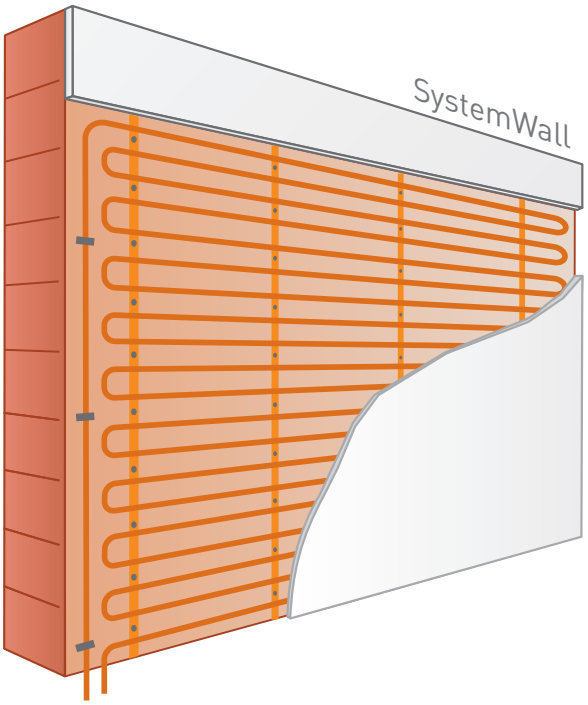
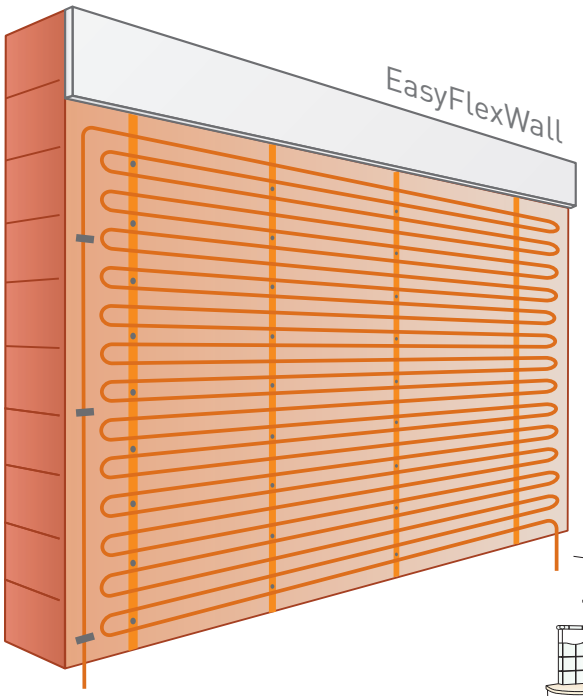
www.variotherm.at

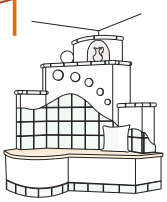
WALL HEATING/COOLING SYSTEMS UNDER PLASTER

SystemWall. EasyFlexWall.

Planning







Designer heating

VARIOTHERM

HEATING. COOLING. COMFORT.

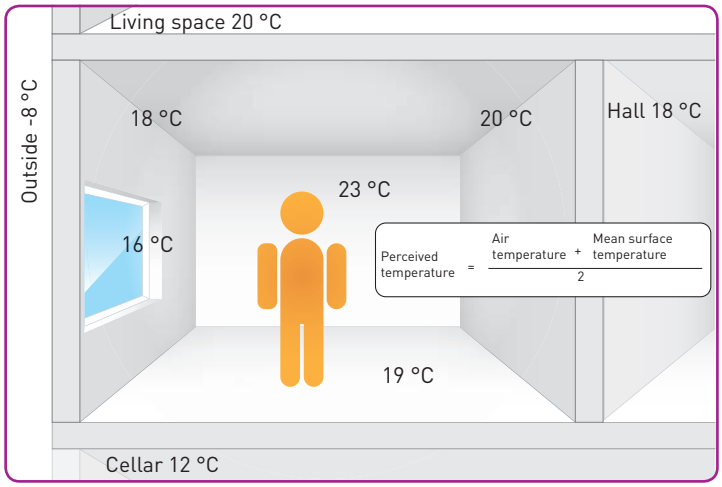
Design manual

e14314

1. Principles

Variotherm System wall or EasyFlex wall heating/cooling installations are a source of well-being. They provide heating through horizontal radiant heat instead of the ascending warm air provided by conventional heating systems. This avoids the permanent movement of air and the associated stirring up of dust. Rooms are evenly heated without different temperature zones in the heated rooms. By the way, solar heat is also radiant heat.

1.1 Cosiness



Perceived temperature

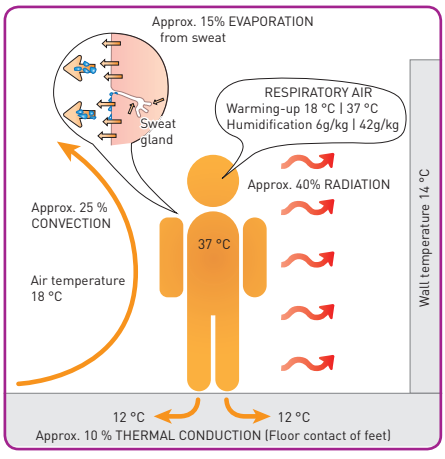
Cosiness is not only created through a certain air temperature in the room. The temperature of the surfaces enclosing the room is of equal importance. The perceived temperature is roughly consistent with the arithmetic mean of both temperatures.

What makes people feel cosy?
People feel cosy when the following basic "thermal cosiness" equation holds:

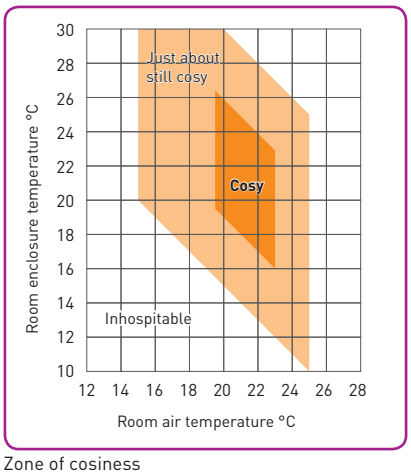
Heat production = heat loss

In this context, it is important that heat loss from the human body is as evenly distributed in all directions as possible. We feel uncomfortable if too much heat is lost in one particular direction (e.g. cold surfaces, draughts) or the heat loss is prevented in one direction (hot surfaces or vapour-tight, thick clothing).

The lower the inside air temperature is, the warmer the surrounding surfaces (wall surfaces, floor and ceiling, as well as doors and windows) must be to ensure cosiness.

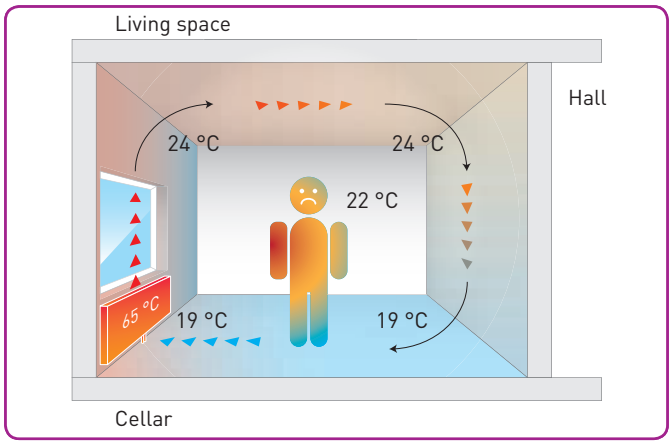


Human heat balance

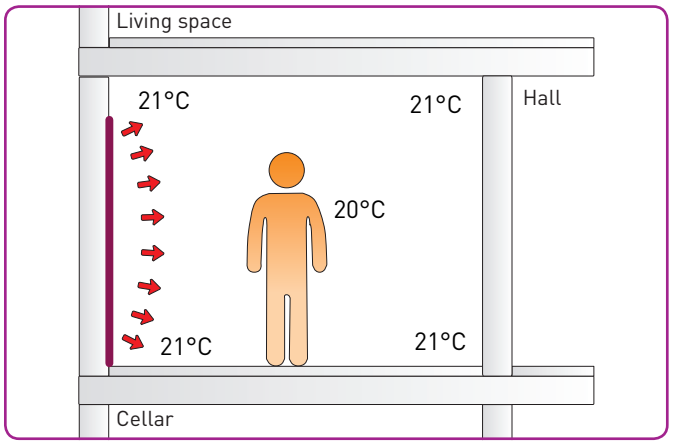


Zone of cosiness

Compared to other heating systems, the System wall or EasyFlex wall heating/cooling installations significantly increases cosiness. The installation of surface heating on an exterior wall, especially under windows, can largely cancel out the unpleasant effects from the radiation exchange between your body and cold exterior walls and windows. You can set the room temperature lower than you would with convection heating, since radiant heat raises the perceived air temperature.



Convection heating:
Heated air rises quickly and returns to the floor as cold air.
> Unbalanced temperature distribution, stirred dust caused by circulating air, "dry air"



Variotherm wall heating:
Heat absorption and heat reflection by the surrounding wall, ceiling and floor surfaces.

1.2 Energy savings

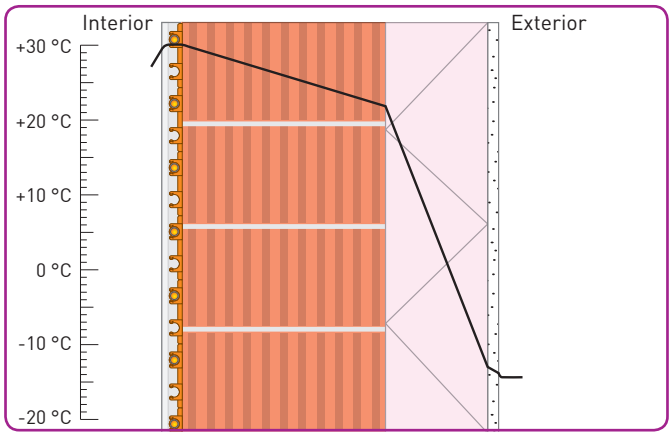
Energy losses are minimised with a lowered room air temperature along with the increased cosiness. The approximate cost savings per 1 °C lower room air temperature are 6 %. The low room air temperature has the additional great physiological advantage of significantly increasing the absorption of oxygen in the body. The wall heating system is ideal for use with low-temperature energy sources such as condensing boilers, heat pumps and solar collectors because it operates with low surface and heating medium temperatures. With the Variotherm wall heating you can achieve energy savings of up to 30% compared to conventional heating systems.

1.3 Adapts to suit your home

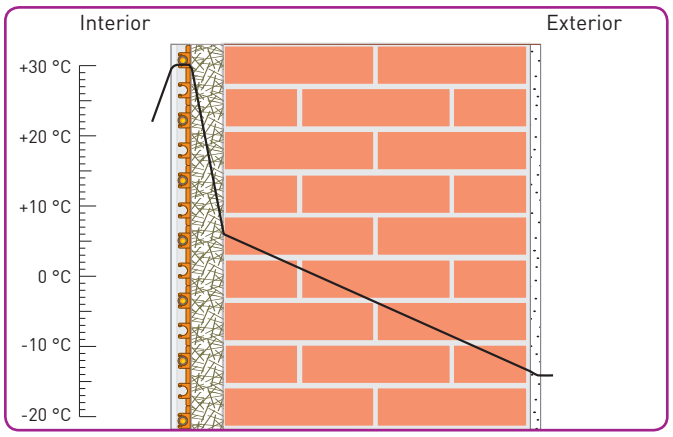
The Variotherm wall heating utilises the existing or intended exterior wall, either as an additional storage medium (if full exterior insulation is present) or as insulation. The wall heating surfaces can be individually adapted to suit the local situation (windows, doors etc.). Visible radiators under the windows are a thing of the past.

1.4 Temperature variations/wall structure

Various different wall fittings at a wall surface temperature of 30 °C and a standard outdoor (air) temperature of -14 °C.



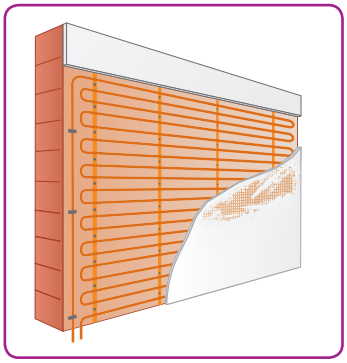
New construction example, structure from left to right: 31 mm plaster incl. SystemWall, 300 mm vertically perforated bricks, 150 mm thermal insulation (EPS), exterior plaster/paint



Existing construction example, structure from left to right: 31 mm plaster incl. SystemWall, 50 mm wood-wool construction panel, 2 x 250 mm NF bricks, exterior plaster/paint

2. Systems

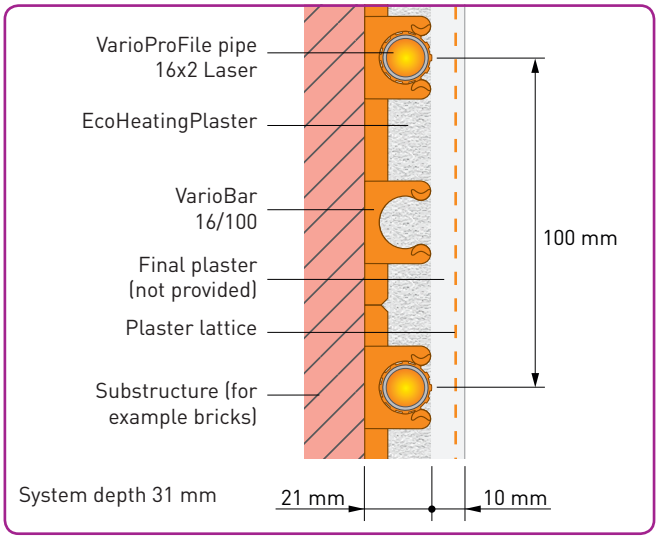
2.1 System description



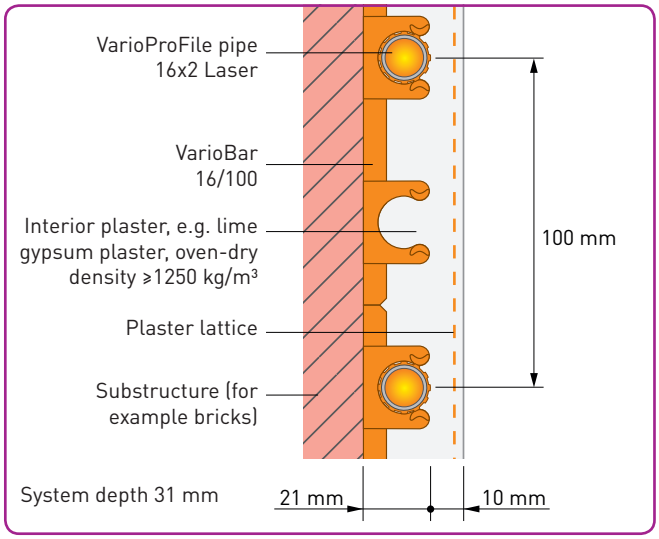
Variotherm offers two different systems for installing a plastered wall heating/cooling system – SystemWall and EasyFlexWall – which differ in the type of plaster and pipe dimension used.

Depending on the subsurface, the VarioBars are attached to the (outer) wall using ScrewFix or nail anchors and the VarioProFile pipe is clamped into the VarioBars, starting from the distribution manifold. There are own retaining clamps for fastening the return to the wall. The plaster is applied after installation.

SystemWall

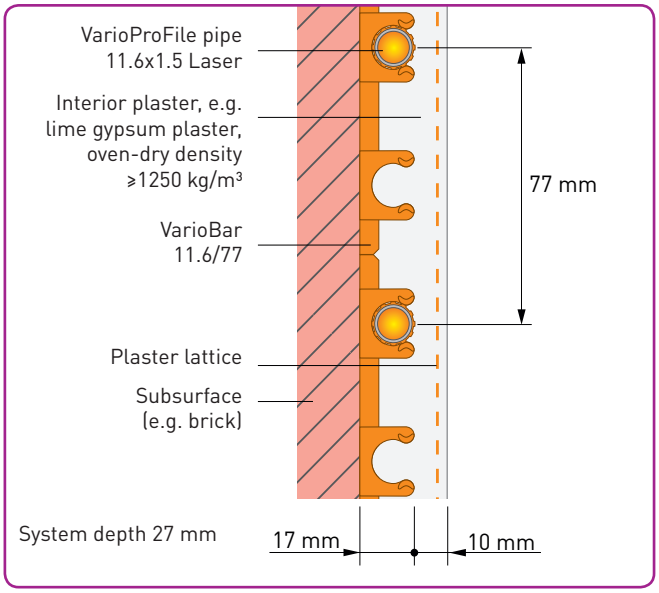


Cross-section – SWHK2: The wall heating/cooling surfaces are plastered with EcoHeatingPlaster as the (rough) base coat plaster, followed by application of the (fine) finishing coat containing the plaster lattice.

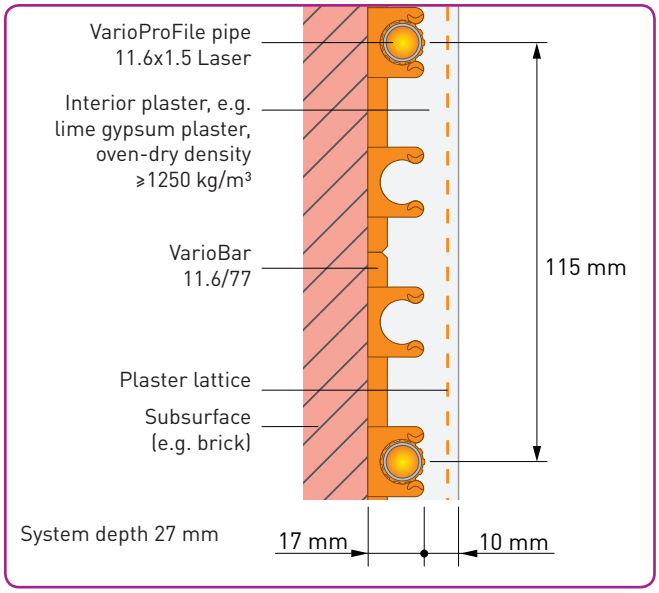


Cross-section – SWHK3: Plastering with single-layer plaster provided on-site.

EasyFlexWall



Cross-section – EWHK77: Plastering with single-layer plaster provided on-site.



Cross-section – EWHK115: Plastering with single-layer plaster provided on-site.

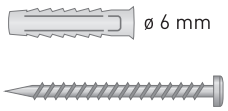
2.2 System components

VarioProFile pipe Laser

Aluminium multi-layer composite pipe, for details, see page 7.

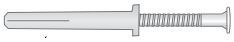
- VarioProFile pipe 16x2 Laser (SystemWall) and
- VarioProFile pipe 11.6x1.5 Laser (EasyFlexWall)

ScrewFix



consisting of dowel + screw for attaching the VarioBar and the retaining clamp, suitable for the following subsurfaces: concrete masonry, vertically perforated brick (porous brick), aerated concrete brick.

Nail anchor



as an alternative to ScrewFix, suitable for the following subsurfaces: concrete, solid brick. Diameter 6 mm, length 60 mm.

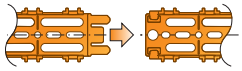
Retaining clamp

for affixing the VarioProFile pipe in the return of the wall heating/cooling system.

VarioBar

made of PE for latching the VarioProFile pipe, can be extended to any desired length using special click technology.

Click technology:

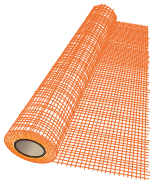


- VarioBar 16/100 (SystemWall), panel thickness 21 mm, grid spacing 50 mm and
- VarioBar 11.6/77 (EasyFlexWall), panel thickness 17 mm, grid spacing 38.5 mm

EcoHeatingPlaster

special plaster (base coat) for the system wall heating/cooling. For details, see page 8.

Plaster lattice 7 x 8 mm



special glass fibre cloth, reduces plaster tearing, large mesh size, maximum tensile load of 2000 Nm/5 cm, tested as per DIN 53854/53857.

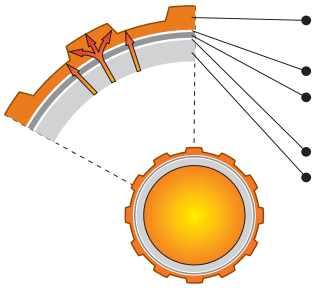
2.3 Advantages of the SystemWall and EasyFlexWall

- A complete system – adapted in accordance with the building structure (structural physics), energy generation system, customer wishes and technical requirements
- Installation without connecting elements in the wall is possible
- Serial flow in the heating circuits – clear hydraulic relationships
- Easy to locate using a pipe locator in the case of subsequent fastening
- No ventilation problems
- Heating and cooling with a single system
- Biologically compatible quality:
  Variotherm is currently the only system manufacturer to be awarded the IBO quality seal (continuously tested since 1996) for a complete wall heating system (SystemWall)
- The EcoHeatingPlaster provides optimal transfer of heat to the finishing plaster coat, while also providing breathability and good condensation behaviour for wall cooling
- Many thousands of m² and decades of experience

3. The VarioProFile pipe 11.6x1.5 and 16x2 Laser

Profiled surface:

- Optimised heat transfer through 10 or 15% larger surface
- Better plaster adhesion

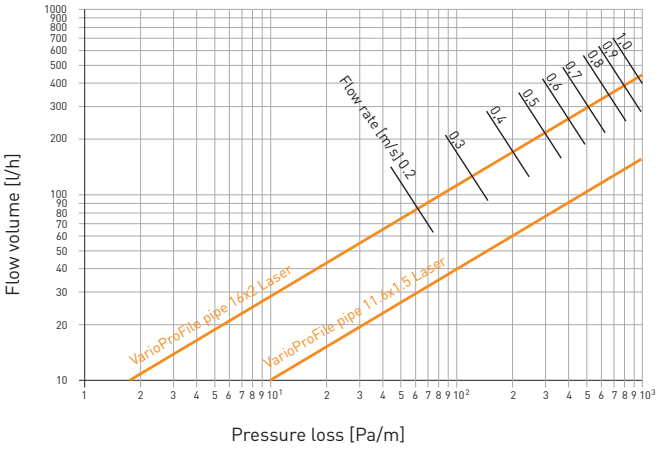


- Raised-temperature-resistance polyethylene (PE-RT) with profiled surface structure
- Adhesive layer
- Homogeneous laser-welded solid aluminium pipe
- Adhesive layer
- Raised-temperature-resistance polyethylene (PE-RT)

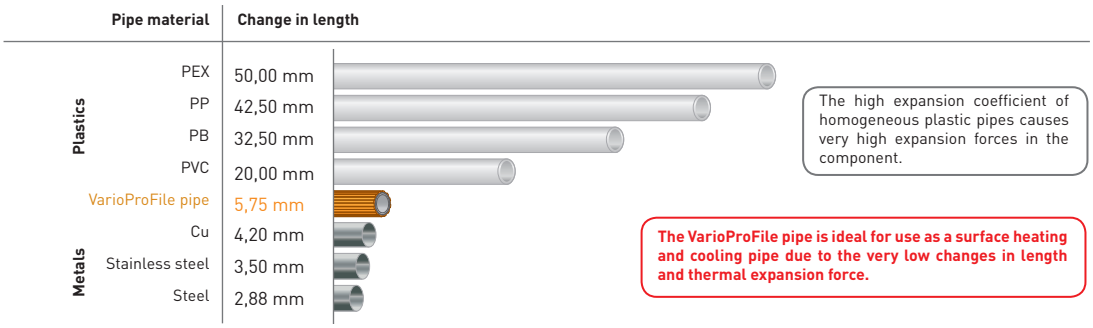
Advantages

- Profiled surface for optimised heat transfer
- Fully corrosion-free
- Optimum creep behaviour
- Just as light as a plastic pipe
- 10-year guarantee with certificate
- Flexible, easy to bend, extremely good hydrostatic stability
- Resistant to hot water additives (inhibitors, antifreeze)
- Mirror-smooth inner surface – less pressure loss – no encrustation
- High pressure and temperature resistance (10 bar, +95 °C)
- 100% oxygen diffusion-tight
- Lower linear coefficient of expansion, lower heat expansion forces
- Tested as per EN 21003 (IMA Dresden), SKZ A 397

Pressure loss



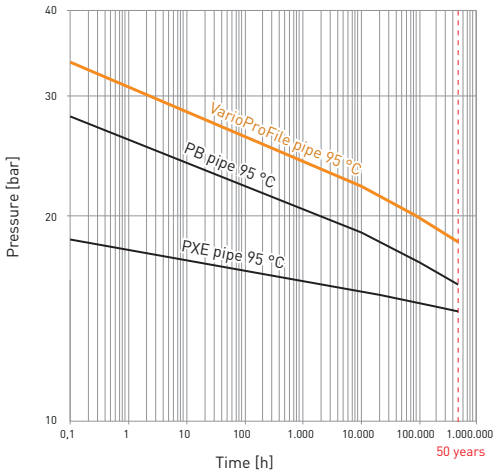
Change in length of various pipe materials
for a length of 10 m and a change in temperature Δt of 25 °C (e.g. from 20 °C to 45 °C)



The high expansion coefficient of homogeneous plastic pipes causes very high expansion forces in the component.

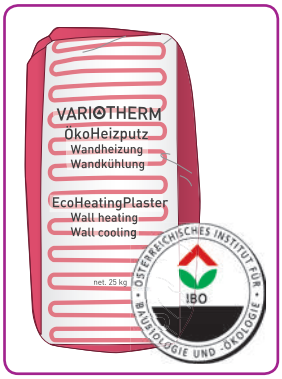
The VarioProFile pipe is ideal for use as a surface heating and cooling pipe due to the very low changes in length and thermal expansion force.

Creep behaviour



Technical data		
	ø11.6x1.5 (EasyFlexWall)	ø16x2 (SystemWall)
Pipe diameter	11.6 mm	16.0 mm
Pipe wall thickness	1.5 mm	2.0 mm
Aluminium pipe thickness	0.15 mm	0.18 mm
Roll length	100/300/500 m	100/300/500 m
Water content	0.058 l/m	0.113 l/m
Especially narrow bending radius (with suitable bending equipment)	30 mm	40 mm
Mean heat conduction coefficient λ	0.44 W/mK	0.45 W/mK
Thermal resistance R_λ	0.0034 m²K/W	0.0045 m²K/W
Max. operating temperature	t_{max} = 95 °C	
Can be exposed for short periods to	t_{mal} = 110 °C	
Max. operating pressure	p_{max} = 10 bar	
Linear expansion coefficient	2.3x10^{-5} [K^{-1}]	

4. The Variotherm EcoHeatingPlaster (for SWHK2)



The Variotherm EcoHeatingPlaster has been developed for use as a base coat plaster for the system wall heating/cooling (SWHK2), for plastering thicknesses (incl. heating pipe) of up 25 mm. It is a natural construction material, with excellent environmentally-friendly characteristics verified by the IBO quality seal.

Advantages

- Premixed hydraulic dry mortar. Classification: GP, PM2, W3
- Purely organic material
- Permeable to water vapour
- Hygroscopic
- Shock resistant
- Good adhesive properties
- High thermal conductivity (about 10 - 25 % better than "normal" plasters)
- Good heat storage properties (due to the extremely high oven-dry density of 1,580 kg/m³)
- Good condensation properties with cooling function
- Smooth application – suitable for machine and manual application (e.g. plaster machine G4)
- Guaranteed heat dissipation values for the whole system (SWHK2)

Components

Plaster sand, additives, trass. What is trass? - Volcanic tuff prepared in a drying and grinding process. The main components of these "pozzolana" substances are silicic acids (water insoluble) and clay. Apart from water, no other additives need to be added at the construction site. The plaster cures hydraulically. Only air and water are required for curing.

Technical data

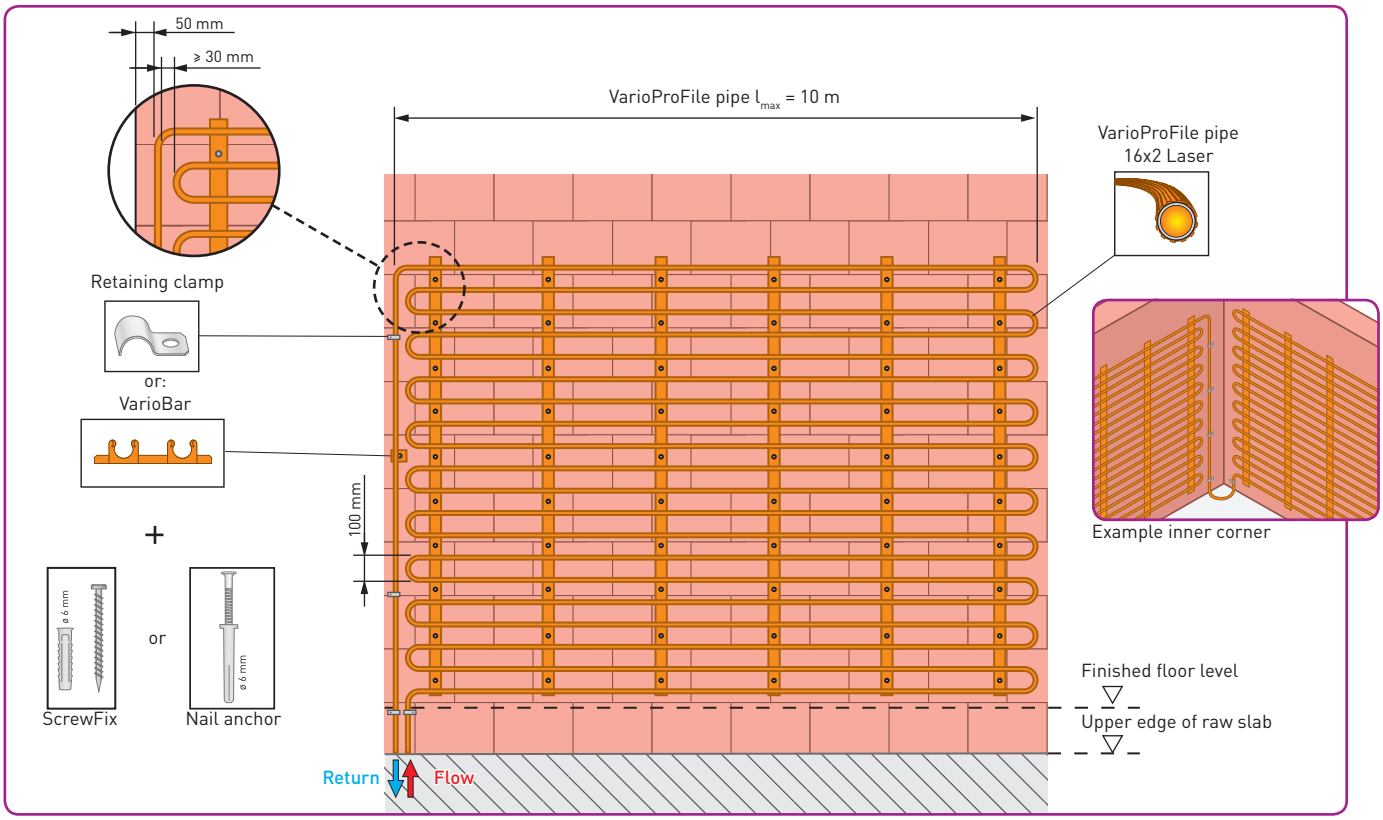
Maximum grain size:	2 mm
Compressive strength (28d):	> 3 N/mm²
Flexural strength (28d):	> 1 N/mm²
Thermal conductivity λ:	0.82 W/mK
Acid capacity (m value):	12.4
Oven-dry density (28d):	approx. 1,500 kg/m³
Fresh mortar bulk density:	approx. 1,700 kg/m³
Water requirement:	approx. 5-6 l/25 kg
Material consumption:	approx. 45 kg/m² (SWHK2)
Minimum plaster thickness:	10 mm
Maximum plaster thickness:	25 mm
Packaging:	25 kg per bag / 42 bags per euro-pallet

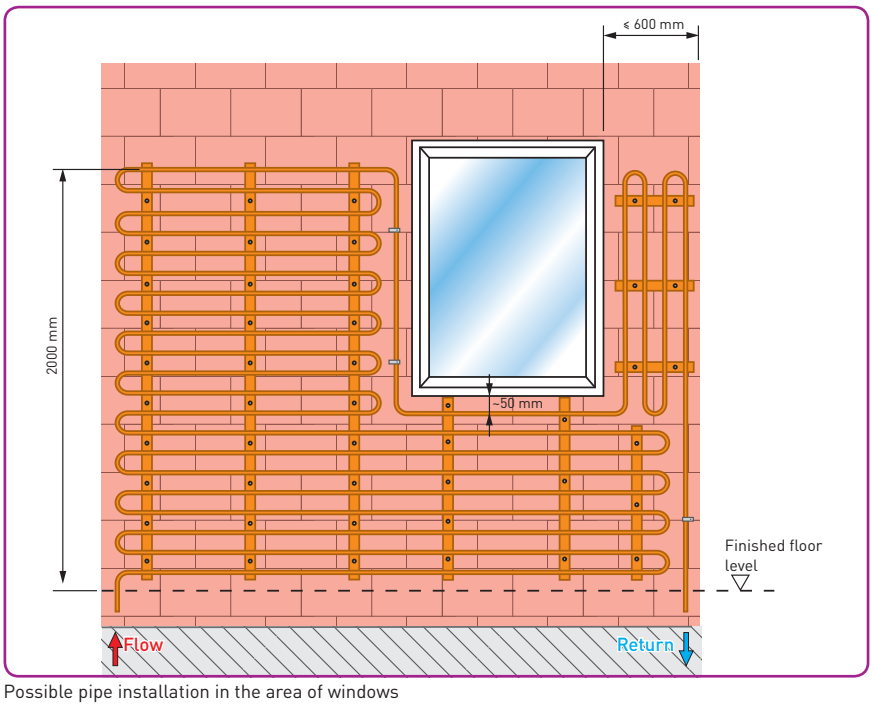
Please note our safety data sheet "EcoHeatingPlaster", available from *www.variotherm.at/en/home/service/info-centre.html*

5. Pipe installation and pipe requirement

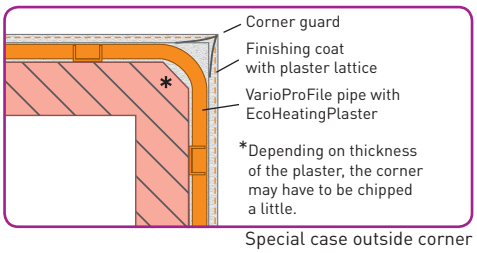
	SWHK3	EWHK77	EWHK115
Pipe spacing	100 mm	77 mm	115 mm
Dimension VarioProFile pipe	16x2	11.6x1.5	11.6x1.5
Pipe requirement per 1 m² wall heating surface	10 m/m²	13 m/m²	8.7 m/m²
Max. pipe length per heating circuit incl. supply	120 m	80 m	80 m

5.1 SystemWall

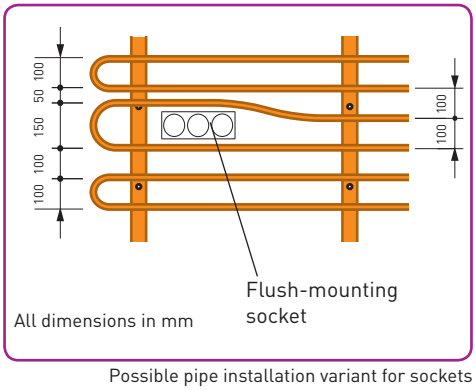




Possible pipe installation in the area of windows

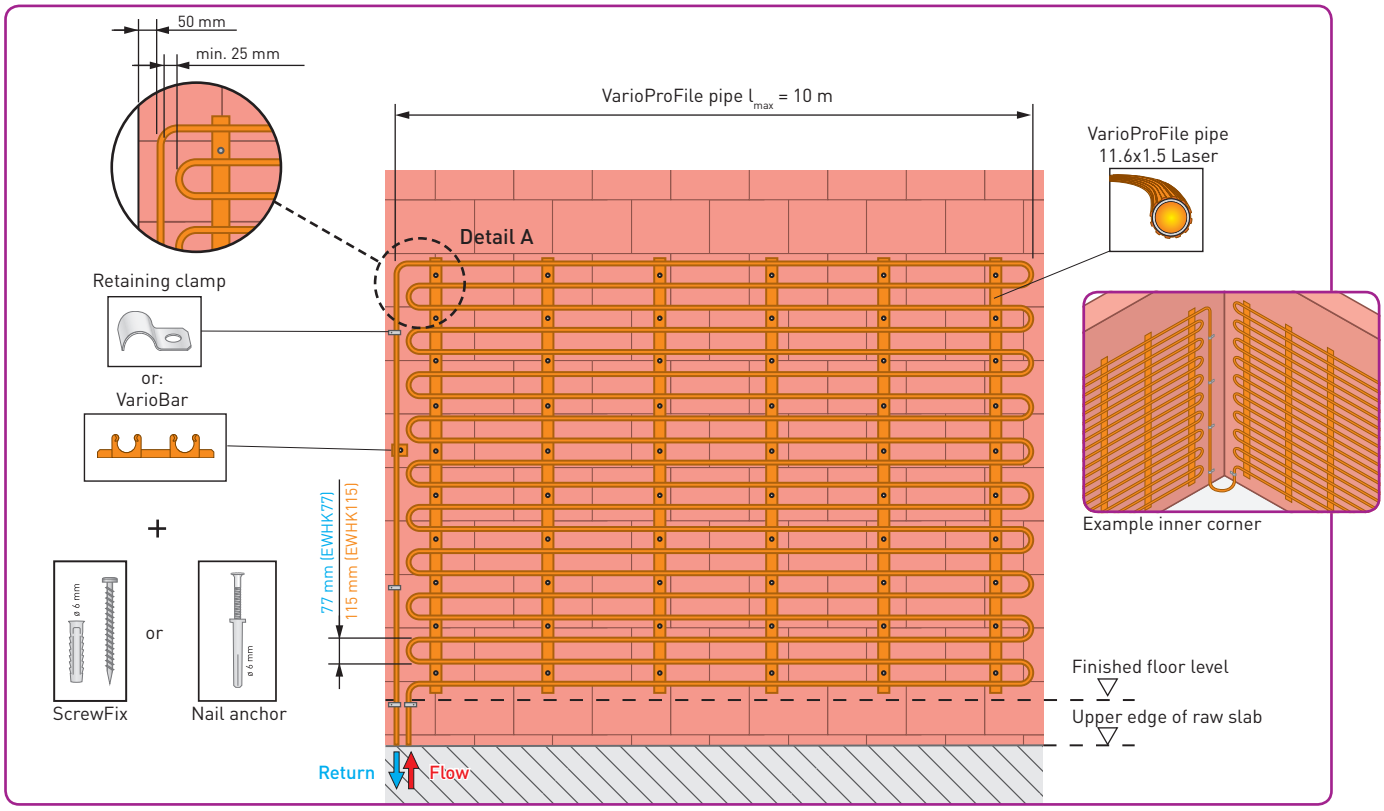


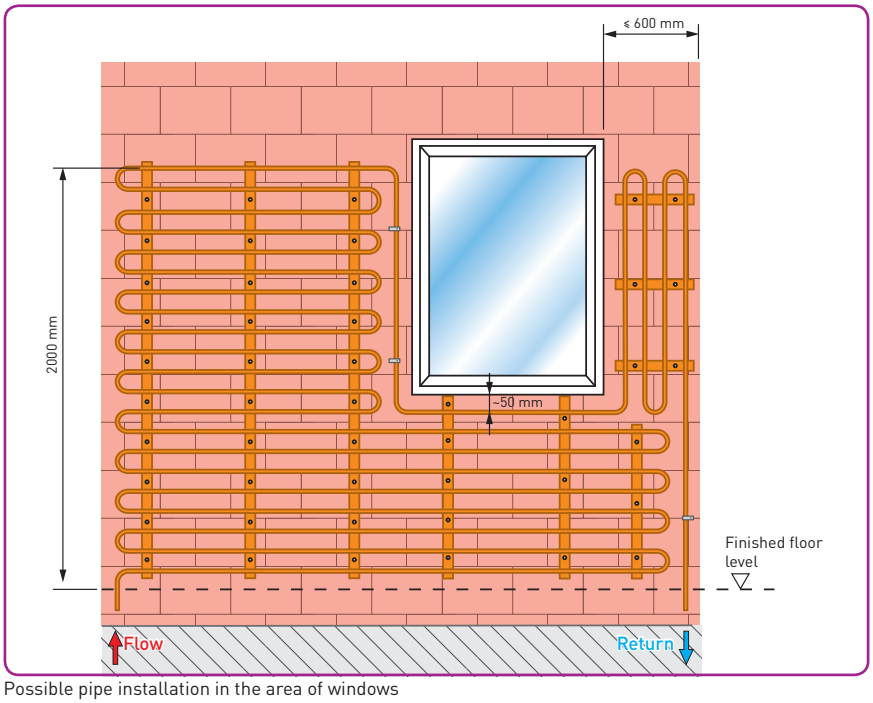
Special case outside corner



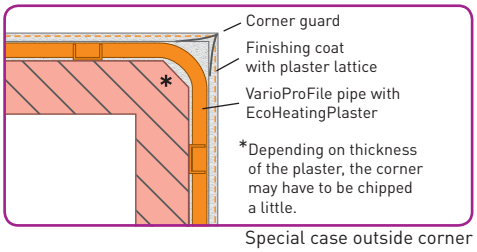
Possible pipe installation variant for sockets

5.2 EasyFlexWall

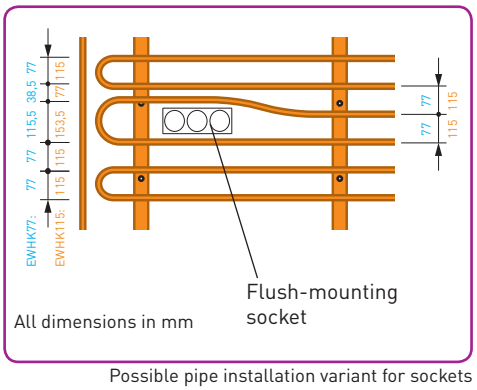




Possible pipe installation in the area of windows



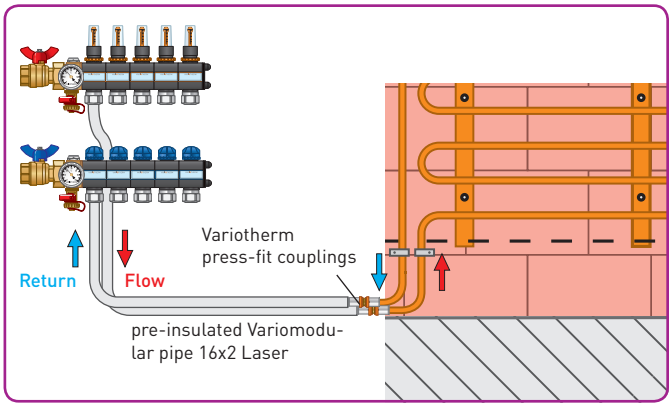
Special case outside corner



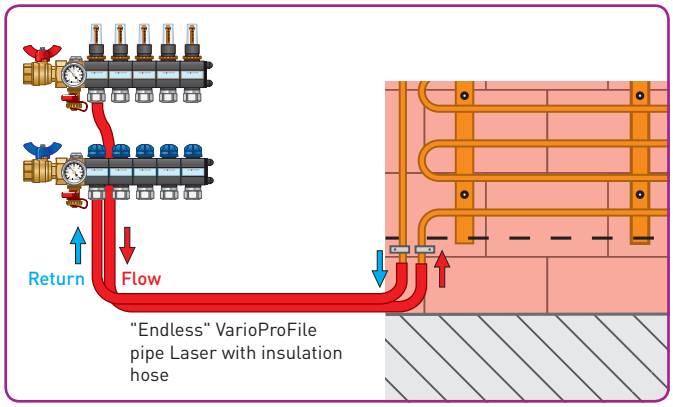
Possible pipe installation variant for sockets

5.3 Supply pipe

Pre-insulated Variomodular pipe 16x2 Laser
Variotherm press-fit coupling connections

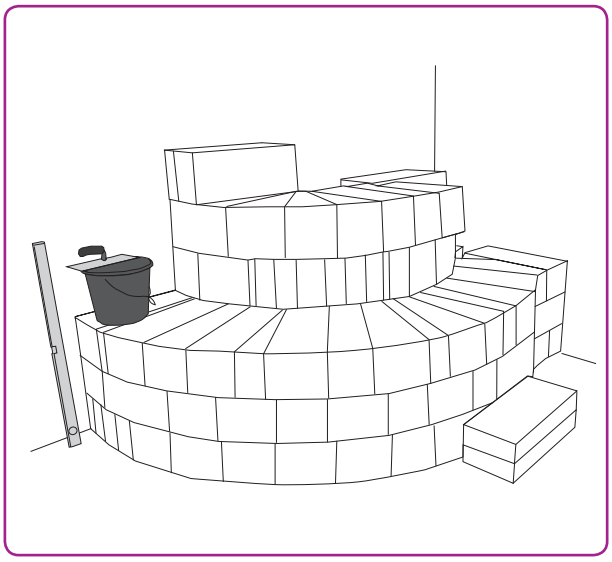


Insulation hose 4 mm
"Endless" VarioProFile pipe with insulation hose

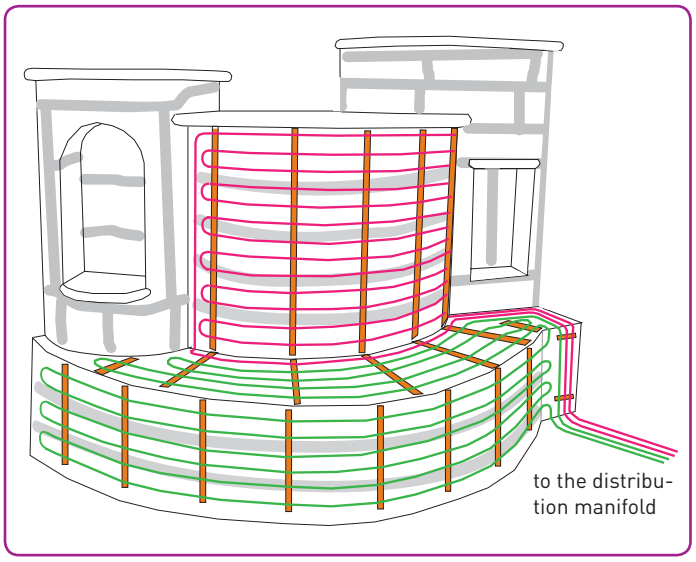


5.4 EasyFlexWall as 'designer heating'

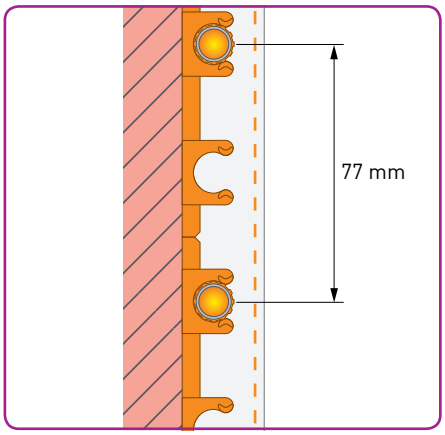
The EasyFlexWall can also be used to heat centrally heated tiled stoves.

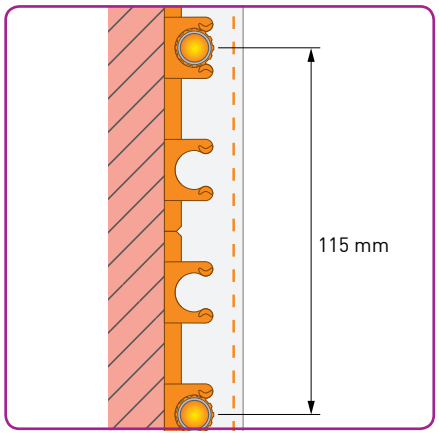


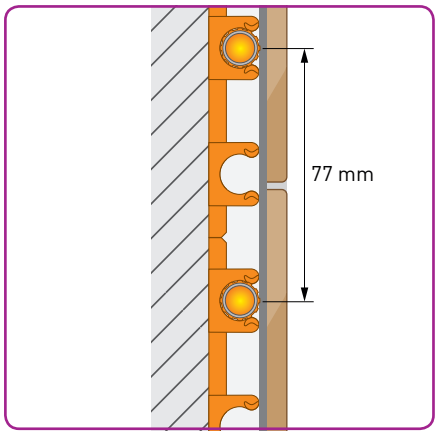
Building a substructure (e.g. with porous concrete)



Installing the VarioProFile pipe







Caution: The plaster must be compatible with the planned flow and surface temperature of the EasyFlex-Wall in the long term!

6. Dimensioning

6.1 Heat requirement calculation

Norm-Heizlast nach ÖNORM EN 12831 (ausführliches Verfahren) Datum: 08.11.2016
Nationaler Anhang: ÖNORM H 7500 Seite: 1

Projekt: XXXXX

Übersicht der Bauteile

Code	Bezeichnung	U-Wert W/m²K	Rges m²K/W	Rsi m²K/W	Rse m²K/W	R-Baut m²K/W
AF01	Außenfenster	1.100	0.909	0.130	0.040	0.739
AT01	Außentür	1.700	0.588	0.130	0.040	0.418
AW01	Außenwand	0.220	4.545	0.130	0.040	4.375

Raum Nr.	Bezeichnung	Θ_{int} °C	A_R m²	Φ_{Te} W	Φ_T W	Φ_V W	Φ_{Netto/m^2} W	Φ_{Netto/m^3} W	Φ_{Netto} W	Φ_{RH} W	Φ_{HL} W
Haus, EG			180,88	5427		3396			9160	0	9160
00.001.001	Eltern	20,0	29,10	833	833	501	46	15	1335	0	1335
00.001.002	Kinder	20,0	20,49	762	762	343	54	19	1106	0	1106
00.001.003	Vorraum	20,0	24,40	571	571	409	40	14	980	0	980
00.001.004	Bad	24,0	12,26	300	324	459	64	22	783	0	783
00.001.005	WC	20,0	1,70	21	21	57	46	16	78	0	78

Extract from EDP heat load calculation for a single family house

The EN 12831 standard with the respective national annex applies to the heat requirement calculations for the heated rooms.
Every room is considered individually. For the outside temperature, the locally acquired and standardised outdoor temperature T_{ne} is used.

6.2 Variotherm dimensioning software

Individual heating circuits can be calculated swiftly and easily with Variotherm's dimensioning software – available at *www.variotherm.at/profi*.

Dimensioning of Variotherm Heating Systems

Building project: _____ ZIP: _____ City: _____ Date: _____ Processed by: _____

No.	Room name	Floor space A [m²]	Maximum length of DCH or SH L [m]	Heating load Q [W]	Supplement heating load Suppl. [%]	Heating load incl. Supplement Q+Suppl. [W]	Room temp. ti [°C]	Heat transfer system	Floor covering FH [d/λ]	Dimensioning temperature tf/tr [°C]	Mathematical Dim.	Unit	Type	Practical No. of circuits	Dim.	Unit	Type	Residual performance	FH to (Ti=20) [°C]	Supply pipe	Supply line length per circuit [m]	Pressure loss per circuit [mWC]	Flow quantity per circuit [kg/h]	Distribution manifold number
1	Room 1	12,50		566	10%	623	20	SystemWall SWHK2		40/30	4,98	m²	SWHK2	1	**6,00**	**m²**	**SWHK2**	127	-	16 x 2	17	0,31	65	●1
2	Room 2	14,50		655	10%	721	20	SystemWall SWHK2		40/30	5,76	m²	SWHK2	1	**7,00**	**m²**	**SWHK2**	155	-	16 x 2	12	0,45	76	●1
3	Kitchen	12,00		610	10%	671	20	SystemWall SWHK2		40/30	5,37	m²	SWHK2	1	**6,50**	**m²**	**SWHK2**	142	-	16 x 2	14	0,38	71	●1
4	Living room	25,00		1250	10%	1.375	22	SystemWall SWHK2		40/30	13,35	m²	SWHK2	2	**7,00**	**m²**	**SWHK2**	67	-	16 x 2	13	0,32	63	●1
5	WC	2,50		187	10%	206	20	SystemWall SWHK2		40/30	1,65	m²	SWHK2	1	**2,50**	**m²**	**SWHK2**	107	-			0,02	27	●1
6	Anteroom	10,50		650	10%	715	20	SystemWall SWHK2		40/30	5,72	m²	SWHK2	1	**6,00**	**m²**	**SWHK2**	35	-	16 x 2	15	0,30	65	(●1)
7	Bath room	8,50		590	10%	649	24	SystemWall SWHK2		40/30	7,91	m²	SWHK2	1	**9,00**	**m²**	**SWHK2**	89	-	16 x 2	20	0,43	64	●1

Summary of the heating systems

Amount	Unit	Heating system	Type	Pipe / Heating element	
51,0	m²	System wall heating	SWHK2	510,0	lfm
	m²	System wall heating	SWHK3		
	m²	Modular wall heating	MSW		
	m²	EasyFlex wall heating	EWH77F		
	m²	EasyFlex wall heating	EWHK77		
	m²	EasyFlex wall heating	EWHK115		
	m²	Modular ceiling heating	MSD/MRD		
	m²	Screed floor heating	RA10		
	m²	Screed floor heating	RA15		
	m²	Screed floor heating	RA20		
	m²	Screed floor heating	RA25		
	m²	Screed floor heating	RA30		
	m²	Compact floor heating	RA10		
	m²	Compact floor heating	RA20		
	m	Skirting heating	HL mini		
	m	Skirting heating	HL Ia		
	m	Skirting heating	HL IIa		
	m	Skirting heating	HL IIIa		
	m	Ducted channel heating	BKH1 mini		
	m	Ducted channel heating	BKH1		
	m	Ducted channel heating	BKH2 mini		
	m	Ducted channel heating	BKH2		
104,0	m	Supply pipe	16x2	104,0	lfm
	m	Supply pipe	11.6x1.5		
		Total filling water		**69,4**	**litres**

Summary of pipe length by line

Line	Room	m ø 16	m ø 11,6	Line	Room	m ø 16	m ø 11,6
1	Room 1	77,0		14			
2	Room 2	82,0		15			
3	Kitchen	79,0		16			
4	Living room	166,0		17			
5	WC	25,0		18			
6	Anteroom	75,0		19			
7	Bath room	110,0		20			
8				21			
9				22			
10				23			
11				24			
12				25			
13				TOTAL		614,0	

Summary of the floor heating surface area

Screed floor heating	m²
Compact floor heating	m²

Summary of loads

Total heating load	4.508 W
Total installed load	5.680 W

	tf/tr	Number of heating circuits	Flow quantity manifold [kg/h]	Max. pressure loss + 0,1 mWC for manifold [mWC]	Manifold notation according to drawing
Distribution manifold ●1	40/30	7	494	0,55	
Distribution manifold ●2					
Distribution manifold ●3					
Distribution manifold ●4					
Distribution manifold ●5					
When all distribution manifolds are fed via one pump, the following applies:					
Total flow quantity:			494	kg/h	
Maximum pressure loss from distribution manifold incl. 0.1mWC for max. opened valve			0,55	mWC	

Variotherm dimensioning software example

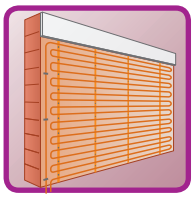
6.3 Heat transfer tables

SystemWall - SWHK2

- **Only valid with usage of Eco heating plaster (dry bulk density 28d = 1580 kg/m³)**
- Pipe distance 100 mm
- Finishing plaster thickness of 10 to 15 mm above pipe apex
- Max. length of *VarioProFile pipe 16x2 Laser* per heating circuit incl. supply pipe: 120 m (1 m² = 10 m), (e.g. 10 m² heating circuit and 20 m supply pipe)

Heat output in W/m²:

t_f/t_r	t_{mH}	Room temperature [T_r] 15 °C	18 °C	20 °C	22 °C	24 °C	T_0 at T_r = 20°C
30/20	25.0	100	65	42	20	-	25
30/25	27.5	121	85	62	41	20	27
35/25	30.0	142	106	83	62	40	29
35/28	31.5	154	118	95	74	52	30
35/30	32.5	162	127	104	82	61	30
37.5/32.5	35.0	183	148	125	103	82	32
40/30	35.0	183	148	125	103	82	32
40/35	37.5	204	169	146	123	103	34
45/35	40.0	225	190	167	144	124	36
45/40	42.5	246	210	187	164	144	38
50/40	45.0	267	231	208	185	164	40
50/45	47.5	288	251	229	206	186	42
55/45	50.0	310	272	250	228	208	44



SystemWall - SWHK3

- **Only valid with usage of plaster provided by the costumer (dry bulk density 28d ≥ 1250 kg/m³)**
- Pipe distance 100 mm
- Pipe coverage approx. 10 mm above pipe apex
- Max. length of *VarioProFile pipe 16x2 Laser* per heating circuit incl. supply pipe: 120 m (1 m² = 10 m), (e.g. 10 m² heating circuit and 20 m supply pipe)

Heat output in W/m²:

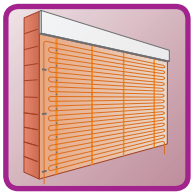
t_f/t_r	t_{mH}	Room temperature [T_r] 15 °C	18 °C	20 °C	22 °C	24 °C	T_0 at T_r = 20°C
30/20	25.0	90	58	37	18	-	23
30/25	27.5	108	76	56	36	18	25
35/25	30.0	127	95	74	55	36	27
35/28	31.5	138	107	85	66	46	28
35/30	32.5	146	114	93	74	54	29
37.5/32.5	35.0	164	133	112	92	73	30
40/30	35.0	164	133	112	92	73	30
40/35	37.5	183	152	131	110	92	32
45/35	40.0	202	171	150	129	111	34
45/40	42.5	221	189	168	148	129	36
50/40	45.0	240	207	187	166	147	38
50/45	47.5	259	225	206	185	167	40
55/45	50.0	279	244	225	205	187	41

t_{mH} = mean heating circuit water temperature = $\frac{t_f + t_r}{2}$ [°C]

t_f/t_r = flow/return temperature [°C]

T_0 = mean surface temperature [°C]

T_r = room temperature [°C]

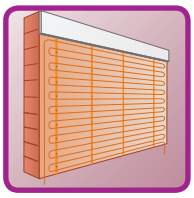


EasyFlexWall - EWHK77

- **Only valid with usage of plaster provided by the costumer (dry bulk density 28d ≥ 1250 kg/m³)**
- Pipe distance 77 mm
- Pipe coverage approx. 10 mm above pipe apex
- Max. length of *VarioProFile pipe 11.6x1.5 Laser* per heating circuit incl. supply pipe: 80 m (1 m² = 13 m), (e.g. 5 m² heating circuit and 15 m supply pipe)

Heat output in W/m²:

t_f/t_r	t_{mH}	Room temperature [T_r] 15 °C	18 °C	20 °C	22 °C	24 °C	T_0 at T_r = 20°C
30/20	25.0	91	58	37	17	-	24
30/25	27.5	110	77	56	37	17	26
35/25	30.0	130	97	76	57	35	28
35/28	31.5	142	109	87	67	47	28
35/30	32.5	150	117	95	75	55	29
37.5/32.5	35.0	170	137	115	94	76	31
40/30	35.0	170	137	115	94	76	31
40/35	37.5	189	157	136	115	95	33
45/35	40.0	209	177	156	134	115	35
45/40	42.5	230	197	175	153	134	36
50/40	45.0	251	217	195	173	153	38



EasyFlexWall - EWHK115

- **Only valid with usage of plaster provided by the costumer (dry bulk density 28d ≥ 1250 kg/m³)**
- Pipe distance 115 mm
- Pipe coverage approx. 10 mm above pipe apex
- Max. length of *VarioProFile pipe 11.6x1.5 Laser* per heating circuit incl. supply pipe: 80 m (1 m² = 8.7 m), (e.g. 7.5 m² heating circuit and 15 m supply pipe)

Heat output in W/m²:

t_f/t_r	t_{mH}	Room temperature [T_r] 15 °C	18 °C	20 °C	22 °C	24 °C	T_0 at T_r = 20°C
30/20	25.0	71	45	29	13	-	24
30/25	27.5	86	60	44	29	13	25
35/25	30.0	102	76	60	45	27	27
35/28	31.5	111	85	69	53	36	27
35/30	32.5	118	92	75	59	43	28
37.5/32.5	35.0	134	108	90	74	60	29
40/30	35.0	134	108	90	74	60	29
40/35	37.5	149	124	107	90	75	30
45/35	40.0	165	139	123	105	90	33
45/40	42.5	181	155	138	120	105	34
50/40	45.0	198	171	154	136	120	35

t_{mH} = mean heating circuit water temperature = $\frac{t_f + t_r}{2}$ [°C]

t_f/t_r = flow/return temperature [°C]

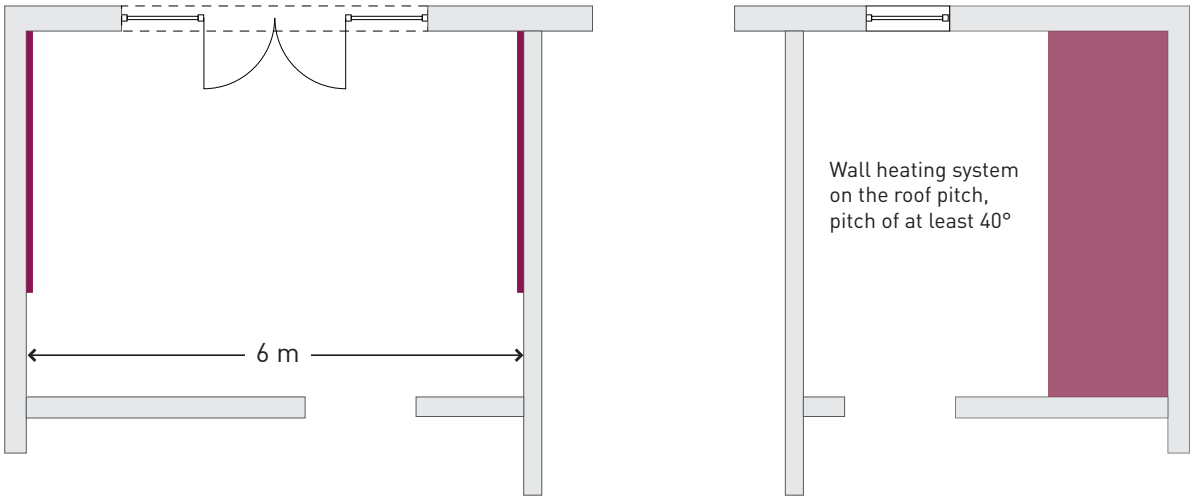
T_0 = mean surface temperature [°C]

T_r = room temperature [°C]

6.4 Distribution of the heating surfaces

Wall heating installations are used for heating occupied areas. For this reason, they should be evenly distributed over the interior sides of exterior walls. At normal ceiling heights (up to 3 m) in buildings with good thermal insulation, designing the System wall heating or Easy flex wall heating (pipe layout) to a maximum height of 2 m above the finished floor level is sufficient. In special cases (ceiling height > 3 m, e.g. halls, stairwells, therapy areas) the wall heating installations must be designed higher than 2 m.

Experience has shown that the comfort effect is perceived at a distance of approximately 5 m from the heated wall.
In larger rooms it is advantageous to install wall heating systems on two opposing walls because the radiance effect on the body declines in proportion to the square of the distance.



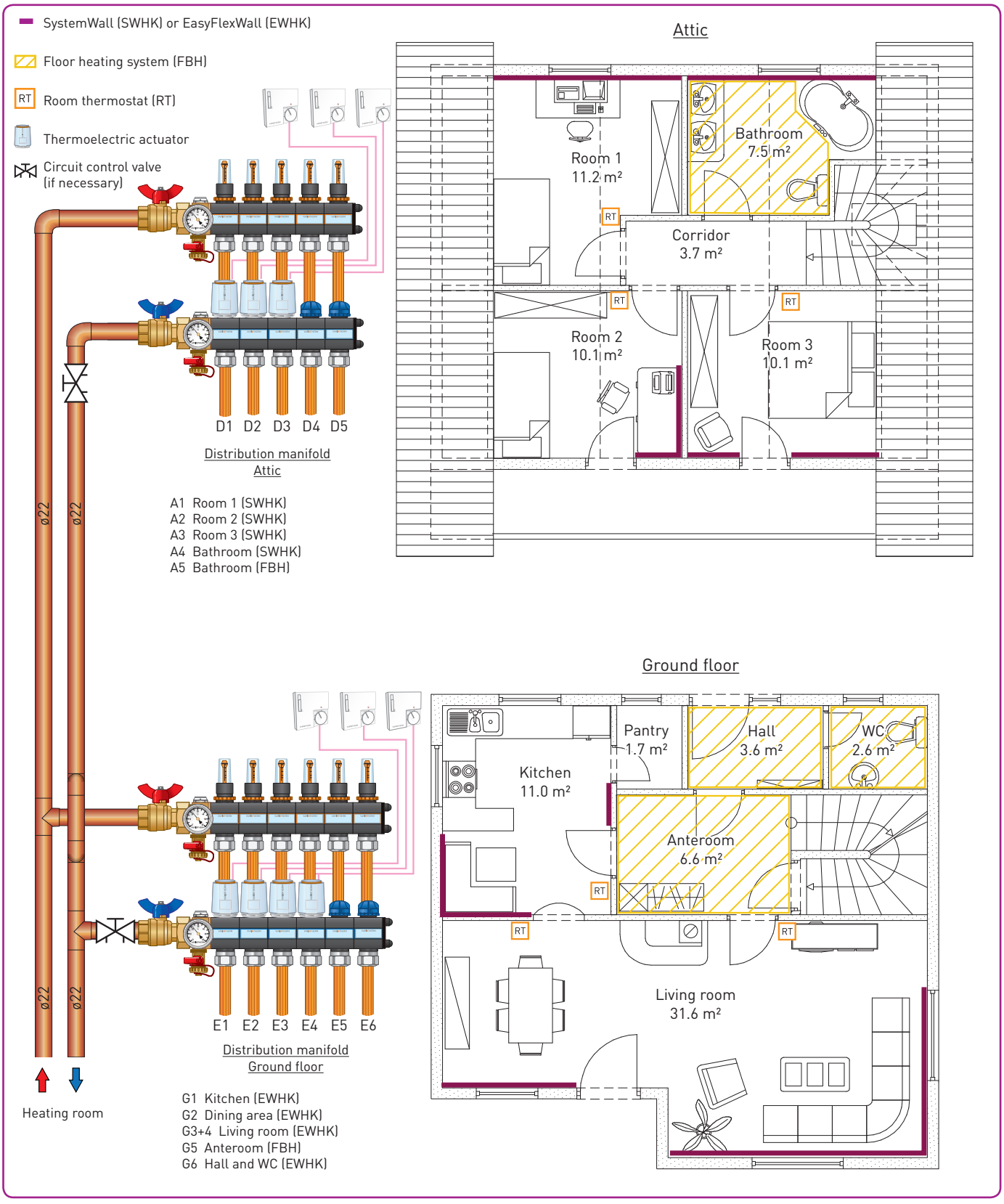
With a good arrangement of the radiant heating surfaces and U-values (exterior wall) of ≤ 0.3 W/m²K the room air temperature can be reduced by up to 3 °C while retaining the same perceived temperature (cosiness). Seating and glass surfaces (e.g. windows) must be taken into consideration when choosing the arrangement of wall heating surfaces.

6.5 Issues relating to furniture

Since the radiant heat should penetrate into the living area, this is to be taken into consideration in the furniture planning. Wall fittings, full bookcases, built-in cupboards etc. should not be planned before the wall heating systems. Desks, chests of drawers, open seats, small boxes, kitchen corner banks, pictures etc. usually present no problem. General rule of thumb: maximum of 15% furnished area.
Tip: Beds (especially the bedheads) should not be placed directly in the radiation area of wall heating elements.

6.6 Single-family house example

In the example provided, the heating system has been adapted to suit the rooms: A floor heating system is planned for tiled rooms (anterooms, toilet, bathroom) and wall heating surfaces are planned for the living rooms, work rooms and bedrooms. A room thermostat for controlling the room temperature is planned for the kitchen, dining area and living room (influence of external heat sources from kitchen appliances, south-facing glass surfaces and tile stoves).



7. Cooling

One reason for the frequent lack of satisfaction with air-conditioning systems is the inadequacy of the thermal ambient conditions in the air-conditioned rooms. Most frequently mentioned is the presence of uncomfortable draughts. Cooling via wall surfaces offers similar cosiness advantages to wall heating systems (see Point 1.1). The heat accumulated in human bodies is dissipated by the mildly cooled wall surfaces.

7.1 Effects of the wall cooling on the room

When a wall surface is cooled, all warmer objects in the room (floor, interior walls, persons, equipment, etc.) radiate heat into this cooled surface. This loss of heat through radiation leads to a reduction in the surface temperature of these objects, thus providing a cooling effect. The ambient air in the room is also cooled to a certain extent.

7.2 Cooling mode

Based on experience, cooling makes sense at a room temperature of 26 °C or more. To achieve a perceivable effect, a reduction of the wall surface temperature to a maximum of 15 °C is possible (dew point!) to ensure an appropriate degree of body cooling.

7.3 Economy

- Water transports heat much better than air. The costs incurred by pumping in wall cooling systems are significantly lower than the costs incurred by using fans. A wall cooling system does not replace an air-conditioning system (no dehumidification and no ventilation). A 100% coverage of the cooling load, as per VDI 2078 (calculation of the cooling load for air-conditioned rooms), is possible in buildings designed for low energy consumption with shadowing equipment and low internal loads.

- One of the major advantages of wall heating/cooling systems is the low additional investment costs. A single system is used for the heating and cooling modes. The same wall surface, the same pipe system, and the same distribution manifold with supply lines and circulation pump are used for both modes. Only the generation of cooling (chiller/heat pump/cooling from the floor and ground water) is planned in parallel to the heating unit.

7.4 Combination of displacement ventilation and wall cooling

Displacement ventilation is an air-conditioning system with low air exhaust speeds and laminar flow of the escaping air at the exhaust vents. Low turbulence in the air flow through the room is achieved through the type of ducting in the room, blowing of air at floor level at a slightly subnormal temperature and extraction of the exhaust air at the ceiling level. This type of displacement flow, known as "displacement ventilation" can achieve almost complete freedom from draughts. The combination of wall cooling and displacement ventilation allows significantly higher cooling performance to be achieved compared to using only a displacement ventilation system, without exceeding thermally comfortable air speeds. If the supplied air is dehumidified then low wall surface temperatures, and thus high radiant cooling performance, can be achieved without the formation of condensation, even on hot and humid days.

7.5 Cooling performance

SystemWall - SWHK2

- Cooling performance in W/m² when using EcoHeatingPlaster (oven-dry density 28d = 1,580 kg/m²)
- approx. 10 - 15 mm pipe covering

t_f/t_r	t_{mC}	Room temperature [T_r]					T_0
		23 °C	24 °C	25 °C	26 °C	27 °C	at T_r = 26°C
16/20	18.0	38	45	53	60	68	18
17/21	19.0	30	38	45	53	60	19

SystemWall - SWHK3

- Cooling performance in W/m² when using on-site plaster (oven-dry density 28d ⩾ 1,250 kg/m²)
- approx. 10 mm pipe covering

t_f/t_r	t_{mC}	Room temperature [T_r]					T_0
		23 °C	24 °C	25 °C	26 °C	27 °C	at T_r = 26°C
16/20	18.0	34	40	47	54	60	19
17/21	19.0	28	34	40	47	57	20

EasyFlexWall - EWHK77

- Cooling performance in W/m² when using on-site plaster (oven-dry density 28d ⩾ 1,250 kg/m²)
- approx. 10 mm pipe covering

t_f/t_r	t_{mC}	Room temperature [T_r]					T_0
		23 °C	24 °C	25 °C	26 °C	27 °C	at T_r = 26°C
16/20	18.0	34	40	47	54	60	19
17/21	19.0	28	34	40	47	57	20

EasyFlexWall - EWHK115

- Cooling performance in W/m² when using on-site plaster (oven-dry density 28d ⩾ 1,250 kg/m²)
- approx. 10 mm pipe covering

t_f/t_r	t_{mC}	Room temperature [T_r]					T_0
		23 °C	24 °C	25 °C	26 °C	27 °C	at T_r = 26°C
16/20	18.0	27	32	38	43	50	20
17/21	19.0	22	27	32	38	43	21

t_{mC} = mean cooling circuit water temperature = $\frac{t_f + t_r}{2}$ [°C]

t_f/t_r = flow/return temperature [°C]

T_0 = mean surface temperature [°C]

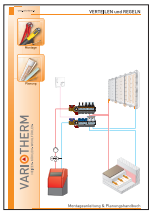
T_r = room temperature [°C]

7.6 Surface condensation

The surface temperature must not reach or fall below the dew point temperature!
The mean surface temperature T_0 corresponds approximately to the return temperature t_r

The Variotherm EcoHeatingPlaster can absorb humidity very well and then release this very quickly.

Relative humidity [%rH]	**Room temperature [T_r]**				
	24 °C	25 °C	26 °C	27 °C	28 °C
70%	18.0	19.0	20.0	21.0	22.0
60%	15.5	16.5	17.5	18.5	19.2
50%	13.0	14.0	15.0	15.8	16.8
40%	9.8	10.5	11.5	12.5	13.2



"DISTRIBUTION and CONTROL"

Details regarding the system and heating circuit pipes and the room temperature control are provided in the "DISTRIBUTION and CONTROL" design and installation manual.

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