ECOPAN®

MODULAR RADIANT PANELS

- Suitable for all structures
- Minimum dimensions
- Pleasing appearance
- Even heat distribution
- Ideal for very large rooms
- No air movement
- Low thermal gradients
- Heating by zones
- Use of any heat-carrying fluid
- No moving parts
- No maintenance
- Quick and easy installation

ECOPAN®
MODULAR RADIANT PANELS

Heat, hygiene, design, energy savings.

The final goal of any heating system is to provide rooms with certain conditions of comfort.
The main obstacles to reaching this goal are the cost of energy and the cost of the system.
This problems takes on its own unique character when large volumes are to be heated, whether they are industrial warehouses, department stores, gymnasiums, etc.

***ECOPAN radiant panels** make it possible to create a radiance heating system that is reliable and long lasting. It lowers operating costs by allowing the same level of physiological comfort at a lower temperature. This is the result of the proper balance between air temperature and the radiant temperature of the surrounding surfaces.*

***ECOPAN radiant panels** are the result of specific technical choices made after in-depth studies and research, both theoretical and experimental. These are combined with the most modern technologies used in the manufacturing process. These are supported by numerous laboratory tests and confirmed by surveys and measurements on existing systems.*
The substantial difference from products that are only formally similar, present on the market today, shows the greater specific emission of the Ecopan panel with respect to others.

***ECOPAN radiant panels** are synonymous with a highly qualified product, with high modularity and absolute reliability, that finds a wide range of application in both industrial and civilian heating systems.*

Construction

ECOPAN radiant panels are made of a steel plate which contain circular grooves at a modular distance, obtained through precision stamping.
The pipes for the carrier fluid are inserted in these housings.
This profile wraps around 2/3 of the pipe and secures it to the plate.
On the top, the panel is complete with transversal brackets that stiffen the system and allow the ties to be fastened.
The plates end laterally with edges that hold the insulating material placed on them.

Models

ECOPAN radiant panels are available in various standard models:
- with intervals between pipes of 150 mm, with 2 - 4 - 6 - 8 pipes of ½” or ¾”;
- with intervals between pipes of 111 mm, with 4 - 6 - 8 - 10 pipes of ½″ or ¾″.

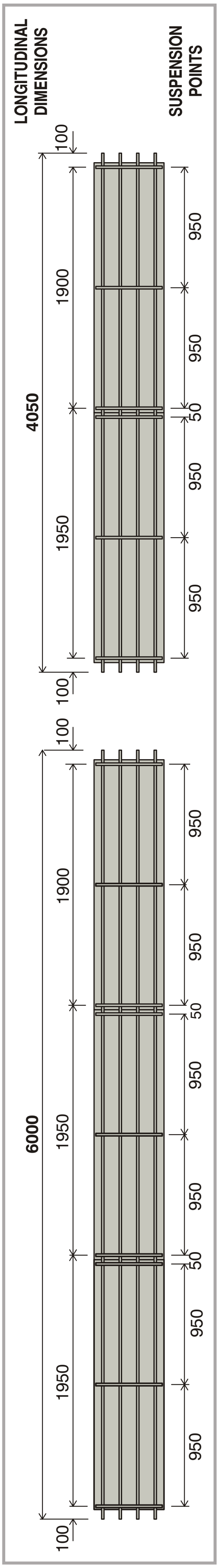
The steel plates have a length of about 2 metres and are assembled so as to obtain modules of 4 and 6 metres.
For hot water systems up to 120°C, the pipes are of ½″ or ¾″. They are electro-welded and tested.
For superheated water, steam, heat-transmitting fluid, etc. steel pipes with no welding (or with equivalent characteristics) are used, measuring ½″ or ¾″.

Painting

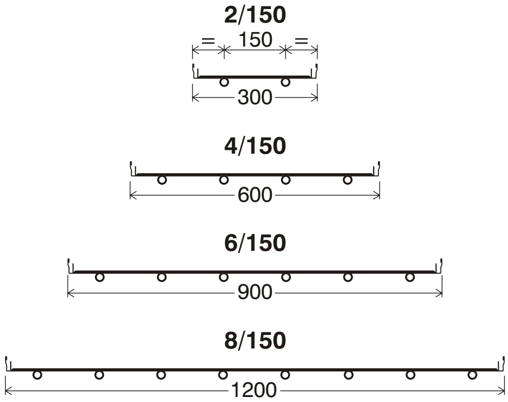
After a hot phosphate de-greasing treatment, the panel is dipped into a tub containing epoxy resin-based water-soluble enamel. It is then sent on to the baking kiln.
The colour of this paint is RAL 7032 silicon grey. It is resistant up to 170°C in water systems and 140°C in steam systems.
For higher temperatures, the plates are treated with special paints.

Insulation

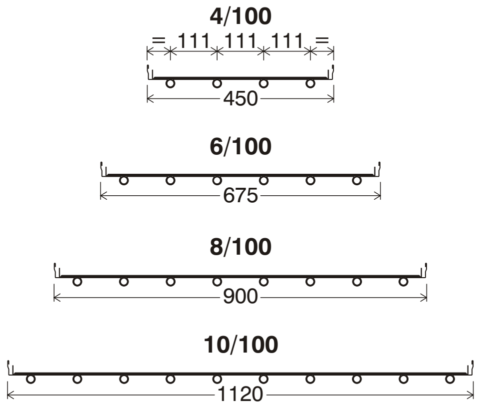
The insulation is composed of a mat of fibreglass wool with a thickness of 400 mm and a density of 14 kg/m^3. It is covered on the upper side with aluminium foil. It comes in rolls, and is to be inserted within the side edges the panel.
The laying of the mat is made easier by the side containment edges and by the lack of any obstacles, since the suspension ties remain along the side edges of the panel.
Special plugs hold the mat to the plate every two metres. They can be installed every metre for special cases, such as inclined plates.
On request, insulation cover profiles are provided for the heads.



INTERVAL BETWEEN PIPES 150 mm - PIPES ½" or ¾"

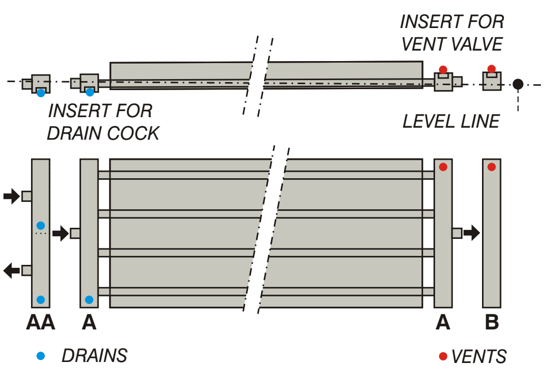


INTERVAL BETWEEN PIPES 111 mm - PIPES ½" or ¾"



On request, ECOPAN provides panels with 3-5-7 pipes of ½" or ¾" with interval of 150 mm and panels of 5-7-9 pipes of ½" or ¾" interval 111 mm.

HEADERS with water connections



HEADERS with connections for steam and condensation

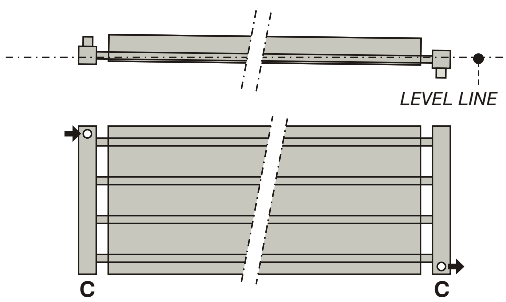


TABLE OF WEIGHTS OF MODULAR RADIANT PANELS

pre-fabricated and modular, complete with:

- side edges
- joint covers
- suspension brackets
- insulation mat with fastening plugs
- silicon grey painting

top line: empty weight in kg/m

Bottom line: weight with water in kg/m

Panels with pipes at intervals of 150 mm					
Model	Width mm	Pipe ½" electro-welded	Pipe ¾" electro-welded	Pipe ½" without welding	Pipe ¾" without welding
2/150	300	4,70 5,23	5,10 6,00	5,40 5,84	6,10 6,88
4/150	600	8,70 9,75	9,70 11,50	10,10 10,98	11,60 13,16
6/150	900	12,70 14,28	14,30 16,99	14,90 16,21	17,10 19,45
8/150	1200	16,80 18,90	18,90 22,49	19,70 21,45	22,60 25,73

Panels with pipes at intervals of 111 mm					
Model	Width mm	Pipe ½" electro-welded	Pipe ¾" electro-welded	Pipe ½" without welding	Pipe ¾" without welding
4/100	450	7,60 8,65	8,70 10,50	9,10 9,98	10,50 12,06
6/100	675	11,00 12,58	12,60 15,29	13,10 14,41	15,30 17,65
8/100	900	14,50 16,60	16,70 20,29	17,40 19,15	20,40 23,53
10/100	1120	18,00 20,63	20,90 25,39	21,80 23,99	25,50 29,41

Thermal emissions

The emissions shown in the diagrams were obtained through tests carried out at the HLK laboratory of the University of Stuttgart, as per standard EN 14037.

Compared to the radiant panels on the market today, the ECOPAN panel features specific technical measures that increase its emission, such as:

- pipe of ½" or ¾" for the carrier fluid, with 2/3 of their surface wrapped in the sheet metal of the panel, according to the maximum angle of downwards radiance
- higher average temperature of the panels, due to the uniform distances between pipes and the continuity of the sheet metal
- side edges for the containment of the insulation obtained from the radiant panel itself, resulting in extension of the heating surface
- longitudinal formation of radiant panels obtained by metal sheets of limited length (about 2 metres), simply placed near one another, which makes the panel indifferent to thermal shock, eliminating the risk of permanent deformation; the initial sliding between the pipes and the sheet metal is kept within the limits of elasticity of the reciprocal joints even in the presence of steam at high or low pressure
- transversal brackets for stiffening and anchoring suitable placed and with limited height in order to eliminate any obstruction in laying the insulation mat continuously along the entire length along the containment edges, resulting in reduced influence of thermal bridges.
- in panels with pipes of ¾" the greater diameter of the pipe for the carrier fluid causes in some models an increase in the emission of the panel and allows, with the same pressure drop, greater water flow.

The tables shown show the emissions of panels with intervals between tubes of 150 and 111 mm for the various pipe diameters.

1 *RADIANT PANELS WITH PIPES OF ½"*

Thermal emissions in watts per linear metre in accordance with EN 14037

(*) ΔT = *difference between the average temperature of the fluid and the ambient*

MODEL		4/100	6/100	8/100	10/100	2/150	4/150	6/150	8/150
$\Delta T = t_m - t_a$ (*)	K	W/m	W/m	W/m	W/m	W/m	W/m	W/m	W/m
	40	191	284	354	423	124	213	297	382
	42	202	301	375	448	131	225	315	404
	44	213	318	396	473	138	238	332	427
	46	225	335	418	499	146	251	350	449
	48	236	352	439	524	153	263	368	472
	50	248	369	461	551	161	276	386	495
	52	260	387	483	577	169	289	404	519
	54	272	404	505	603	176	302	422	542
	55	**278**	**413**	**516**	**616**	**180**	**309**	**431**	**554**
	56	284	422	527	630	184	315	440	566
	58	296	440	549	656	192	328	459	589
	60	308	458	572	683	199	342	477	613
	62	320	476	594	710	207	355	496	637
	64	332	494	617	738	215	368	515	661
	66	345	512	640	765	223	382	534	685
	68	357	531	663	793	231	395	552	710
	70	369	549	686	820	239	409	572	734
	72	382	568	709	848	247	423	591	759
	74	395	586	733	876	255	436	610	783
	76	407	605	756	904	263	450	629	808
	78	420	624	780	933	271	464	648	833
	80	433	643	803	961	280	478	668	858
	82	446	662	827	990	288	492	687	883
	84	458	681	851	1018	296	506	707	908
	86	471	700	875	1047	304	520	727	934
	88	484	719	899	1076	313	534	747	959
	90	497	738	923	1105	321	548	766	985
	92	510	758	948	1134	330	563	786	1010
	94	524	777	972	1164	338	577	806	1036
	96	537	797	997	1193	346	591	826	1062
	98	550	816	1021	1222	355	606	847	1088

CE
04
EN 14037-1
Ceiling mounted radiant panels

Maximum operating pressure:
6 bar

ECOPAN radiant panels are available, as shown in the diagram, in a wide range of models. These models, through carefully planned choices, make it possible to obtain, with technically valid solutions and with limited costs, highly functional systems.
The operation of these systems normally has energy savings of 30% with respect to convection systems.

❷ *RADIANT PANELS WITH PIPES OF ¾"*
Thermal emissions in watts per linear metre in accordance with EN 14037
(*) ΔT = *difference between the average temperature of the fluid and the ambient*

MODEL		4/100	6/100	8/100	10/100	2/150	4/150	6/150	8/150
$\Delta T = t_m - t_a$ (*)	K	W/m	W/m	W/m	W/m	W/m	W/m	W/m	W/m
	40	192	285	366	446	131	219	309	399
	42	203	302	388	472	138	231	327	423
	44	215	319	410	499	146	245	346	447
	46	226	336	432	526	154	258	364	471
	48	238	353	454	553	162	271	383	495
	50	250	370	477	581	170	284	402	519
	52	261	388	499	608	178	298	421	544
	54	273	406	522	636	186	311	440	568
	55	**279**	**415**	**534**	**650**	**190**	**318**	**449**	**581**
	56	285	423	545	664	194	325	459	593
	58	298	441	568	692	202	338	478	618
	60	310	459	592	721	210	352	498	644
	62	322	477	615	749	219	366	517	669
	64	334	496	638	778	227	380	537	694
	66	347	514	662	807	235	394	557	720
	68	359	532	686	836	244	408	577	746
	70	372	551	710	865	252	422	597	772
	72	384	570	734	895	261	436	617	798
	74	397	588	758	924	269	451	637	824
	76	410	607	782	954	278	465	658	850
	78	423	626	807	984	286	479	678	877
	80	435	645	831	1014	295	494	698	903
	82	448	664	856	1044	304	509	719	930
	84	461	683	881	1074	312	523	740	957
	86	474	702	905	1104	321	538	761	984
	88	488	722	930	1135	330	553	781	1011
	90	501	741	955	1166	339	567	802	1038
	92	514	760	981	1196	348	582	823	1065
	94	527	780	1006	1227	357	597	844	1092
	96	540	800	1031	1258	366	612	866	1120
	98	554	819	1057	1289	375	627	887	1147
	100	567	839	1082	1321	384	642	908	1175

❸ *ATTENUATION OF RADIATION IN RELATION TO HEIGHT*

h (m)	"f"
6	1,00
7	0,97
8	0,95
9	0,92
10	0,90
11	0,88
12	0,86
13	0,84
14	0,82
15	0,80
16	0,79
17	0,78
18	0,76
19	0,74
20	0,73

Pressure drops

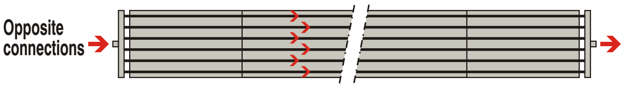
For energy savings in the operation of the system, it is important to limit the consumption of electricity by the pumps; to achieve this result, the pressure drops due to friction in the pipes of the panel should normally not exceed 250 Pa/m.

During the design phase, one needs also to consider that the carrier fluid must have a minimum speed in order draw off the air so as to avoid the formation of air pockets in counter-sloped pipes. Based on the above, in an electro-welded pipe of ½", a flow rate of 200 to 500 l/h would be considered, whereas in an electro-welded pipe of ¾", the flow rate would be 500 to 1,000 l/h.

Specific technical choices such as the length of the panel, the temperature difference, the temperature of the carrier fluid and the position of the connections indicate whether the panels to be installed require pipes of ½" or ¾".

Example

One wishes to determine the possible length of an ECOPAN panel mod. 6/150 of ½" with opposite connections supplied with hot water at 85-75°C, therefore with an average temperature t_m of 80°C. With an ambient temperature t_a of 14 °C, the $\Delta T = t_m - t_a$ will be 66°C.

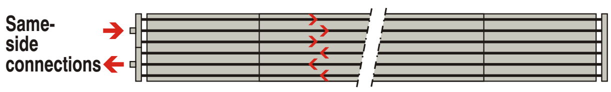


Supposing that each pipe of ½" of the panel carries 400 l/h, the panel in question, having 6 pipes, carries 2,400 l/h.

Since the hot water passing through the panel loses 10°C, the panel emisssios a total of 24,000 kcal/h which is equal to 27,912 W.

Table 1 shows that a panel mod. 6/150 ½" with a ΔT of 66°C emissions about 534 W/m, hence 27,912 / 534 = 52 metres of approximate length for the panel.

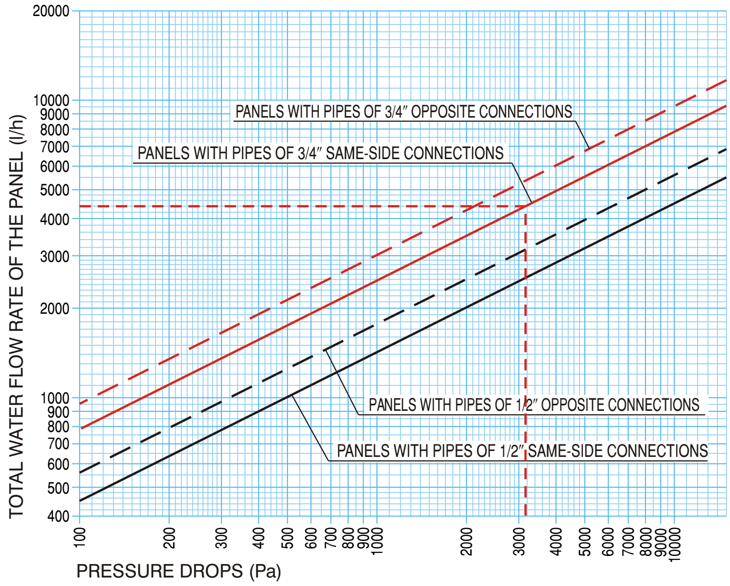
If instead of a panel with pipes of ½" and opposite connections, one considers a panel mod. 6/150 with pipes of ¾" and same-side connections, with approximately the same emission one has 3 delivery pipes and 3 return ones. Considering a flow rate in each pipe of 800 l/h, the flow rate of the panel will always be 800 l/h x 3 pipes = 2,400 l/h and with a temperature differential of the water of 10°C, the panel will emission 24,000 kcal/h equal to 27,912 W. Table 1 shows that a panel mod. 6/150 ¾" with ΔT=66°C has a emission of 557 W/m and hence 27,912 / 557 = 50 metres of approximate length for



4 *TABLE FOR DETERMINING PRESSURE DROPS OF PIPES OF PANELS IN Pa/m*

Water flow rate for each single Pipe	Electro-welded pipes				Pipes without welding			
	½"		¾"		½"		¾"	
	pressure drops	speed	pressure drops	speed	pressure drops	speed	pressure drops	speed
l/h	**Pa/m**	**m/s**	**Pa/m**	**m/s**	**Pa/m**	**m/s**	**Pa/m**	**m/s**
200	41	0,21			70	0,25		
300	86	0,32			150	0,39		
400	145	0,42	42	0,25	250	0,51	60	0,29
500	219	0,53	62	0,32	360	0,66	90	0,36
600	309	0,64	86	0,38	525	0,77	130	0,44
700			114	0,44			170	0,51
800			146	0,51			220	0,58
900			182	0,57			275	0,65
1000			222	0,64			350	0,75
1100			266	0,70			400	0,80
1200			313	0,76			455	0,88
1300			364	0,83			550	0,95
1400			420	0,88			640	1,04

5 *DIAGRAM FOR DETERMINING PRESSURE DROPS OF 1 HEADER BASED ON THE DIAMETER OF PIPES AND CONNECTIONS*

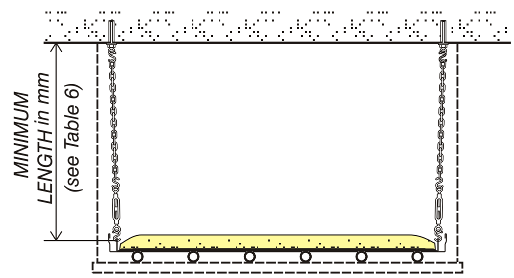


Installation

Once the suspension ties have been placed on the roof, the radiant panels are lifted using elevator platforms until the ties are hooked onto the holes on the brackets.

The ties, not included in the supply, can be chains, steel cords, or other; it does not matter what kind of ties are used as long as they are adjustable in height.

In special cases the ties, instead of hooking onto the upper brackets, can be hooked onto crosspieces to be placed under the panels.



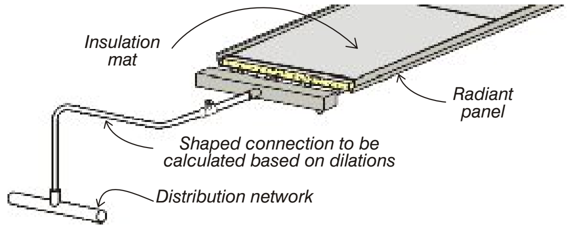
After installing the various models of 4 and 6 metres that make up the panels, weld the heads of the pipes and adjust the inclination, so that each panel is complete before continuing.

Since the panels dilate as they heat up, the support ties must allow extension (see table 6).

6 *TABLE FOR THE DETERMINATION OF THE MINIMUM LENGTH OF THE SUSPENSION TIES OF THE RADIANT PANELS LENGTHS IN mm*

PANEL LENGTH m	$\Delta T = t_m$ (heating fluid) $- t_a$ (ambient) in °C				
	Δt 75°C	Δt 100°C	Δt 125°C	Δt 150°C	Δt 175°C
25	150	200	250	300	350
50	300	400	450	550	650
75	450	550	700	850	1000
100	550	750	950	1100	1300
150	850	1100	1400	1650	1950
200	1100	1500	1900	2200	2600

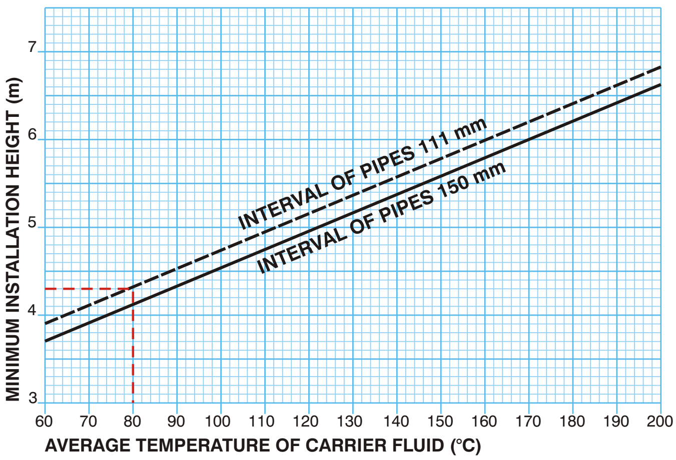
The connection pipe between the header and the distribution network must be properly shaped so that it absorbs the dilation movement in the system.



Height and distance between panels

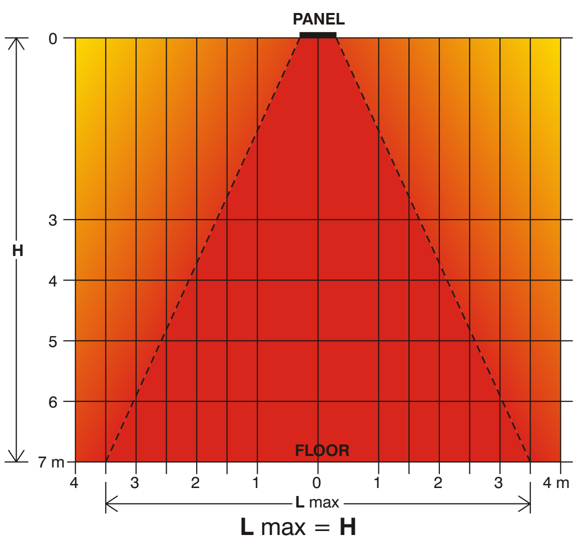
The height of installation is normally limited by the type of building, its use, the type of fluid being used, etc.
It is advisable to install as low as permitted by the space needed for activities.
Considering a proper relationship between cold and hot surfaces, it logical that the higher the temperature of the carrier fluid, the less radiant surface will be required.
Based on the height of installation, however, there will be a maximum panel temperature which should not be exceeded in order to guarantee the comfort of the persons exposed to the radiance (see diagram 7).

7 *DIAGRAM FOR THE DETERMINATION OF THE MINIMUM INSTALLATION HEIGHT ABOVE THE FLOOR BASED ON AVERAGE TEMPERATURE OF THE CARRIER FLUID*



The height of installation also affects the zones of maximum radiance of the panel, as shown in the following figure:

8 *GRAPH OF ZONE OF MAXIMUM RADIANCE BASED ON HEIGHT OF PANEL*



To ensure uniform radiance, it is advisable to place the panels at a distance from one another that is not greater than the installation height.

Example

Consider a warehouse measuring 84×50 metres, with a height of 8 metres and a heating requirement estimated at 370 kW for an ambient temperature of 16 °C.

Consider the water at 85 - 75 °C and panels installed at a height of 7 metres.

Since the installation height is greater than 6 metres, the number of panels to be installed must be increased in order to take into account the attenuation of radiance due to the height. Therefore, the necessary panels must cover a power that is greater than the initially estimated requirement (see attenuation factor shown in table 3). The power to be provided will be 370 kW / 0.97 = 381 kW.

To obtain uniform radiance, the distance between panels must not be greater than the height of installation, which is 7 metres (graph 8). Therefore, considering panels that are parallel to the long side of the building, at least 8 panels with a length of 80 metres will be needed, for a total of 640 metres with a minimum emission of 381,000 W / 640 m = 595 W/m.

Table 2 shows that the panel mod. 8/100 ¾″ with a width of 900 mm with $\Delta T = t_{m\ water} - t_{ambient} = 80°C - 16°C = 64°C$ has a emission of 638 W/m and is therefore sufficient.

The minimum installation height (diagram 7) is also verified, based on the average temperature of the carrier fluid.

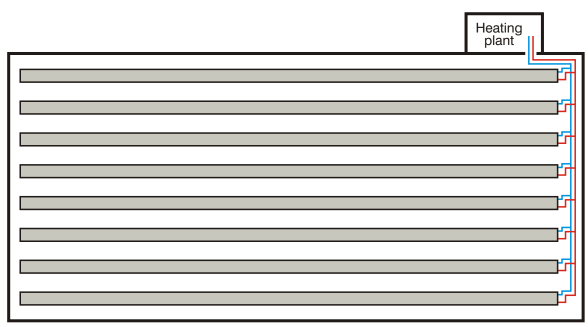
The emission of a panel with a length of 80 metres will be 638 W/m × 80 m = 51,040 W, equal to about 43,886 kcal/h, which, when divided by the temperature difference of the water of 10°C, will provide a flow rate for each panel of about 4,400 l/h.

To limit the cost of the distribution network, it is advisable to use panels with same-side connections. This means there will be 4 delivery pipes and 4 return pipes with a flow rate of about 1,100 l/h pipes. For an electro-welded pipe of ¾″, this corresponds to a pressure drop of 266 Pa/m (table 4). The pressure drop in the tubes will therefore be 80 m × 2 x 266 Pa/m = 42,560 Pa.

In addition to this pressure drop, there is the pressure drop of the headers (diagram 5). For a panel with same-side connections, pipes of ¾″ and a flow rate of 4,400 l/h, this is about 3,200 Pa × 3 headers = 9,600 Pa.

The total pressure drops of the panel are therefore 42,560 + 9,600 = 52,160 Pa.

Still to be verified, using table 6, is the length of the suspension ties required to allow the panel to lengthen. With panels that are 80 metres long and $\Delta T = t_m - t_a = 64°C$, the minimum length of the suspensions will be about 450 mm.



The method of calculation of the thermal requirement of a building to be heated with ceiling mounted radiant panels is different from the one that is normally used for convection heating.
ECOPAN technicians can rapidly provide exact, detailed data to assist in the selection of panels, and they can aid professionals in the realization of their projects.

ECOPAN®

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S.r.l.

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