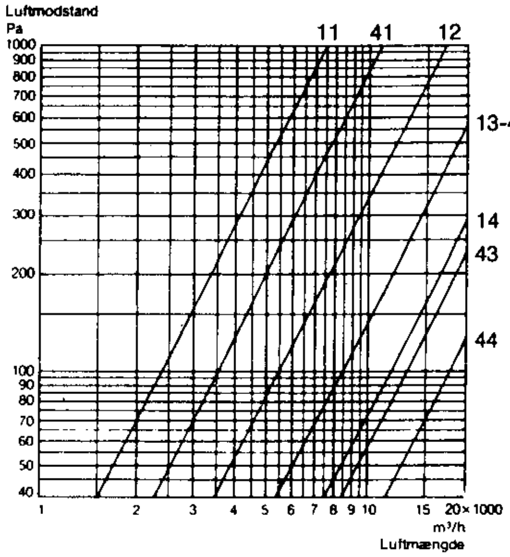
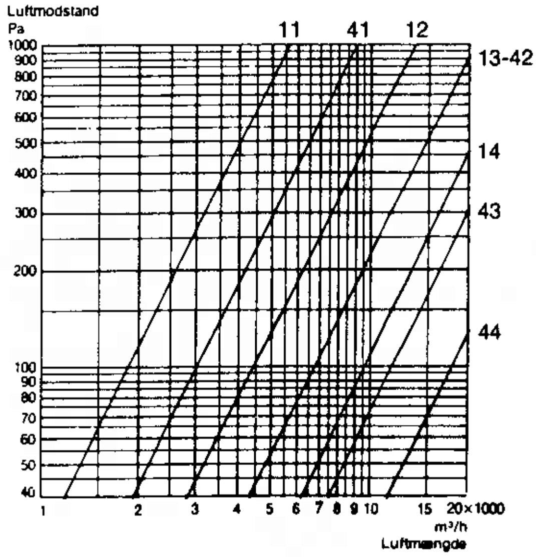
ACCESSORIES

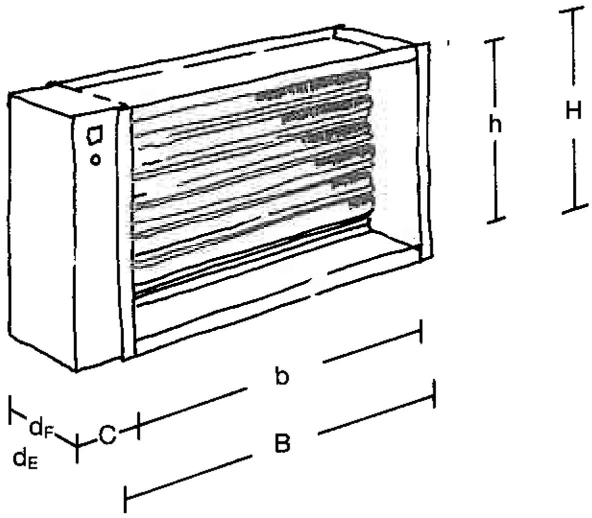
The air resistance for electric heating coils shown in the graph below can be used when sizing the fan motors - Please note that there are suitable graphs for after heating and for frost protection coils.

Resistance over electric pre heating coils



Resistance over electric after heating coils





	Preheating kW	Afterheating kW	B mm	b mm	H mm	h mm	C mm	d_F preheating mm	d_E afterheating mm
XVV 11	7,5	15	350	300	470	420	150	200	300
XVV 12	15	30	650	600	470	420	150	200	300
XVV 13	22,5	45	1050	1000	470	420	150	200	300
XVV 14	30	60	1250	1200	470	420	150	200	300
XVV 41	11	21,5	350	300	650	600	150	200	300
XVV 42	21,5	43	650	600	650	600	150	200	300
XVV 43	32	64	1050	1000	650	600	150	200	300
XVV 44	43	86	1250	1200	650	600	150	200	300

ELECTRIC HEATING COILS

Electric heating coils are particulary suitable as pre-heating coils for frost protection, but can of course be used for after heating as well, particulary in conjunction with a heat pump.

The electric elements are fitted with aluminium fins, ensuring a high heat transfer and uniform distribution.

The separate elements of the electric heating coil are internally led to a countersunk terminal row where supply cables and control current cables can be connected.

The necessary safety thermostats are built into the terminal box to protect the heating coil. A control thermostat (LIM), the temperature setting of which is adjustable, switches off the heat at abnormally high temperatures and switches it on again automatically when the temperature has dropped.

An overheat thermostat (OT) is an extra safety and switches off at an air temperature of 100°C. OT does not reset automatically when the temperature has dropped but has to be manually operated via a reset-buttom on the terminal box.

The 3 phase supply voltage for the heating coil can be as specified by the customer.

The heat output is normally split up on serveral steps, and the output of the single steps is normally adjusted in the following proportion 1 - 2 - 4 - 4.
The table below states the necessary output in kW at different temperatures (Δt) of the normal air volumes.

TYPE	Q m³/h	kW at Δt = 5°C	10°C	15°C	20°C
XVV-11	2250	3,7	7,5	11,3	15,0
XVV-12	4500	7,5	15,0	22,4	30,0
XVV-13	6750	11,3	22,5	33,9	45,0
XVV-14	9000	15,0	30,0	45,0	60,0
XVV-41	3200	5,4	10,7	16,1	21,4
XVV-42	6400	10,7	21,4	32,2	42,8
XVV-43	9600	16,1	32,2	48,2	64,2
XVV-44	12800	21,4	42,9	64,3	85,8

The heat output is calculated in accordance with the formula:

$E = Q \times 0{,}335 \times \Delta t$ (W)
Q = Air volume in m^3/h

Splitting up the output into steps makes it possible to switch in and out gradually, dependent on the actual heat requirement.

Each step requires its own contactor.

Binary step control can also be provided.

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Example of calculation - wet system

Givet:	T1	= 30°C	T2	= +4°C
	RH1	= 60% RH	RH 2	= 80% RH
	Q1	= 1,80 m^3/s	Q2	= 1,70 m^3/s
		(~ 6480 m^3/h)		(~ 6120 m^3/h)

Step 1: Ascertainment of wet or dry system

a) In the Mollier diagram plot in T1 as the intersection point between a horizontal line for 30°C and the 60% RH line.

b) Find the dew point TD by plotting a vertical line for T1 downwards till it meets the 100% RH curve. From the temperature scale on the left hand side you find TD = 21,6°C.

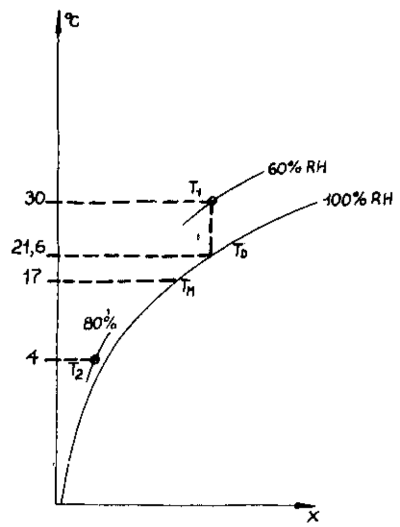
c) Plot in T2 as the point of intersection between a horizontal line for +4°C and the 80% RH.

d) Find the average temperature

$$TM = \frac{T1 + T2}{2} = \frac{30 + 4}{2} = 17°C$$

which is drawn horizontally downwards till it intersects the 100% RH curve.

e) As TM = 17°C is lower than TD = 21,6°C, we have a wet system.



Step 2: Selection of recuperator combination and size

a) In »Quick selection chart« on page X7.01, we find two realistic module combinations for the biggest air volume Q1 = 1,8 $m/^3$ (= 6480 m^3/h), either 1x3M with a pressure drop of approx. 230 Pa or 4x2M with 260 Pa.

b) In order to get the highest efficiency we select 4x2M.

Step 3: Marking of air volumes in the capacity chart

a) As there are two rows of modules next to each other in a 4x2M, it is necessary to divide the air volumes by 2 when using the capacity chart.
qe = 1,8:2 = 0,9 m^3/s
qs = 1,7:2 = 0,85 m^3/s

b) Start in diagram »B« by plotting horizontal lines for qs = 0,85 m^3/s and qe = 0,9 m^3/s until it intersects the diagonal line for 4x1M.

Step 4: Correction for WET SYSTEM and air volume

a) Continue plotting the horizontal line for qs from diagram »B« to diagram»D«.

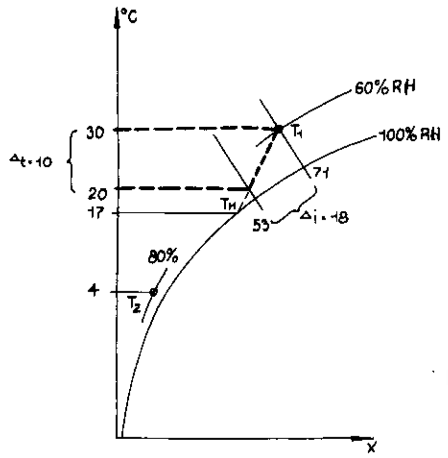
b) Specific heat flow We is found

$$We = qe \times 1,2 \times \frac{\Delta i}{\Delta t} \quad (kJ/S°C)$$

NOTE: The proportion $\frac{\Delta i}{\Delta t}$ is the heat being released from the exhaust air in kJ per kg air and per °C by which the exhaust air is cooled off. In reality it is an expression of the curve of the line between T1 and TM in the Mollier diagram and it can be found in the Mollier diagram by following this procedure: Enthalpy at 30°C/60% RH is 71 kJ/kg. At a temperature which is 10°C lower, that is the intersection between 20°C and the T1 - TM line, the enthalpy is 53 kJ.

$$\frac{\Delta i}{\Delta t} = \frac{71\text{-}53}{10} = \frac{18}{10} = 1,8$$

We = 0,9 x 1,2 x 1,8 = 1,94 kJ/s x °C.



c) From the top row in diagram »D« draw a vertical line for We = 1,94 until it intersects the horizontal qs line.

In the intersection point we find the proportion $\frac{Ws}{We}$ ~ 0,55

(See calculation page X7.02, with correct densities, giving $\frac{Ws}{We}$ = 0,57).

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Step 7: How to calculate the temperature of the air being returned to the building T3

a) By using the efficiency found from the diagram it is now possible to calculate the air temperature being returned to the building T3:

$T3 = T2 + \eta s\ (T1-T2)$

$T3 = 4 + 0{,}64\ (50-4)$

$T3 = 4 + 29{,}4 = 33{,}4°C$

Step 8: How to calculate the heat recovery

a) Having now found the temperature rise in the fresh air stream, we can easily find the heat recovery by using the formula in section 3.1.2.

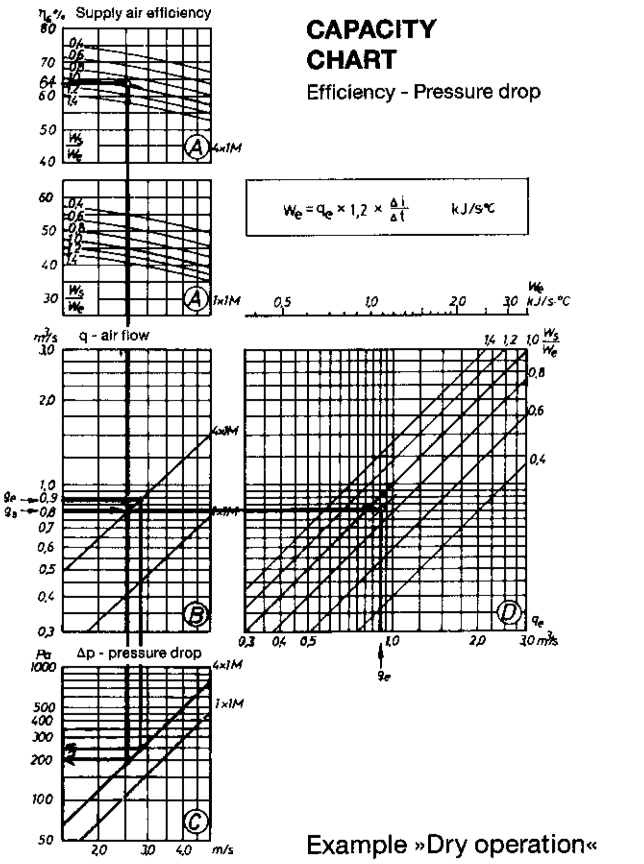
$E = Q2 \times \rho s \times 1{,}006 \times (T3-T2)\ (kW)$

$= 1{,}62 \times 1{,}27 \times 1{,}006 \times (33{,}4-4) = 60{,}8\ kW.$

Step 9: How to calculate the temperature of the final exhaust air T4

Here there is a difference in air flow and as the temperatures differ so much from 20°C the density of 1,2 kg/m³ cannot be used. The formulae on pages X7.02 and X7.03 must be used instead.

The exhaust temperature T4 is equal to the T1-temperature less ΔT on fresh air and multiplied by the mass-relation on the two air streams.



Example »Dry operation«

$$T4 = T1 - (T3-T2) \times \frac{qs \cdot \rho s}{qe \cdot \rho e}$$

$$T2 = 4°C \Rightarrow \rho 4 = 1{,}205\ \frac{293}{273+4} = 1{,}27\ kg/m^3$$

$$T1 = 50°C \Rightarrow \rho 50 = 1{,}205\ \frac{293}{273+50} = 1{,}09\ kg/m^3$$

$$T4 = 50-(33{,}4-4) \times \frac{0{,}81 \cdot 1{,}27}{0{,}885 \cdot 1{,}09}$$

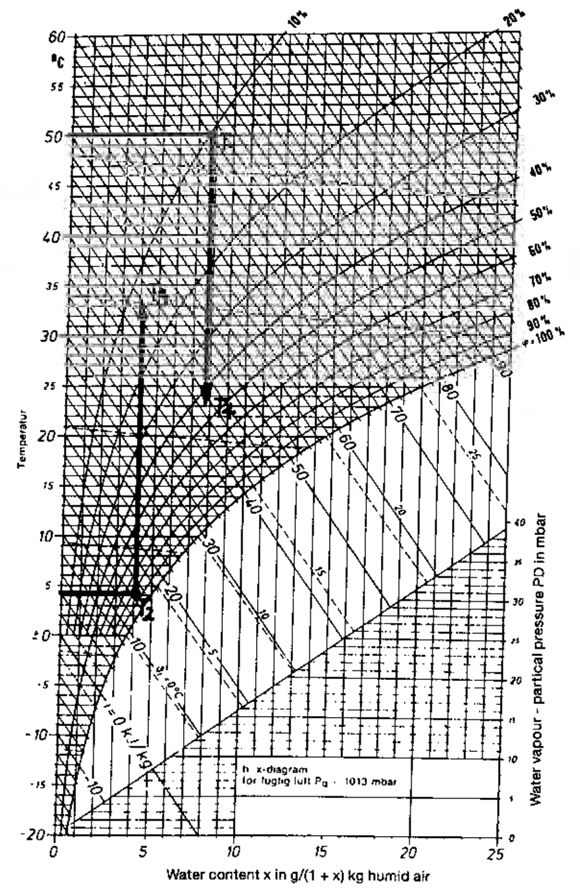
$$T4 = 50-29{,}4 \times 1{,}07 = 18{,}6°C$$

Step 10: Marking on Mollier diagram

a) From T2 = 4°C/80% RH draw a vertical line upwards until it intersects 33,4°C. Relative humidity for T3 is approx. 12% RH.

b) From T1 = 50°C/10% RH draw a vertical line downwards until intersects 18,6°C. Relative humidity for T4 is found to be approx. 59% RH

NOTE: Normally it is not necessary to carry out step 9 and 10 if you only want to know the heat recovery.



Example: Dry operation

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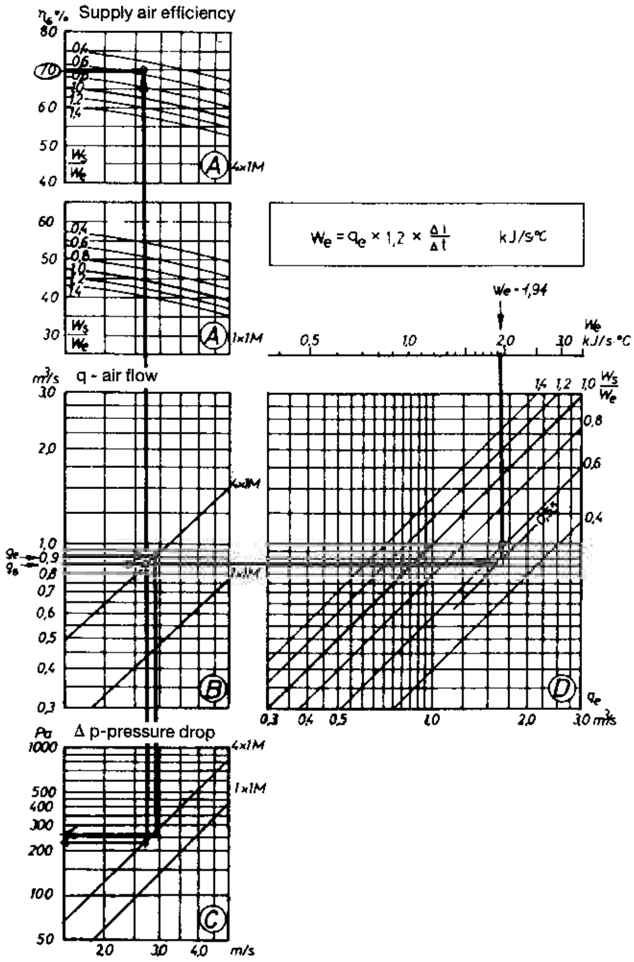
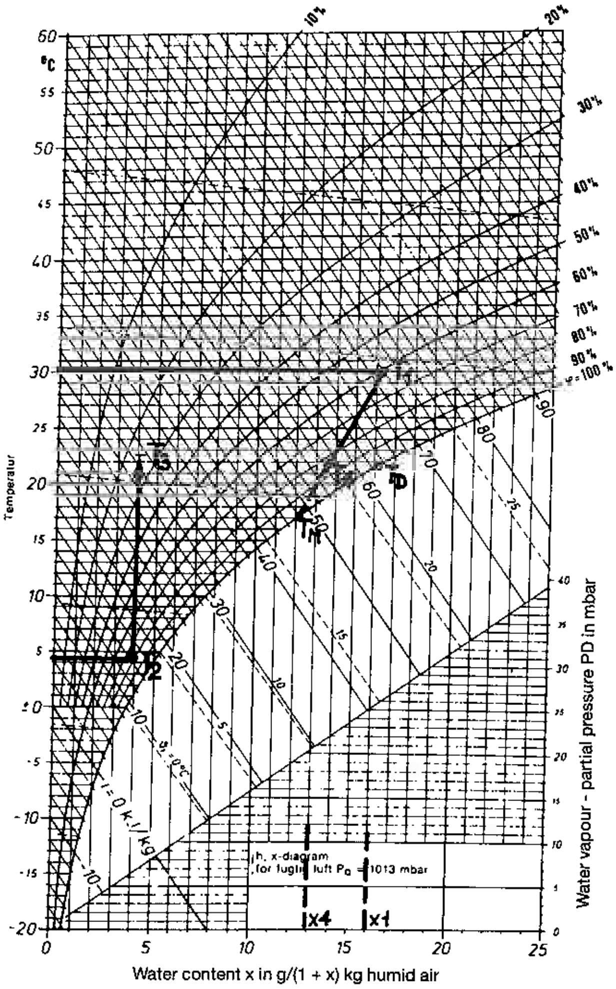
Capacity chart efficiency - pressure drop



Example: Wet operation.

Process plotted into Mollier (h,x) -diagram



Example: Wet operation.

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CALCULATIONS

Step 5: How to find the efficiency

a) Through the qs intersection with the diagonal line for 4x1M in diagram »B« plot a vertical line upwards to the upper diagram »A« for 4x1M.

b) When this vertical line intersects the line having the found proportion $\frac{Ws}{We} = 0,55$ plot a line to the left hand scale to find the efficiency of the recuperator = 70%. Even though the calculated relation (0,57) is used, it leads to the same efficiency.

Step 6: How to find the pressure drop

a) From diagram »B« at the intersection of qs and the diagonal line for 4x1M plot a line downwards to diagram »C« until it intersects the diagonal line for 3x1M.

b) Draw the corresponding line for qe till intersection with the diagonal line in diagram »C«.

c) Drawing a line from the two points to the left hand column shows a pressure drop of qs = 230 Pa and qe = 260 Pa.

Step 7: How to calculate the temperature of the air being returned to the building T3

a) By using the efficiency found from the diagram it is now possible to calculate the air temperature being returned to the building T3:
$\underline{T3 = T2 + \eta s \times (T1-T2)}$
$T3 = 4 + 0,70 \times (30-4)$
$T3 = 4 + 18,2 = 22,2°C$

Step 8: How to calculate the heat recovery

a) Having now found the temperature rise in the fresh air stream, we can easily find the heat recovery by using the formula in ??? x7.03.
$E = Q2 \times \rho s \times 1,006\ (T3-T2)\ (kW)$
$E = 1,7 \times 1,27 \times 1,006\ (22,2-4) = 39,5\ kW$

Step 9: How to calculate the temperature of the final exhaust air T4

a) Basis for calculating T4 is that the temperature rise of the fresh air supply is of the same magnitude as the temperature fall of the exhaust air. The enthalpy difference in the exhaust air is the same as the enthalpy difference of the supply air, multiplied by the air mass proportion.

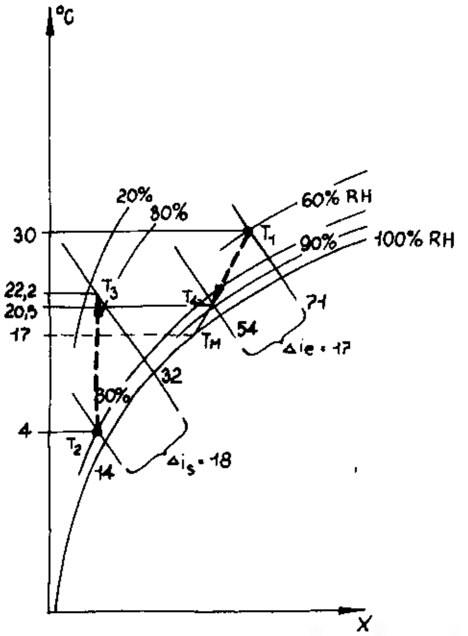
$$\Delta i_e = \Delta i_s \times \frac{qs \cdot \rho s}{qe \cdot \rho e}$$

b) Find Δi_s in Mollier diagram, where enthalpy in
T3 = 32 kJ/kg
and in T2 = 14 kJ/kg

$\Delta i_s = 32 - 14 = 18\ kJ/kg$

c) $\Delta i_e = 18 \times \frac{0,85 \cdot 1,27}{0,9 \cdot 1,17} 18,5\ kJ/kg$

Enthalpy of T1 is 71 kJ/kg. If we deduct Δi_e = 18,5 kJ/kg we find that T4 is lying on the enthalpy line for 52,5 kJ/kg.
It intersects the T1-TM in
T4 = 19,7°C/90% RF.



Step 10: Marking on Mollier diagram

a) From T2 = 4°C/80% RH draw a vertical line upwards till it intersects the 22,2°C line. Relative humidity for T3 is approx. 25% RH.

b) From T1 = 30°C/60% RH draw a vertical line to T4 = 19,7°C/90% RH.

Step 11: Calculation of condensed water quantity

a) From Mollier diagram plot to the bottom from T1 to find x_1 = 16 g/kg and T4 to find x_4 = 13 g/kg.

b) Volume of water being condensed out per hour:
$Q1 \times \rho e \times (x_1-x_4) \times 3,6\ (l/h)$
where:
Q1 is total volume of exhaust air in m^3/s
ρe density (kg/m^3) of exhaust air
$3,6 = \frac{3600}{1000}$ to get l/h

Water quantity = 1,8 x 1,17 x (16-13) x 3,6 = 22,7 l/h

NOTE: It is not necessary to carry out step 9 - 11 if you only want to know the heat recovery.

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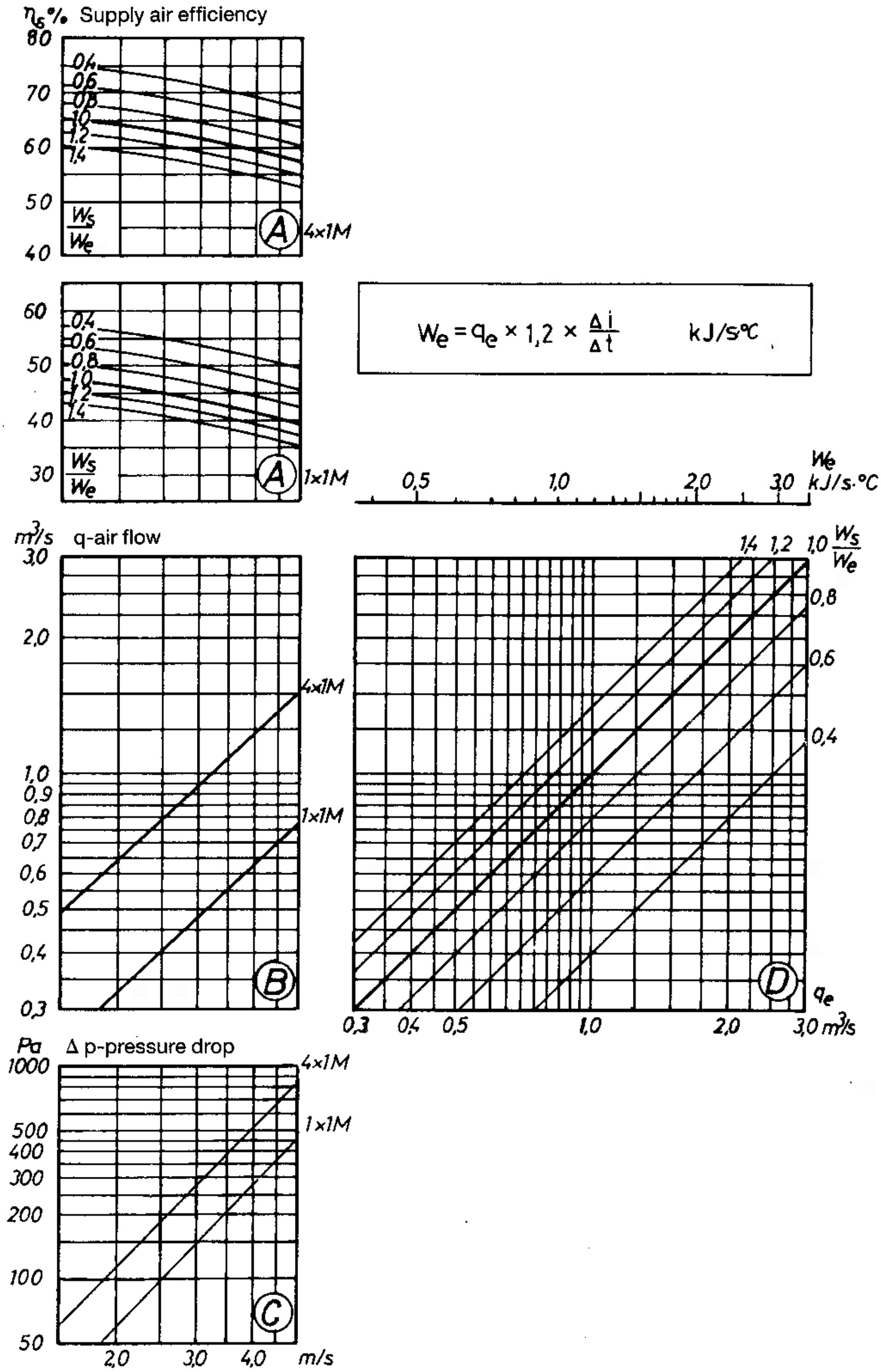
CALCULATIONS

Efficiency - pressure drop



$$W_e = q_e \times 1,2 \times \frac{\Delta i}{\Delta t} \qquad kJ/s°C$$

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CALCULATION FORM

Customer ______________________________

Exhaust		**Supply**	
Q1: ____________	m^3/s	Q2: ____________	m^3/s
(= ____________	m^3/s)	(= ____________	m^3/s)
T1: ____________	°C	T2: ____________	°C
RH1: ____________	% RH	RH2: ____________	% RH

1. Find $TM = \frac{T1 + T2}{2} = \frac{\quad}{2}$	TM =	°C
2. Find TD (From Mollier diagram)	TD =	°C
3A. TM < TD => wet operation		
3B. TM ⩾ TD => dry operation		
4. Find module combination		
5. Find m^3/s per 1 x 1 M or per 4 x 1 M	qs	m^3/s
6. Plot in qs in capacity chart horizontally through diagram »B« and »D«	qe	m^3/s
7A. **Dry operation:** Plot in qe vertically from bottom of diagram »D« point of intersection = $\frac{Ws}{We}$	$\frac{Ws}{We}$ =	
7B. **Wet operation:** Enter T1 - TM in Mollier diagram Find enthalpy drop per °C $(\frac{\Delta i}{\Delta t})$ Calculate $We = qe \times 1{,}2 \times \frac{\Delta i}{\Delta t} =$ Plot in We vertically downwards till it intersects the qs line point of intersection = $\frac{Ws}{We}$	$\frac{\Delta i}{\Delta t}$ = We = $\frac{Ws}{We}$ =	
8. From intersection point between qs and the diagonal line in diagram B, plot a line vertically up till intersection with $\frac{Ws}{We}$ in the respective diagram A. Find efficiency	ηs =	%
9. Draw both lines down from intersection with diagonal in D to diagonal in C. Find pressure drop for qs and qe	$\Delta \rho s$ = $\Delta \rho e$ =	Pa Pa
10. Find supply air temperature $T3 = T2 + \eta s \times (T1 - T2) =$	T3 =	°C
11. Find heat recovery: E = Q2 x 1,2 x 1,006 x (T3-T2) =	E =	kW
12. Find frost limit in diagram	T2, FR =	°C
13. Capacity frost protection: E, FC = Q2 x 1,2 x 1,006 x (T2,FR - T, MIN) (T,MIN is lowest permissible dimensioning out-door temperature)	E, FC	kW
14. Find capacity for after heating coil: E, HC = Q2 x 1,2 x 1,006 x (T1-T3)	E,HC =	kW
15. **Dry operation:** $T4 = T1 - \eta s (T1 - T2) \times qs/qe =$ **Wet operation:** $\Delta ie = \Delta is \times qs/qe$ (Δis from Mollier diagram) Find T4 from Mollier diagram	T4 = Δie = T4 =	°C kJ/kg °C
16. Condensate water = Q1 x 1,2 (X1 - X4) x 3,6	WATER =	l/h

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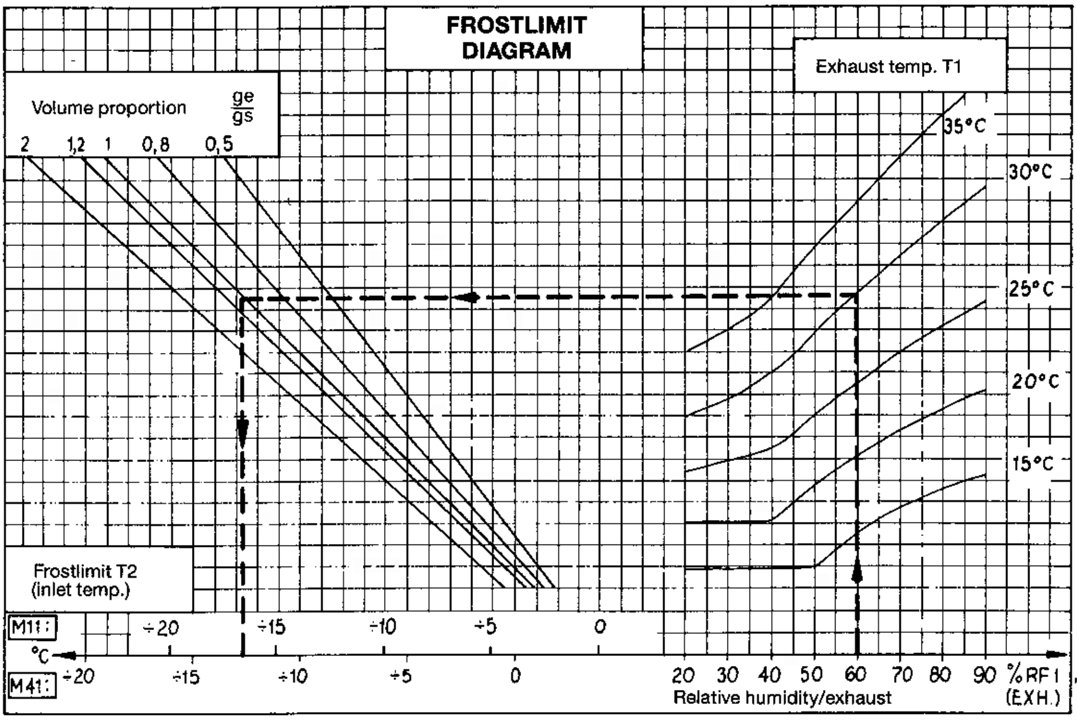
CALCULATIONS

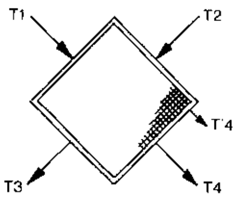
Frost limit chart



How to use the frost limit chart and basis for same

Basis is the relative humidity of the exhaust air on the scale at the bottom right hand side.
On the scale at the bottom right hand side, select the RH of the exhaust air.
Plot a line vertically to the exhaust air temperature T1 and from the point of intersection plot a line horizontally to the left to intersection with the volume proportion.
$\frac{ge}{qs}$ = proportion betwwen exhaust air and supply air volume.
Vertically under this point you will find the frost limit on the scale for either 1x1M or 4x1M (see the plotted example).

Conditions:
Frost limit is the lowest temperature T2 that fresh air can enter the recuperator before freezing of the condensate will take place in the exhaust air.



The lowest temperatures, and thus freezing, will start in the hatched corner. If the temperature of the plate surfaces is 0°C on the exhaust air side, freezing of the condensate will take place.

The calculated T4 temperature is an average temperature, which may differ up to ± 2°C at 1x1M and ± 4°C at 4x1M.
The conditions for frost limit can also be paraphrased as follows: With the actual temperature and humidity for T1 we shall find the T2 temperature which just fulfills the conditions

$$\frac{T2+T4}{2} = 0°C$$

The frost limit is important for calculating max. efficiency, as temperatures below the frost limit cannot be used for this calculation.

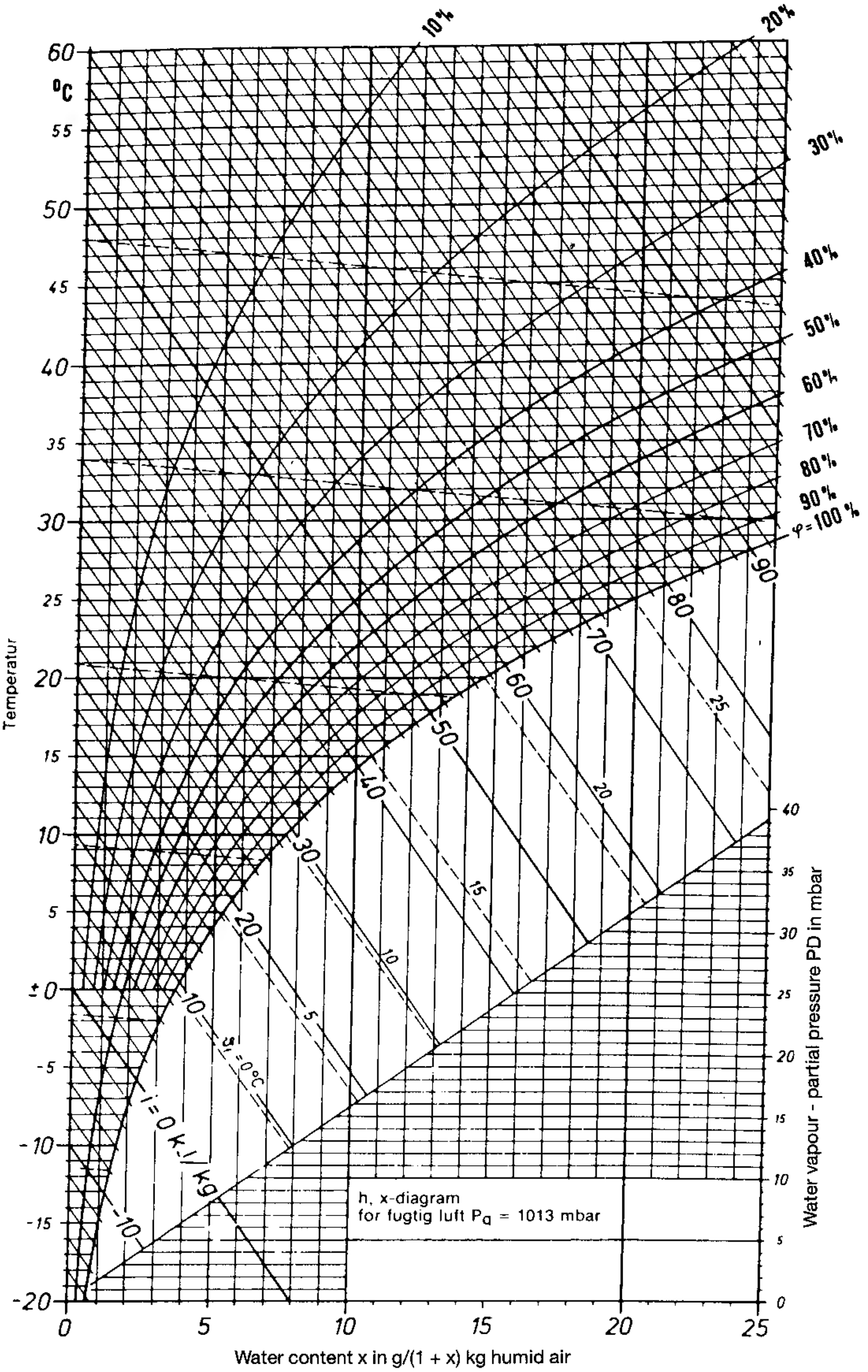
Furthermore it is important when calculating preheating coils, if any, where necessary capacity is:

E = Q2 x 0,335 x Δt(W)

where Q2 is fresh air volume (m^3/h) and
Δt temperature difference between lowest outdoor temperature and frost limit.

CALCULATIONS

h,x-diagram



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CALCULATIONS

Information chart for sizing of cross flow heat exhangers

Customer: ____ Name: ____ Adress: ____	PROJECT: ____ Name: ____
Date:	Filled in by: ____
Exhaust air volume .... temperature .... rel. humidity .... Contaminants, which .... (dirt, aggressive)	Q1 = ____ m^3/s (____ m^3/h) T1 = ____ °C RH1 = ____ % RH ____ ____
Fresh air volume................................ temperature (or average .... rel. humidity .... Lowest outdoor temp. .... Required inlet temp.	Q2 = ____ m^3/s (____ m^3/h) T2 = ____ °C RH2 = ____ % RH ____ °C ____ °C
Running hours (hours/day x days/week x weeks/year) .	____ x ____ x ____ = ____ hours/year
Estimated duct resistance fresh air .... (or sketch of duct system) exhaust air	____ Pa ____ Pa
Comparison with .... Energy price	☐ electr. ☐ oil ☐ gas ☐ district heating ____ /kWh ____ /l ____ $/m^3$ ____ /kJ
Electricity supply	____ Volt
Type of plant .... Optional extras - heat pump .... - after heat coil .... - electric frost coil .... - alu grille .... (XVV) - alu eliminator plates .... - filter 80/25 .... - damper .... (MVV) - silencer	☐ XVV ☐ MVV ☐ { temp. ____ °C ☐ medium ____ { pressure ____ Pa ☐ ☐ ☐ ☐ ☐ ☐

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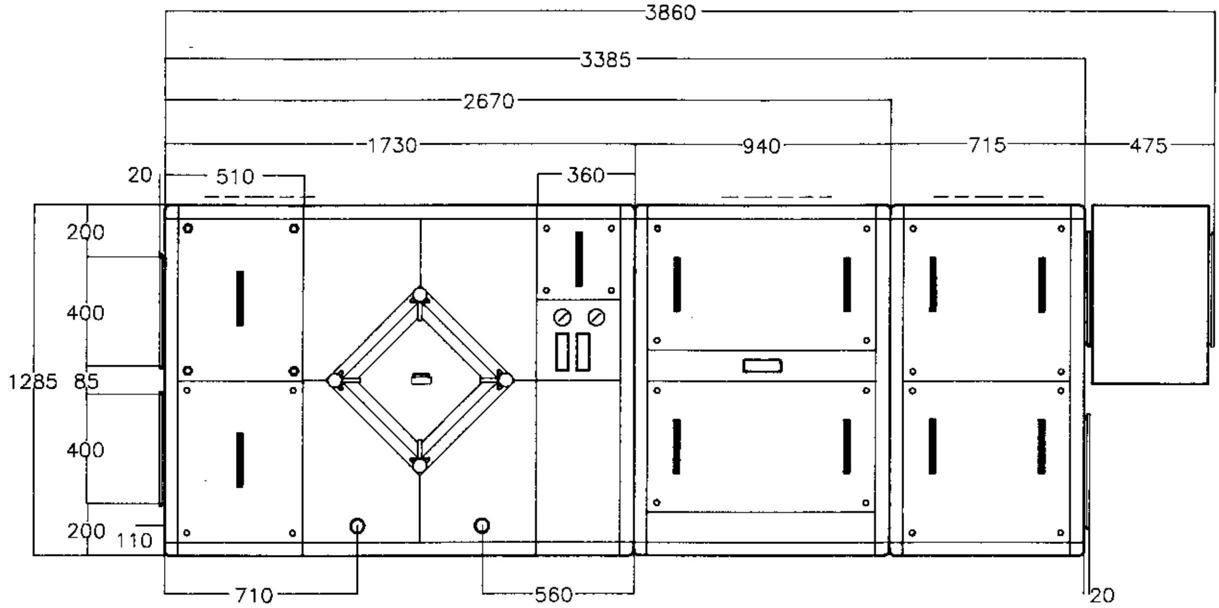
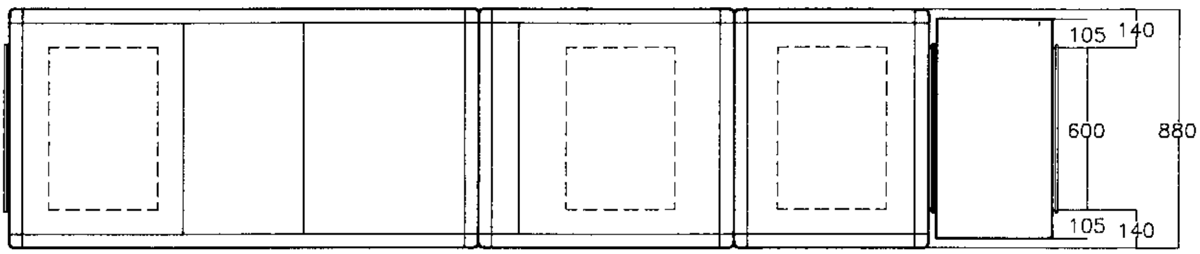
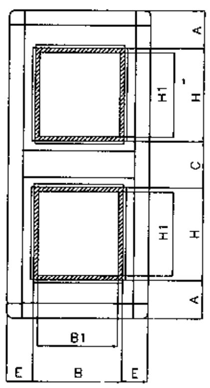
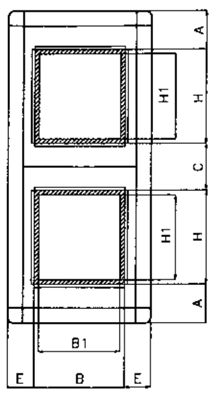
DIMENSIONS







DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
600	570	400	370	200	85	140

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
600	570	400	370	108	270	140

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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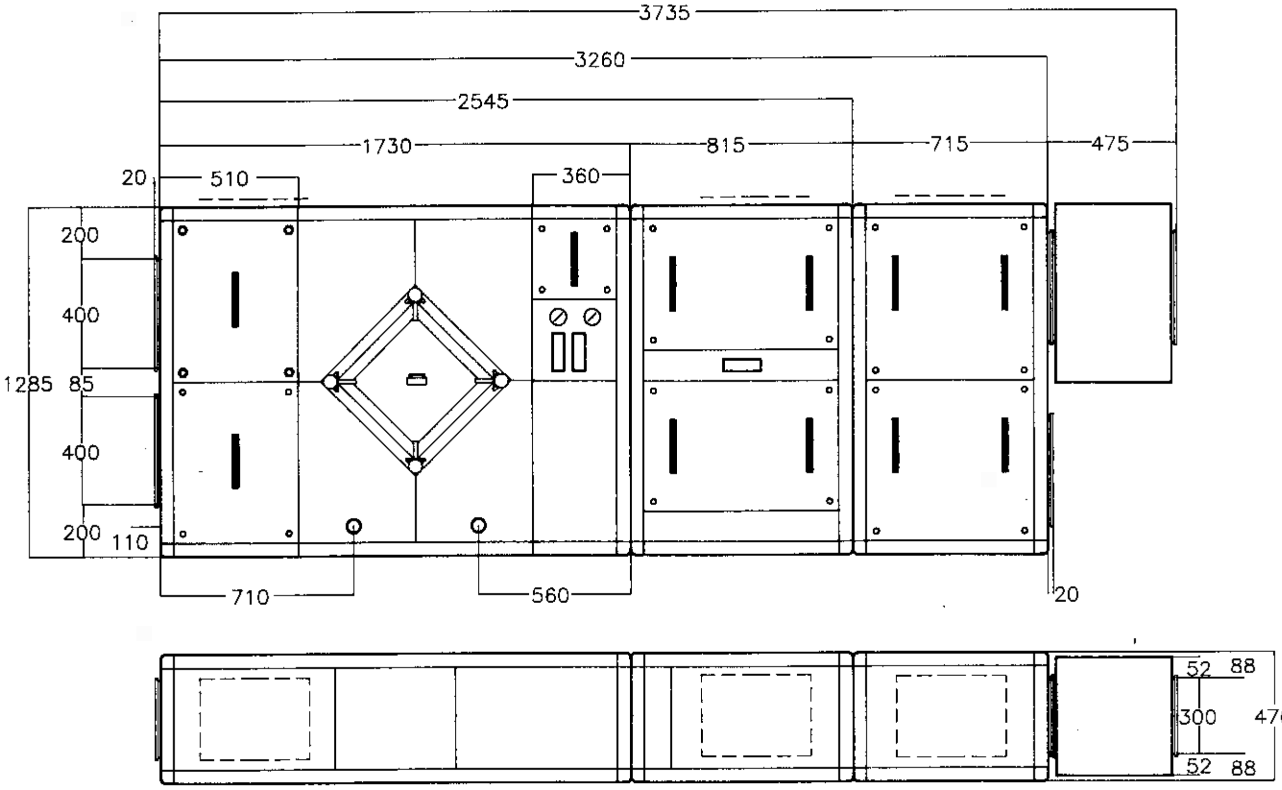
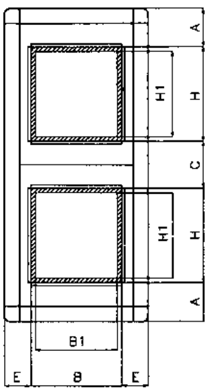
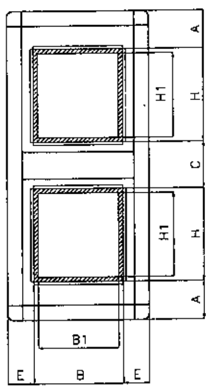
DIMENSIONS XVV 11





DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
300	270	400	370	200	85	88

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
300	270	400	370	108	270	88

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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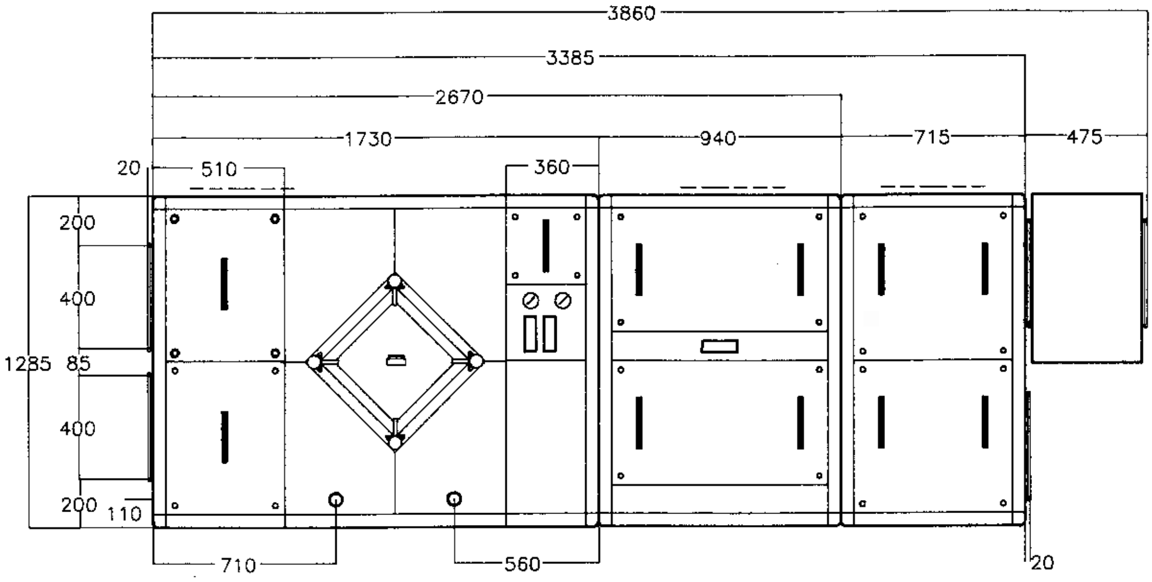
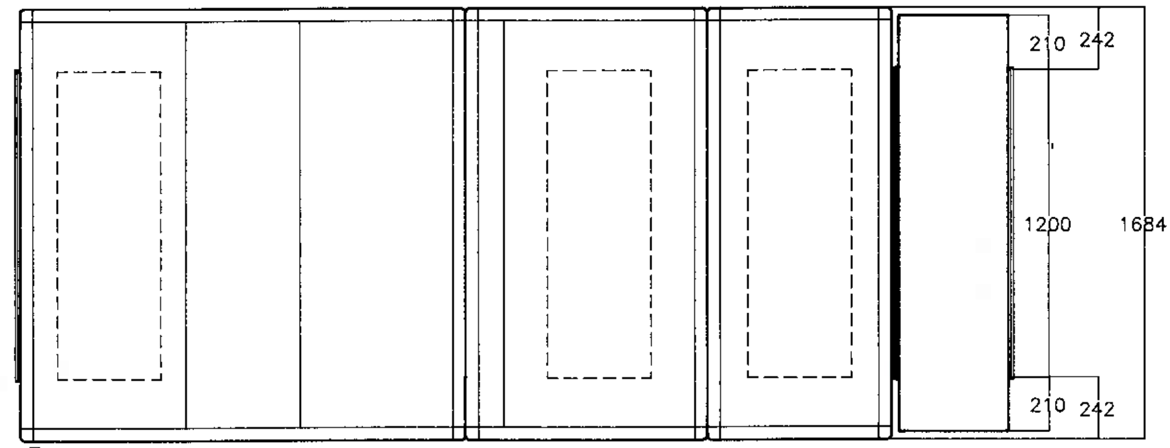
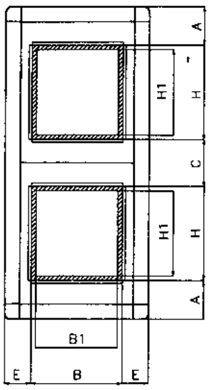
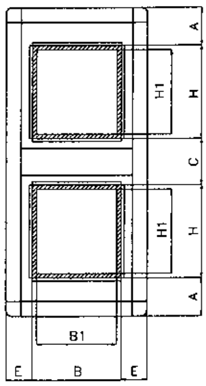






DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1200	1170	400	370	200	85	242

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1200	1170	400	370	108	270	242

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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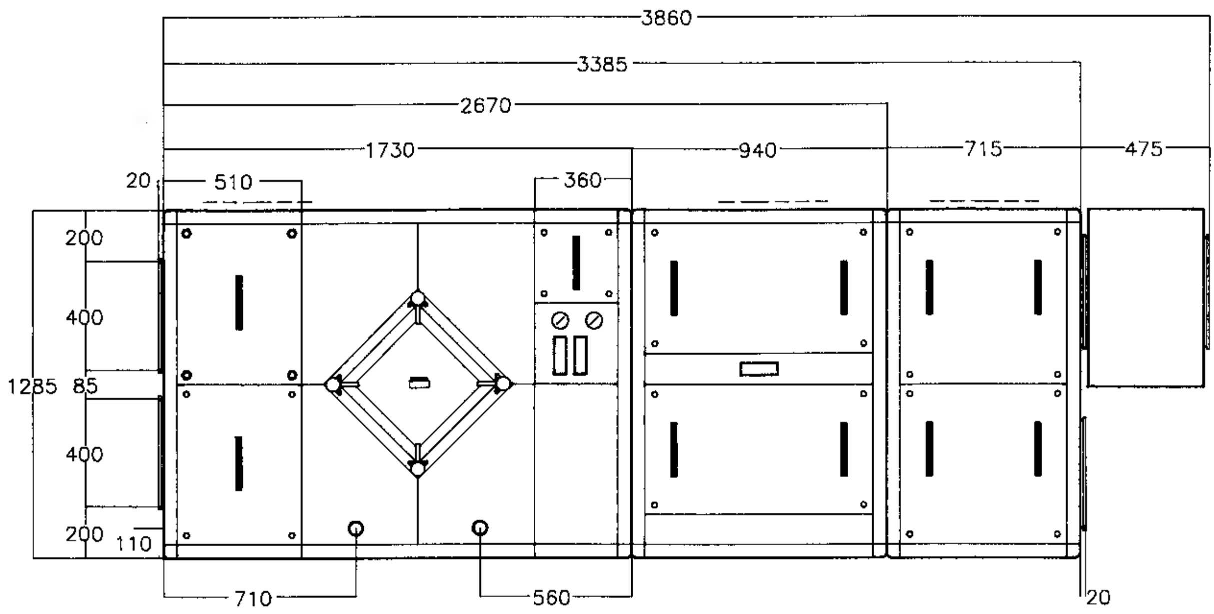
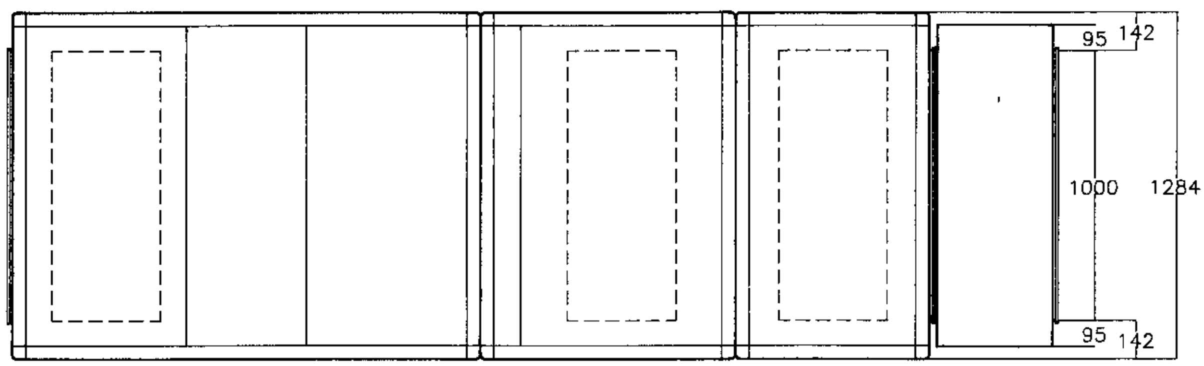
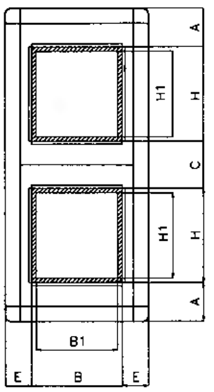
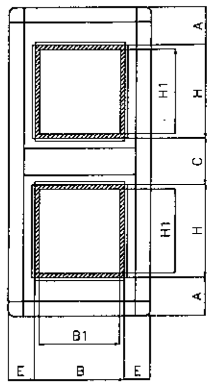
DIMENSIONS XVV 13







DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1000	970	400	370	200	85	142

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1000	970	400	370	108	270	142

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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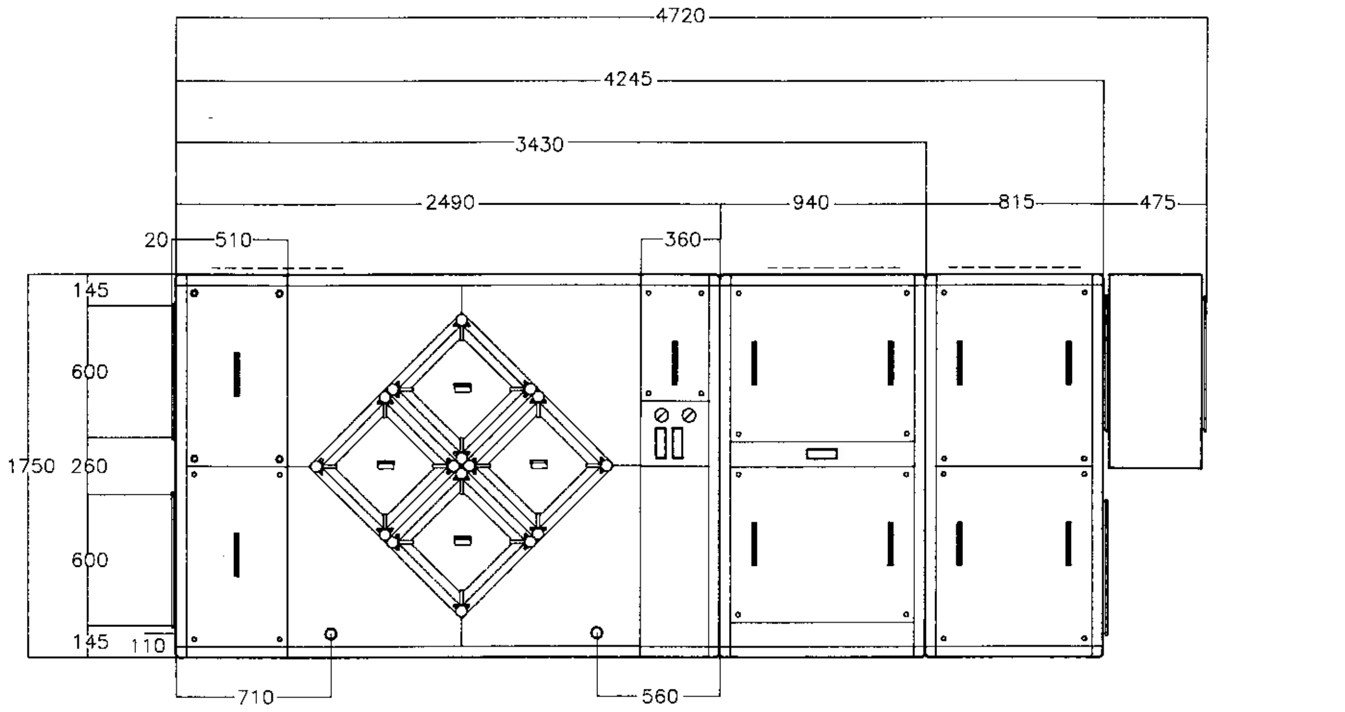
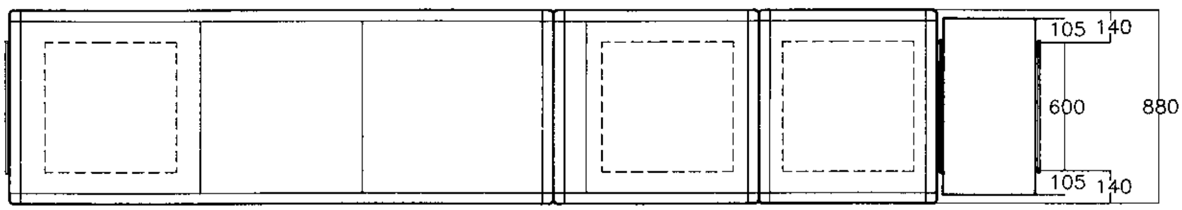
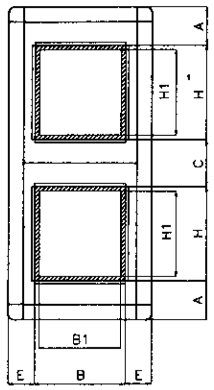
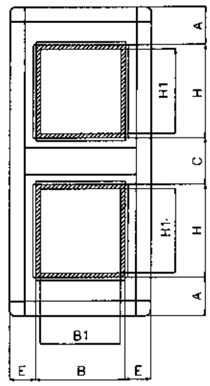






DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
600	570	600	570	145	260	140

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
600	570	600	570	108	334	140

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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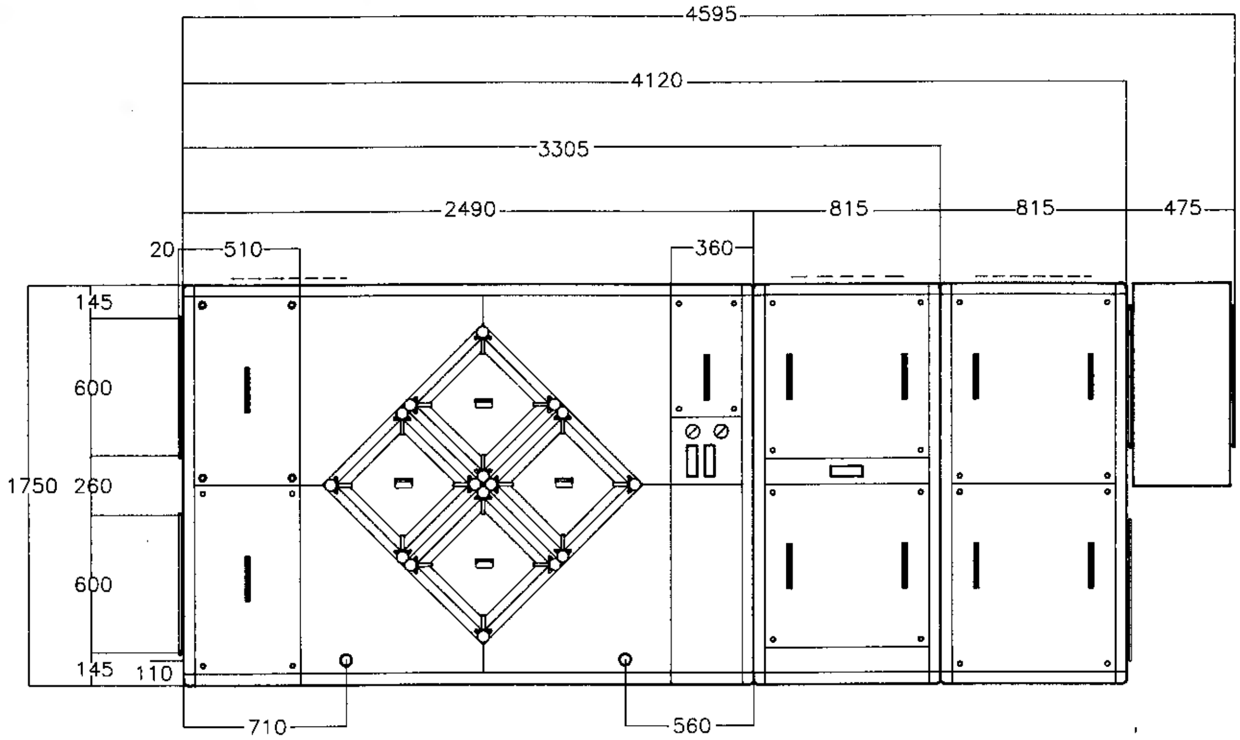
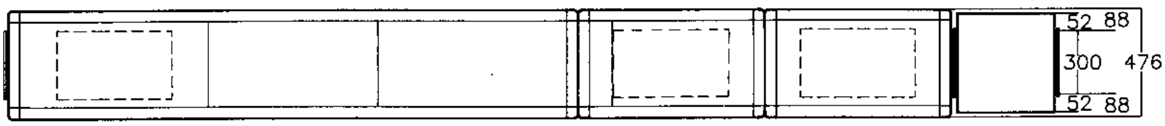
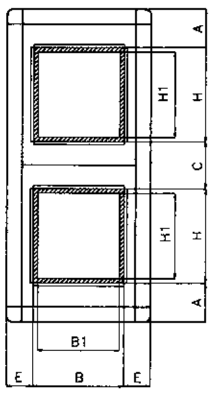


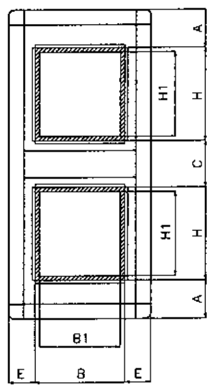




DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
300	270	600	570	145	260	88

B + H = Duct connection. B1 + H1 = Internal dimensions.



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
300	270	600	570	108	334	88

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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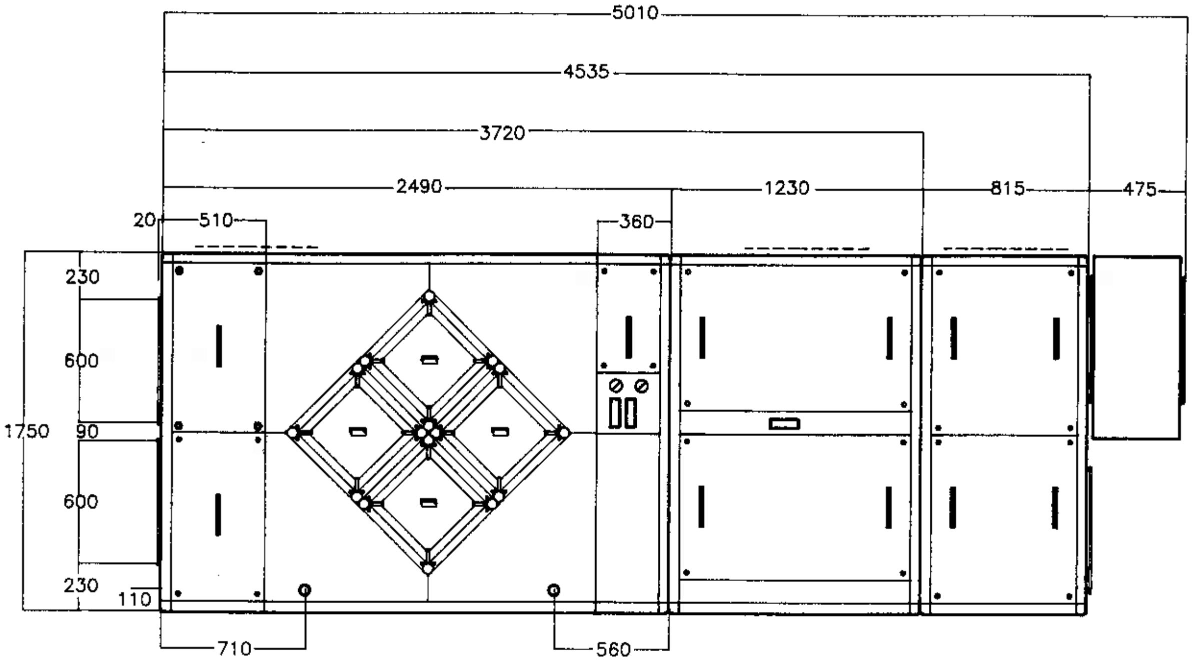
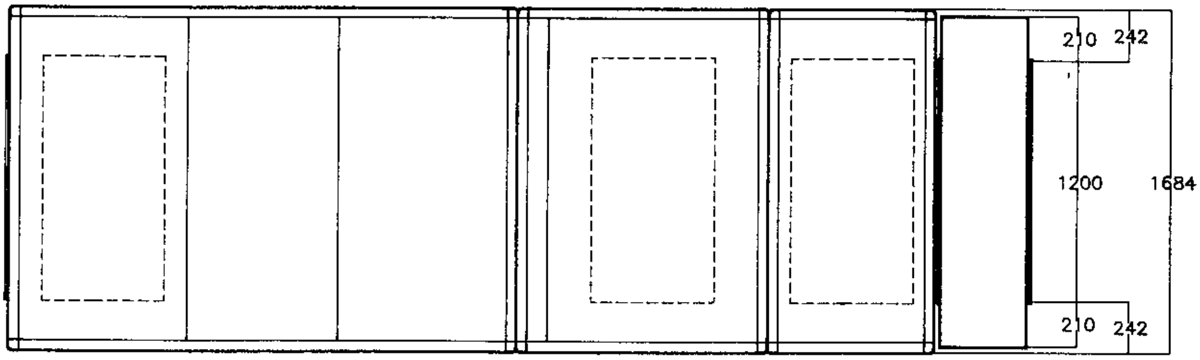
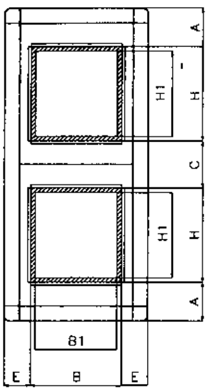
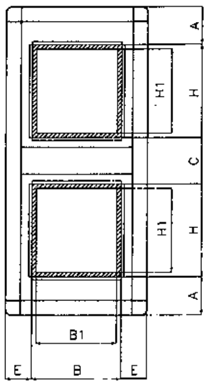






DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1200	1170	600	570	230	90	242

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1200	1170	600	570	108	334	242

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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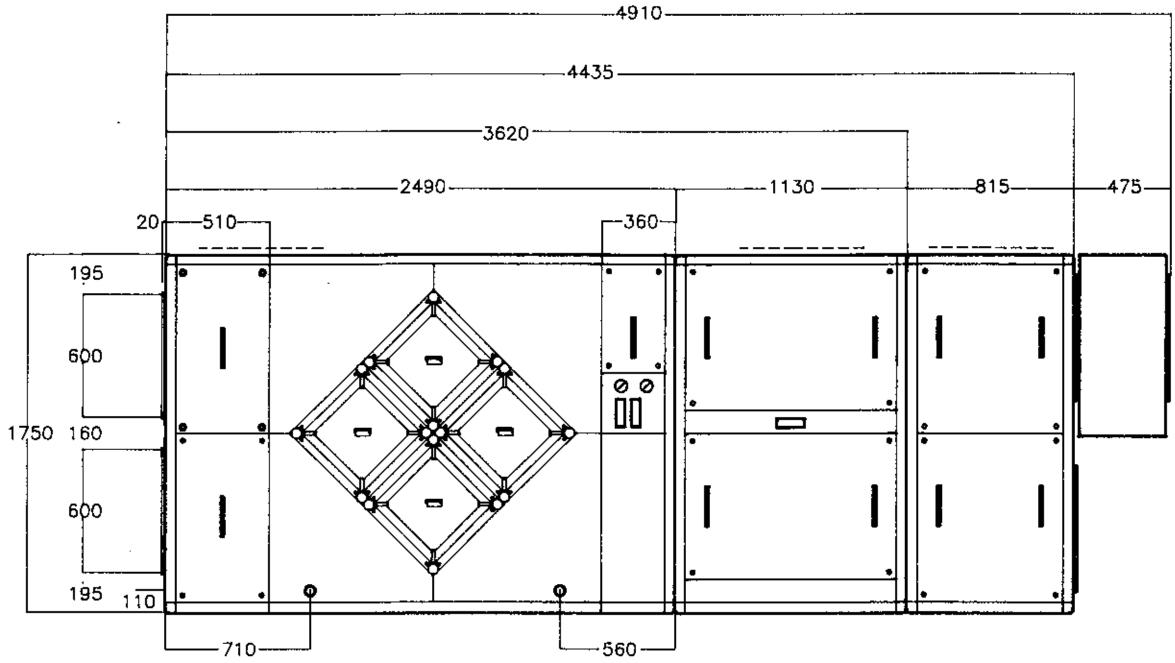
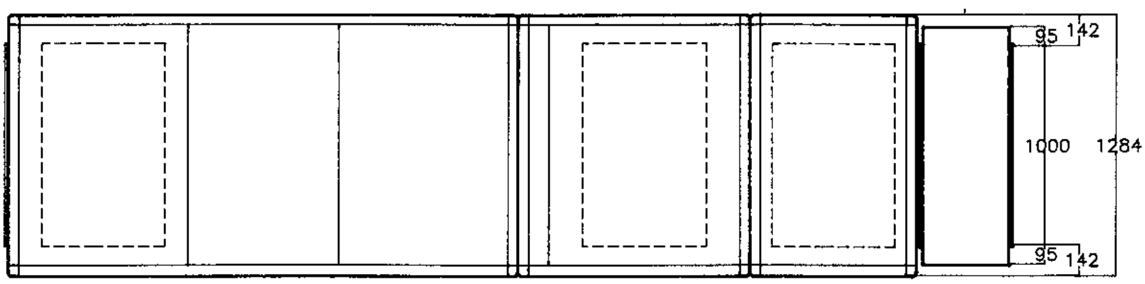
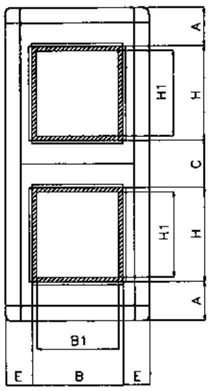
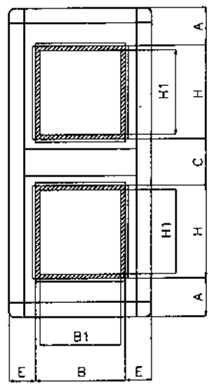
DIMENSIONS XVV 43







DUCT CONNECTION
RECUPERATOR SECTION XVV
FAN SECTION W



DUCT CONNECTION
MIXING SECTION BL

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1000	970	600	570	145	260	142

B + H = Duct connection. B1 + H1 = Internal dimensions.

B mm	B1 mm	H mm	H1 mm	A mm	C mm	E mm
1000	970	600	570	108	334	142

B + H = Duct connection. B1 + H1 = Internal dimensions.

The dashed lines indicate alternative duct connection location. All dimensions in mm.

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The first step is to calculate the evaporation rate and on the basis of this determine the necessary maximum air volume required. Based on these results the size of the unit is found.

Evaporation from the pool surface is the main factor when calculating the dehumidification requirement. The quantity of evaporation depends on such factors as pool area, water temperature, air temperature, humidity, air velocity, and the bathing activity.

The calculations can be carried out by using several formulae, most of which, however, give rather high values compared to what experience has proven to be sufficient.

We have chosen to use the Biasin + Krumme formula for the dimensioning of indoor swimming pools, as it gives a reasonable margin of safety. The formula below takes into consideration that the evaporation is influenced by the difference in pressure between saturated air at water temperature and the partial vapour pressure at the conditions of the air in the room. Furthermore it takes account of the type of pool and level of occupation.

The evaporation is calculated as follows:

$$W = (0.118 + 0.01995 \times a \times \frac{P_B - P_L}{1.333}) \times A$$

A = Pool surface (m²)

P_B = Saturated vapour pressure at water temperature (mBar)

P_L = Partial vapour pressure at air temperature/%RH (mBar)

a = empiric factor, usually

0.5 for public pools
0.4 for hotel pools
0.3 for private pools

NECESSARY AIR CHANGE

The amount of outdoor air necessary to remove the evaporation can be calculated as follows:

$$m_L = \frac{m_w}{(X_u - X_i)} \quad \text{(kg/s)}$$

m_L = mass flow, outdoor air (kg/s)

m_w = mass flow, condensate (kg/s)

X_u = absolute humidity, outdoor air (kg/kg)

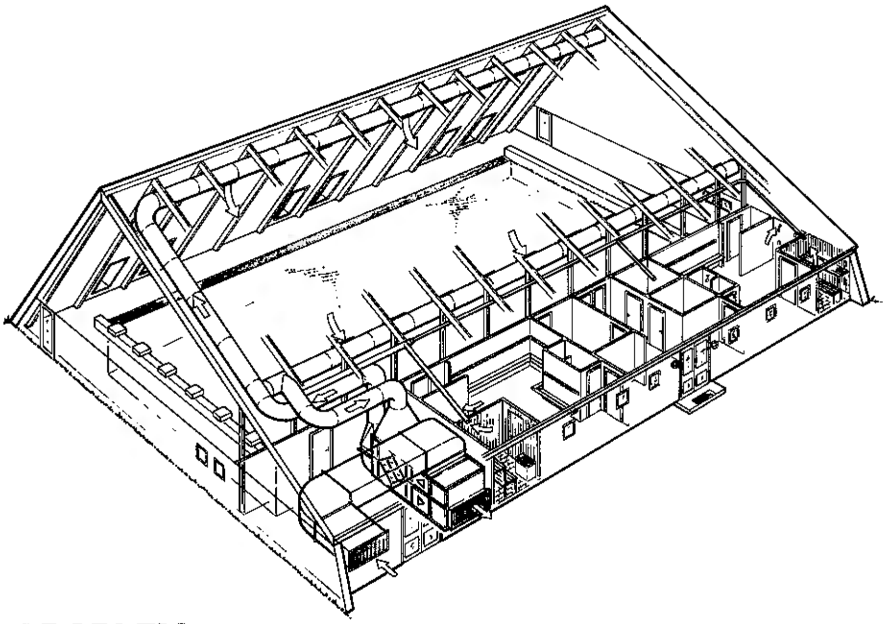
X_i = absolute humidity, indoor (kg/kg)

The absolute humidity (X_u) of the outdoor air varies according to the season of the year - from max. 11-12 g/kg in the summer to 2-3 g/kg in the winter.
In practice X_u can be set to 11.6 g/kg, which will only be exceeded about 2% of the year.
During summertime condense problems are rare and the water content X_i might be allowed to be a little higher.

Amount of evaporation from pool (g/m²)														
	Air temperature °C/Relative humidity % RH													
Water °C	24		25		26		27		28		29		30	
temp °C % RH	50	60	50	60	50	60	50	60	50	60	50	60	50	60
22	204	182	197	174	190	165	182	156						
23	217	194	209	187	203	178	194	169	187	158				
24	230	208	223	200	215	191	208	182	118	172	192	162		
25			235	213	229	204	21	195	213	185	205	175	196	164
26					244	219	236	210	228	200	220	190	211	179
27							250	223	243	215	235	205	226	194
28									259	230	250	221	241	209
29											268	238	259	227.
30													277	244

The above table shows values calculated for an accupancy factor of 0-5.

SWIMMING POOL VENTILATION



THE MOISTURE PROBLEM

In a swimming pool hall large quantities of water evaporate into the air of the room. If the humidity is not kept low artifically the relative humidity will adjust itself on a level unacceptably high, both for the structure of the building and for comfort.
The building fabric will eventually be damaged because the water vapour will condense on cold surfaces and cause corrosion or fungus attack. Badly insulated windows will become steamed up, if the room air is cooled below the dew point. The highest acceptable humidity is therefore dependent on the degree of insulation and the lowest outdoor temperature.

Room air with, for example conditions 28°C/65% RH, has a dew point of 21°C, and if the outdoor temperature is -10°C the construction must have a U-value not less than approximately 1 W/m^{2}K. The air movement and especially the distribution of the inlet air in the swimming pool hall is of great importance because the warmer and drier inlet air does not condense as easily as stagnant air, which has time to cool off. The inlet air should therefore be blown upwards along the walls and window panels at high velocity. At the opposite side of the room the damp air can be drawn out.
On the other hand the air movement above the pool surface should be as low as possible, as the air movement influences the evaporation.
Furthermore the pressure in the room should be kept a little lower than outside in order not to press the water vapour out into the fabric of the building.
For reasons of comfort the pool air relative humidity should be kept below 65% RH, dependent on the temperature, but corresponding to an absolute water content of not more than approx. 14,3 g/kg.
When chosing reasonable operating conditions moisture problems as well as operational expenditure can be controlled. The more the room temperature is higher than the water temperature, the less evaporation. In practice, however, a difference of more than 2-3°C cannot be maintained. A relative humidity lower than necessary is not desirable either, as this will make the evaporation increase.
In public pools the room air is often set at 28°C/60% RH and the water temperature at 26-27°C. In hydrotherapy pools the water temperature is normally 4-8°C higher.

VENTILATION WITH HEAT RECOVERY

The object of the ventilation plant is to maintain the set temperature and humidity and to secure good air quality. As the air in the swimming pool hall normally has a higher absolute water content than the outdoor air the desired relative humidity in the swimming pool hall can be maintained by exchanging a certain amount of the air with fresh air.
The process consumes much energy and therefore it is important to recuperate as much heat as possible and to avoid changing more air than is necessary. A Dantherm diagonal flow heat recuperator with heat pump and mixing unit complete with control is a good solution for this purpose.

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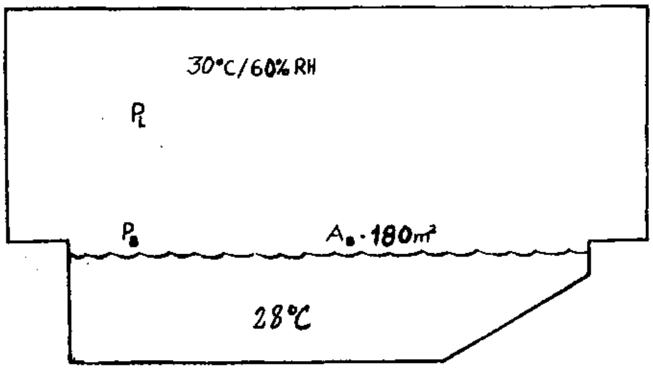
SELECTION EXAMPLE

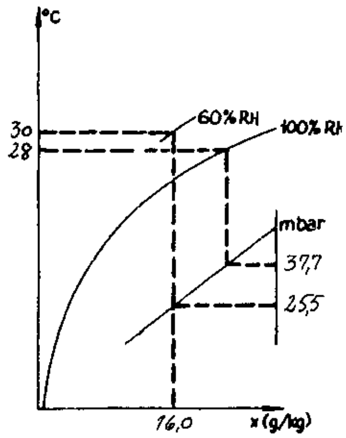
A normal public swimming pool room with a 25 m pool for competition and a small pool for children is chosen as an example.

The calculations are made according to the formula on page X 12.02. For this we need the vapour pressure of the air and at the pool surface, which can be found in an h,x-diagram.

Example:



h,x-diagram:



In the h,x-diagram is found:
at 28°C/100% RH: P_B = 37,7 mbar
at 30°C/65% RH: P_L = 25,5 mbar

CALCULATION

Large pool: 25,0 x 12,0 m .... = 300 m²
Small pool: 6,0 x 12,0 m .... = 72,0 m²

Water temp. 28°C (100% RH): ... P_B = 37,7 mbar
Room cond. 30°C (60% RH): ...... P_L = 25,5 mbar
Water contents .... X_i = 16,2 g/kg

Evaporation:

Large pool:

$$W = \left(0.118 + 0.01995 \times 0.5 \times \frac{37.7 - 25.5}{1.333}\right) \times 300.0 = 63.0 \text{ kg/h}$$

Small pool:

$$W = \left(0.118 + 0.01995 \times 0.3 \times \frac{37.7 - 25.5}{1.333}\right) \times 72.0 = 12.5 \text{ kg/h}$$

Total evaporation = ... 75500 g/h

Ambient design humidity .... = 11,60 g/kg
Density of ambient air............... = 1,175 kg/m³

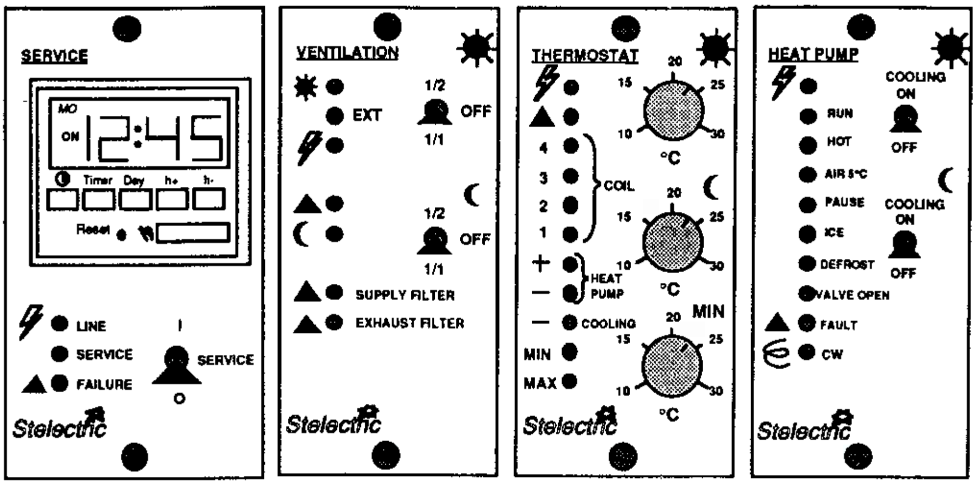
Required air volume:

$$\frac{75500}{(16.2-11.6) \times 1.175 \times 3600} = 3.88 \text{ m}^3/\text{s}$$

Unit type	Dantherm type XVV 44
Exhaust air volume:	3.88 m³/s
Suply air volume:	3.70 m³/s

Engergy saving

The calculation of anticipated running cost is fairly complex and requires much detailed work. Dantherm has computer programs available to facilitate this and will be pleased to provide these calculations in each case.



DESCRIPTION OF THE CONTROLS

For control of the desired funtions of the ventilation plant for swimming polls the above modules are used.

The modules are set into the door of the control panel and give ready indication of the current mode of operation. Control functions can be programmed on the modules.

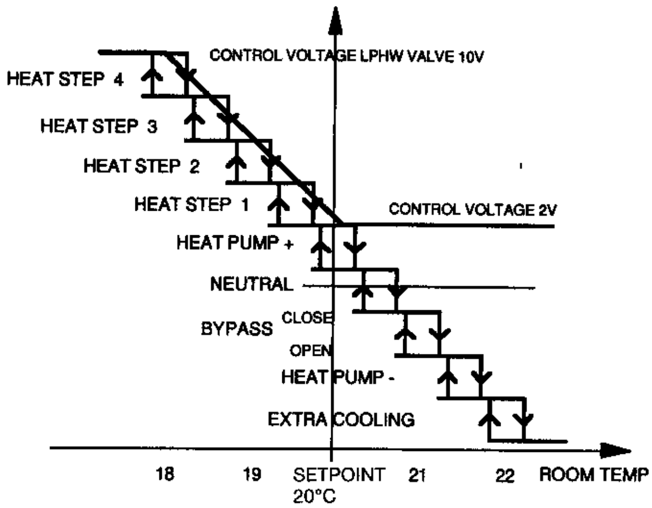
The individual modules are described in section 6 but a little more information is stated below.

1. THE SERVICE MODULE switches between day and night operation with the chosen settings by means of the time switch. It also comprises a service breaker and some light indications.

2. THE FAN MODULE. On the fan control module it is possible to set the fan speed for night/day operation and it also contains lights indicating operation and faults as well as dirty filter condition.

3. THE THERMOSTAT MODULE keeps the room temperature at a constant level by switching in the individual functions of the plant in the right sequence as a function of a deviation from the set temperature. The basic module consists of a 8-step thermostat with adjustable proportional band.

The print is connected to a min./max. sensor in the air inlet and a temperature sensor in the return air side. On the thermostat control module day, night and min. temperatures can be pre-set and there are lamps to indicate the sequence of control.



THERMOSTAT MODULE CONTROL SEQUENCE (Xp=4°C SHOWN)

4. THE HEAT PUMP MODULE comprises operation and safety control for the compressor. The thermostat control module signals to the heat pump whether to heat or cool the inlet air.
The cooling function can be switched off at night time to avoid unnecessary evening use.

5. OTHER CONTROLS, such as fire thermostats (40°C/70°C), frost thermostat and filter pressure switches, are connected to terminals in the control panel.
A detailed description of function and wiring diagrams etc. is supplied with the control panel.

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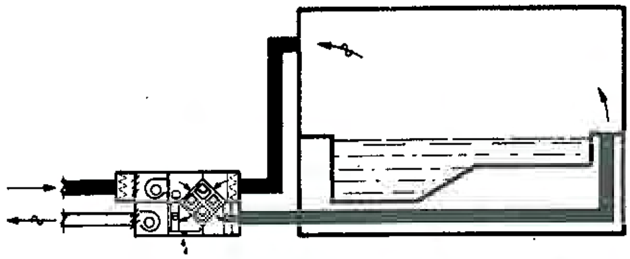
SWIMMING POLL VENTILATION

Fundamental solution



DESCRIPTION OF THE PLANT

The plant is delivered in the following units:

1. Diagonal flow recuperator unit type XVV
2. Fan unit type W

The units are easily assembled on site by means of assembly fittings and sealing profiles.

The units are built of insulated profiles and double skin cover plates, which protect against condensation and at the same time gives some sound absorbing effect.

A separate control panel is supplied, complete with connection cables with plugs between control panel and the unit.
A support frame for the unit and a separate fresh air filter unit can be supplied.

The specification for the individual units can be varied according to the requirement.

The plant as shown is as follows:

1 off DIAGONAL FLOW RECUPERATOR UNIT type XVV-44 with 16 off detachable module recuperator units with an overall temperature efficiency of 70%. The plant is equipped with bag filter type 80/25 in the exhaust air stream and at the bottom a stainless steel condensate tray with drain and aluminium eliminator plates.

The diagonal flow recuperator unit is also supplied with a built-in heat pump type WP-44 consisting of hermetically sealed cooling circuit with compressor and evaporator/condenser etc.

A heating coil for either water, electricity or steam is normally included. In order to get the full benefit from the heat pump during the cooling operation the diagonal flow recuperator section can also be supplied with a built-in by-pass to ensure that the inlet air is not heated in the recuperator first.

For transport of the air the FAN UNIT type W-44 with two centrifugal fans for air exhaust resp. air inlet is available. Both fans have two-speed motors with belt drive.

The RPM of the fans and the size of the motor is calculated with regard to the pressure drop of the plant. For the lower pressure drops fans with forward curved blades are used - but when larger pressures fans with backward curved blades are necessary. These also give higher efficiency.

All internal electrical connections are led to plugs on the access side.

The separate control panel is designed for installation on a wall and 10 m cables with plugs are normally included.

The control panel is fitted complete with overloads, fuses, transformer, switch, lamp and complete electronic control of the system.

The controls comprise motorised valve for heating coil, fire thermostat, frost thermostat, sensors for room temperature and relative humidity and, if desired, filter guards.

FUNCTION

During periods with low air humidity in the swimming pool hall the plant will run at low speed, sufficient for maintaining temperature and air movement.

When the air humidity increases the fans will run at full speed.

The controls are described on the next page (X12.06).

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