INTRODUCTION

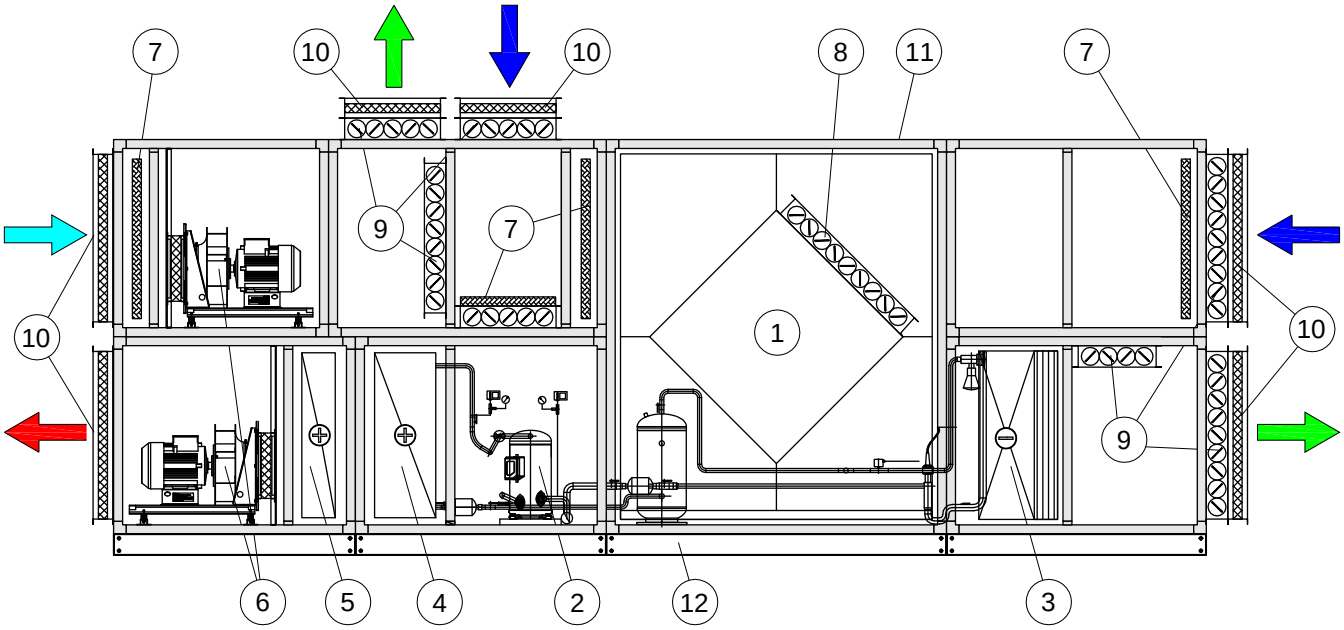
Pool units are the group of units intended for servicing swimming pools halls. They were designed in the result of many years experience of Juwent Company. Especially configured heating pump systems and the cross-flow plate exchangers permit to adequate air processing through all the year. Used automatics system ensures optimization of energetic mediums consumption. There are 7 sizes available with drying capacity from 20 to 160kg/h and air flow from 4000 to 32000m^3/h

CONFIGURATION

Standard CSB units are equipped with following elements:

1. Cross-flow plate exchanger
2. Heating pump - R407c medium
3. Evaporator - R407c medium
4. Condenser - R407c medium
5. Water heater
6. Fan with direct drive
7. F5 class filter
8. By-pass throttling valve
9. PWA throttling valve
10. Elastic spout
11. Casing
12. Base

- Fresh air
- Air supply to the compartments
- Air exhaust from the compartments
- Removed air



CONSTRUCTION

CSB units construction is based on the adequately modified CSK units. In any case these modification include following constructional elements:

- internal panel sheets are made of galvanized, epoxy coated sheets;
- external side and upper panel sheets are made of varnished, galvanized sheet and the floor panel is made of galvanized sheet;
- all the gaps in casing elements are filled with certified silicone with antibacterial addition;
- door panel gaskets are made of material resistant to activity of the disinfecting and washing agents;
- rails and guide bars working with sliding elements and the drip trays placed under coolers heat recovery exchangers are made of stainless sheet
- filters frames, heat exchangers casings, fans partitions are made of galvanized, epoxy coated zinc sheets;
- elements carrying the liquids away with a fall toward the drain
- drains of condensate protected against backflow with the help of siphons;
- fans and heat exchangers are epoxy coated;
- throttles panels are epoxy coated.

WORKING MODES

Juwent pool units were designed with taking into account working of the device through all the year. For the calculation purposes were accepted 5 schemes of air processing were distinguished:

- Drying the air in the pool hall during the night.
- Drying the air in the pool hall during night time in the winter.
- Drying the air in the pool hall during the work in the winter time.
- Drying the air in the pool hall during the work in the summer time.
- Drying the air in the pool hall in the transitional periods.

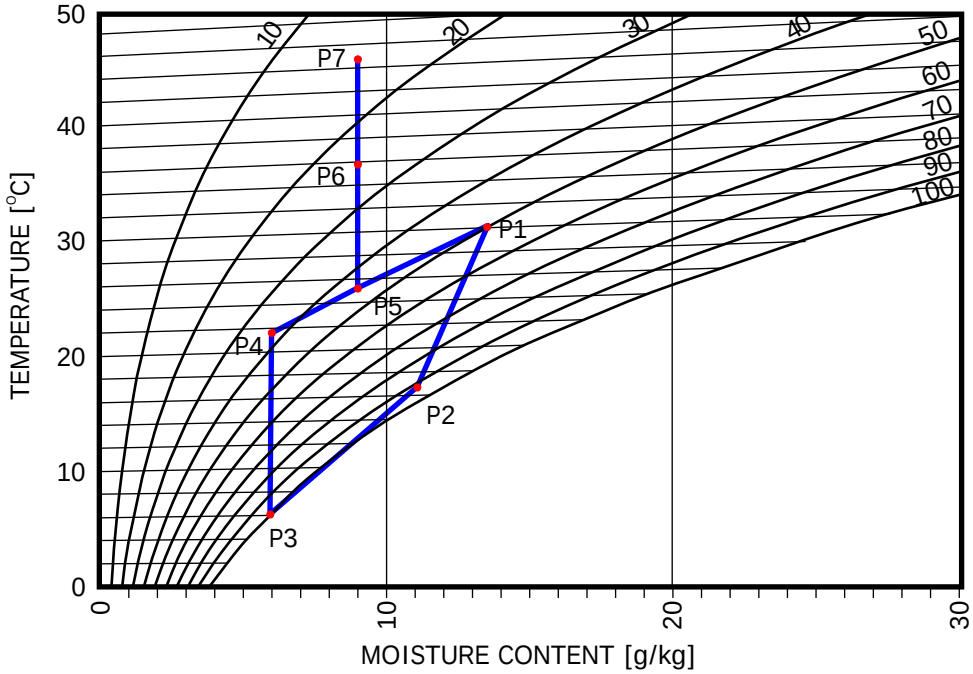
To show the changes in the air in mentioned above working modes the following data on the diagrams was assumed:

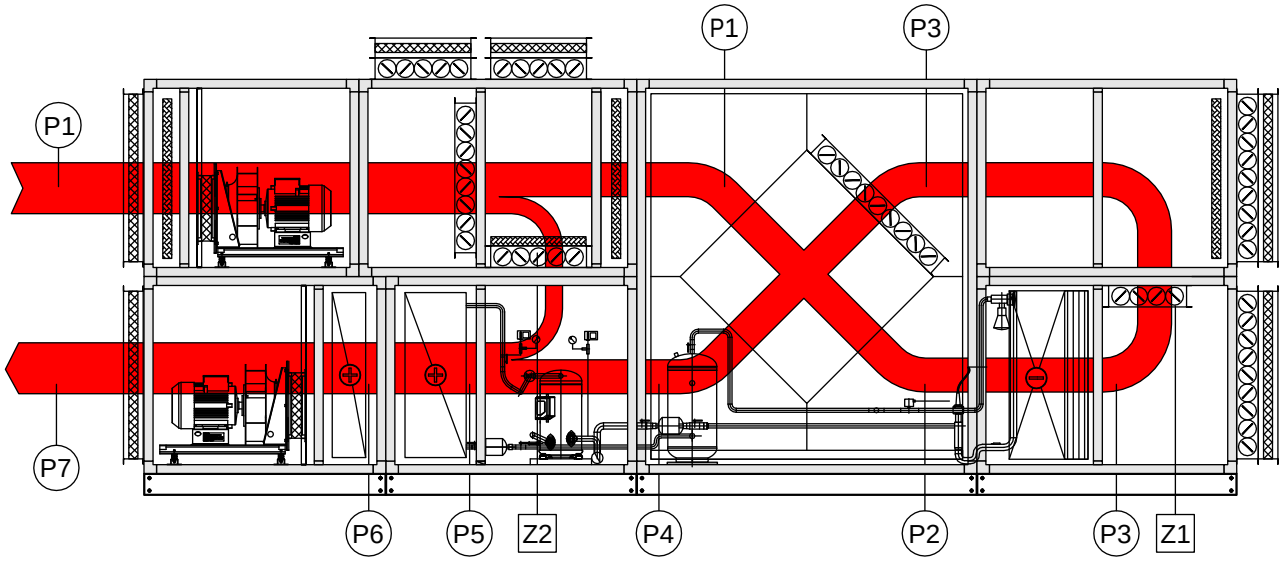
- outside air parameters in the summertime: 32°C; 40%; 12,1 g/kg
- outside air parameters in the nighttime: -20°C; 95%; 0,7 g/kg
- outside air parameters in the transitional periods: 15°C; 60%; 6,4 g/kg
- air parameters in the pool hall: 30°C; 50%; 13,5 g/kg
- supply air parameters 45°C; 14%; 9 g/kg

CAUTION.

Presented values are used as an example. Depending on the pool destination the values of air parameters in the pool hall can be different and they are presented in the further part of his catalogue, in the chapter "Guidelines for designers"

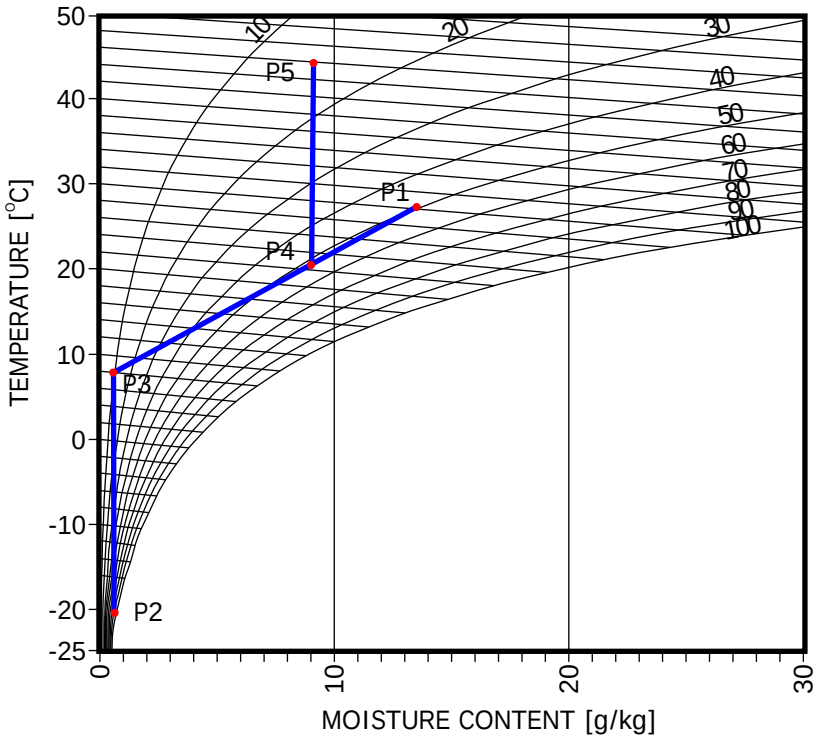
DRYING THE AIR DURING THE NIGHT

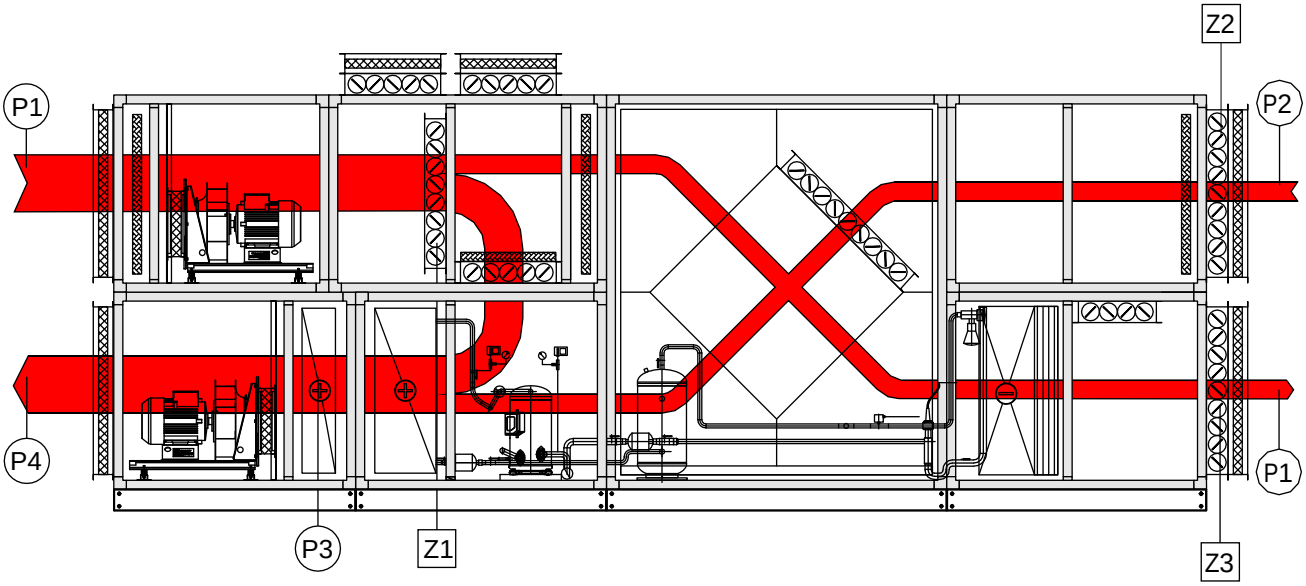




The cooling device is activated if permissible value of the air moisture in the pool hall is exceeded. Part of the air (P1) flows through the cross-flow exchanger in which is realized the preliminary cooling process is realized (P2), and then through evaporator of cooling device (P3) where the air is still cooled and dried. Dried air (P3) flows again through the cross-flow exchanger where is preliminary heated (P4). Leaving the cross-flow exchanger air (P4) is mixed with the circulating air from pool hall (P1) reaching the point (P5), and then is heated by the condenser of cooling device (P6) and the water heater (P7). Mixing throttling valves Z1 and Z2 keep the optimal air flow through the evaporator in order to ensure adequate drying conditions.

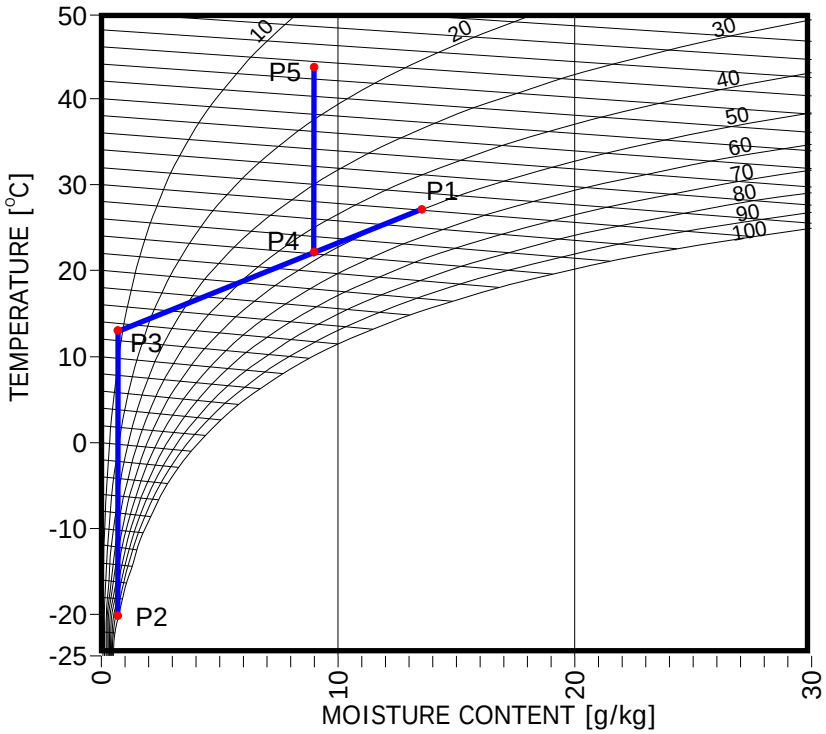
DRYING THE AIR DURING THE NIGHT IN THE WINTER

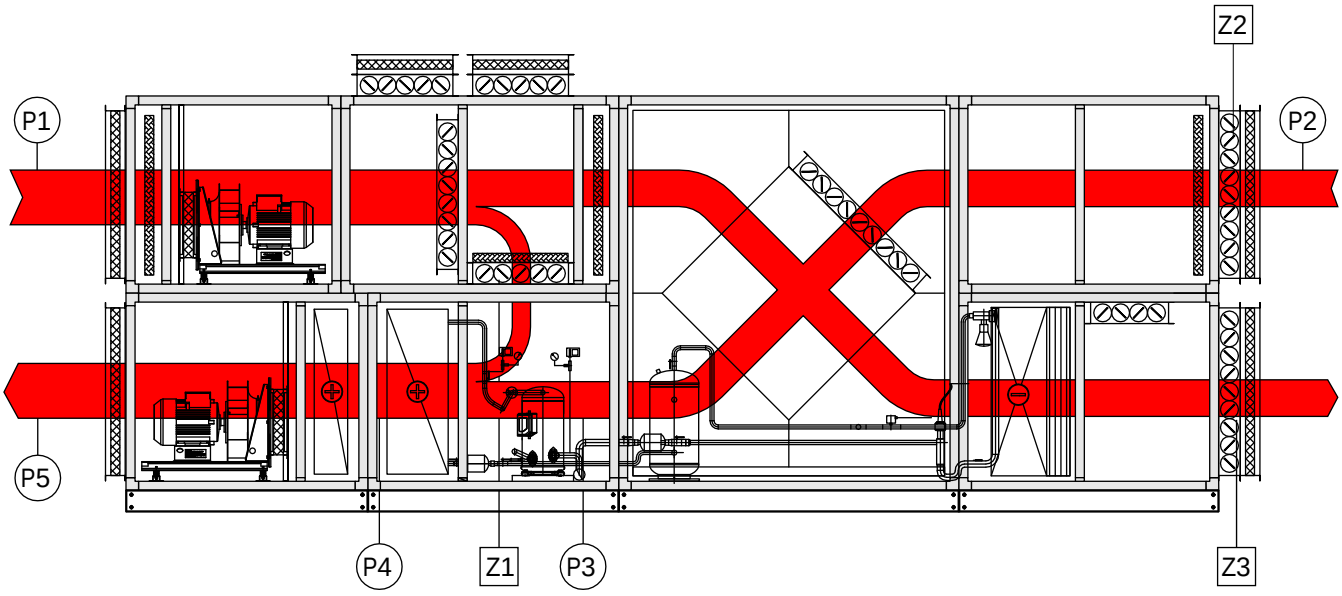




If internal air (P1) permissible humidity in the pool hall will be exceeded necessary part of internal air (P2) will be delivered to the mixing chamber. As a result of mixing the external air (P2) with low moisture content x<9g/kg with the air exhausted from the pool hall (P1), the dried air (P3) and heated air by the water heater (P4) is delivered to the pool hall Mixing throttling valves Z1 and Z2 and Z3 throttling valves keep the optimal air flow in order to ensure the adequate drying conditions.

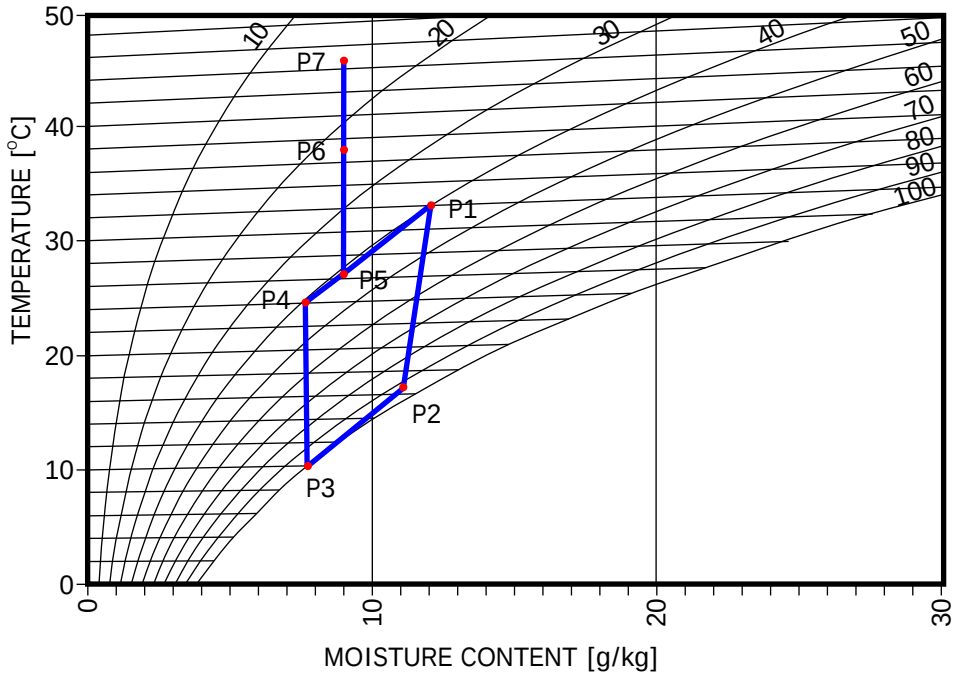
DRYING THE AIR DURING THE WINTER

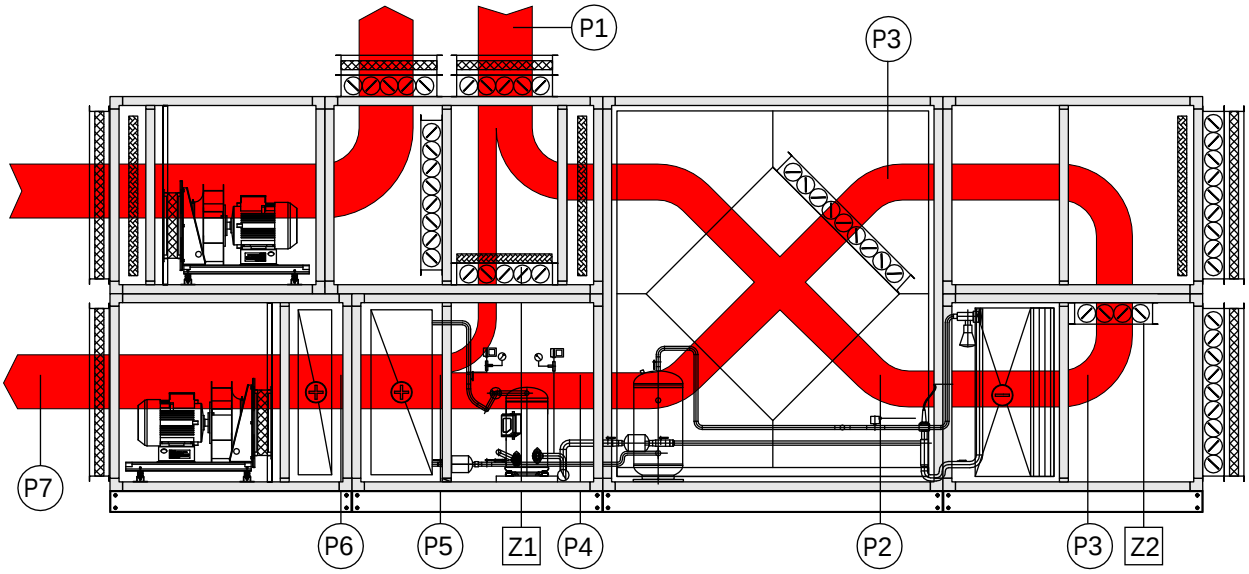




During the pool operation in the wintertime the air exhausted from the pool hall is divided in the stream o removed air and stream of circulating air. Air removed from pool hall (P1) flows through the cross-flow exchanger and flows outside after recovering the heat from it. External air (P2) after preliminary heating in the cross-flow exchanger (P3) is mixed with circulating air in the proportion which permits to achieve the air moisture content x=9g/kg (P4) and then is heated by the water heater up to the supply air temperature (P5). Mixing throttling valve Z1 and the external air throttling valves Z2 and Z3 keep the optimal air flows in order to ensure adequate drying conditions

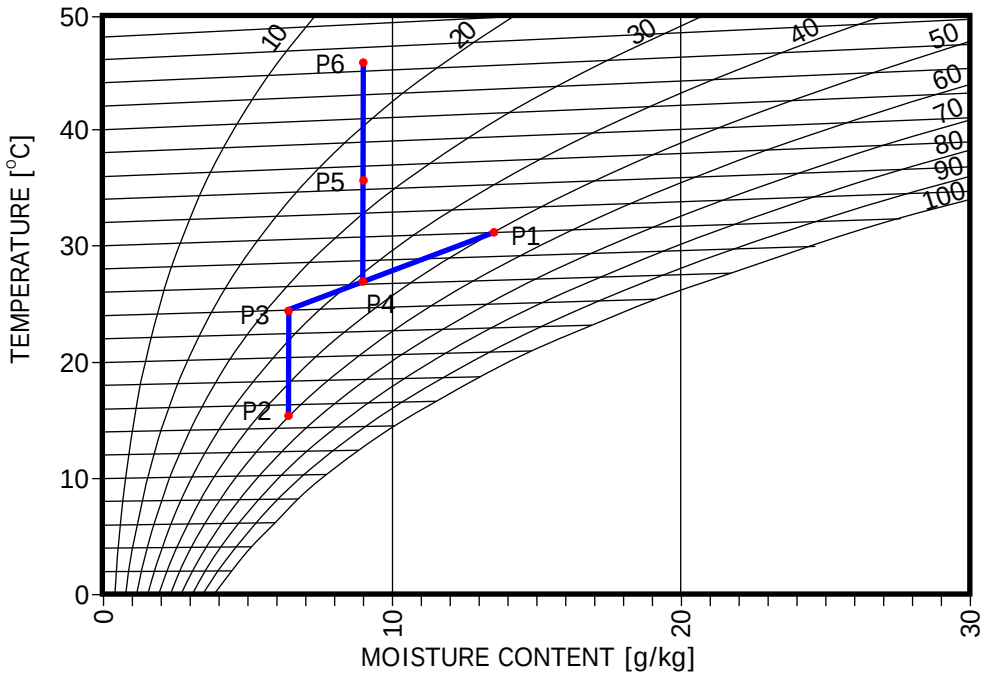
DRYING THE AIR DURING THE WORK IN THE SUMMER TIME

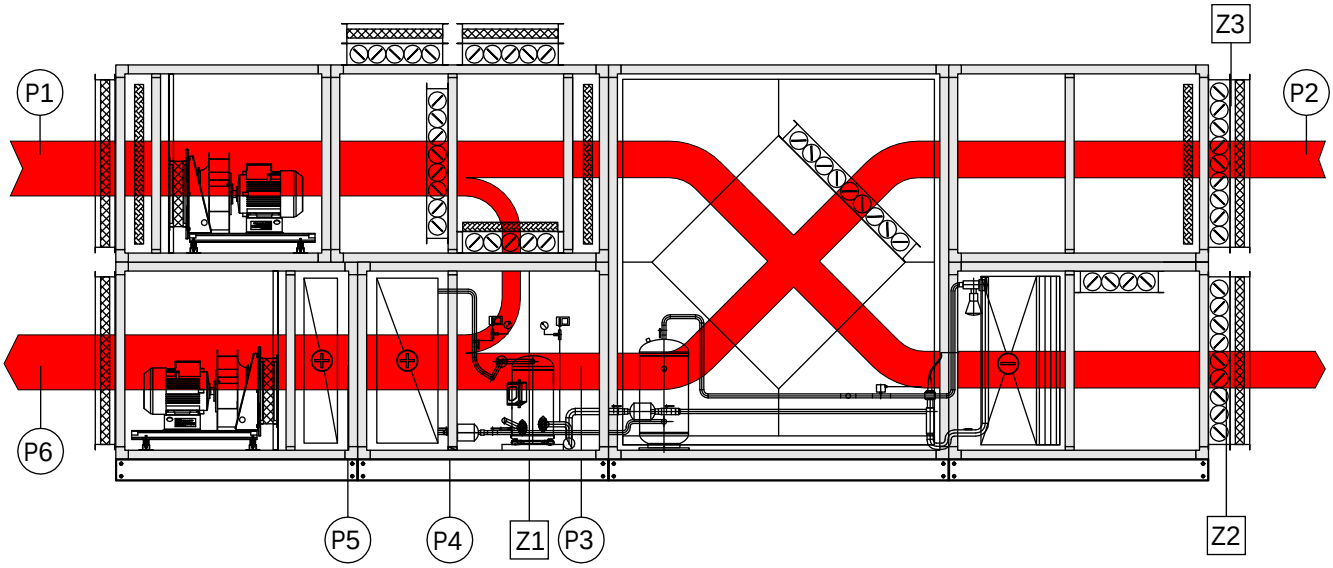




During the pool operation in the summertime the air exhausted from the pool hall is completely removed outside. External air (P1) partially flows through the cross-flow exchanger where preliminary air cooling (P2) is executed, and then through the evaporator of cooling device where is still cooled and dried (P3). Dried air flows again through the cross-flow exchanger where is preliminary heated (P4). Leaving the cross-flow exchanger air is mixed with the other part of external air (P5), and then is heated by condenser of the cooling device (P6) and water heater (P7). Mixing throttling valves Z1 and Z2 keep the adequate proportion of air flow through the evaporator in order to ensure the proper drying conditions

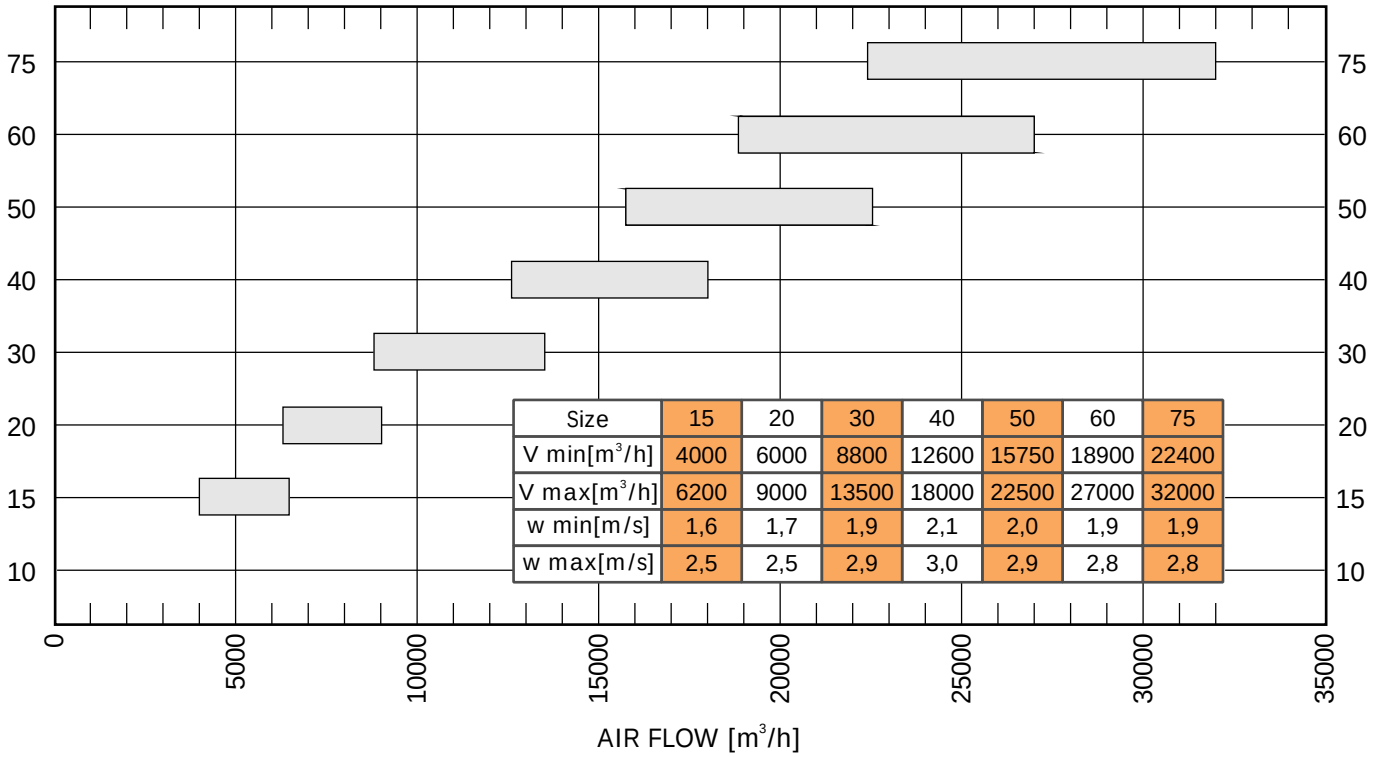
DRYING THE AIR IN THE TRANSITIONAL PERIODS





During the pool operation in the sunny spring and autumn days, when the external air humidity doesn't exceed 60%, the air exhausted from the pool hall is divided into removed air stream and circulating air stream. Air removed from the pool hall (P1) flows through cross-flow exchanger and after recovering the heat is directed to the evaporator of cooling device where is additionally cooled and is used as the low-temperature heat source which is used for preliminary heating of the air supplied to the pool hall. External air (P2) after preliminary heating in cross-flow exchanger (P3) is mixed with the circulating air (P1), in the proportion which permits to achieve the humidity content in the air equal x=9g/kg (P4), and is then heated by the condenser (P5) of cooling device and by the water heater. To the temperature of the supplied air (P6). Mixing throttling valve and Z1 and external air throttling valve Z3 as well as removed air throttling valve Z2 keep the optimal air flows in order to ensure proper drying conditions.

AIR CAPACITY RANGE



Size	15	20	30	40	50	60	75
V min[m³/h]	4000	6000	8800	12600	15750	18900	22400
V max[m³/h]	6200	9000	13500	18000	22500	27000	32000
w min[m/s]	1,6	1,7	1,9	2,1	2,0	1,9	1,9
w max[m/s]	2,5	2,5	2,9	3,0	2,9	2,8	2,8

TECHNICAL DATA

SIZE		CSB-15	CSB-20	CSB-30	CSB-40	CSB-50	CSB-60	CSB-75
Air capacity min.	[m³/h]	4000	6300	8800	12600	15750	18900	22400
Air capacity max.	[m³/h]	6500	9000	13500	18000	22500	27000	32000
Air drying capacity min[2)]	[kg/h]	20	30	44	63	78	95	112
Air drying capacity max[2)]	[kg/h]	31	45	67	90	112	135	160
Heat pump function		+	+	+	+	+	+	+
Cooling power [1)]	[kW]	30	38	58	75	96	117	140
Heating power [1)]	[kW]	39	49	75	98	125	151	180
Compressors power consumption [1)]	[kW]	9	11,5	17,5	22	29	35	40
Compressors operating current	[A]	2x15,9	2x16,8	2x34	2x41	3x34	3x41	3x52
Compressors start-up current	[A]	2x95	2x111	2x174	2x225	3x174	3x225	3x272
Intake fan motor nominal power	[kW]	4,0	7,5	11,0	15,0	18,5	22,0	22,0
Intake fan air pressure	[Pa]	380	500	360	500	500	500	500
Exhaust fan motor nominal power	[kW]	4,0	5,5	7,5	11,0	15,0	18,5	22,0
Exhaust fan air pressurea	[Pa]	380	500	360	500	500	500	500

1. Maximal unit drying capacity in the summertime
2. According to VDI 2089 (supply air humidity =9g/kg, air humidity in the pool hall =14,3g/kg)
3. Power supply voltage for compressors and fan motors 3x400V/50 Hz

TECHNICAL DATA

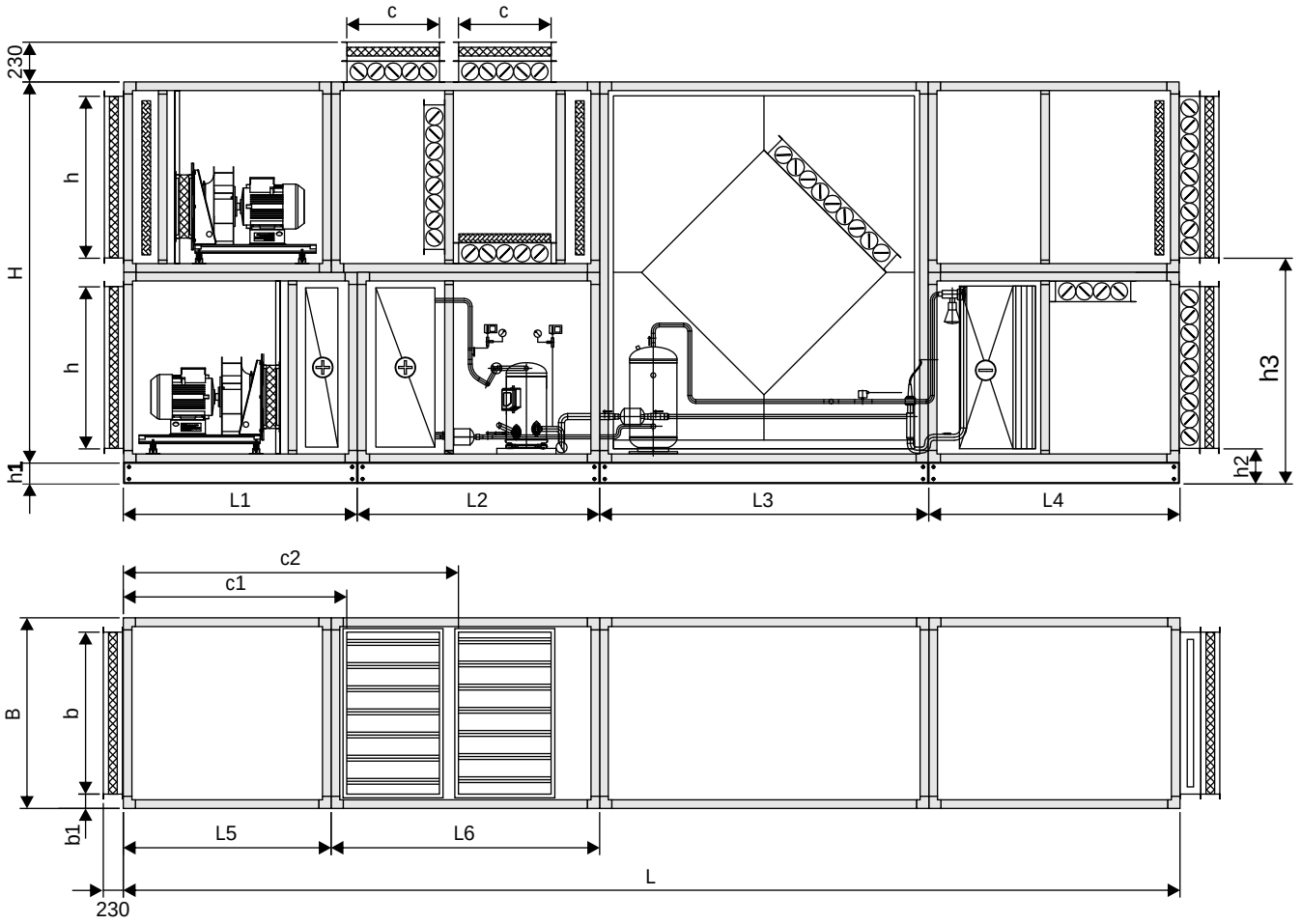
Designations for the heating calculations table:

- T1 – air temperature in the front of exchanger
- Tn air temperature behind the exchanger
- Q – exchanger power for set parameters
- Mw – mass flow of heating medium
- Pw – hydraulic resistances in the exchanger on heating medium side
- V – exchanger volume

Unit size	Heating medium parameters	V	T1	Tn	Q	Mw	Pw
		[dm^3]	[°C]	[°C]	[kW]	[kg/s]	[kPa]
CSB-15	90/70	4,8	10	63	109	1,3	38,8
	80/60			54,8	92,5	1,1	28,9
	70/50			46,6	75,5	0,9	20,2
CSB-20	90/70	7,5	10	64,2	162	1,94	35,0
	80/60			55,9	138	1,65	26,1
	70/50			47,5	112	1,34	18,1
CSB-30	90/70	10,0	10	60,6	227	2,72	12,8
	80/60			52,4	190	2,28	9,3
	70/50			44,1	153	1,84	6,3
CSB-40	90/70	13,7	10	61	305,8	3,65	12,4
	80/60			52,7	256	3,1	9,1
	70/50			44,4	206	2,46	6,2
CSB-50	90/70	18,5	10	63,5	401	4,79	24,5
	80/60			55,2	339	4,05	18,3
	70/50			46,8	276	3,3	12,7
CSB-60	90/70	23,4	10	64,4	489	5,8	22,8
	80/60			56	413	4,9	17,0
	70/50			47,4	336	4,0	11,9
CSB-75	90/70	28,6	10	65,6	593	7,0	37,0
	80/60			57,2	503	6,0	27,8
	70/50			48,6	412	4,9	19,7

NOTE:Calculations were made for external air parameters -20,0°C and 100% of humidity with assumption of 100% air flow through the cross flow exchanger and without recirculating air participation

DIMENSIONS AND WEIGHTS OF THE UNITS



DIMENSIONS OF SECTIONS								
SIZE		CSB-15	CSB-20	CSB-30	CSB-40	CSB-50	CSB-60	CSB-75
H	[mm]	1600	2200	2200	2800	2800	3500	3500
h1		120	120	120	120	120	120	160
h2		202,5	202,5	202,5	202,5	202,5	202,5	242,5
h3		1002,5	1302,5	1302,5	1602,5	1602,5	1952,5	1952,5
B		1100	1100	1400	1400	1750	1750	2050
h		635	935	935	1235	1235	1585	1585
b		935	935	1235	1235	1585	1585	1885
c		335	435	435	535	535	735	735
c1		1182,5	1282,5	1482,5	1632,5	1832,5	2432,5	2632,5
c2		1632,5	1832,5	2032,5	2282,5	2482,5	3282,5	3482,5
L		5250	6050	6250	6900	7100	9100	9300
L1		1250	1350	1550	1700	1900	2650	2850
L2		1250	1350	1350	1450	1450	1650	1650
L3		1400	1900	1900	2200	2200	2600	2600
L4		1350	1450	1450	1550	1550	2200	2200
L5		1100	1200	1400	1550	1750	2350	2550
L5		1150	1350	1350	1550	1550	1950	1950
Weight	[kg]	1460	1950	2350	3200	3800	5100	6500

COMPUTATIONAL FACTORS

Vaporization factor E	
Pool type	[d/m^{2}h x m x bar]
Rest	5
Private	15
Swimming	20
Recreational	28
Artificial wave	35

Humidity gains from water attractions	
Kind of attraction	[g/h]
Wild river for 1m.	300
Air bottom geyser	5000
Water bottom geyser	3000
Mushroom	3000
Water curtain	5000
Deckchair for massage	5000
Scottish whip	3000
Shower	400
Slide for 1mb	500
Water pistol	3000

Air stream necessary for windows drying	
Window height [m]	Air stream for 1m of window length [m^3/h/m]
1	120
2	200
3	250
4	300
5	330
6	370
7	400

Number of air changes	
Pool hall	Number of air changes
Large	4
Standard	5
Small	6

EXAMPLE OF SELECTION

Public swimming pool parameters			
Element desription	Designation	Value	Unit
Water pool temperature	Tw	28	[°C]
Pressure of water vapour saturation at the temperature of pool water	pd,W	37,82	[mbar]
Air temperature in pool hall	Tp	30	[°C]
Air relative humidity in pool hall	Rh	50	[%]
Water steam partial pressure of the air in the pool hall	pd, L	21,23	[mbar]
Absolute air humidity in pool hall	xd,L	13,5	[g/kg]
Absolute supply air humidity in pool hall	xd,A	9,0	[g/kg]
Supply air density	ρ	1,2	[kg/m^3]
Water mirror surface	Fw	312,5	[m^2]
Pool hall cubature	Vb	2868	[m^3]
Air changes quantity	Iw	4	[1/h]
Supply air unit stream for the height of the windows equal 5m	Vok	330	[m^3/h/m]
Windows length	Lov	15	[m.]
Steaming from water attractions (shower)	Wa	400	[g/h]
Empirical evaporating coefficient	E	20	[g/m^{2}hxmbar]

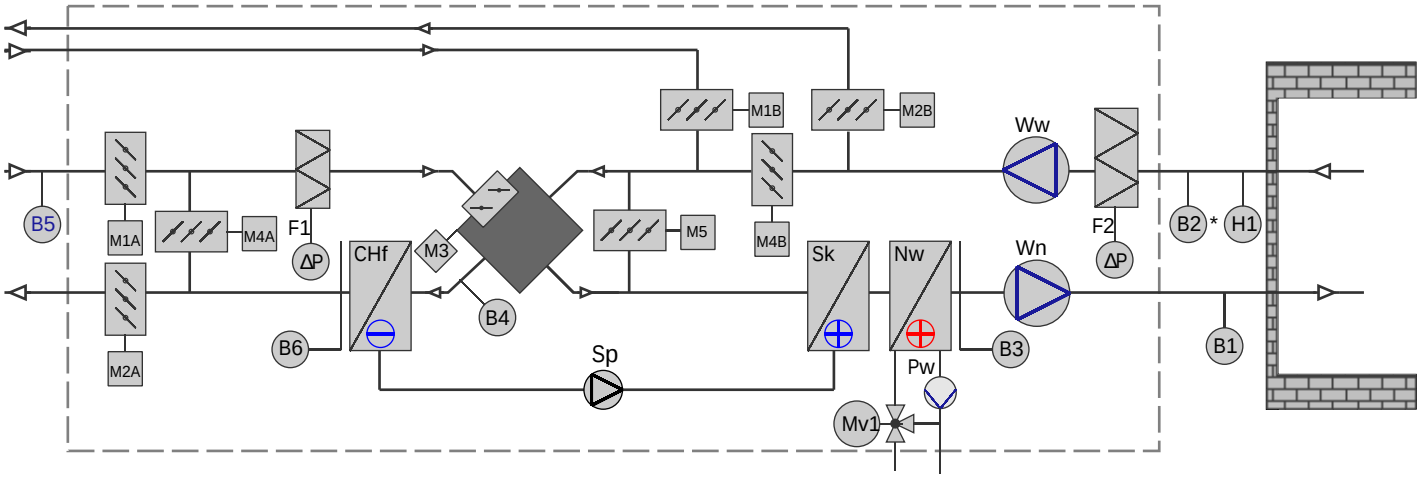
Calculations			
Element desription	Data	Value	Unit
Humidity gains			
Humidity gains from pool trough Wn=E x (pd,W - pd,L) x Fw	20 x (38,82 - 21,23) x 321,5	109938	[g/h]
Water attractions Wa	-	400	[g/h]
Total humidity gains Wc=Wn+Wa	109938 + 400	110338	[g/h]
Supply air stream			
Regarding water pool hall drying V=Wc / xd,L-xd,A) x ρ	110338 / ((13,5 - 9,0)x 1,2)	20433	[m^3/h]
Regarding the number of exchanges V=Vb x Iw	2868 x4	11472	[m^3/h]
Regarding the length of windows V=Vok x Lok	330 x 15	4950	[m^3/h]

Units are selected for biggest calculated value V=20433m^3/h. Selected unit is CSB-50 with Vmin=15750m^3/h, Vmax=22500m^3/h and the drying efficiency 78-112 kg/h.

AUTOMATICS

Automatics system supplying and controlling the pool unit operation with recirculation, cross-flow exchanger and with heating pump

This unit is intended for keeping the constant temperature value with taking into consideration the relative exhausted air humidity and with restriction of the temperature on supply.



DESIGNATIONS:

M1- supply throttling valve servo-motor
M2- exhaust throttling valve servo-motor
M4- SUPPLY/EXHAUST throttling valve servo-motor
M3- cross-flow exchanger servo-motor
M5- recirculation throttling valve servo-motor of mixing
B1- duct supply temperature sensor
B2- exhaust duct temperature sensor
B3- anti- freeze thermostat
B4- duct exchanger temperature sensor
B5- external temperature sensor
B6-duct cooler temperature sensor
H1- duct exhaust humidity sensor
MV1- 3-way valve of the heater with servo-motor
Pw- water pump
CHf- Freon cooler
Sk- condenser

SYSTEM DESCRIPTION:

Supply control cabinet with temperature controller control the unit operation. After switching the unit on, the controller as the answer for the signal from the temperature sensors controls the level of heat recovery in the cross-flow exchanger and air reheating in the water heater. It keeps the humidity programmed in the room by the adequate recirculation level and depending on the unit working mode.

Unit working modes:

- NIGHT TIME (without necessity of drying) automatics keeps the constant pool air temperature by reheating the air in water heater, only supply fan is working then, 100% of recirculation (throttling valves: M4B,M5- open; all the other - closed);
- air drying in the NIGHT TIME, both fans, heating pump are started and recirculation on the M5 throttling valve starts when the humidity in the pool hall increases above the set value (ensures drying the air, throttling valves: M4B,M4A- open; all the others: closed). In the case of lack of significant humidity recoveries unit returns to the mode "NIGHT TIME (without drying necessity)";
- air drying in the SUMMER TIME, automatics ensures removing the all then air exhausted from the pool hall and fresh air flow depends on the requirements (recirculation on M5) for drying, (throttling valves: M1B,M2B,M4A- open, all the others - closed).
- air drying in the WINTER TIME, automatics ensures the partition of exhaust air into removed air and circulating air and the fresh air flow depends on the requirements (recirculation n throttling valve M5) for drying, which is then heated by the water heater, (throttling valves: M1A,M2A,M4B- open, all the others -closed).
- air drying in TRANSITIONAL PERIOD, automatics ensures the exhaust air partition into removed air and circulating air, and the fresh air flow depends on the requirements (recirculation on throttling valve M5) which is then heated in the cross-flow exchanger and by the water heater (throttling valves: M1A,M2A,M4B- open , all the others - closed).

Air capacity adjustment in the pool units is determined by the inverters.

SENSORS:

- B1 temperature duct sensor controls the temperature of supplied air;
- B2 temperature duct sensor controls the temperature of exhaust air ;
- B3 anti – freeze sensor protects the heater against freezing in the two stage way (active also in stand-by mode)
- B4 exchanger sensor protecting it against icing;
- external B5 together with the clock determines the working mode of the unit;
- B6 cooler sensor protects it against icing ;
- pressure switches F1 and F2 inform about excessive filter contamination;

Temperature and humidity adjustment is made on the CPU with the possibility of readout and setting the adjustment parameters on the display.

PROTECTIONS AND CONTROL:

- Anti – freeze - in the case of temperature decrease behind the heater below the threshold value+5C, B3 sensor will switch the unit off, close the M1,M2 throttling valves, fully open MV1 valve until the temperature increase on the heater, and the lamp HEATER FAILURE on the cabinet will be turned on (triple thermostat activation will cause blocking the system);
- Filters pressure switches -Filter is equipped with pressure switch (F1,F2) measuring the pressure drop on the filter. In the case of filter contamination the lamp "DIRTY FILTER" on the cabinet will be switched on.
- fans operation -lamp on the cabinet signalizes the fans operation;
- pump operation - Lamp on the cabinet "PUMP OPERATIONAL" indicates switching the pump on with the heater valve opened by 5%.
- fan control in the case of to small capacity or in the case of exceeding motor nominal currents the lamp “DRIVE FAILURE” on the cabined will be switched on.
- Exchanger sensor - In the case of temperature decrease behind the B4 exchanger below the value set on the controller(t=5^{o}C) controller starts the process of closing the exchanger M3 throttling valvewith simultaneous opening the by-pass. This condition lasts until the the temperature behind the exchanger returns to the safe value;