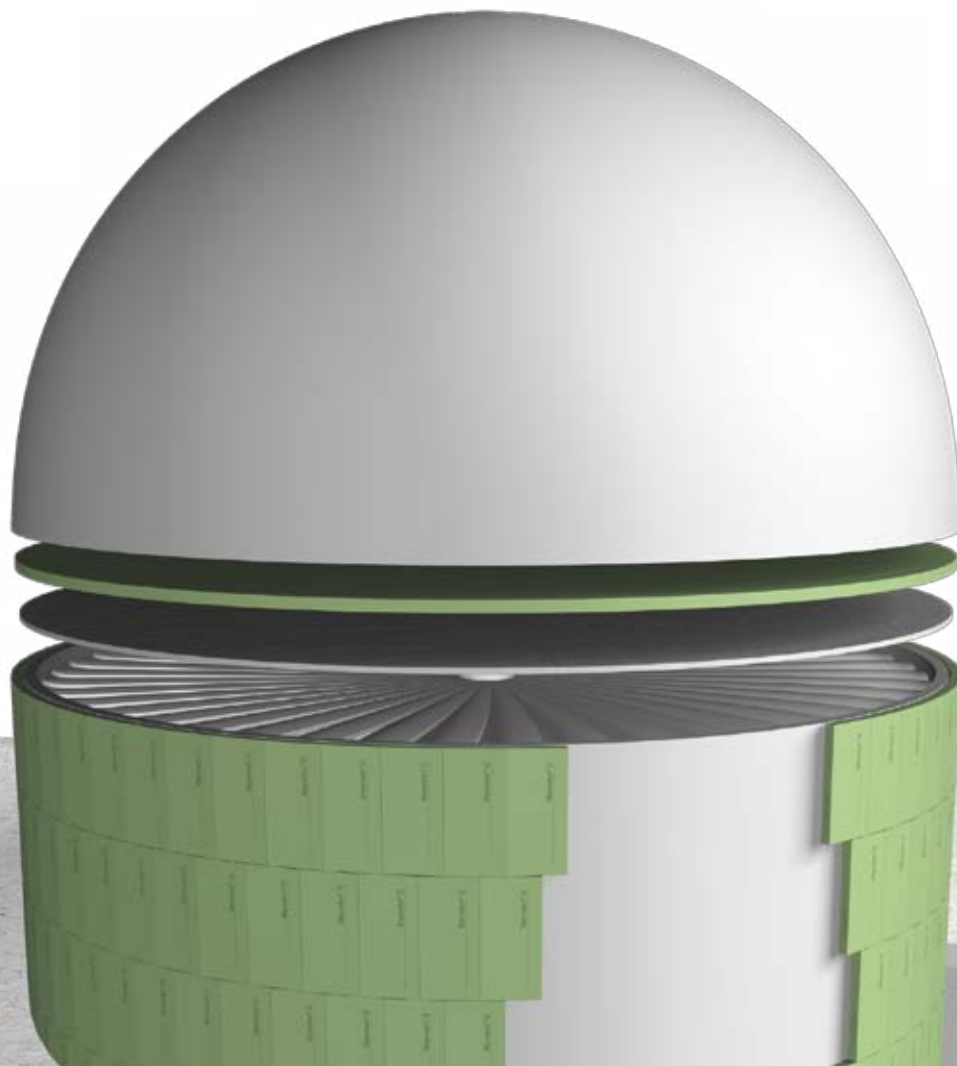


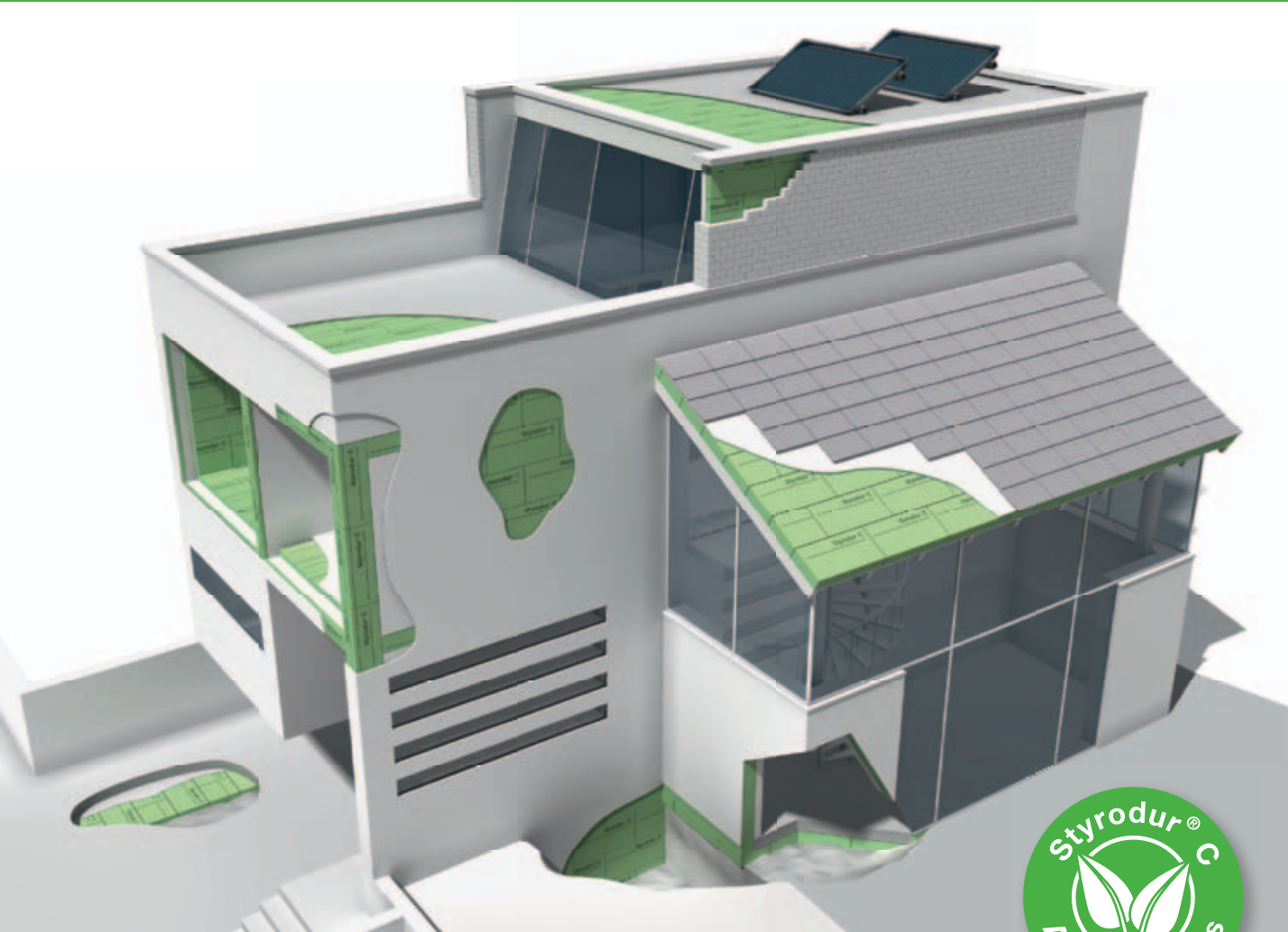
Thermal Insulation of Biogas Plants



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Note:

The data contained in this publication are based on our current knowledge and experience. In view of the many factors that may affect processing and application of our product, these data do not relieve processors from carrying out their own investigations and tests; neither do these data imply any guarantee of certain properties, nor the suitability of the product for a specific purpose. Any descriptions, drawings, photographs, data, proportions, weights, etc. given herein may be changed without prior notice and do not constitute the agreed contractual quality of the product. It is the responsibility of the recipient of our products to ensure that any proprietary rights and existing laws and legislation are observed. (March 2010)



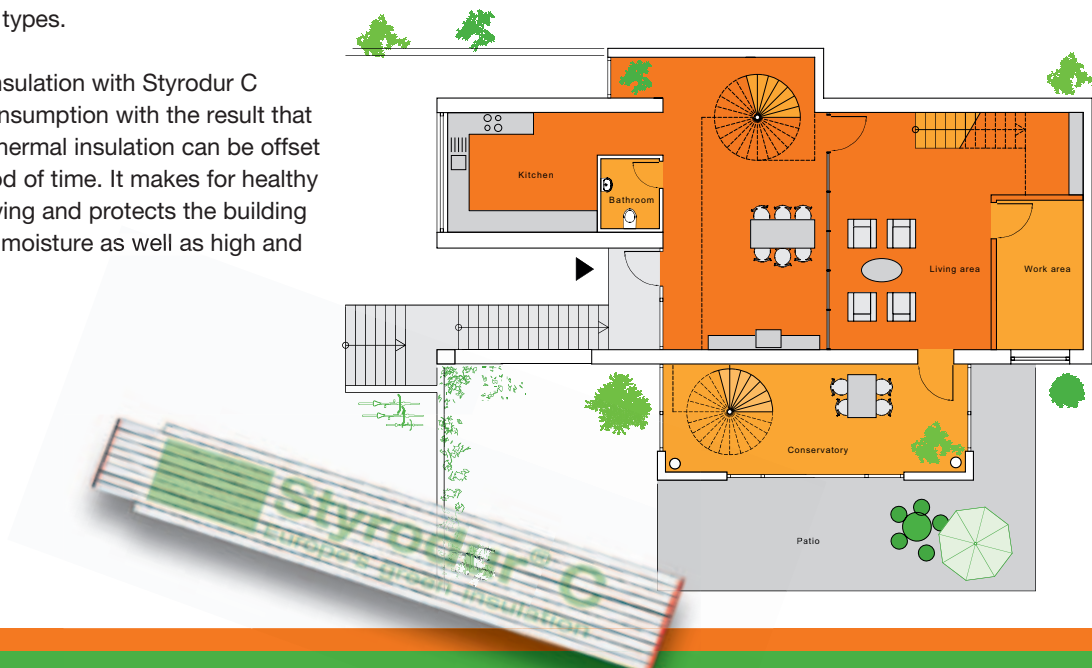
1. Styrodur® C Thermal Insulation

Styrodur® C is BASF's environmentally friendly, extruded polystyrene rigid foam. It is free of CFC, HCFC, and HFC and makes an important contribution toward reducing emissions of carbon dioxide (CO₂).

Due to its high compressive strength, low moisture absorption, durability, and resistance to decay, Styrodur C has become synonymous with XPS in Europe. The compressive strength is the main distinction between the various Styrodur C types.

Effective thermal insulation with Styrodur C reduces energy consumption with the result that the investment in thermal insulation can be offset within a short period of time. It makes for healthy and comfortable living and protects the building from the effects of moisture as well as high and low temperatures.

Styrodur C is manufactured in accordance with the requirements of the European standard DIN EN 13 164. In terms of fire protection, it has been classified as Euro-class E in accordance with DIN EN 13501-1. It is quality-controlled by Wärmeschutz e.V. and has been granted the approval no. Z-23.15-1481 by the DIBt, an institute of the Federal and Laender Governments for a uniform fulfillment of technical tasks in the field of public law.



2. Insulation of Biogas Plants With Styrodur® C

2.1 Thermal Insulation of Biogas Plants

This brochure is designed to provide planners, manufacturers, and operators of biogas plants with aids and background information on the use of Styrodur® C in biogas plants.

Animal feeding operations generate large quantities of slurry that can be used to produce biogases in relatively simple and economic fermentation processes. These biogases are then used to generate energy or heat. The optimum operating temperature for the production process of biogas is higher than the ambient temperature. Heat is generated in the fermentation process itself.

In order to maintain the process at an optimum operating temperature with regard to the biogas yield, it is advisable to reduce heat loss from the fermenter tanks. Thermal insulation materials are installed on the walls, floors, and covers of tanks.



Fig. 1: Styrodur® C thermal insulation on a reinforced concrete fermenter wall.

2.2 Requirements for Thermal Insulation Materials in Biogas Plants

Robust requirements such as:

- high compressive stress,
- moisture,
- contact with humic acid,
- biogas atmosphere

call for robust thermal insulation materials. The extruded rigid polystyrene (XPS) foam Styrodur C meets these requirements at an outstanding price-performance ratio.

2.3 Composition of Biogas and Suitability of Styrodur C

Biogas is the term for a mixture of various gases in different mix ratios.

- 50–80% by volume of methane
- 20–50% by volume of carbon dioxide
- 0.01–0.4% by volume of hydrogen sulphide
- Traces of:
 - Ammonia
 - Hydrogen
 - Nitrogen
 - Carbon monoxide

Styrodur C is resistant to the gas composition of this atmosphere.

2.4 Fermenter Constructions

In general, fermenters are designed to either stand upright or lie horizontally. They are built above ground, partly set into the ground, or fully sunk into the ground, and may

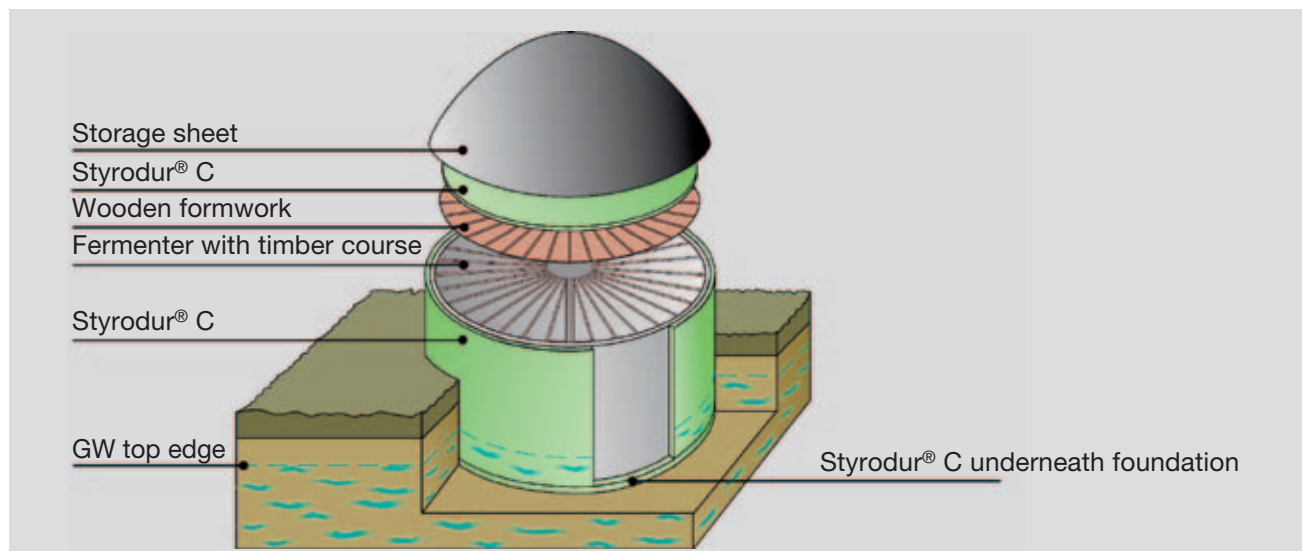


Fig. 2: Schematic diagram of fermenter with sheet dome.

therefore be designed to bear the load of traffic. One of the most common forms is the standing bin shape with a sheet dome.

For all variations, thermal insulation is ideally applied to the exterior, with the exception of the fermenter cover in form of a wooden construction. In this case, the fermenter open toward the top is covered with a timber course, then the wooden formwork is added, and the Styrodur® C insulation goes on top. The gas sheet dome provides the top cover.

2.5 Process Temperatures and Using Styrodur® C

Depending on its composition, the substrate slurry has different dwell times in the fermenter, with the decaying process taking place at temperatures of between 20°C and 55°C. Styrodur C is a thermoplastic whose physical properties change with the charged temperature level. The application temperature threshold of Styrodur C is 75°C. The temperature in heat-insulated biogas plants consistently remains below this level.

As the temperature falls, the thermal conductivity of Styrodur C decreases and therefore improves the thermal insulation performance of the insulation boards in the wintertime. This physical product property reduces the amount of energy supplied when calculating the thermal energy required to maintain the process temperature in the slurry.

Table 1: Thermal conductivity of Styrodur® C in relation to temperature.

Example: Styrodur 3035 CS, board thickness 50 mm

Temperature [°C]	Thermal conductivity in W/(m·K) Styrodur® C
-20	0.030
0	0.032
10	0.033
20	0.034
30	0.035
40	0.036
50	0.037

3. Application of Styrodur C

3.1 Areas of Application for Styrodur C in Fermenters

Fermenters should preferably be insulated on the outside, covering the entire structure. Depending on the type of construction and its depth in the ground, there are different designs with differentiated static and structural requirements on the insulation material, which the builder must incorporate in the planning of the supporting framework, also performing diffusion calculations.

Fermenters built above the ground—not sunk into the ground—can be protected with thermal insulation as a frost shield against subsoil cooling and potential frost heaves. Fermenters sunk into the ground must be fitted with perimeter insulation similar to heated living areas in the basement of buildings. Constructions that are completely sunk into the ground, are covered with soil, or must withstand traffic are likewise comprehensively protected against heat loss by means of perimeter insulation.

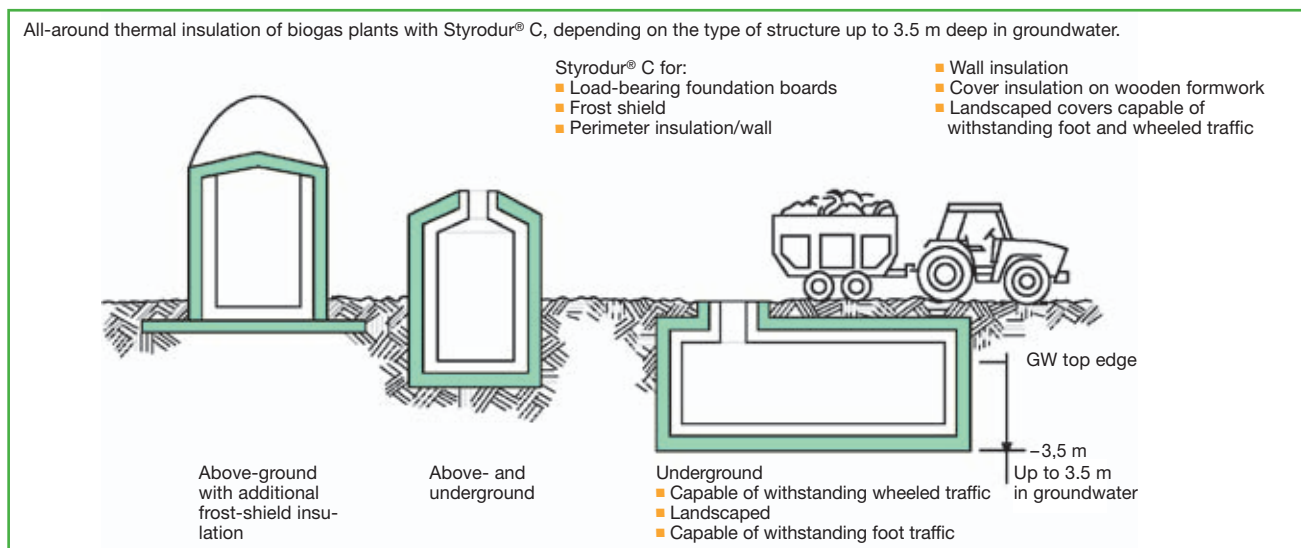


Fig. 3: Thermal insulation with Styrodur® C for various fermenters.

3.2 Information on Water-vapor Diffusion

Styrodur® C is a closed-cell, extruded rigid polystyrene foam that practically does not absorb water in droplet form. In terms of diffusion, however, extruded foams are not vapor-proof construction materials, and gaseous water molecules are able to permeate the insulating material. The water-vapor partial pressure, which is dependent on the temperature and relative humidity content, is sufficient to act as a driving force for water-vapor diffusion movement. The respective potential equalization always occurs from the higher to the lower level.

Biogas plants maintain a higher water-vapor partial pressure inside the fermenter compared to the ambient air, virtually year-round. In the vapor-pressure compensation process, it is important to ensure that resistance to water-vapor transmission in each partial layer becomes increasingly lower toward the outside. Otherwise, this may result in water-vapor concentration in the layer with higher resistance. If the temperature falls below the dew-point level along the diffusion route, as it does in fermenters, water-vapor concentration and the risk of condensation in the layer with higher resistance is the consequence.

In mesophilic biogas plants, the ambient temperature in summer may be the same as the temperature in the fermenter. The higher moisture content in the fermenter and the higher water-vapor partial pressure generate the outward movement of water vapor to create moisture-potential equalization.

Where parts of the structure are sunk into the ground (floor and wall), the bordering soil may also prevent water-vapor from escaping, which can be the case with damp, cohesive soils with a high fine-particle content. Here again, condensation may occur in the insulating material.

The diffusion behavior must be factored into the planning of the fermenter by minimizing or preventing any diffusion flow through the proper arrangement of vapor-barrier layers. The water-vapor barrier should always be added on the warm side of the thermal insulation boards toward the fermenter. **Table 2** shows the water-vapor diffusion resistance of Styrodur C as a function of the layer thickness.

Table 2: Water-vapor diffusion resistance index of Styrodur® C in relation to thickness.

Thickness of layer in mm	Water-vapor diffusion resistance index [-]
20	200
40	150
60	100
80	100
100	100
120	80
140	80

If moisture dimensioning is incorrect, water may collect in the insulating material. It is important to note that if the moisture content in the extruded foam increases by 1% by volume, the thermal conductivity increases by 2.3% on average.

From a cost-benefit point of view, it may at times be advantageous to accept the concentration of moisture during long-term operation of the fermenter. In order to counteract a concentration of condensate of approx. 10–20% by volume, the calculated thickness of the insulating material required can be increased by approx. 25–50%, for example.

3.3 Thermal Insulation of Bed Plates

Styrodur C grades 3035 CS, 4000 CS, and 5000 CS, which feature different compressive strengths, are suitable for applications with high permanent loads. The extruded foam boards may also be used in areas with permanent or continuously pressing water (ground-water); however, the boards must be installed no deeper than 3.5 m in the water.

For this construction method, the requirements of the general technical approval Z-23.34-1325 for use as load-bearing thermal insulation underneath foundation boards may serve as a basis.

The following allowable continuous compressive stress values should be used to establish structural stability:

- Styrodur 3035 CS: $\sigma_{perm} = 130 \text{ kPa}$
- Styrodur 4000 CS: $\sigma_{perm} = 180 \text{ kPa}$
- Styrodur 5000 CS: $\sigma_{perm} = 250 \text{ kPa}$

The uniaxial compressive stress of the bed plate according to DIN 1045-1, which is recorded on insulation and substrate, can be determined as the rated value f_{cd} in dimensioning the concrete tank, depending on the grade of Styrodur C:

- Styrodur 3035 CS: $f_{cd} = 185 \text{ kPa}$
- Styrodur 4000 CS: $f_{cd} = 255 \text{ kPa}$
- Styrodur 5000 CS: $f_{cd} = 355 \text{ kPa}$

Vapor barrier in the area of the bed plate

Due to diffusion, two layers of polyethylene (PE) film with a minimum thickness of 0.1 mm and with reciprocal overlapping of half the sheet width should be laid on the thermal insulation boards. The PE films additionally prevent any laitance from entering between the joints of the Styrodur C boards during the concreting procedure. They act as an adequate vapor barrier for water-vapor diffusion.

3.4 Thermal Insulation of Fermenter Walls in the Ground

In many cases, it is advantageous to install the wafer-textured Styrodur® 2800 C boards in the formwork for the concrete wall and nail them to the wooden formwork. If the diffusion-related review of the overall construction shows this to be a problem, a vapor-barrier coating can be applied on the interior fermenter wall.

Interior vapor barrier on fermenter walls

When using Styrodur 2800 C in the concrete formwork, outward water-vapor diffusion from inside the fermenter can only be reduced through an inner vapor-barrier layer.

An s_d value for the diffusion-equivalent air-layer thickness of at least 200 m is sufficient, in accordance with the Glaser method, to keep the insulating material free of condensate.

With an inner vapor barrier, the insulating material boards may be subsequently installed from the outside with pointwise adhesive application on the concrete masonry, or in groundwater areas (up to a depth of max. 3.5 m) across the entire surface.

Exterior vapor barrier made of thick bitumen layers

This method enables the application of a vapor-barrier coating to the outside of the fermenter. A thick bitumen coating such as PCI Pecimor 2N, with a 4 mm-thick cured layer yields an s_d value of just over 200 m. Thick coatings can only be applied on dry substrate, which in fermenter construction is only feasible with new plants prior to commissioning.

Once the thick bitumen coating has hardened (normally after 2 days), the Styrodur C boards can be fixated to the vapor-barrier layer with 5 to 8 bonding points, using PCI Pecimor 2N, for example. The mounting adhesion holds the thermal insulation boards in place until backfilling.

In areas with groundwater or retained seepage water over the long term, adhesion must cover the entire surface to prevent water from permeating behind the insulation boards. PCI Pecimor DK is used for this purpose, for instance. The bonding must be completely cured prior to water contact.

Exterior vapor barrier using bitumen cold-bonding self-adhesive sheets

For the subsequent insulation of plants already in operation, the exterior concrete surface must have dried off. A vapor-barrier effect of approx. 200 m can then be achieved with the use of a cold-bonding self-adhesive bitumen sheet such as PCI Pecithene. In this case, a double-sided self-adhesive butyl rubber strip of PCI Pecithene is used as the mounting adhesive to assemble the Styrodur C boards.

3.5 Styrodur® C Board Adhesion and Installation Depths

Depending on the diameter of the fermenter, the Styrodur C boards can be applied vertically in circular tanks, using the whole width of the board, or they must be segmented or slit and pressed onto the construction with securing straps. Different Styrodur C grades may be used, depending on the installation depth.

Table 3: Maximum installation depths for Styrodur® C grades

Field of application	Installation depth in m for Styrodur® C grades			
	2800 C	3035 CS	4000 CS	5000 CS
Without pressing water	9	9	17	24
Pressing water (groundwater)	–	3.5	3.5	3.5

3.6 Backfilling, Drain- and Vapor-pressure Compensation Layers

Backfilling is to occur in layers and must be compacted. When installing Styrodur 2800 C, the filling material must not be cohesive in formwork and direct concreting. Granular, water-repellent materials such as gravel-sand mixtures should be used. Dimpled sheets or randomly laid mats with tile coatings may be used to cover the Styrodur 2800 C insulation boards, for example, as a vapor-pressure equalization layer and for the discharge of condensation.

Based on diffusion parameters, constructions with vapor-barrier layers on the concrete tank place no particular requirements on backfilling.

3.7 Thermal Insulation with Frost Shield

In ground susceptible to frost and in areas with prolonged periods of severe frost, the risk of frost heaves due to the formation of ice lenses can be reduced by installing a frost shield made of Styrodur® C boards around the periphery of the structure where the depth of the foundation is too low. The boards are laid horizontally with a slight outward slope of 2% and covered, for example, with concrete pavement in a bed of chippings. The frost shield minimizes the cooling of the ground and therefore the risk of frost for the whole structure.

3.8 Thermal Insulation of Fermenter Walls Against Outside Air

The fermenter wall can best be thermally protected against the outside air above the ground with Styrodur 2800 C boards that are inserted into the formwork. The thermal insulation is nailed to the wooden formwork and when concreted forms a continuous, virtually undetachable bond to the concrete wall.

The wafer-structured surface of the Styrodur 2800 C boards can then be covered with a plaster system or with back-ventilated wood or metal flashing, for instance.

3.9 Thermal Insulation of Landscaped Fermenter Covers Subject to Traffic

Fermenters sunk into the ground and other structures can be covered and used in different ways if externally insulated with Styrodur C boards. Soil covers, landscaping, traffic surfaces, etc. may be designed in accordance with the rules established for the construction of inverted roofs. Specific planning information is provided in the Styrodur C brochure “Roof Insulation,” which can be downloaded at www.styrodur.com.

The most important rule for this type of construction is that Styrodur® C boards below service and protective surfaces always be directly followed by a permeable and drainable layer before the actual “surface” is applied as landscaping or reinforcement capable of bearing traffic. The following Styrodur C grades are used, depending on the load effect and the height of the construction.

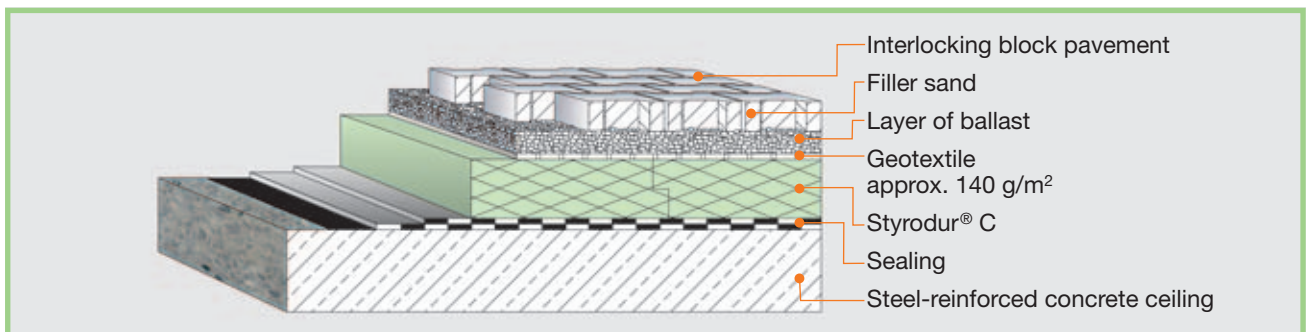


Fig. 4: Rooftop carpark construction with interlocking block pavement on layer of ballast.

Table 4: Dimensioning aid for Styrodur® C applications in load-bearing floor or roof constructions with vehicular traffic.

Vehicle				Compressive stress with traffic loads in N/mm ²							
				Unreinforced layer structure Thickness of layer above insulation board in mm				Reinforced concrete Static height in mm			
Type	Weight in t	Wheel load in kN	Contact area in mm x mm	180	200	220	240	90	100	110	120
Heavy truck	30	50	200 x 400	0.20	0.18	0.17	0.14	0.23	0.20	0.19	0.18
Truck	12	40	200 x 300	0.19	0.17	0.16	0.15	0.22	0.20	0.18	0.17
Truck	9	30	200 x 260	0.16	0.14	0.13	0.12	0.18	0.16	0.15	0.14
Truck	6	20	200 x 200	0.12	0.11	0.10	0.09	0.14	0.13	0.10	0.10
Truck	3	10	200 x 160	0.06	0.05	0.05	0.04	0.07	0.06	0.06	0.05
Fork truck	7	32.5	200 x 200	0.20	0.17	0.16	0.14	0.22	0.20	0.18	0.17

Table 5: Allowable compressive stress for Styrodur C grades with traffic loads.

Styrodur® C grade	Dimensioning of Styrodur® C grade			
	2800 C	3035 CS	4000 CS	5000 CS
Allowable compressive stress with vehicle loads in N/mm ²	0.10	0.13	0.23	0.30

Important: The dimensioning aids are nonbinding planning aids. They do not replace the sectorial and support-framework planning by a specialist engineer.

3.10 Thermal Insulation Between Fermenter and Gas Sheet Dome

For fermenters with a gas sheet dome, a closed wooden formwork is raised on rafters. The wooden rafters have a slight outward slope of 2–5% and are located at a certain distance to the edge of the tank, through which the biogas can rise from the substrate upward into the gas storage.

Styrodur C insulation boards are laid on the wooden formwork to improve the thermal insulation of the tank cover, generally using boards with thicknesses of 50–100 mm. Styrodur C 2500 C is sufficient for this application since there are no special requirements with regard to compressive strength. This material grade is also closed-cell and suitable for high moisture loads, but in principle, other grades such as Styrodur 3035 CS and Styrodur 3035 CN can be used as well.

3.11 Structural Information for Interior Insulation of Concrete Components of Biogas Plants

Since there is always outward movement of water vapor in biogas plants due to the temperature and moisture conditions, we recommend only exterior insulation for slurry tanks. Only in the area of the timber course with wooden formwork in fermenters with gas sheet domes is Styrodur C also suitable as interior insulation. The surrounding atmospheric conditions are approximately the same in this case and therefore the “driving forces” described above are relatively limited for water-vapor diffusion movement.

If interior insulation is mandatory, moisture penetration of the insulation material must be prevented by adding an interior water-vapor diffusion barrier. The resistance to slurry, the chemical compatibility with Styrodur C, and the manufacturer’s laying instructions for the vapor-barrier layer must be observed.

Interior insulation with Styrodur C does not provide chemical protection for concrete against aggressive substances in the slurry. The cross joints of the boards are not sealed tight. The insulation boards are subject to a thermal change in length, which longitudinally is approx. 0.08 mm/(m · K), and transversally approx. 0.06 mm/(m · K).

4. Properties of Styrodur® C

4.1 Fire Behavior

In terms of fire behavior, all Styrodur C grades and thicknesses meet the requirements of Euroclass E. According to the old nomenclature, Styrodur C complied with the requirements for low-flammability building materials of materials class B1 under DIN 4108.

In accordance with Barbara Eder and Heinz Schulz in Biogas Praxis, ökobuch Verlag, 2006 edition, thermal insulation applied above the ground should at least be in the category standard flammability according to materials class B2, which makes Styrodur C suitable for insulating biogas plants from a fire-behavior perspective.

4.2 Protection Against UV Radiation

Styrodur C is a rigid polystyrene foam, which like most plastics must be protected long-term against the UV rays of the sun. The surface of the insulation material can be covered with, for example, wood or metal cladding, plaster systems, or facings. If mortar systems are used, please refer to the “Data Sheet for the Installation of Extruded Rigid Polystyrene Foam Boards” (www.fpx-daemmstoffe.de).

In this connection, it is important to note that only Styrodur 2800 C is suitable for concreting and plastering. Only Styrodur 2800 C exhibits a rough, wafer-textured surface structure that can tightly bond with concrete as well as mortar and achieve adhesive tensile strengths of approx. 200 kPa. All other Styrodur C grades come with smooth surfaces and are not suitable for concreting, durable bonding with mineral adhesive mortars, or plastering.

5. Dimensioning Aids for Thermal Insulation of Biogas Plants

Empirical values are available for the reduction of heat losses and temperature variations in the fermenter with thermal insulation layers. A heat transfer coefficient (U value) of 0.3 W/(m²·K) is recommended for mesophilic fermentation (approx. 35°C), and a U value of 0.2 W/(m²·K) is appropriate for thermophilic fermentation (approx. 50°C).

Insulation layer thicknesses of approx. 100–180 mm are thus derived. The table below calculates the U values in dependency of the insulation layer thickness, thermal conductivity of the insulation boards, without taking into consideration the concrete wall of the tank, and with the heat transfer resistances for slurry to concrete wall $R_i = 0.00$ (m²·K)/W and insulating board to soil $R_a = 0.00$ (m²·K)/W. Taking into account the concrete walls of biogas plants with different thicknesses, the U values are once again slightly reduced.

Table 6: U value in relation to thermal conductivity and thickness of the insulating material.

U values W/(m ² ·K) for different thicknesses of insulation layers and thermal conductivities					
Thickness of insulation layer [mm]	Declared thermal conductivity λ_D in W/(m·K)				
	0.032	0.034	0.036	0.038	0.040
80	0.40	0.43	0.45	0.48	0.50
100	0.32	0.34	0.36	0.38	0.40
120	0.27	0.28	0.30	0.32	0.33
140	0.23	0.24	0.26	0.27	0.29
160	0.20	0.21	0.23	0.24	0.25
180	0.18	0.19	0.20	0.21	0.22

The following heat transfer resistance values must be factored into the calculation:

$R_i = 0.00$ (m²·K)/W (slurry contact) and $R_a = 0.00$ (m²·K)/W (soil contact)

The declared thermal conductivity λ_D for Styrodur® C was current at the time of going to print and can be reviewed on the Internet at www.styrodur.com along with all other information and data.

The correlation of heat loss per square meter of the tank surface per day and the heat transfer coefficient, the U value, is shown in **Figure 4** (according to Perwanger). The tank wall is not considered in the calculation for the required insulation thickness. The thermal conductivity of the insulation material was selected at 0.04 W/(m·K) and is kept at the same level. The heat transfer resistance values $R_i = (0.13$ m²·K)/W and $R_a = (0.04$ m²·K)/W are taken into consideration for the fermenter wall above the slurry against the outside air.

The thermal conductivity λ_D of Styrodur C boards is shown as a function of the insulation thickness in **Table 7**.

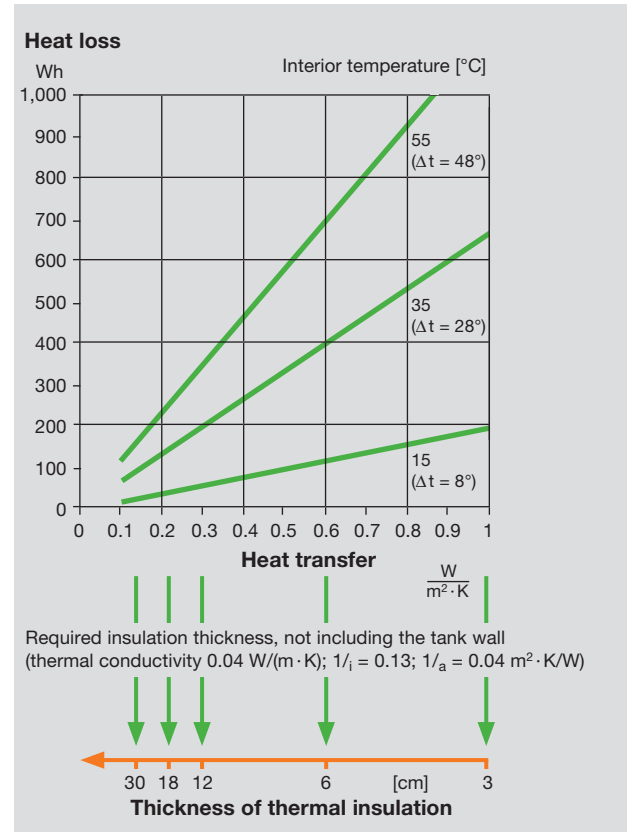














Fig. 5: Heat loss in relation to U value (according to Perwanger).

Styrodur C boards have different thermal conductivity values, depending on the respective thickness of the board.

Table 7: Declared thermal conductivity λ_D according to thickness of the board.

Board thickness in mm	Declared thermal conductivity λ_D in W/(m·K)
20	0.032
30	0.032
40	0.034
50	0.034
60	0.034
80	0.036
100	0.038
120	0.038
140	0.038
160	0.038
180	0.040

6. Technical Data Styrodur® C

Property	Unit ¹⁾	Code according to DIN EN 13164	2500 C		2800 C		3035 CS		3035 CN		4000 CS		5000 CS		Standard
															
Edge profile															
Surface			skin	embossed	skin	skin	skin	skin	skin	skin	skin	skin	skin		
Length x width	mm		1250 x 600	1250 x 600	1265 x 615	2515 x 615 ²⁾	1265 x 615	1265 x 615							
Density	kg/m ³		28	30	33	30	35	45							DIN EN 1602
Thermal conductivity	λ_D [W/(m·K)]		λ_D	λ_D	λ_D	λ_D	λ_D	λ_D	λ_D	λ_D	λ_D	λ_D	λ_D		DIN EN 13164
Thermal resistance	R_D [m ² ·K/W]		R_D	R_D	R_D	R_D	R_D	R_D	R_D	R_D	R_D	R_D	R_D		
Thickness															
	20 mm	–	0.030	0.65	0.030	0.65	–	–	–	–	–	–	–	–	
	30 mm	–	0.031	1.00	0.031	1.00	0.031	1.00	0.031	1.00	0.031	1.00	–	–	
	40 mm	–	0.032	1.25	0.032	1.25	0.032	1.25	0.032	1.25	0.032	1.25	0.032	1.25	
	50 mm	–	0.033	1.55	0.033	1.55	0.033	1.55	0.033	1.55	0.033	1.55	0.033	1.55	
	60 mm	–	0.034	1.80	0.034	1.80	0.034	1.80	0.034	1.80	0.034	1.80	0.034	1.80	
	80 mm	–	–	–	0.035	2.35	0.035	2.35	0.035	2.35	0.035	2.35	0.035	2.35	
	100 mm	–	–	–	0.037	2.80	0.037	2.80	–	–	0.037	2.80	0.037	2.80	
	120 mm	–	–	–	0.038	3.30	0.038	3.30	–	–	0.038	3.30	0.038	3.30	
	140 mm	–	–	–	–	–	0.038	3.70	–	–	0.038	3.70	–	–	
	160 mm	–	–	–	–	–	0.038	4.20	–	–	–	–	–	–	
	180 mm	–	–	–	–	–	0.040	4.55	–	–	–	–	–	–	
Compressive stress or compressive strength at 10% deformation	(kPa)	CS(10\Y)	200	200	300	250	500	700							DIN EN 826
Compressive creep over 50 years at < 2% deformation	(kPa)	CC(2/1.5/50)	80	80	130	100	180	250							DIN EN 1606
Rated value of the compressive stress under foundation slabs	σ_{perm}	–	–	–	130 ³⁾	–	180	250							DIBT Z-23.34-1325
	f_{cd}	–	–	–	185	–	255	355							
Adhesive strength on concrete	kPa	TR 200	–	> 200	–	–	–	–							DIN EN 1607
Compressive modulus of elasticity	Short-term E	CM	10,000	15,000	20,000	15,000	30,000	40,000							DIN EN 826
	Long-term E50		–	–	5,000	–	10,000	14,000							
Dimensional stability: 70°C; 90% r. h.	%	DS(TH)	≤ 5%	≤ 5%	≤ 5%	≤ 5%	≤ 5%	≤ 5%							DIN EN 1604
Deformation behavior: load 40 kPa; 70°C	%	DLT(2)5	≤ 5%	≤ 5%	≤ 5%	≤ 5%	≤ 5%	≤ 5%							DIN EN 1605
Linear coefficient of thermal expansion	Longitudinal	–	0.08	0.08	0.08	0.08	0.08	0.08							DIN 53752
	Transverse		0.06	0.06	0.06	0.06	0.06	0.06							
Reaction to fire ⁴⁾	Euroclass	–	E	E	E	E	E	E							DIN EN 13501-1
Long-term water absorption by immersion	% v/v	WL(T)0.7	0.2	0.3	0.2	0.2	0.2	0.2							DIN EN 12087
Long-term water absorption by diffusion	% v/v	WD(V)3	≤ 3	≤ 5	≤ 3	≤ 3	≤ 3	≤ 3							DIN EN 12088
Water-vapor transmission (thickness-dependent)		MU	200–100	200–80	150–50	150–100	150–80	150–100							DIN EN 12086
Freeze-thaw resistance	% v/v	FT2	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1							DIN EN 12091
Maximum service temperature	°C	–	75	75	75	75	75	75							DIN EN 14706

¹⁾ N/mm² = 1 MPa = 1,000 kPa ²⁾ Thickness 30 and 40 mm: 2510 x 610 mm ³⁾ For multilayer laying: 100 kPa ⁴⁾ Building material class DIN 4102-B1

Further Information on Styrodur® C

■ Product Brochure: Europe's Green Insulation

■ Applications

Basement Insulation
Load-bearing Applications and Floor Insulation
Wall Insulation
Roof Insulation
Ceiling Insulation

■ Special Themes

Reconstruction and Refurbishment
Thermal Insulation of Biogas Plants
Styrodur® 2500 CNS—Insulation for Underfloor Heating Systems

■ Technical Data

Recommended Applications and Technical Data
Technical Data and Assistance Data for Dimensioning

■ Chemical Resistance

■ Styrodur C Film: Europe's Green Insulation

■ Website: www.styrodur.com

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