Institut für **Brandtechnologie GmbH**

Project Nr. F 040101

Determination and assessment of the continuous glowing combustion behaviour of building products in the SBI test method

Final report, October 2004

Project sponsors:

BING

Federation of the European Rigid Polyurethane Foam Associations

FSK

Fachverband Schaumkunststoffe e. V.

VKE

Verband Kunststofferzeugende Industrie e. V.

Contents

0 Executive summary

Introduction

Continuous glowing combustion fires pose a risk which the European reaction-to-fire classification does not assess.

Accordingly, there is currently a proposal, Construct 04/659 dated 15 September 2004, to be considered at the CPD Standing Committee meeting on 26 October for the insertion into the M/103 Thermal Insulation Products Mandate of the requirement to assess continuous glowing combustion.

Continuous glowing combustion is a self-propagating combustion process without flaming that may occur inside certain porous materials for example thermal insulation products, and fibre boards. With these products heat build up internally occurs due to the continuing exothermic processes initiated by the original exposure to an ignition source. This heat build-up may cease with time if the insulation allows the excessive heat to escape. If not, the process continues with the temperature continuing to rise within the product eventually thereby causing ignition of the product. Insulation products are usually installed behind interior room linings and in cavities behind large surface areas. Continuous glowing combustion fires occurring within the insulation develop slowly and therefore pose a risk because they might remain undetected behind the lining product for a long period of time (up to several hours). Thus these products possibly act as an ignition source with a large-area for adjacent products/items resulting in a developing flaming fire.

The European reaction-to-fire classification assessment for fire propagation is solely based on the occurrence/spread of flames and the heat release (rate). Continuous glowing combustion is not directly or indirectly evaluated.

Objective of this project

Since continuous glowing combustion is not assessed in the European reaction-to-fire classification procedure, the objective of this project was to investigate if the Single Burning Item Test according to EN 13823 could be modified to determine and assess the continuous glowing combustion behaviour of building products.

Test set-up and testing time

In order to find a practical and cost-efficient solution for the determination of continuous glowing combustion in the SBI test it was intended to make as few modifications as possible with regard to the original test procedure. Most of the test parameters were adopted in accordance with EN 13823, in particular the intensity and duration of the thermal exposure, the ventilation conditions as well as the specimen dimensions and conditioning.

Since continuous glowing combustion cannot reliably be determined by means of heat release rate only, the continuous glowing combustion tests were carried out by the additional use of thermocouples that were mounted within the test specimens.

Furthermore, the test specimens were covered by steel sheets in order to simulate end-use conditions, to prevent flaming combustion and reduce the oxygen supply. Hence this test procedure represented typical real end-use application conditions with regard to continuous glowing combustion fires.

The period of observation of the test specimens was extended beyond the standard assessment (20 min) as continuous glowing combustion is a slowly-propagating process. Therefore the tests were run for not less than 135 min, even with products showing no indications of continuous glowing combustion. However, the standard duration of the ignition source impingement was not changed (21 min).

Results

The test results indicate that a modified SBI test procedure could be the basis of a test capable of determining continuous glowing combustion behaviour.

The temperatures recorded at different points within the test specimens made it possible to detect the initiation of ongoing combustion (which may or may not then decline in intensity so as to become (or not) continuous glowing combustion) and to be able to determine the propagation of the fire reaction zone (continuous glowing combustion).

Significant continuous glowing combustion occurred in the tests with hemp.

A rock wool product was found to exhibit locally confined ongoing combustion at the test specimen surface although this did not develop into full continuous glowing combustion. The other rock wool panels tested did not exhibit continuous glowing combustion probably due to their low binder content.

The glass wool product showed no continuous glowing combustion behaviour.

The PUR/PIR insulation board and the melamine resin foam were partially pyrolysed during exposure to the ignition source but a continuous glowing combustion process was not initiated.

1 Project background

The European Construction Products Directive (CPD)[1] states as an essential requirement that construction works must be safe in case of fire. In this context a harmonised European testing and classification system for the reaction to fire performance of construction products has been developed. There are five European fire test methods that shall be used by the EU member states:

- Single Flame Source Test (EN ISO 11925-2)
- Single Burning Item Test (EN 13823)
- Radiant Panel Test (EN ISO 9239) for flooring products
- Determination of the Heat of Combustion (EN ISO 1716)
- Non-combustibility Test (EN ISO 1182)

These test methods represent different stages of a developing fire:

1. Small ignition source (EN ISO 11925-2)
2. Single burning items (EN 13823)
   Flooring products: fully developed fire in an adjacent room (EN ISO 9239)
3. Fully developed fire (EN ISO 1716 and EN ISO 1182)

Based on test results the reaction to fire performance of construction products is classified according to EN 13501-1. The following criteria are taken into account:

- Ignitability
- Heat release (rate)
- Flame spread
- Smoke production (rate)
- Formation of burning droplets/debris

However, continuous glowing combustion is neither directly nor indirectly considered. The risk assessment of fire propagation is solely based on the occurrence/spread of flames and the heat release (rate). Self propagating fire-spread as a result of continuous glowing combustion is not determined. Continuous glowing combustion fires do generate effluents and may directly pose a hazard. In addition, if a continuous glowing combustion fire comes into contact with other materials, such as decorations/furnishing etc., secondary items may be ignited. It is a nature of continuous glowing combustion fires that they often – high-rise buildings, cavities etc. – can not easily be extinguished.

2 Theoretical background

Continuous glowing combustion is a self-propagating flameless combustion process that can only take place inside certain porous materials such as cellulosic fabrics or fibre boards. Porosity is required for supplying air (oxygen) to and to remove the effluents from the reaction area. Most materials that have the potential for continuous glowing combustion form a solid char when thermally decomposed. This char has a rather high heat of oxidation and is susceptible to rapid oxygen attack. If sufficient energy is supplied, e. g. by an external ignition source, oxidation occurs at the char front and a combustion zone develops that causes adjacent parts of the material to be decomposed (to form char) so that the reaction front propagates. Due to their porous structure materials capable of exhibiting continuous glowing combustion provide a large surface area at which oxidation can occur and at the same time they allow oxygen to permeate into deeper layers to maintain the combustion process. Furthermore, the interstices in the material which surround the reaction zone act as thermal insulators that reduce heat losses to the environment. This implicates that a material must be sufficiently thick to allow for continuous glowing combustion, otherwise the thermal potential required for sustained combustion can not develop.

Due to the restricted oxygen supply and the associated low energy release continuous glowing combustion fires generally propagate slowly. The propagation velocity depends on the temperature in the reaction zone which is significantly affected by the oxygen supply rate, i. e. the ventilation conditions. For most organic materials exposed to still air, maximum temperatures in the reaction zone are typically in the range of 400 to 750 °C whereas the thermal decomposition already initiates at temperatures of 250 to 300 °C[2]. Continuous glowing combustion velocities usually vary between $1 \cdot 10^{-3}$ and $1 \cdot 10^{-2}$ cm/s.

Further information concerning continuous glowing combustion can be found in articles by *Ohlemiller*[3] and *Babrauskas*[4] who present the current state of knowledge on this topic. Influencing factors such as ignition source properties, ventilation conditions, thermal conductivity of the material, etc. are discussed and models for one- and multi-dimensional continuous glowing combustion propagation are presented.

3 Objective of the project

Several construction products meet the requirements described above, i. e. they have a potential for continuous glowing combustion. This especially applies to thermal insulation products. These products are usually installed behind linings and in cavities where they often cover large surfaces. Continuous glowing combustion fires occurring under such conditions pose a considerable risk because the typical scenario is that they remain undetected for a long time period (up to several hours) until they may act as an ignition source with a large-area for adjacent products/items possibly resulting in a rapid developing of the fire.

Investigations by *Wiendl*[5] in 1996 revealed that some rock wool insulation products that were even A-classified (according to DIN 4102) may exhibit continuous glowing combustion. A high fibre layer density and a binder content of at least 5.5 to 8 % were found to be prerequisites for continuous glowing combustion.

Since continuous glowing combustion is not an appraisal criterion in the European reaction-to-fire classification system the objective of this project was to investigate if the Single Burning Item Test according to EN 13823 is an appropriate method for the determination and assessment of the continuous glowing combustion behaviour of building products. The other four European test methods do not seem to be capable because they use too small specimen dimensions that make it difficult to initiate continuous glowing combustion fires. In the SBI apparatus, however, much larger specimens with a maximum thickness of 200 mm can be tested producing a higher insulation effect and thus providing suitable conditions for the occurrence of continuous glowing combustion fires.

4 Experimental investigations

All experiments were carried out by and/or under the auspice of IBW at the fire testing facilities of Bayer Industry Services, SUA-SPA/Fire Technology, Leverkusen (Germany) between 9 December 2003 and 1 July 2004.

4.1 Tested products

The continuous glowing combustion behaviour of seven selected building insulation products was investigated in the SBI test device. The product data are listed in Table 1. All products were provided by the project sponsors.

No.	Material	Designation	Manufacturer	Thickness (mm)
1	Hemp	[1]		60
2	Rock wool	Tervol PTP	Termo d.d., Slovenja	60
3	Rock wool	Rhinox	Rockwool, Benelux	140
4	Melamine resin foam	Basotect	BASF AG	200
5	Polyurethane rigid foam		Bayer AG	200
6	Rock wool	[2]		200
7	Glass wool	[2]		60

[1] not specified, product samples supplied by Steinbacher Dämmstoff GmbH
[2] not specified, product samples supplied by Korff & Co. KG

Table 1: Products tested in the SBI

In addition to the mineral wool products (Table 1), further mineral wool products were supplied by the project sponsors (6 rock wool and 7 glass wool products altogether). Since the binder content is an important factor influencing the continuous glowing combustion potential of a mineral wool product preliminary investigations were necessary. For this purpose all mineral wool products supplied were thermally exposed in the non-combustibility test apparatus according to DIN 4102-1 in order to determine mass loss. The test results gave information about the fraction of combustible constituents that are mainly due to the binder in most cases. Three rock wool products and one glass wool product exhibiting the highest mass losses were chosen for testing in the SBI. All mass loss test results are presented in Annex B.

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4.2 Test setup and procedure

In order to find a practical and cost-efficient solution for the determination of continuous glowing combustion in the SBI it was intended to make as few modifications as possible with regard to the original test setup. So only the factors described below were subject to changes. All other test parameters were adopted in accordance with EN 13823, in particular the intensity and duration of the thermal exposure, the ventilation conditions as well as the specimen dimensions and conditioning. A schematic drawing of the test setup used is shown in Figure 1.

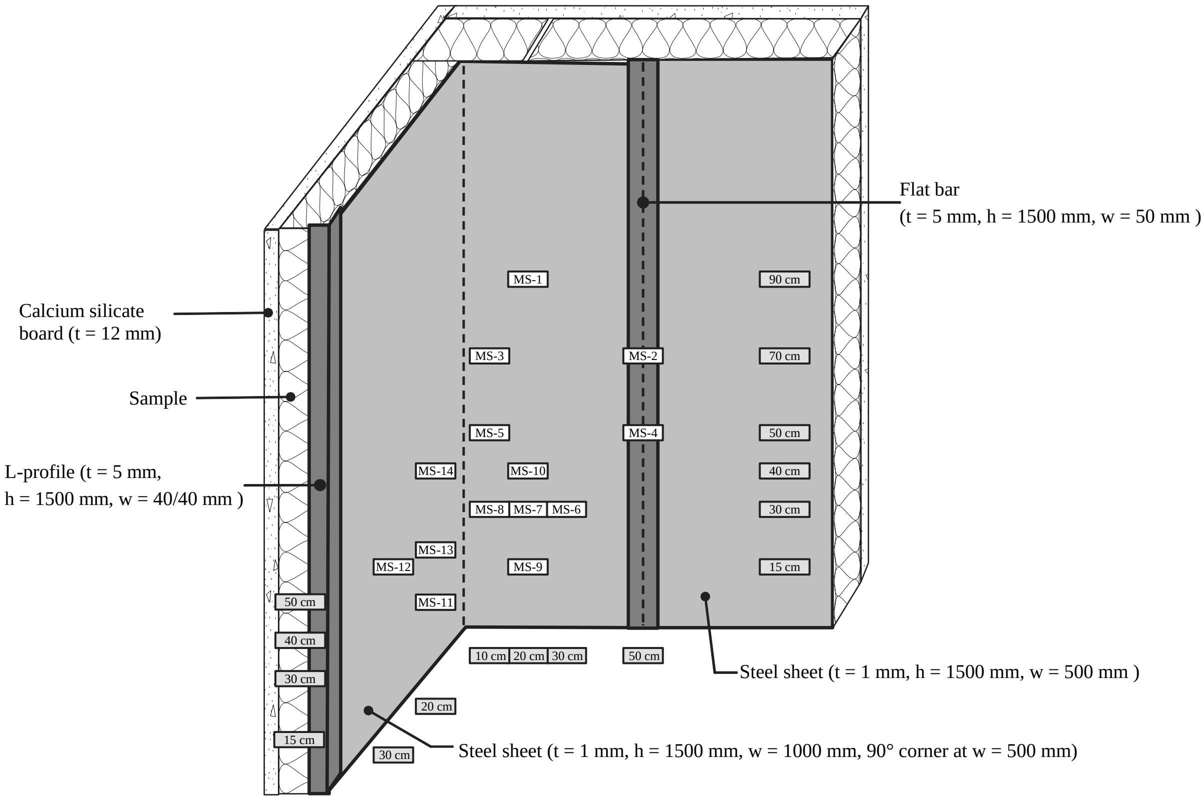

Figure 1: Test setup

a) Mounting and fixing

The complete specimen surface exposed to the burner was covered by 1 mm steel sheets in order to prevent the test material from being directly impinged by the burner flame. Otherwise flaming combustion would have probably occurred with combustible materials due to the ignition of pyrolysis gases by the burner flame. In addition to that, the covering reduced the oxygen supply. Hence this test setup represented typical conditions with regard to continuous glowing combustion fires occurring in reality. Due to their easy commercial availability, two steel sheets (1500 mm high by 1000 mm long and 1500 mm high by 500 mm long) were employed, whereof the longer one was bent to 90 degrees in center. 12 mm calcium silicate boards were used as substrates. Fixing was carried out by means of bolted connections at both outer ends of the specimen wings and also in the middle of the long wing (at the joint between both steel sheets). To prevent warping of the steel sheets which was observed at the bolted connections during the SBI tests carried out first, an L-profile and a flat bar were additionally provided for the later tests.

b) Test duration

Since continuous glowing combustion is a slowly-propagating process it is first recognisable when the period of observation extends beyond that required in the standard assessment (20 min). For this reason the tests were run not less than 135 min, even with products showing no indications of continuous glowing combustion. However, the standard duration of the flame impingement was not changed (21 min).

c) Temperature measurements

In addition to the quantities measured in a standard SBI test, the temperatures within the specimens were recorded because the ventilation in the SBI was found to be too high to determine the low heat releases of continuous glowing combustion fires by means of Oxygen Consumption Calorimetry in a reliable way. Thermocouples (Type K) were inserted through the substrate panels into the specimens at different horizontal and vertical positions around the area of the flame impingement. With regard to the specimen thickness, the measuring points (MS) were normally located in the middle, however, a maximum distance from the steel sheet of 70 mm was provided for specimens thicker than 140 mm. The configuration of the measuring points was varied between some tests in order to find suitable distances that allow for shorter test durations.

5 Test results

Annex A contains the test setups, measured data, test reports and photographs of the continuous glowing combustion tests carried out in the SBI.

5.1 Hemp insulation panel

Two SBI tests with hemp were carried out. In the first test the hemp sample was completely covered by the steel sheets. The second one was conducted providing an opening in the steel sheet covering to allow for direct flame attack.

5.1.1 Test 1

In this test the most significant continuous glowing combustion behaviour of all tests conducted was observed. At the beginning of the test, temperature increases were detected at all measuring points resulting from the flame impingement. After switching off the burner (after 21 minutes) temperatures decreased. Since the heat transfer within the test material is mainly by conduction the height of a temperature peak and the time to reach the peak depend on the distance of a thermocouple from the heat source (i. e. the burner flame or the glowing combustion zone, respectively). That means that high maximum temperatures and short periods to reach the maximum temperature are associated with small distances from the heat source and vice versa (e. g. the highest temperatures at the beginning of this test were recorded by the measuring points MS-14 and MS-16 that were both located the nearest to the burner flame). However, after about 120 minutes some thermocouples detected an increase in temperature again. This was caused by the heat release of a continuous glowing combustion fire within the hemp panel. The spread of the combustion zone (especially its upward moving in the specimen corner) can be seen clearly when considering the sharp temperature rises (up to about 350 °C) recorded by measuring points MS-16, MS-14, MS-12, MS-8 and MS-4 (marked by a red circle, cp. Annex A.1.1). The photographs in Annex A.1.1 show the parts of the hemp sample that were affected by the continuous glowing combustion fire. Even self-ignition of the sample occurred when it was removed from the SBI because of the high thermal potential still present within the material and the sudden increase in oxygen supply.

In addition to the sample temperatures, the smoke production and the concentrations of CO_2, CO and O_2 were recorded during the test using the standard SBI equipment (smoke measurement system according to DIN 50055, CO_2/CO-NDIR-analysers and paramagnetic O_2-analyser). As shown in Annex A.1.1, the light transmittance and the CO_2/CO concentrations changed significantly in the initial stage of the test, but this was mainly caused by the fire effluents from the burner. After switching off the burner the transmittance returned to its original value and then decreased slightly (somewhat more clearly after about 280 min, $\Delta T_{max} \approx 4.5$ %) indicating the release of small amounts of smoke particles by the continuous glowing combustion fire. Similarly, a small increase in CO_2 and CO concentrations was determined ($\Delta c_{CO2,\,max} \approx 0.01$ vol.-% and $\Delta c_{CO,\,max} \approx 200$ ppm). The heat release rate (RHR) and the total heat release (THR) were recorded according to EN 13823 (from 300 s to 1500 s, i. e. during flame impingement). As expected, only very small values were determined ($RHR(30)_{max} = 1.5$ kW and $THR_{max} = 1.1$ MJ).

5.1.2 Test 2

In the second test with hemp an opening (50 cm × 30 cm) was provided in the steel sheet covering enabling a direct contact between the burner flame and the material surface. Both, continuous glowing combustion and flaming combustion occurred. The uncovered surface of the hemp sample ignited during the flame impingement and the flaming fire proceeded behind the steel sheet. After switching off the burner, flaming combustion continued especially affecting the corner of the specimen. Continuous glowing combustion occurred in areas of the sample adjacent to the flaming zone, partially followed by flaming ignition after some time. As can be seen in Annex A.1.2, high temperatures (> 700 °C) were measured resulting from the flaming combustion. Due to the high energy release and sample mass loss comparatively large amounts of smoke particles, CO and CO_2 were released. Since the occurrence of both, flaming and continuous glowing combustion, prevents a well-defined assessment of the continuous glowing combustion behaviour an opening in the steel sheet covering was not provided anymore in the following tests.

5.2 Rock wool insulation panel “Tervol PTP”

In order to reduce test durations a new configuration of the measuring points was used in this test providing smaller distances of the thermocouples to the burner flame. Furthermore, three additional thermocouples were glued on the steel sheet covering (cp. Annex A.2) in order to examine if surface thermocouples can be used to detect continuous glowing combustion in the sample. This would have simplified the test preparation. However, “Tervol PTP” (mass loss 3.2 % in the non-combustibility apparatus) exhibited no continuous glowing combustion behaviour. Only pyrolysis of the sample surface occurred during flame impingement. After switching off the burner, temperatures decreased continuously at all measuring points until the test was terminated after 135 minutes. Due to the high thermal conductivity of steel the surface thermocouples showed a much faster response to the flame exposure than the thermocouples located within the sample.

5.3 Rock wool insulation panel “Rhinox”

In the non-combustibility test apparatus “Rhinox” exhibited the highest mass loss (4.6 %) of all rock wool products investigated. In the SBI test ongoing glowing combustion occurred in some locally confined areas of the sample surface. However, there was no formation of a distinct continuous glowing combustion front affecting larger areas of the test material. As shown in Annex A.3, certain measuring points (marked by a red circle) registered a significant change in the slope of the temperature curve shortly after the burner had been turned off. A maximum temperature of 420 °C was recorded by thermocouple MS-9. As can be seen from the photograph in Annex A.3, the locations of these measuring points correspond with those areas of the sample where glowing combustion occurred. Due to the early initiation of the combustion process(es) and the close distance of the measuring points to the combustion zone(s) the temperature curves from this test show a sharp bend rather than a second increase in temperature (as observed in the hemp test). In addition, after switching off the burner (small) amounts of CO_2 and CO were still being released for some time resulting from the ongoing glowing combustion processes.

The thermocouples that were glued on the steel sheet covering did not register an increase in temperature although they were located close to a zone where glowing combustion occurred (cp. measuring points MS-7 and MS-15, for example). This was probably due to a (small) gap between the sample and the covering which prevented the heat transfer. Since it would have been very difficult to realise a perfect contact between the sample and the steel sheets with regard to the complete test duration the following tests were done without surface thermocouples.

5.4 Melamine resin foam “Basotect” (BASF)

Continuous glowing combustion was not determined in this test. During the flame impingement a relatively large amount of sample mass was pyrolysed accompanied by significant smoke production but after terminating the thermal exposure the test material exhibited no continuous glowing combustion behaviour.

As warping of the steel sheets was observed in the previous tests an L-profile and a flat bar were additionally mounted on the covering in this test (cp. test setup shown in Annex A.4). Thus, the problem of warping could be reduced. This slightly modified test setup was also employed in the following tests.

5.5 Polyurethane rigid foam (BAYER)

The PUR sample tested was taken from a common PUR sandwich panel. The reaction of the PUR sample was similar to that of "Basotect". Pyrolysis occurred during the exposure to the burner and comparatively much smoke was released but a continuous glowing combustion process was not initiated.

5.6 Rock wool insulation panel (Korff)

This rock wool product was supplied by Korff & Co. KG without further specifications. The relative mass loss (binder content) was determined to be 3.7 % as an average. Continuous glowing combustion did not occur. During the flame impingement small amounts of smoke, CO_2 and CO were emitted.

5.7 Glass wool insulation panel (Korff)

This glass wool product was also supplied by Korff & Co. KG without further specifications. Although having a high binder content (relative mass loss 7.9 % as an average) the product showed no continuous glowing combustion behaviour. At the sample surface that was directly exposed to the flame material melted away from the heat attack.

6 Summary and conclusions

In standard SBI tests the oxygen concentration, the CO_2/CO concentrations and the light transmittance are measured in the fire effluents from the test product in order to determine its heat release (rate) and its smoke production (rate). Since comparatively small amounts of heat, smoke particles and fire gases are released during continuous glowing combustion fires the air flow rate employed in SBI tests (0.5 to 0.65 m^3/s) is too high to reliably determine potential continuous glowing combustion behaviour by means of the above quoted parameters only. For this reason continuous glowing combustion tests were carried out in the SBI by the additional use of 17 thermocouples that were mounted within the samples. Furthermore, the samples were covered by steel sheets in order to simulate end-use conditions and to prevent flaming combustion.

The test results indicate that the modified SBI test setup is generally capable of determining continuous glowing combustion behaviour. Significant continuous glowing combustion occurred in the tests with hemp. The rock wool product “Rhinox” was found to exhibit locally confined ongoing combustion at the sample surface although this did not develop into full continuous glowing combustion. The temperature recording at different points within the samples made it possible to detect the initiation of glowing combustion and to determine the propagation of the reaction zone. Two typical temperature curves were found to indicate continuous/ ongoing glowing combustion: After terminating the flame impingement there is either a second increase in temperature after some time (hemp test) or there is a strong change in the slope of the temperature curve (“Rhinox” test). In both cases the results from the temperature curves could be confirmed by the measured CO_2/CO concentrations and the light transmittance values.

The rest of the products tested showed no continuous glowing combustion behaviour. The foam products “Basotect” and PUR were partially pyrolysed during flame exposure but a continuous glowing combustion process was not initiated. The rock wool panels (except “Rhinox”) did not exhibit continuous glowing combustion probably due to their low binder content. In case of the glass wool product which was found to exhibit a higher mass loss in the non-combustibility apparatus than all the rock wool products there may be two reasons for the non-initiation of continuous glowing combustion. On the one hand, the fibre layer density of glass wool products is normally lower than that of rock wool products and subsequently their binder content is also lower related to the *volume* of the product (i. e. the binder distribution is more compact in rock wool products). On the other hand, glass wool products have got a comparatively low thermal durability and therefore this material typically removes from the heat source before a potential continuous glowing combustion fire can actually be initiated.

7 Future work

The most reliable pass/fail assessment for continuous glowing combustion is waiting until the combustion process is completely terminated. This may, however, take a long time, up to hours. Then the damaged area inside the product has to be assessed. As demonstrated, continuous glowing combustion can be detected by measuring temperatures inside the product since the occurrence of a self-sustained combustion zone (after terminating the flame impingement) is associated with characteristic temperature increases. This procedure is generally suitable to shorten the observation time in SBI. It would also be possible to regulate maximum continuous glowing combustion velocities, which are calculated via the time-dependent temperature increases. Anyway, the position and number of thermocouples should be mandatory. The closer thermocouples are positioned to the place of origin the shorter the necessary observation time. But, a too short distance poses the risk of not having a second temperature peak. The position of thermocouples therefore needs to be systematically investigated.

Furthermore, an adequate test duration will have to be determined allowing for economically maintainable testing and also taking into consideration that continuous glowing combustion may not occur instantly in either case.

In this test series a thin metal sheet product surface covering was used to prevent flaming ignition but to provide enough activation energy inside the product. It was not investigated to what extend more insulating coverings would lead to more severe conditions. A better surface insulation prevents heat losses. Too much insulation may cause that the activation energy (in SBI) is not enough. The necessary activation energy is, however, generally low and removing parts from the surface product is not necessary nor regarded suitable. Taking into account the standardised SBI heating regime, it is anticipated that the insulating properties of a surface covering for posing most severe condition can be determined.

Alternatively, the assessment of the continuous glowing combustion potential could be based on maximum temperatures (above the material-related activation temperature). But this would require preliminary information about the material-specific continuous glowing combustion temperatures. For some materials these are known, for others not.

At present, a reliable appraisal method can not be established due to the lack of representative data. For this purpose further systematic investigations are needed with materials known to have the potential for continuous glowing combustion.

8 References

[1] Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products

[2] D. Drysdale: *An Introduction to Fire Dynamics*, John Wiley & Sons Ltd. (1985)

[3] T.J. Ohlemiller: *Smouldering Combustion*, SFPE Handbook of Fire Protection Engineering, Third Edition, Section 2, Chapter 9, National Fire Protection Association, Quincy, Massachusetts (2002)

[4] V. Babrauskas: Ignition Handbook (2004)

[5] S. Wiendl: *Tests on the smouldering fire behaviour of mineral fibre insulation materials*, Diploma thesis, University of Wuppertal, Department of Civil Engineering (1996)

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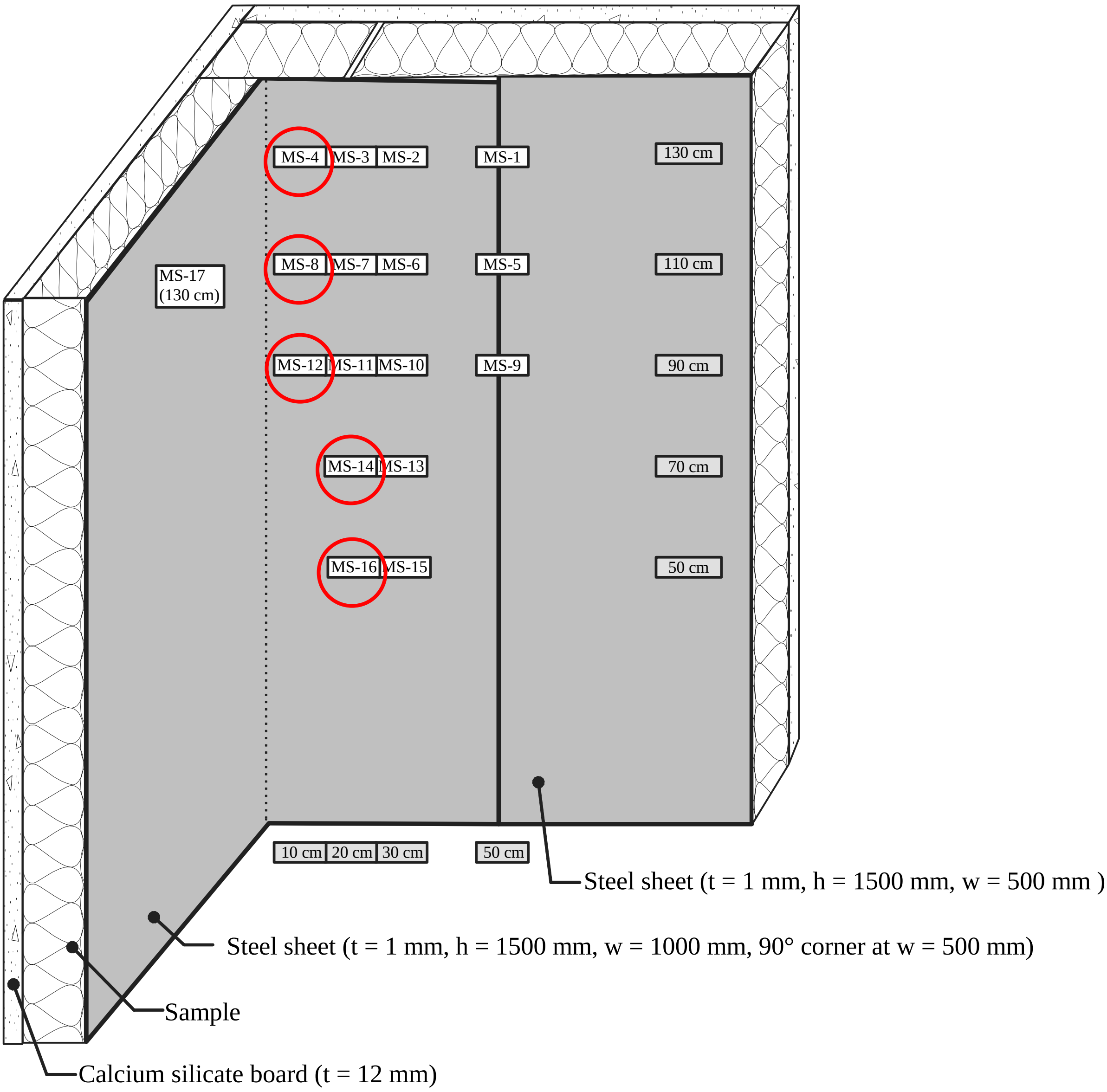
Annex A

SBI test results

A.1 Hemp insulation panel

A.1.1 Test 1

Test setup and temperature measuring points



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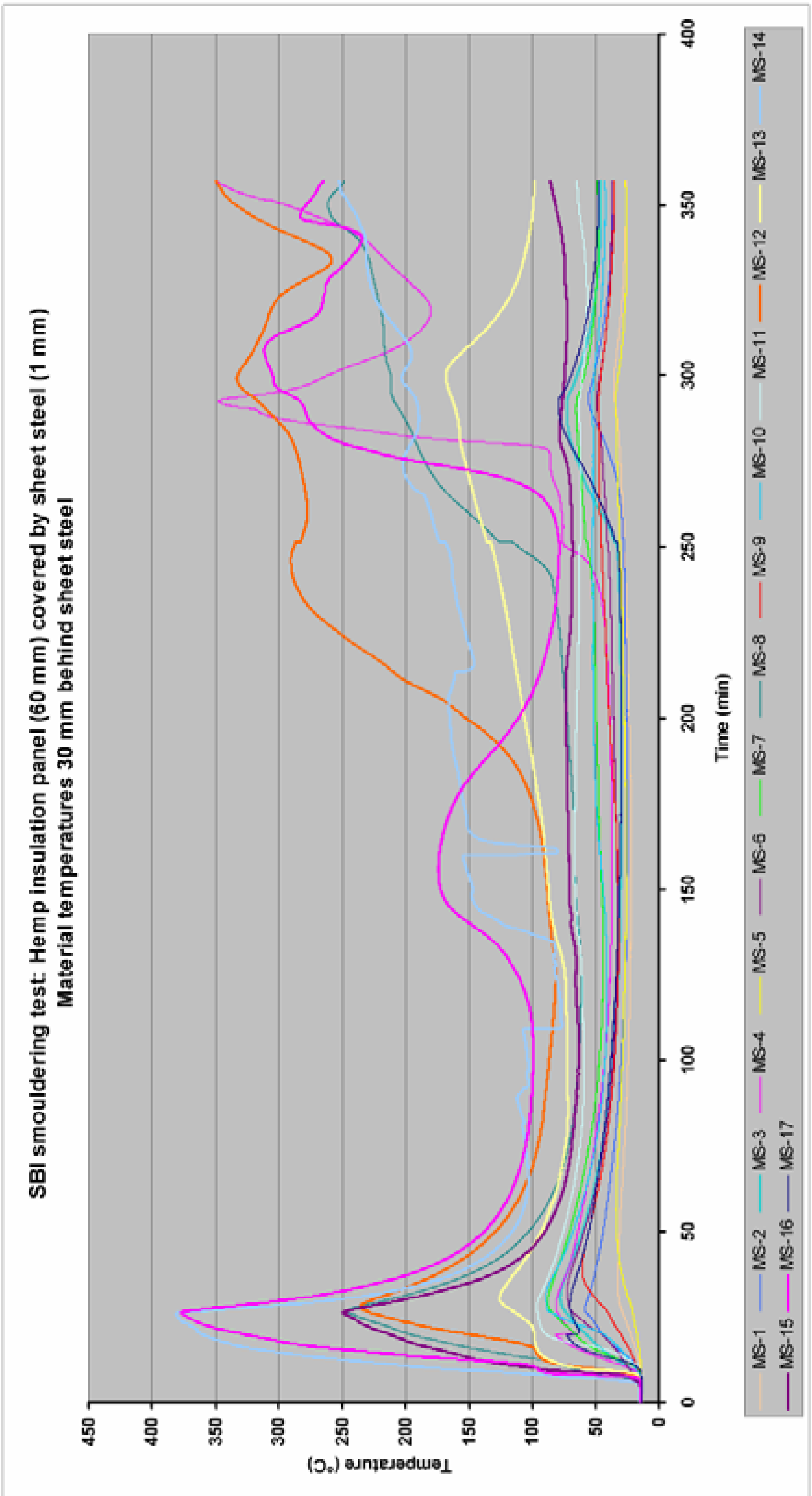
<u>Temperatures</u>



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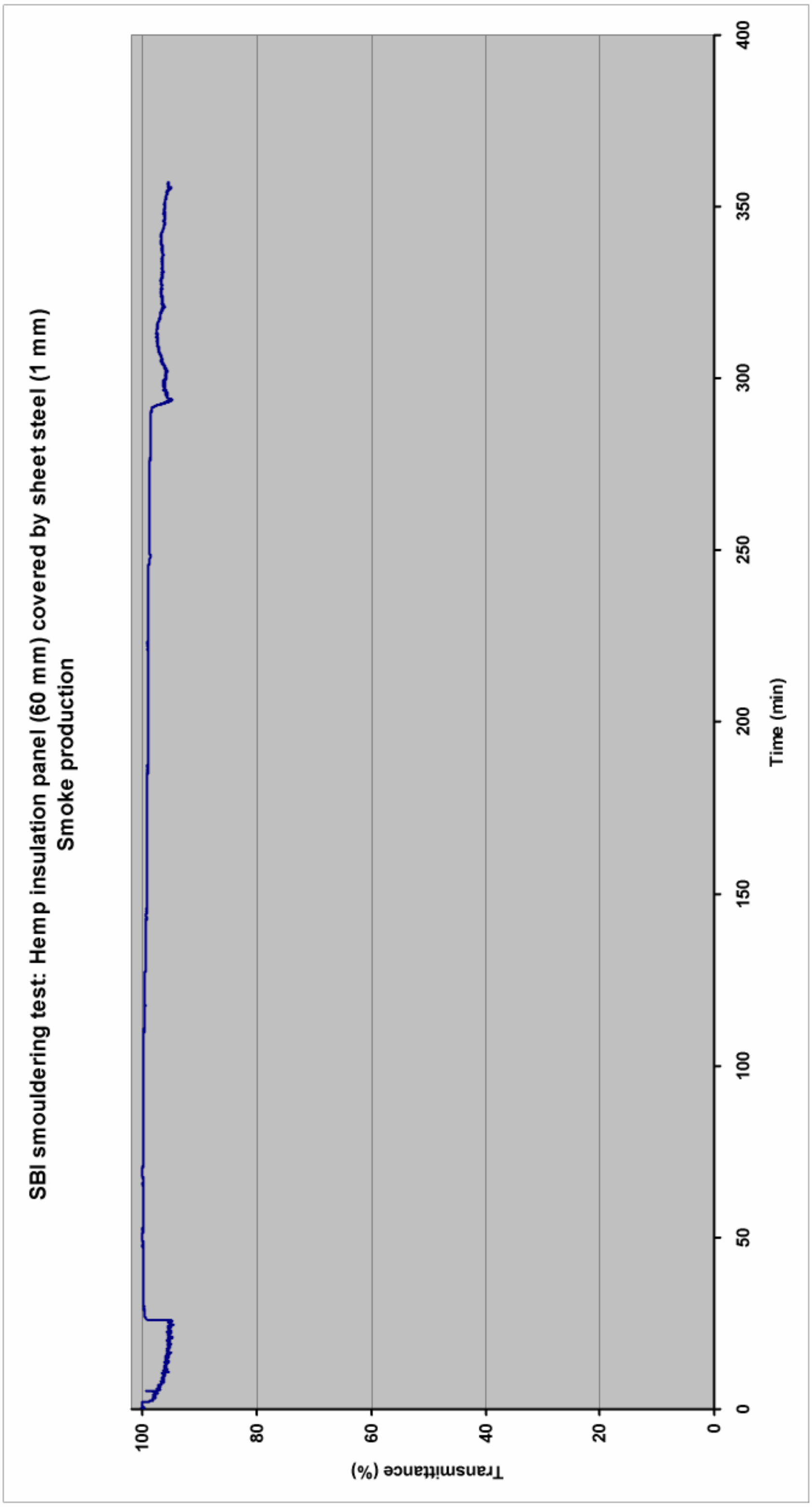
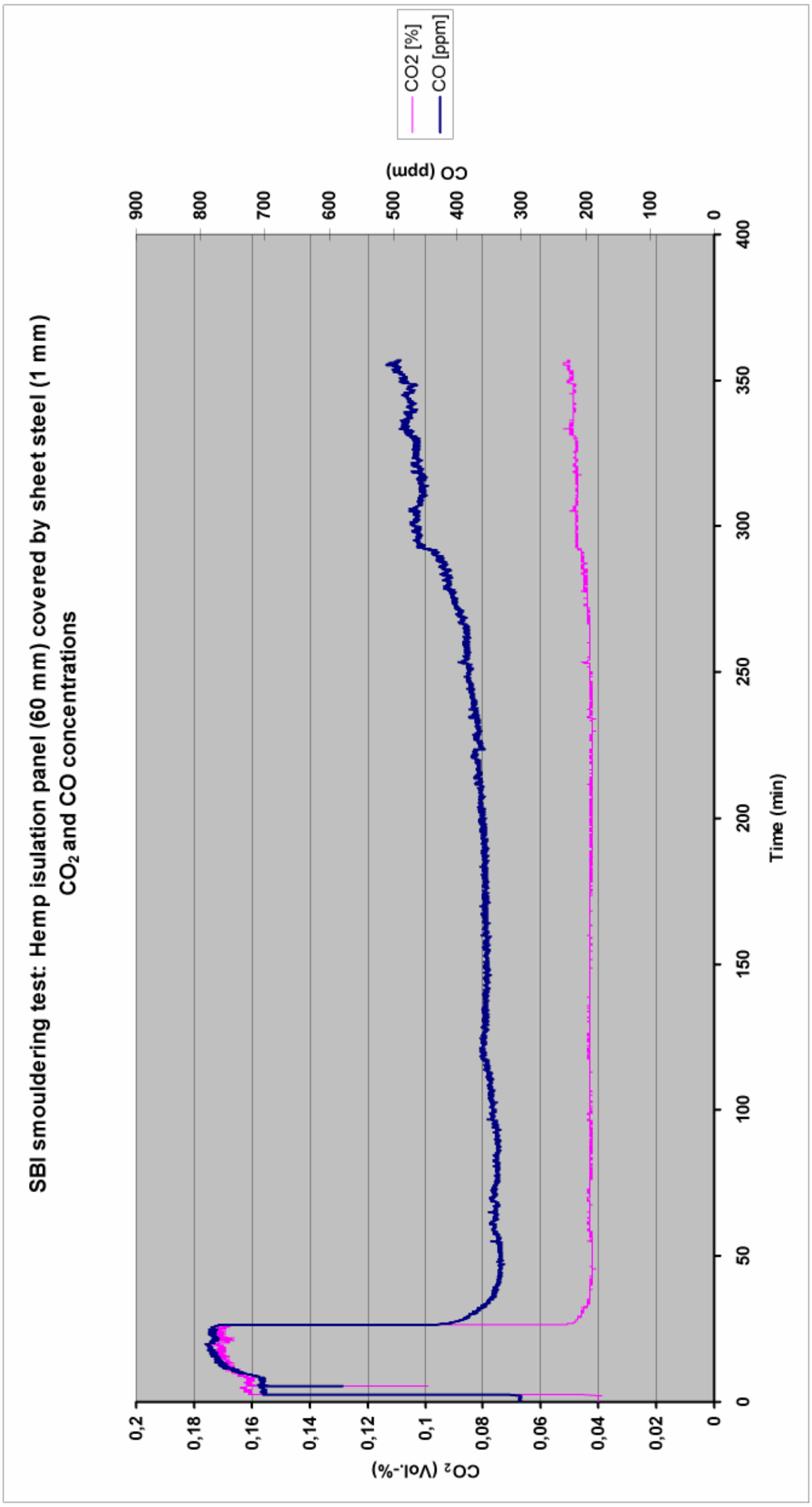
Smoke production



CO_2 and CO concentrations



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SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

BIS-SUA-SPA/Brandtechnologie

Customer: **IBW**

Hemp insulation panel 60 mm

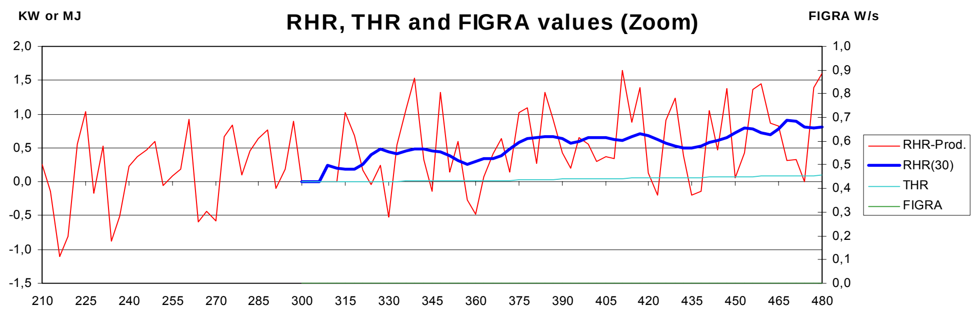
Substrate: CaSi 12 mm ; Mounting: Sheet steel 1 mm covering sample

Filename	Test no.	Operator	Test Date:	Print Date:
T30288_1A	1	Pelzer	09. Dez 03	06. Aug 04

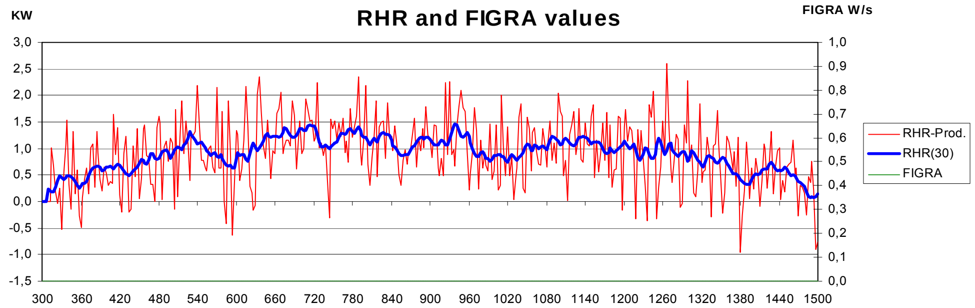
Test condition		Check points		Results	
Ambient Temp. $_{(t=30\text{-}90)}$ [°K]	288,92	$RHR_{av,burner}$ [KW]	32,097	FIGRA Threshold: 0.2 MJ [W/s]	**0**
Ambient pressure. [Pa]	100900	$RHR_{std\ burner}$ [KW]	0,600	FIGRA Threshold:0.4 MJ [W/s]	**0**
Humidity [%]	48,0	CO_2/O_2 $Ratio_{burner}$	0,432	THR_{600} [MJ] *	**0,6**
		$RSP_{av,burner}$ [m²/s]	0,042	Latheral flame spread (LFS) reach the edge?	**no**
K(t)	0,8900	$RSP_{std\ burner}$ [m²/s]	0,004	SMOGRA [m²/s²]	**0**
K(p)	1,0800			TSP_{600} [m²] *	**18**
E [KJ/m³]	17200	Baseline Duct temp. $_{(t=30\text{-}90)}$ [°K]	288,54	Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Duct Diameter: [m]	0,315	Min. no. of accep. Thermocouples	3	Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Conditioning:	fixed period	Minimum for flow [m³/s]	0,56	Time to max Figra [s] *	0
Conditioning time [days]	>3	Maximum for flow [m³/s]	0,63	Tig (2*6KW) [s] *	Not reach
Cond. start weight [g]	0	Burner response time [s]	12	RHR(30) max.	1,5
Cond. end weight [g]	0	Conditioning cond. [%/day]	#DIV/0!	* After ignition of main burner	
Baseline $O_2{}^a$ $_{(t=30\text{-}90)}$ [%]	20,7762				
Baseline O_2 $_{(t=30\text{-}90)}$ [%]	20,9505	End data O_2 [%]	20,94		
Baseline CO_2 $_{(t=30\text{-}90)}$ [%]	0,0400	End data CO_2 [%]	0,03		
Baseline Light sig. $_{(t=30\text{-}90)}$	100,0314	End data Light signal	99,9		

Synchronisation information	Baseline	Last point
T-Duct (2.5 °K drop from baseline)	311,09	315
O2 (0.05% rise from baseline)	20,6683	312
CO2 (0.02% drop from baseline)	0,1623	315

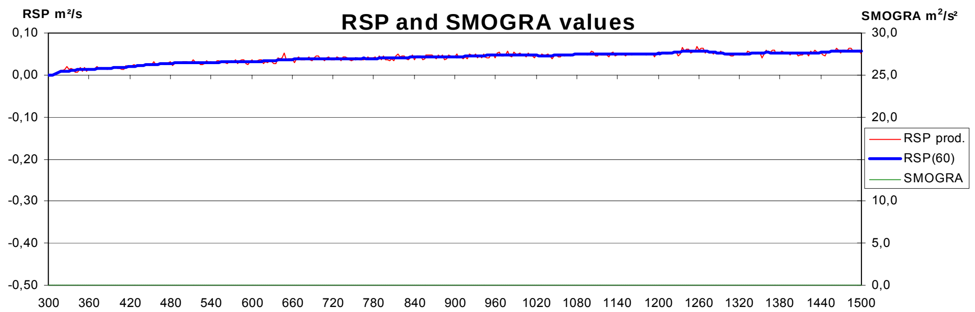
RHR, THR and FIGRA values (Zoom)



RHR and FIGRA values



RSP and SMOGRA values



Recorded events

Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

Classification (1 Test):

(if the material fulfil the standarts EN ISO 11925-2; exposure 30s)

A2/B	Burn (A2/B; C; D; no SBI-class)
S1	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

Photographs

Sample (back view)

Steel sheet covering (screwed)

Thermocouples and substrate board

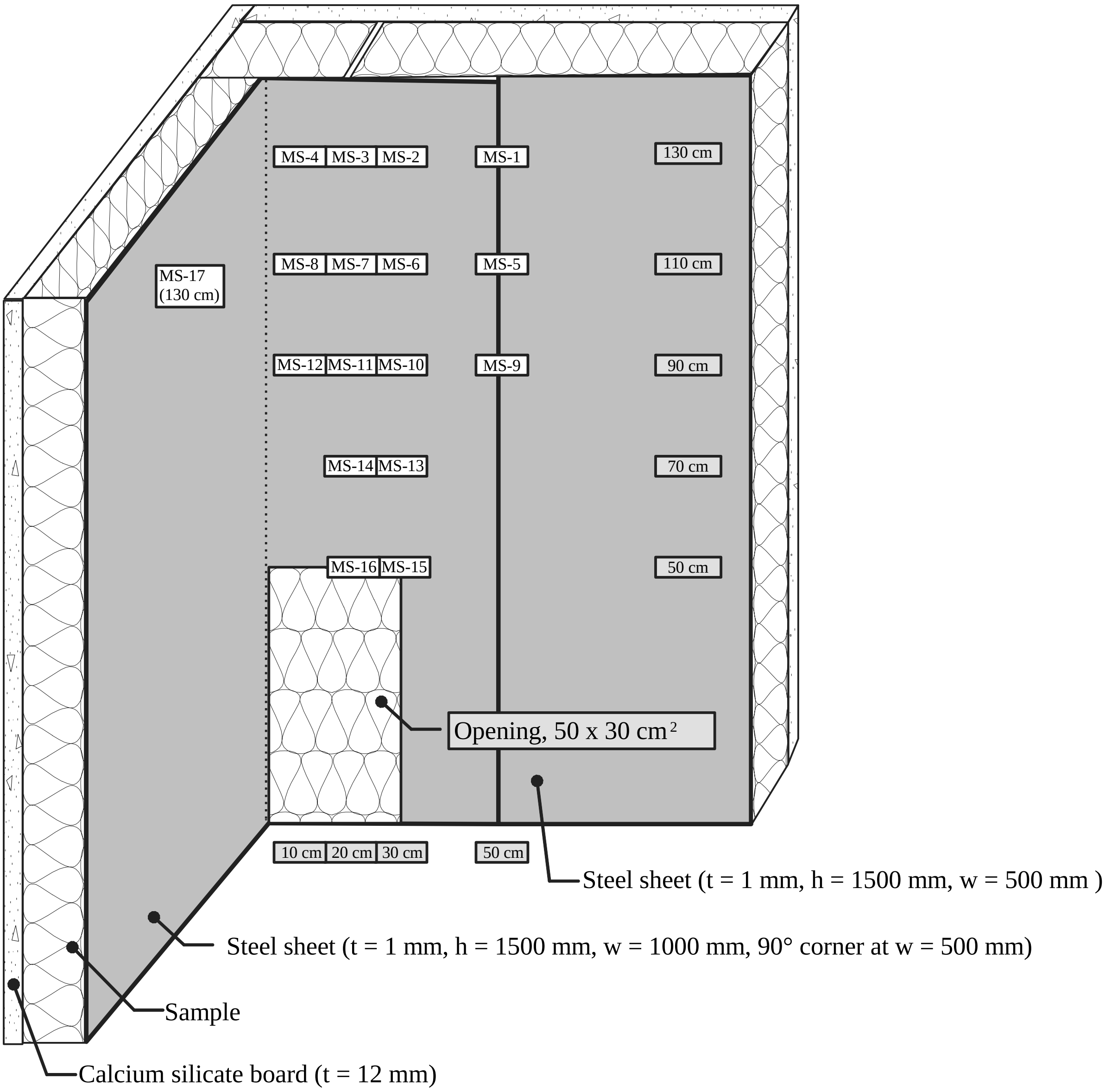
Sample after test

Self-ignition after test while removing sample from SBI

Sample after test

A.1.2 Test 2

Test setup and temperature measuring points



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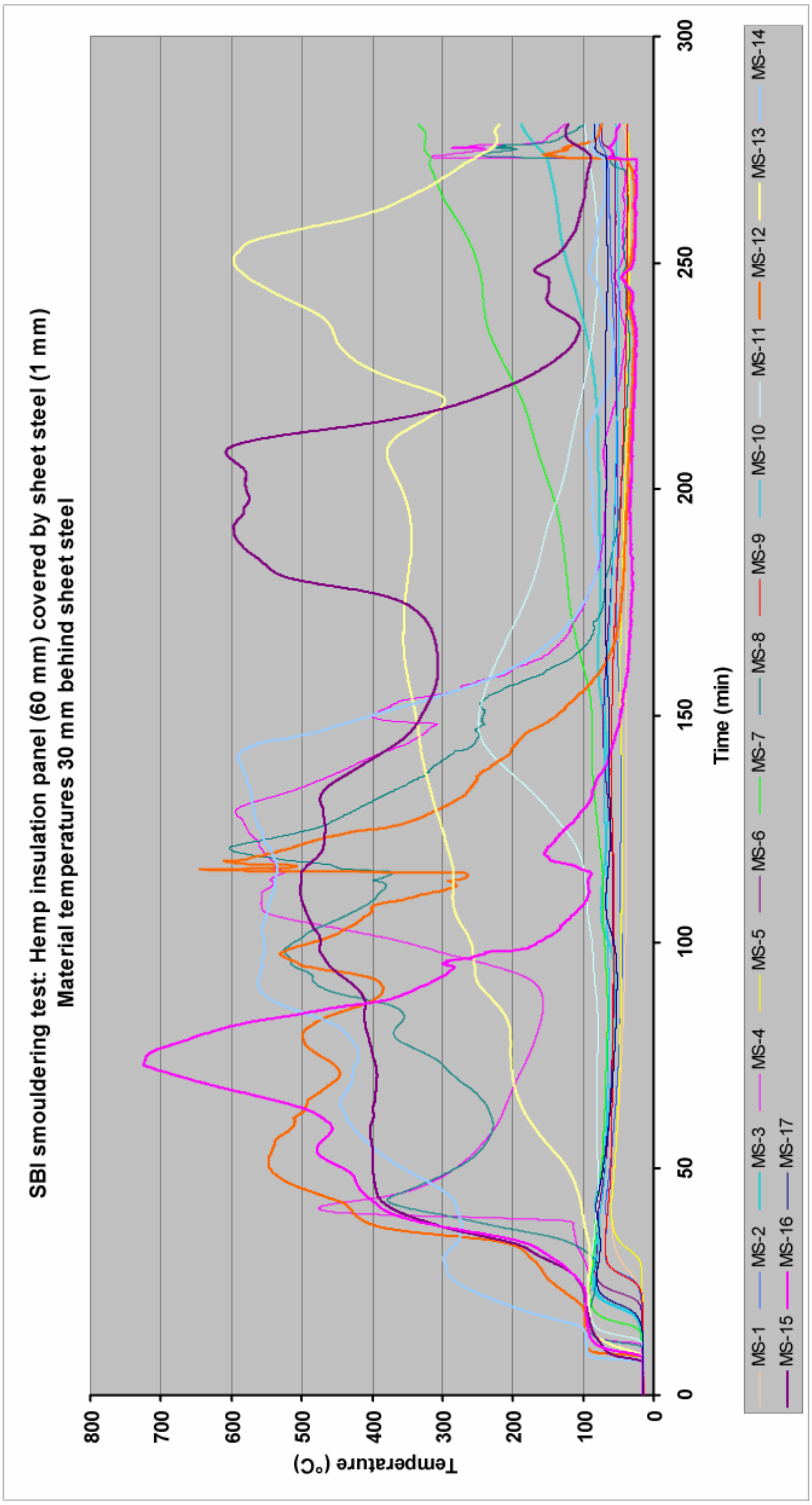
Temperatures



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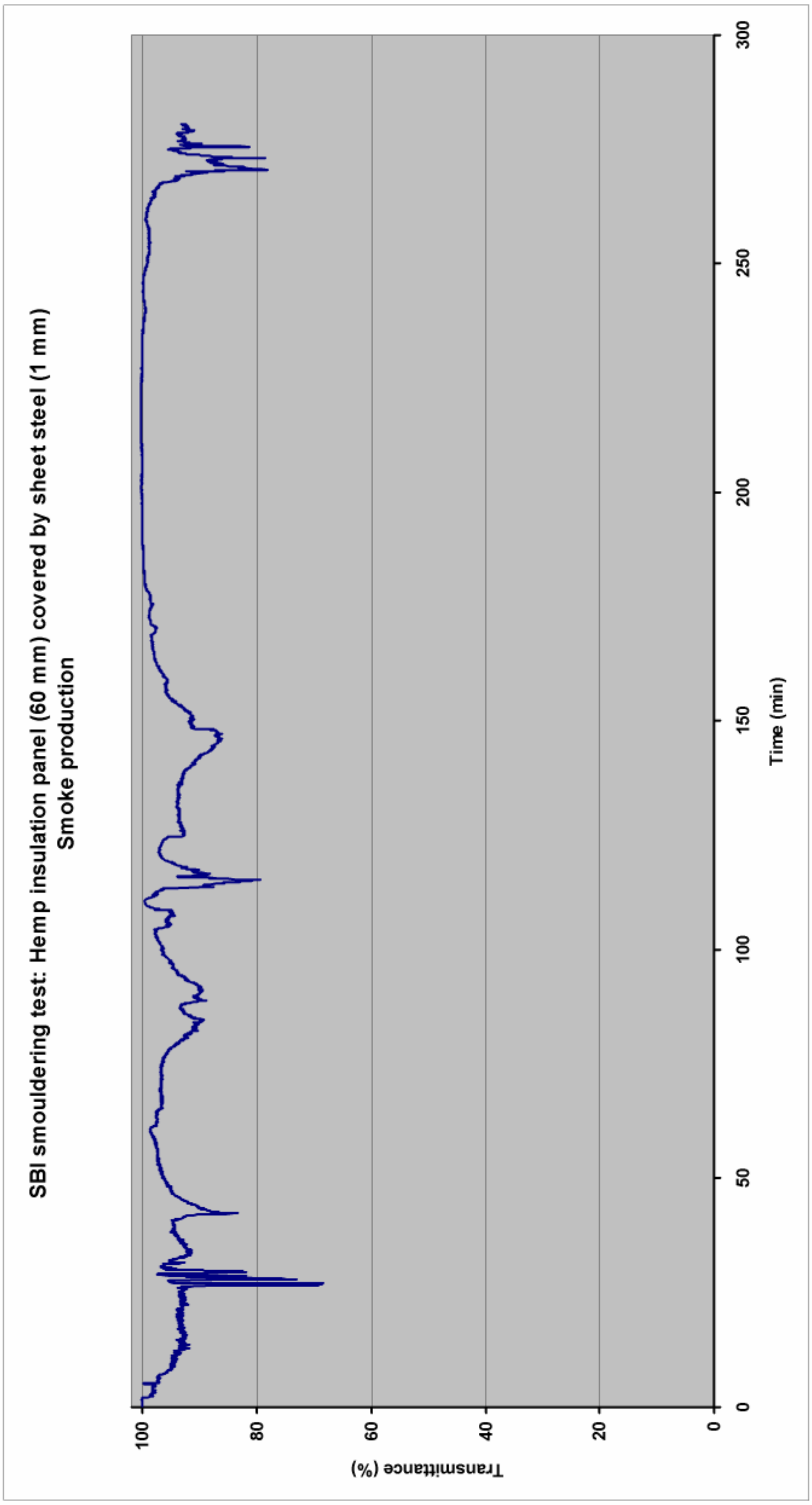
Smoke production



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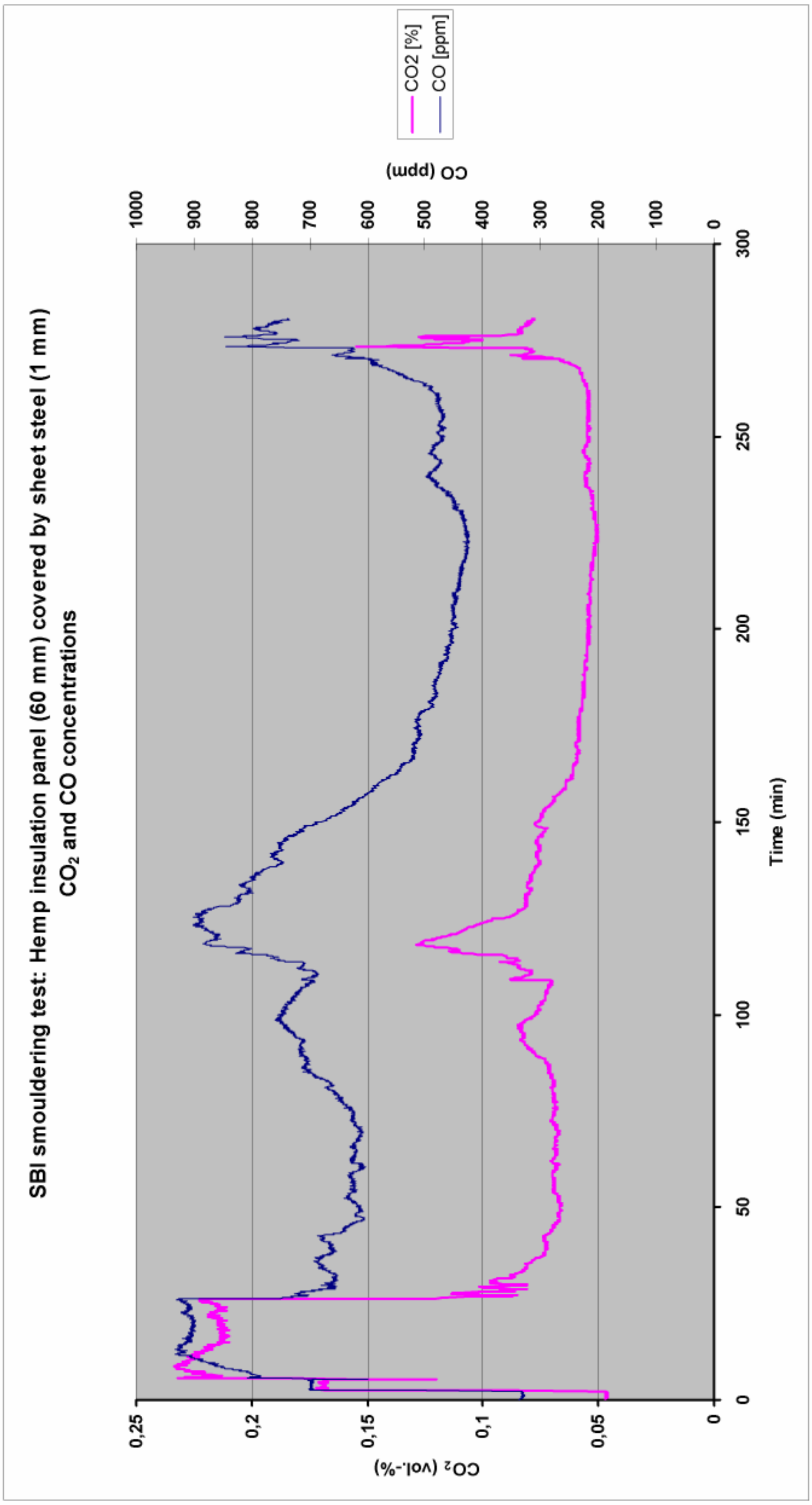
CO_2 and CO concentrations



Photographs

Test setup, steel sheet with opening

Opening 50 × 30 cm^2 at the long wing

Flame impingement

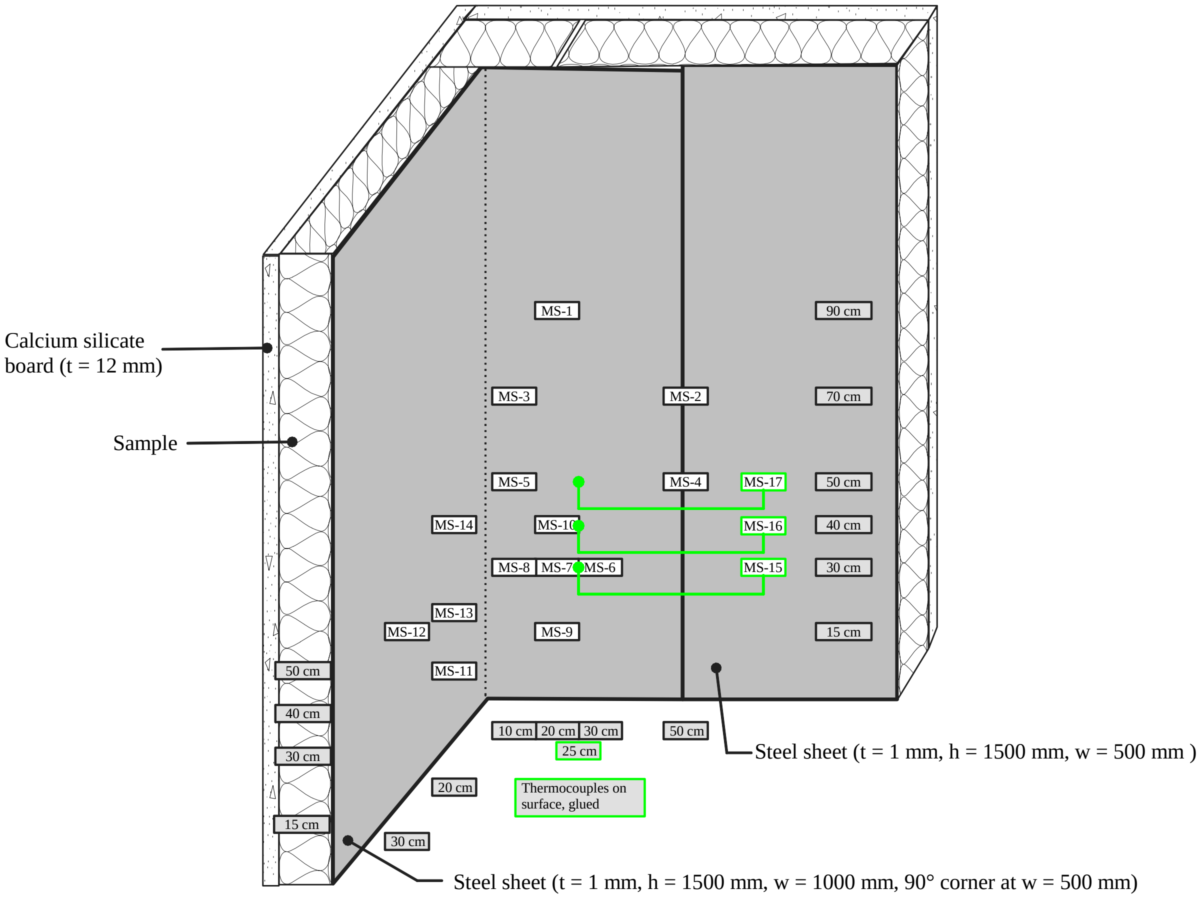
Ignition of pyrolysis gases at the opening (burner switched off)


Flames behind steel sheet

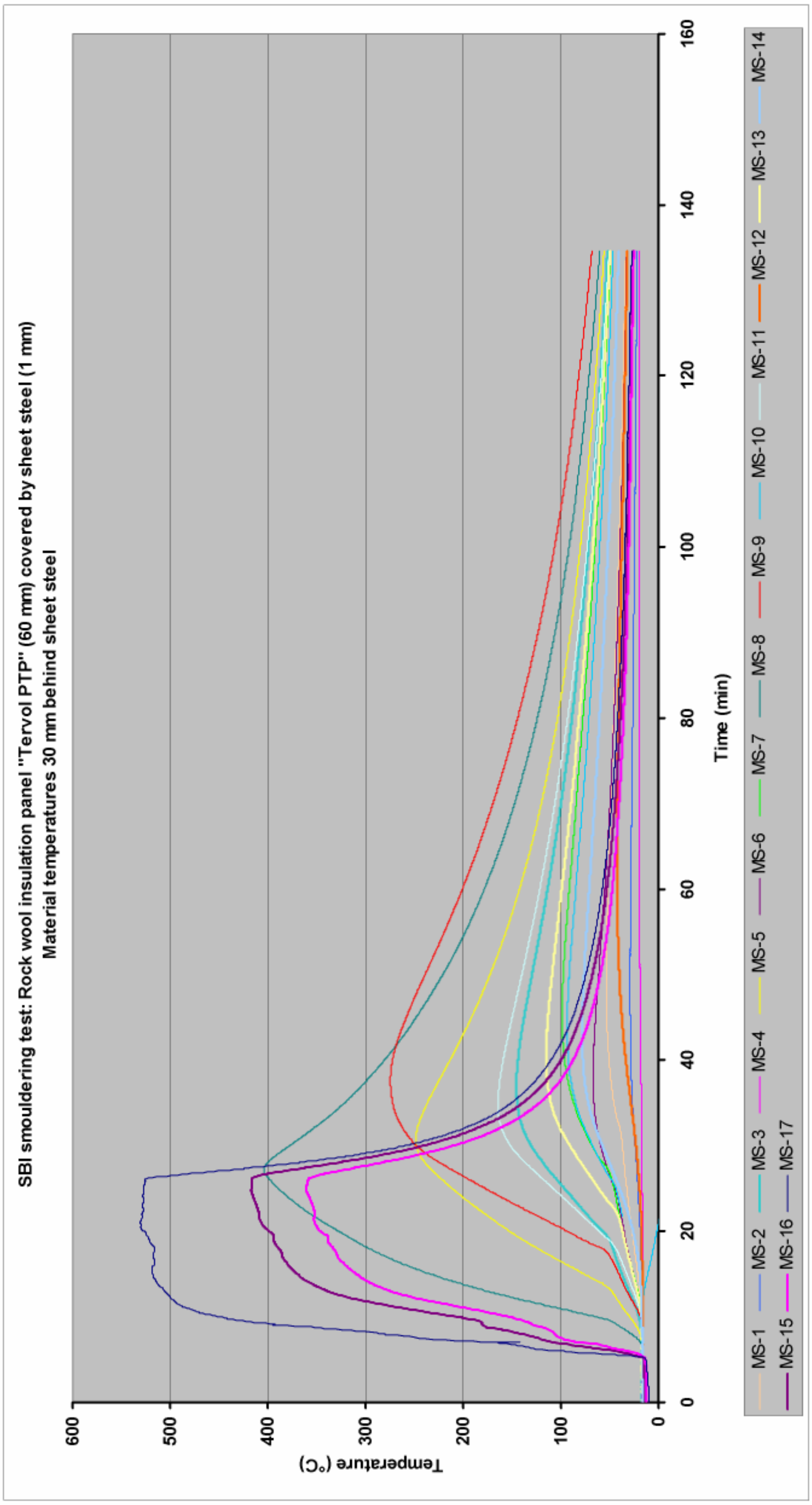

Sample after test

A.2 Rock wool insulation panel “Tervol PTP”

Test setup and temperature measuring points



Temperatures



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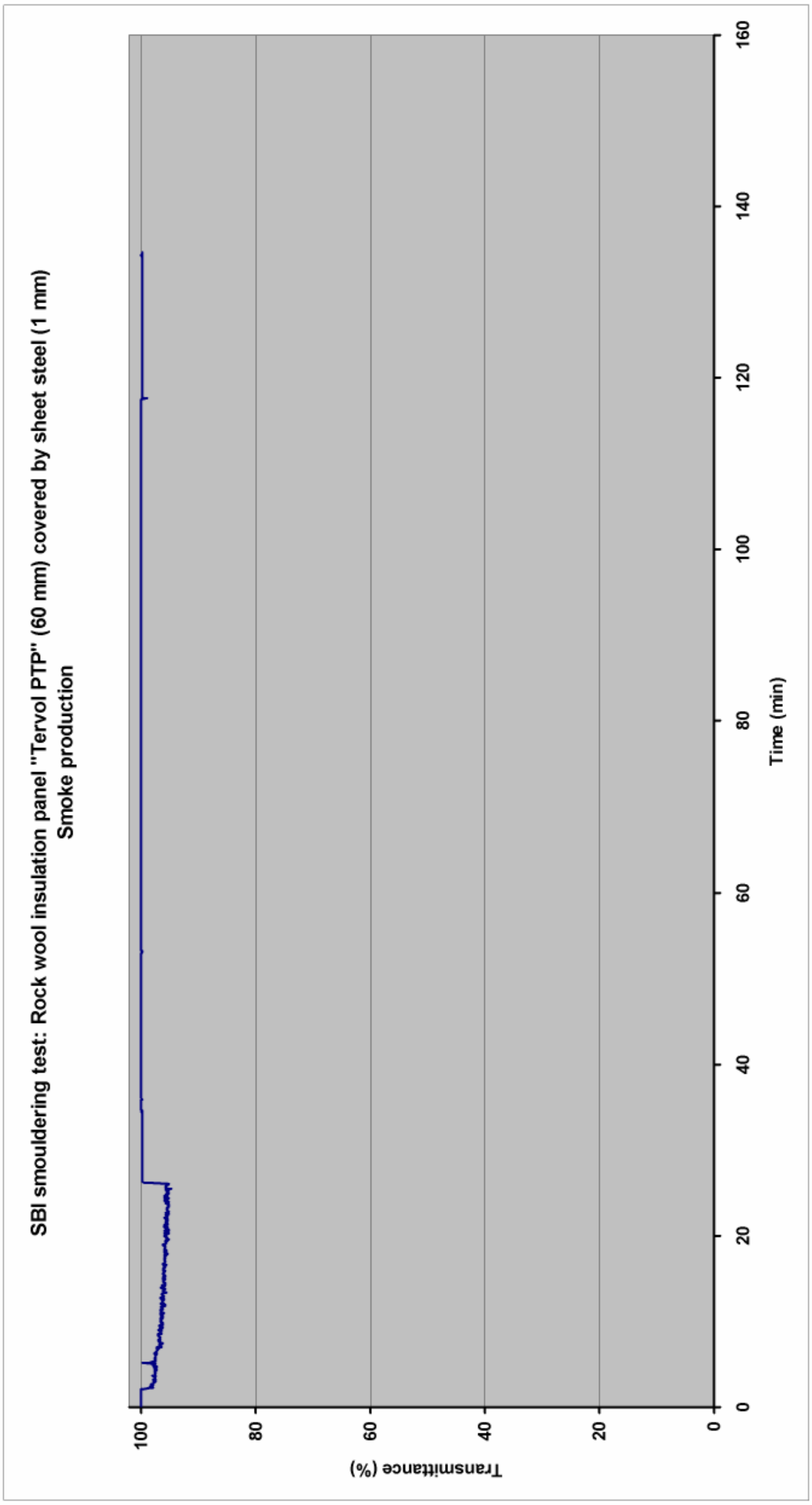
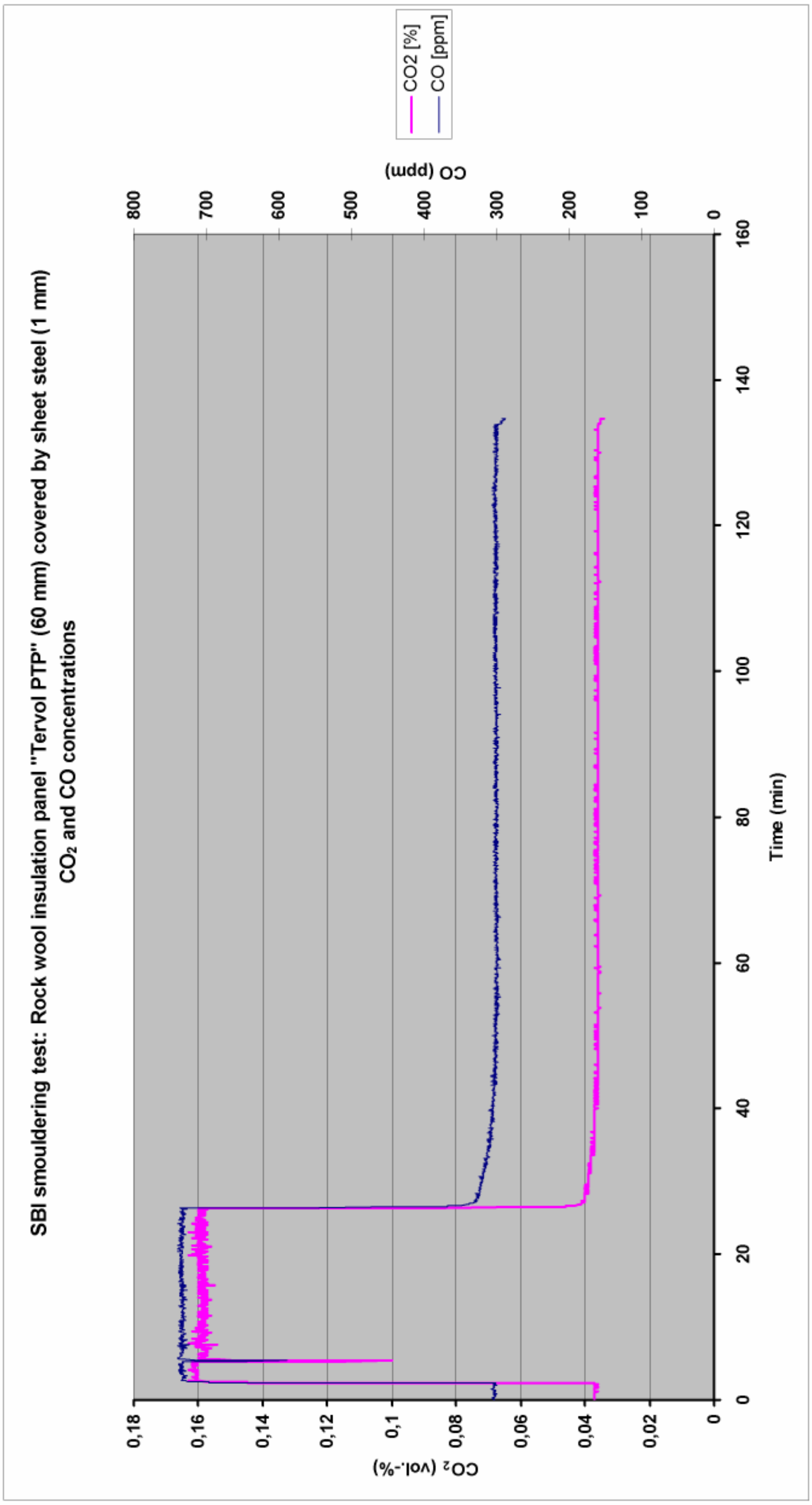
Smoke production



CO_2 and CO concentrations



Photographs

Test setup,
glued thermocouples MS-15, MS-16, MS-17

Flame impingement,
warping of the steel sheet (left wing)

Flame impingement,
warping of the steel sheet (right wing)

Sample after test

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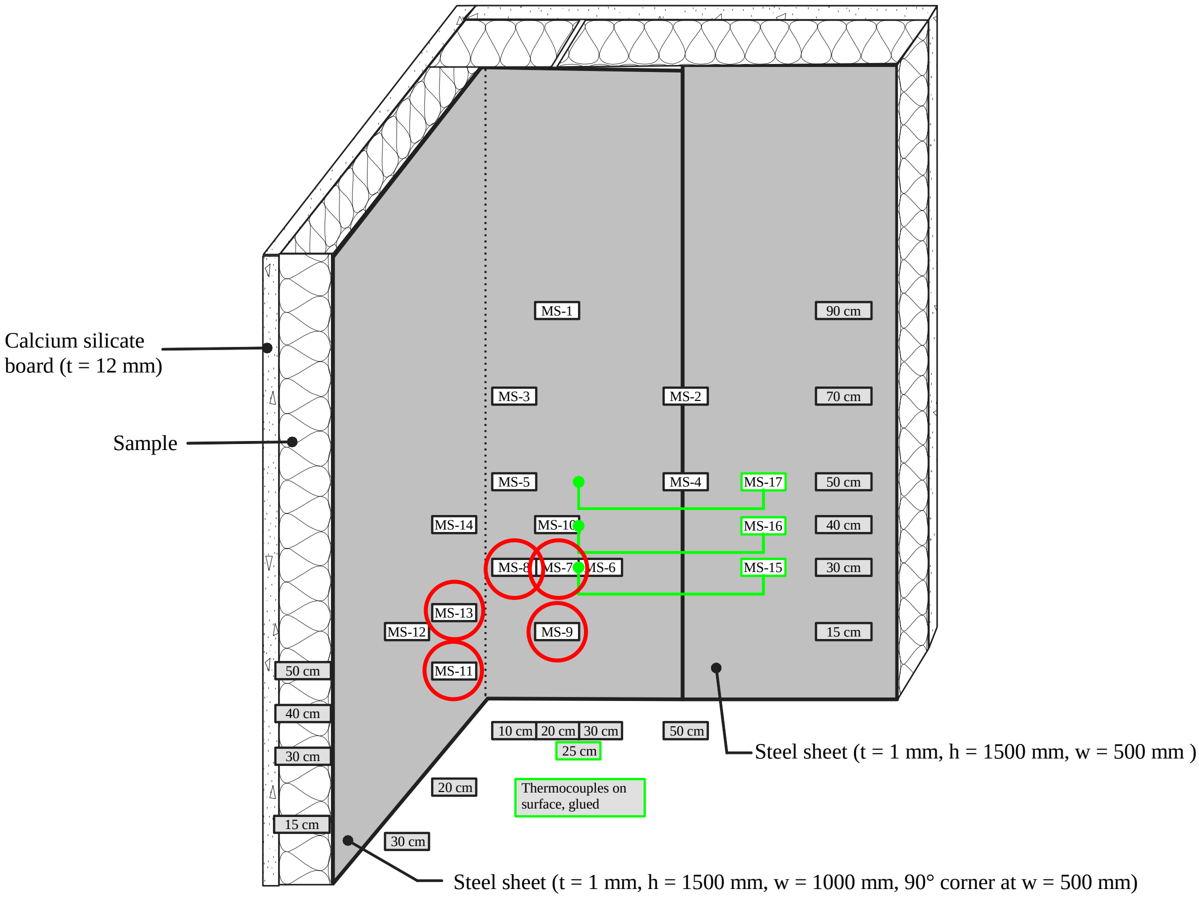
A.3 Rock wool insulation panel "Rhinox"

<u>Test setup and temperature measuring points</u>



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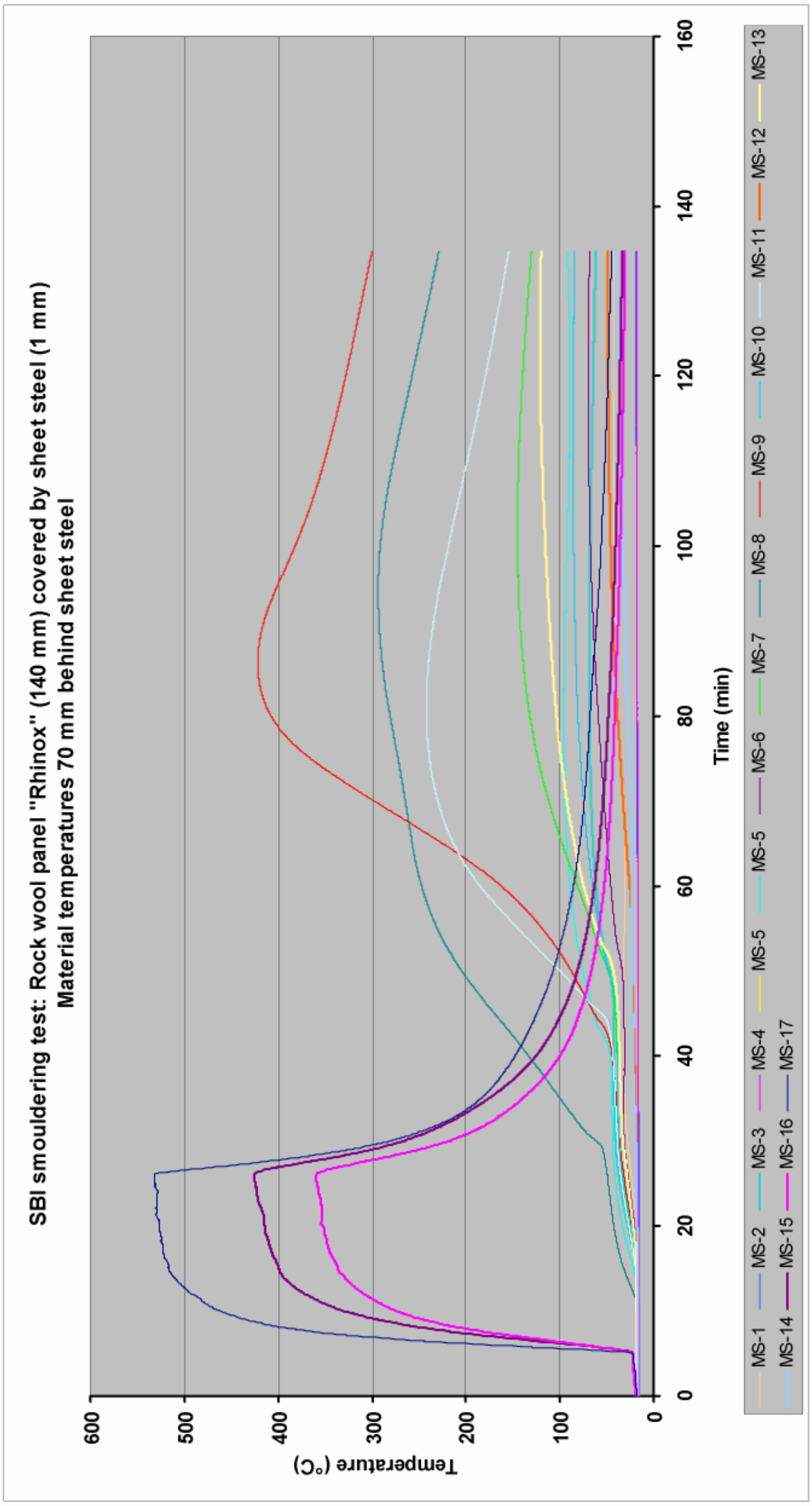
Temperatures



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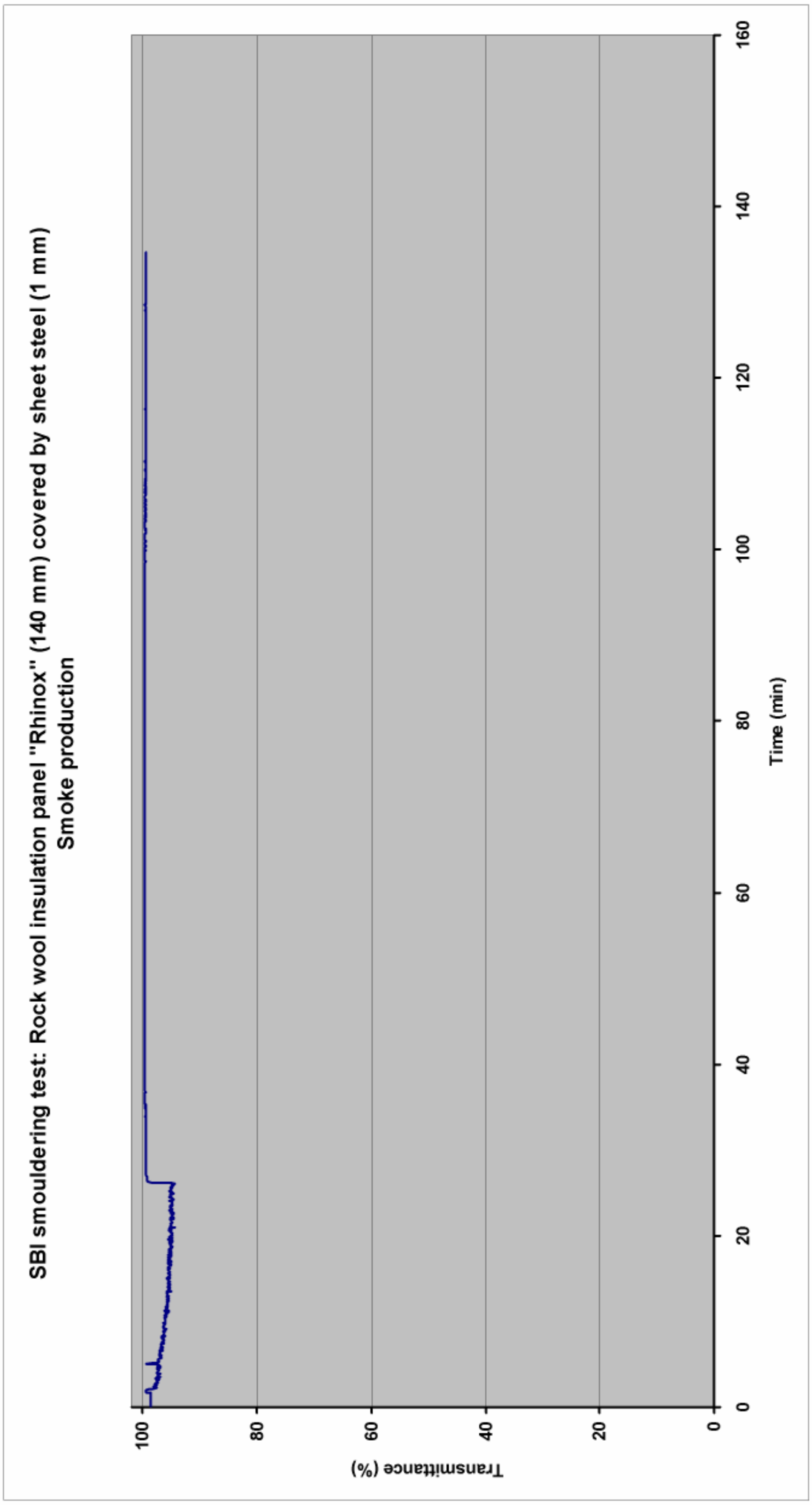
Smoke production



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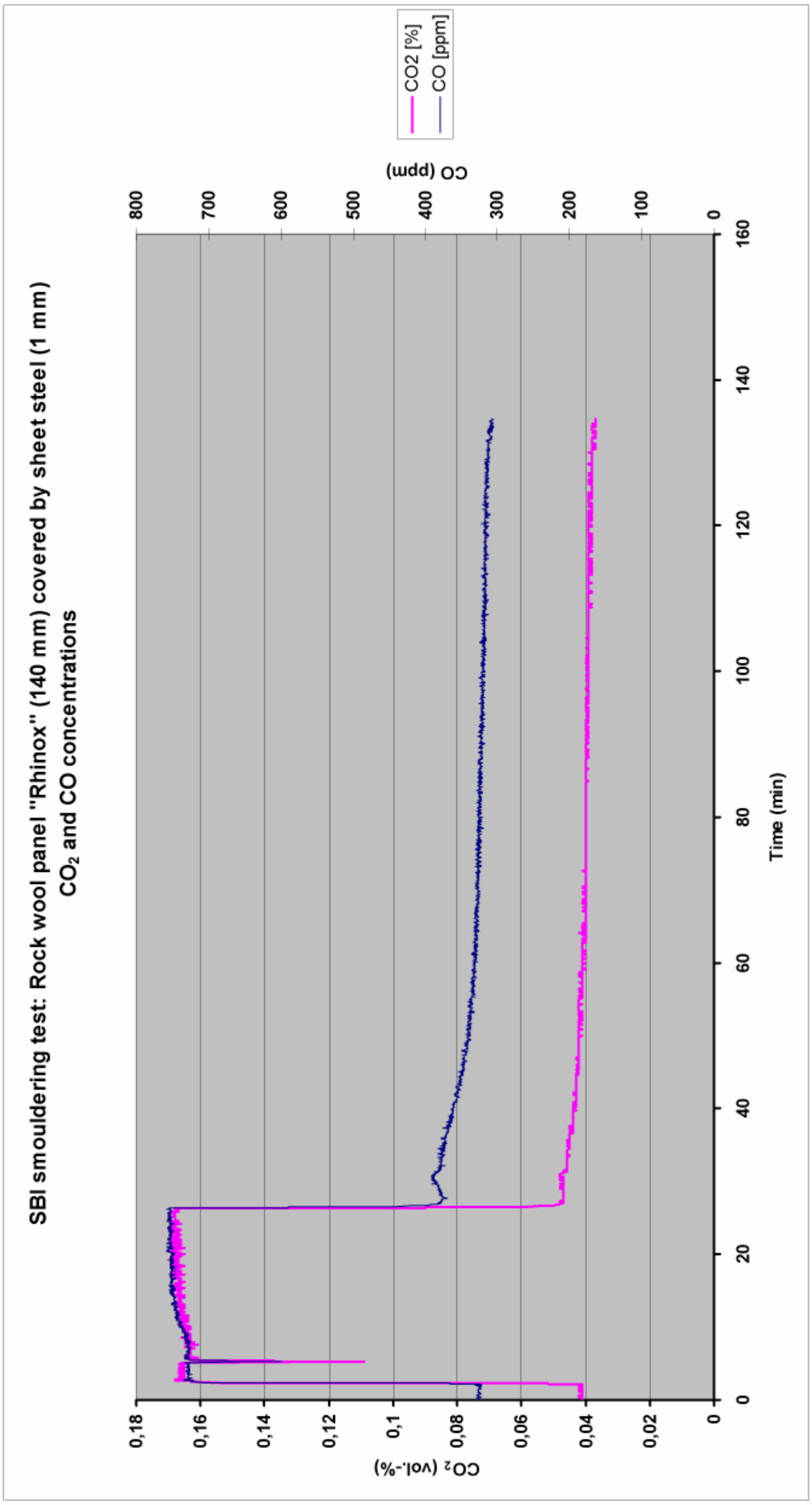
CO_2 and CO concentrations



Institut für **Brandtechnologie GmbH**

SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

Customer: **IBW**

BIS-SUA-SPA/Brandtechnologie

Rock wool insulation panel "Rhinox" 140 mm

Filename	Test no.	Operator	Test Date:	Print Date:
T30288C	1	Pelzer	17. Dez 03	16. Aug 04

Substrate: CaSi 12mm; Mounting: Sheet steel covering 1 mm

Test condition

Ambient Temp. $_{(t=30-90)}$ [°K]	289,08
Ambient pressure. [Pa]	101300
Humidity [%]	40,0
K(t)	0,9
K(p)	1,0800
E [KJ/m³]	17200
Duct Diameter: [m]	0,315
Conditioning:	fixed period
Conditioning time [days]	>3
Cond. start weight [g]	0
Cond. end weight [g]	0
Baseline O_2^a $_{(t=30-90)}$ [%]	20,7544
Baseline O_2 $_{(t=30-90)}$ [%]	20,9536
Baseline CO_2 $_{(t=30-90)}$ [%]	0,0413
Baseline Light sig. $_{(t=30-90)}$	98,6752

Check points

$RHR_{av,burner}$ [KW]	31,743
$RHR_{std\ burner}$ [KW]	0,620
CO_2/O_2 $Ratio_{burner}$	0,441
$RSP_{av,burner}$ [m³/s]	0,026
$RSP_{std\ burner}$ [m³/s]	0,004
Baseline Duct temp.$_{(t=30-90)}$ [°K]	293,57
Min. no. of accep. Thermocouples	3
Minimum for flow [m³/s]	0,54
Maximum for flow [m³/s]	0,61
Burner response time [s]	9
Conditioning cond. [%/day]	#DIV/0!
End data O_2 [%]	20,95
End data CO_2 [%]	0,04
End data Light signal	100,3

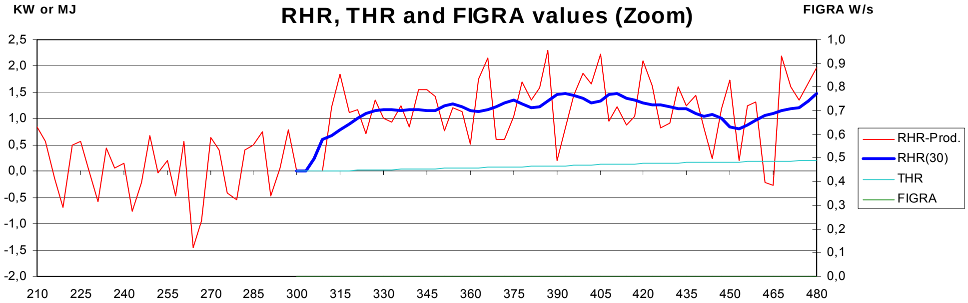
Results

FIGRA Threshold: 0.2 MJ [W/s]	**3**
FIGRA Threshold:0.4 MJ [W/s]	**3**
THR_{600} [MJ] *	**1,0**
Latheral flame spread (LFS) reach the edge?	**no**
SMOGRA [m²/s²]	**0**
TSP_{600} [m²] *	**14**
Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Time to max Figra [s] *	996
Tig (2*6KW) [s] *	Not reach
RHR(30) max.	3,3

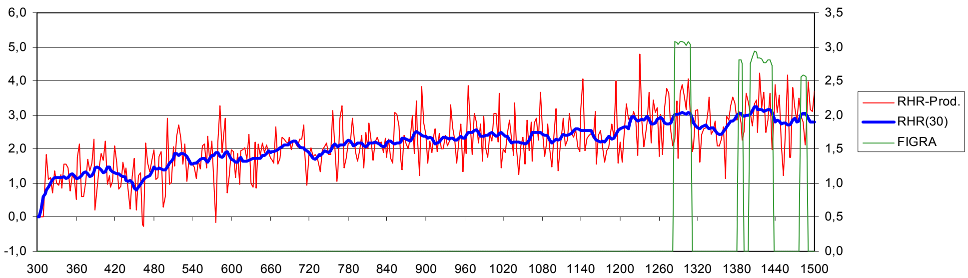
* After ignition of main burner

Synchronisation information	Baseline	Last point
T-Duct (2.5 °K drop from baseline)	314,52	309
O2 (0.05% rise from baseline)	20,6707	306
CO2 (0.02% drop from baseline)	0,1660	309

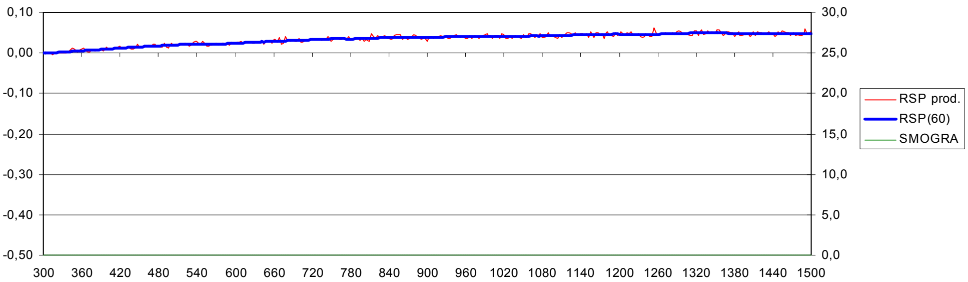
RHR, THR and FIGRA values (Zoom)



RHR and FIGRA values



RSP and SMOGRA values



Recorded events	
Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

Classification (1 Test)**:**
(if the material fulfil the standards EN ISO 11925-2; exposure 30s)

A2/B	Burn (A2/B; C; D; no SBI-class)
S1	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

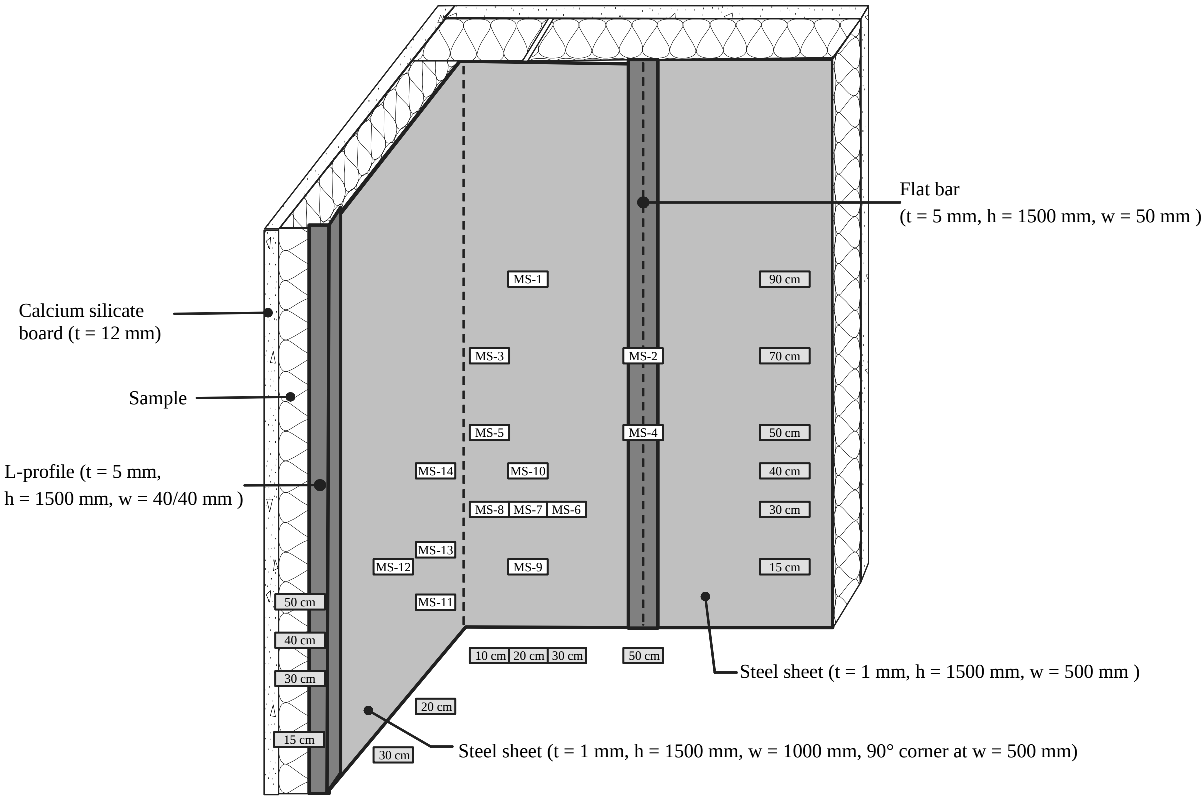
Photograph

Sample after test

Institut für Brandtechnologie GmbH

A.4 Melamine resin foam “Basotect”

Test setup and temperature measuring points



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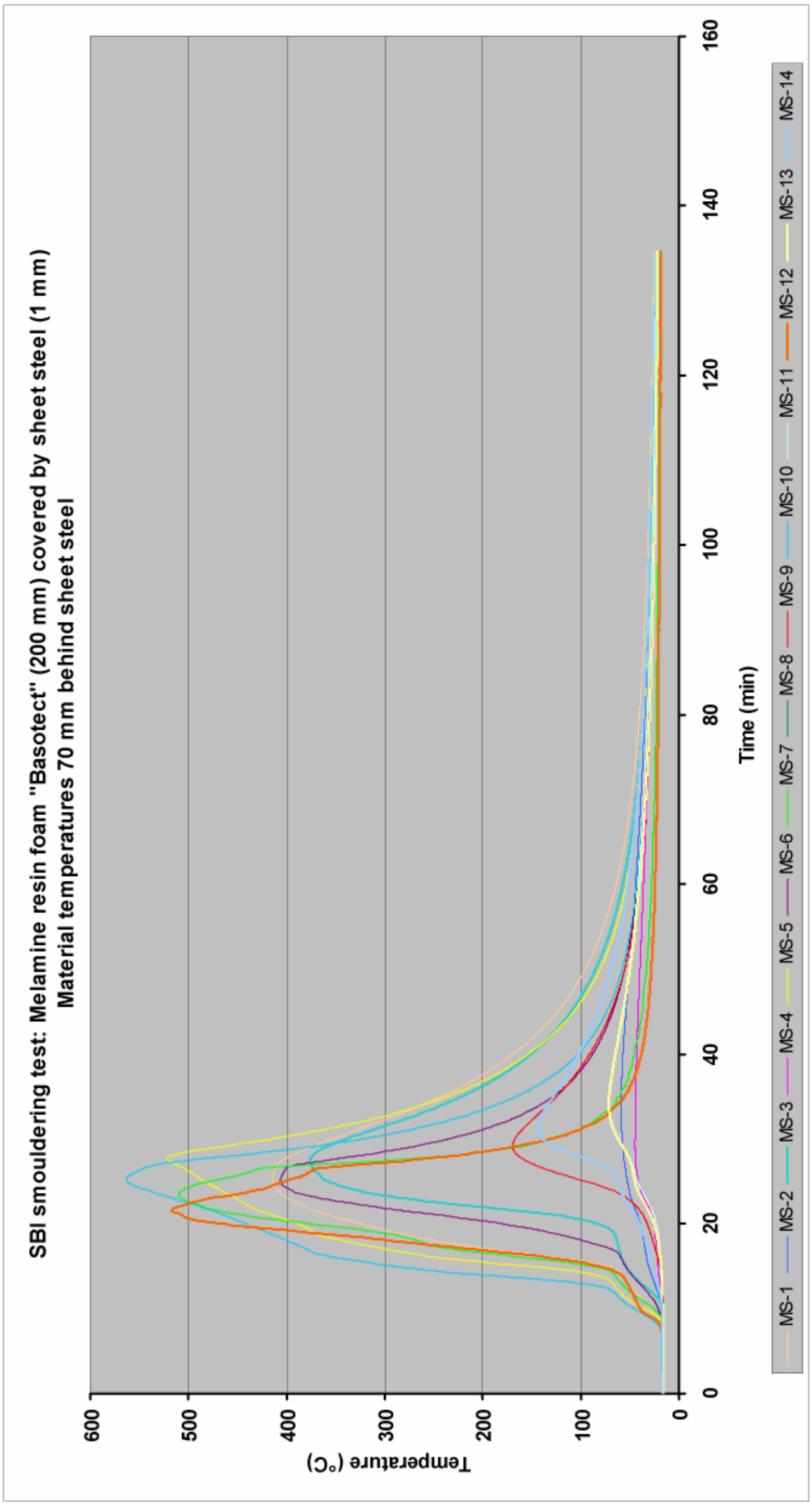
Temperatures



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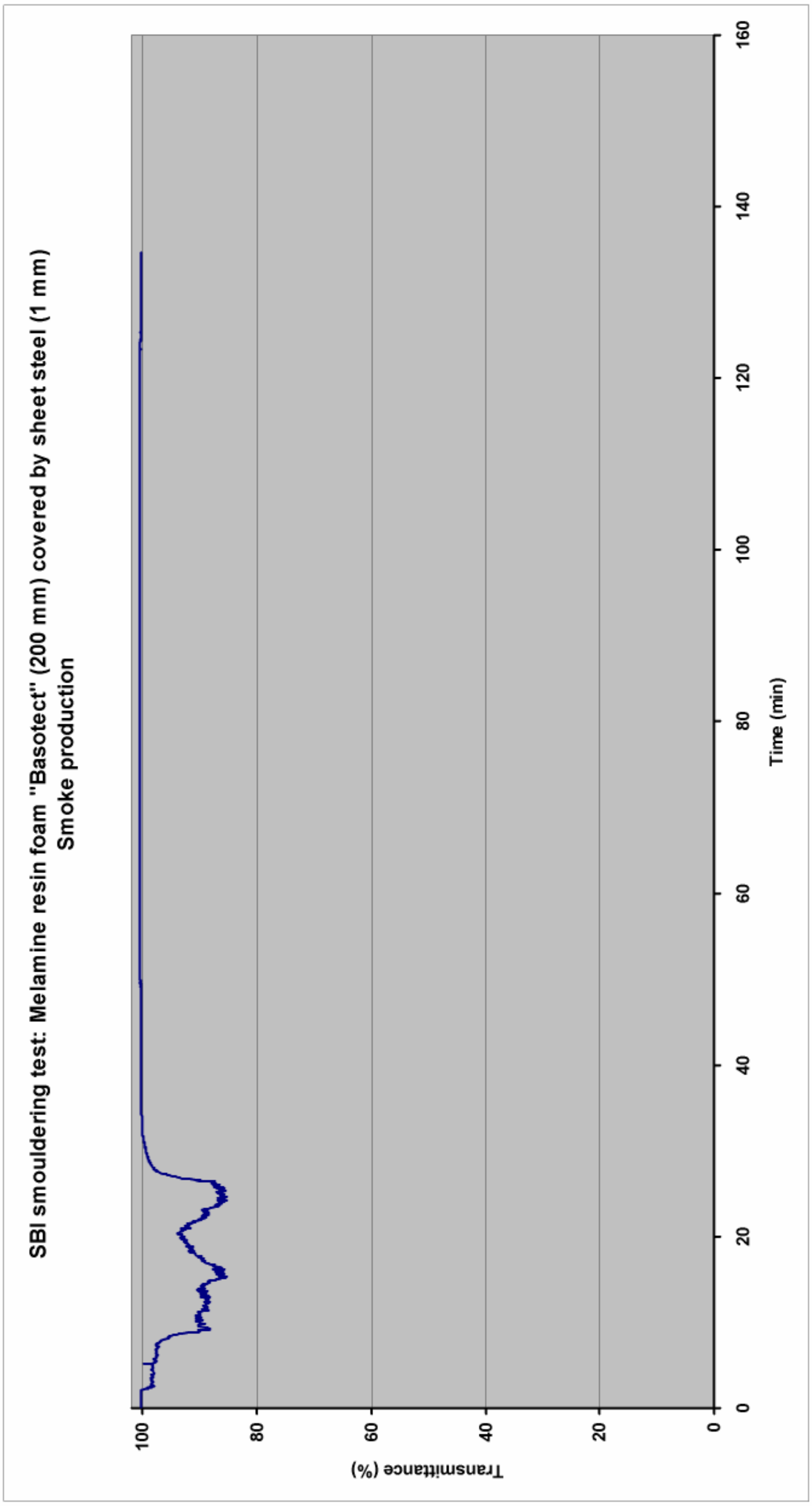
Smoke production



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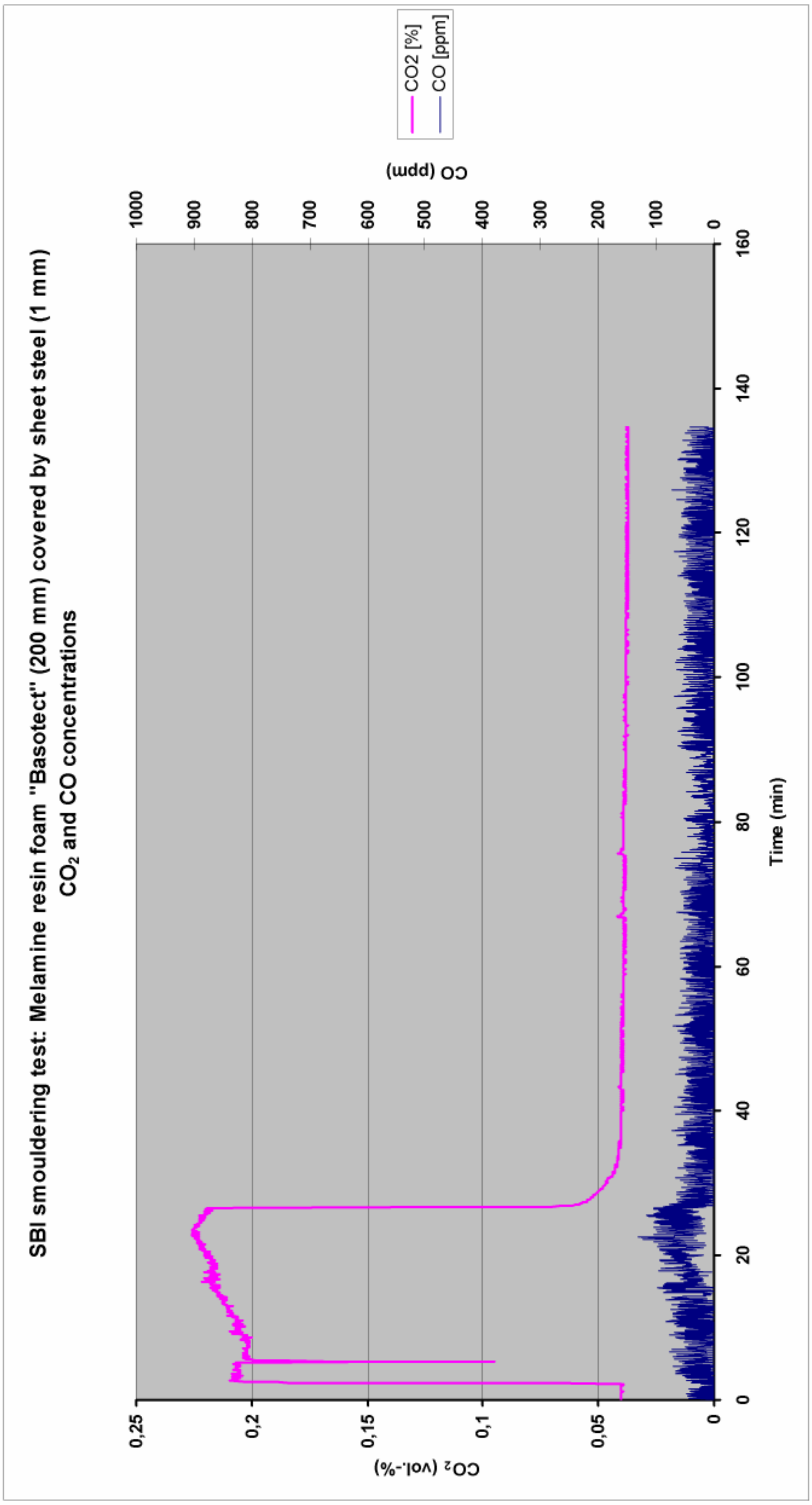
CO_2 and CO concentrations



Institut für **Brandtechnologie GmbH**

SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

BIS-SUA-SPA/Brandtechnologie

Customer: **IBW**

Filename	Test no.	Operator	Test Date:	Print Date:
T30288D	1	Pelzer	29. Jan 04	17. Aug 04

Melamine resin foam "Basotect"

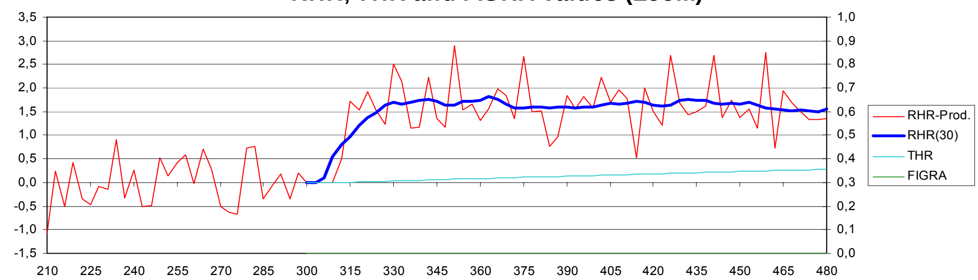
Substrate: CaSi 12mm; Mounting: Sheet steel covering 1 mm

ohne

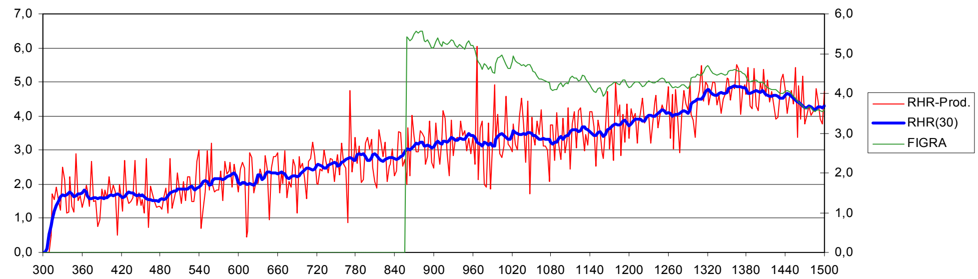
Test condition		Check points		Results	
Ambient Temp. $_{(t=30-90)}$ [°K]	288,73	$RHR_{av,burner}$ [KW]	32,418	FIGRA Threshold: 0.2 MJ [W/s]	**6**
Ambient pressure. [Pa]	100300	$RHR_{std\ burner}$ [KW]	0,507	FIGRA Threshold:0.4 MJ [W/s]	**6**
Humidity [%]	34,0	CO_2/O_2 $Ratio_{burner}$	0,570	THR_{600} [MJ] *	**1,3**
		$RSP_{av,burner}$ [m²/s]	0,038	Latheral flame spread (LFS) reach the edge?	**no**
K(t)	0,9	$RSP_{std\ burner}$ [m²/s]	0,004	SMOGRA [m²/s²]	**7**
K(p)	1,0800			TSP_{600} [m²] *	**77**
E [KJ/m³]	17200	Baseline Duct temp.$_{(t=30-90)}$ [°K]	289,72	Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Duct Diameter: [m]	0,315	Min. no. of accep. Thermocouples	3	Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Conditioning:	fixed period	Minimum for flow [m³/s]	0,58	Time to max Figra [s] *	573
Conditioning time [days]	>3	Maximum for flow [m³/s]	0,62	Tig (2*6KW) [s] *	Not reach
Cond. start weight [g]	0	Burner response time [s]	9	RHR(30) max.	4,9
Cond. end weight [g]	0	Conditioning cond. [%/day]	#DIV/0!	* After ignition of main burner	

				Synchronisation information	Baseline	Last point
Baseline O_2^a $_{(t=30-90)}$ [%]	20,8170					
Baseline O_2 $_{(t=30-90)}$ [%]	20,9510	End data O_2 [%]	20,95	T-Duct (2.5 °K drop from baseline)	312,71	315
Baseline CO_2 $_{(t=30-90)}$ [%]	0,0400	End data CO_2 [%]	0,04	O2 (0.05% rise from baseline)	20,6589	312
Baseline Light sig. $_{(t=30-90)}$	100,2471	End data Light signal	100,3	CO2 (0.02% drop from baseline)	0,2064	312

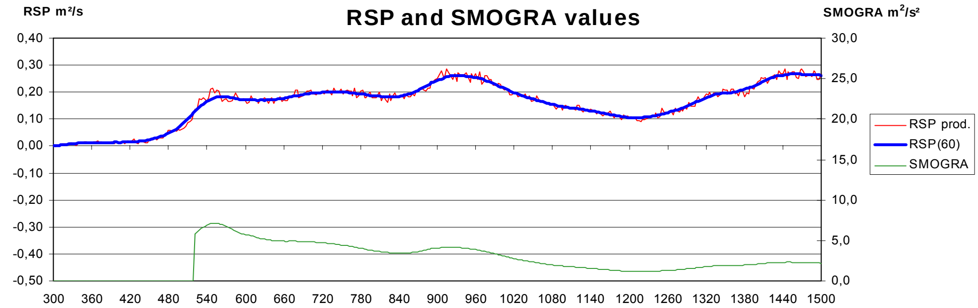
RHR, THR and FIGRA values (Zoom)



RHR and FIGRA values



RSP and SMOGRA values



Recorded events

Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

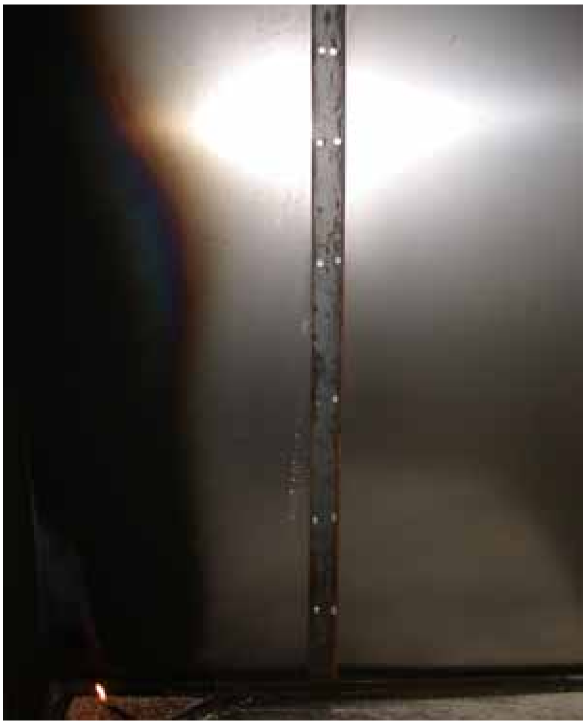
Classification (1 Test)**:**

(if the material fulfil the standarts EN ISO 11925-2; exposure 30s)

A2/B	Burn (A2/B; C; D; no SBI-class)
S2	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

Photographs

Test setup



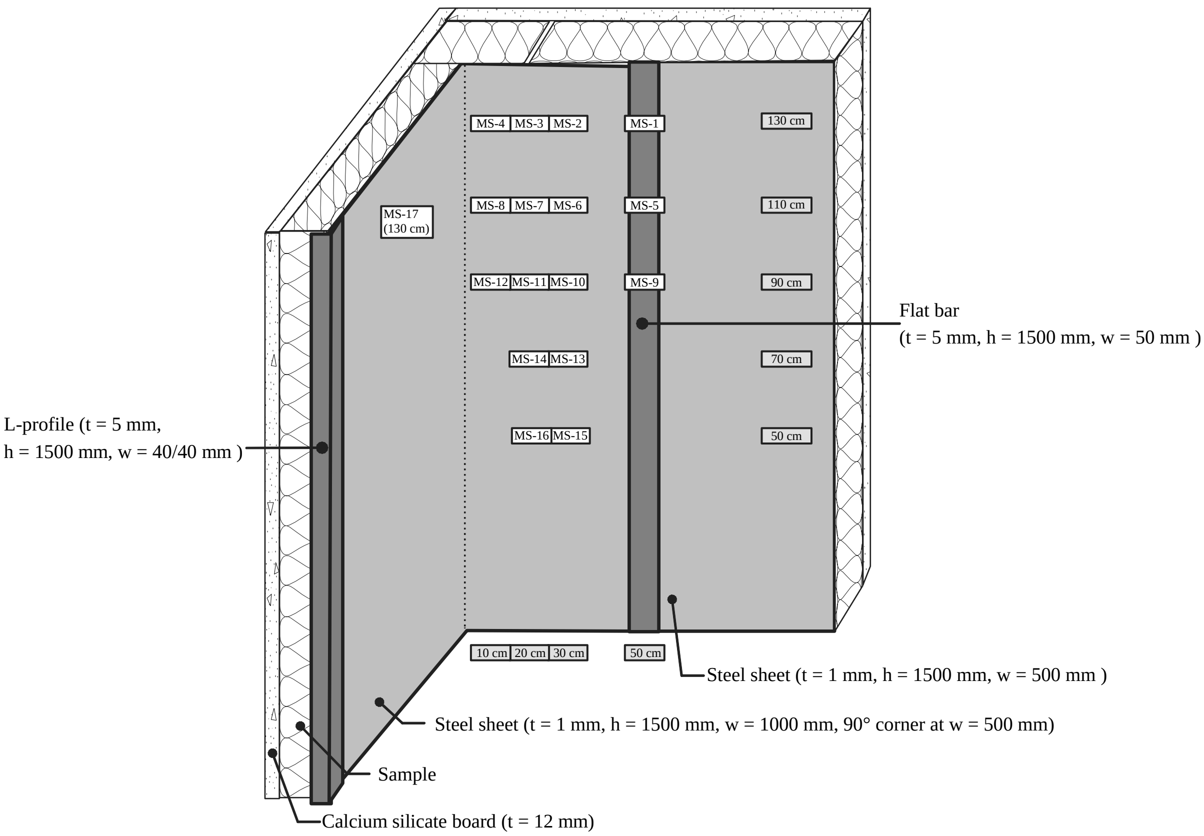
Flat bar in front of the joint between the two pieces of steel sheet (long wing)

Sample after test

Sample after test (side view short wing)

A.5 Polyurethane rigid foam

Test setup and temperature measuring points



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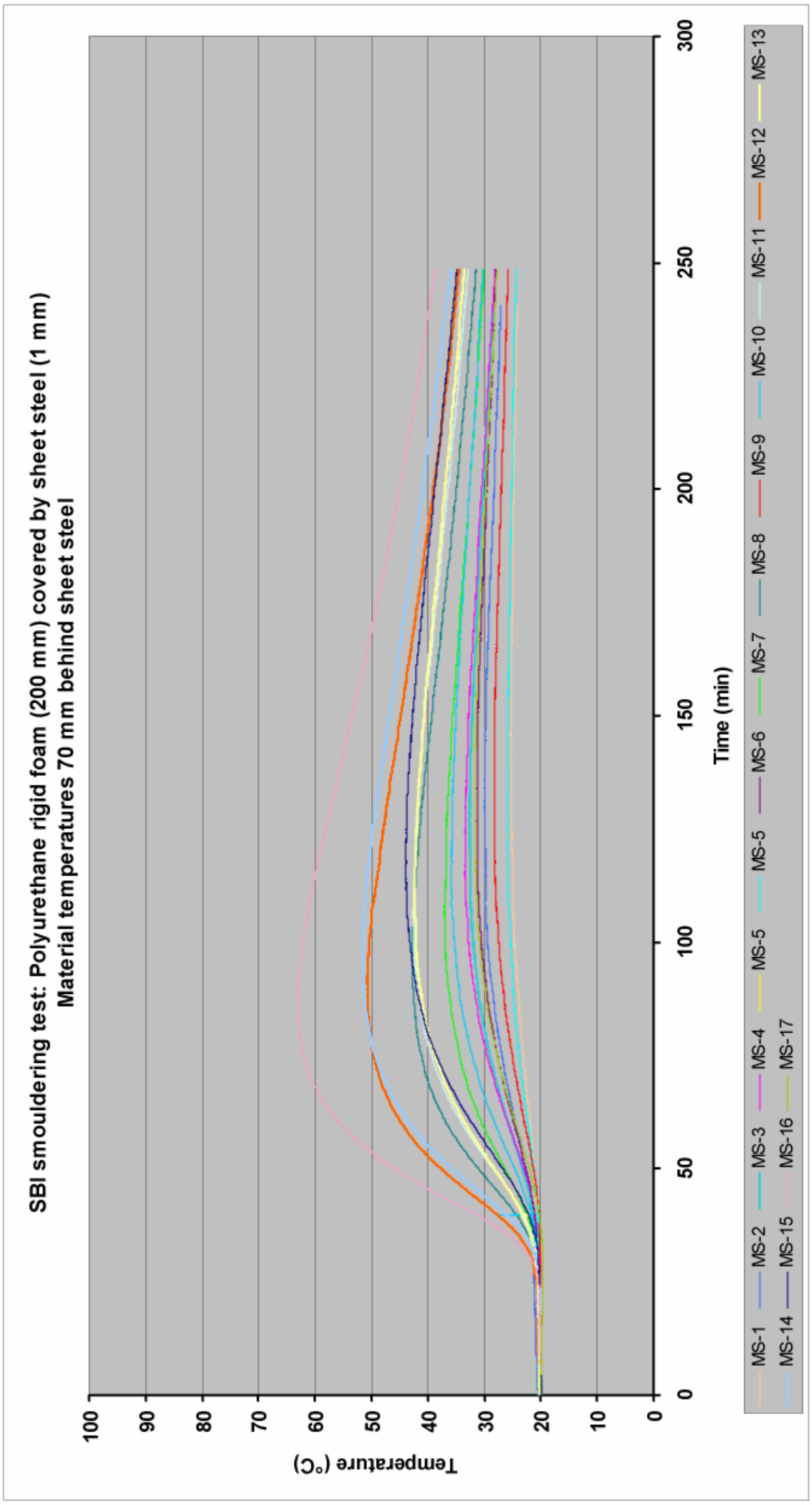
Temperatures



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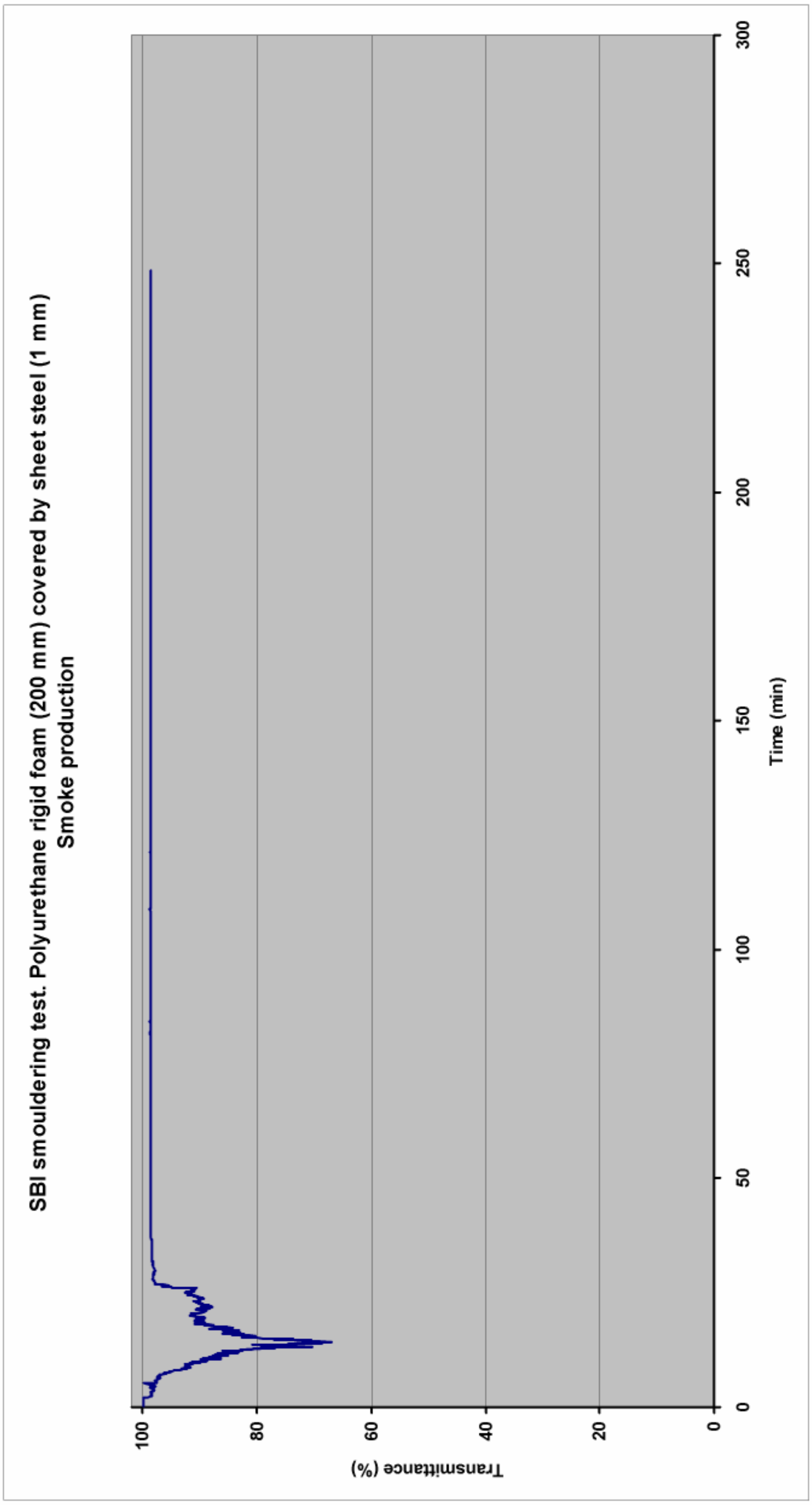
Smoke production



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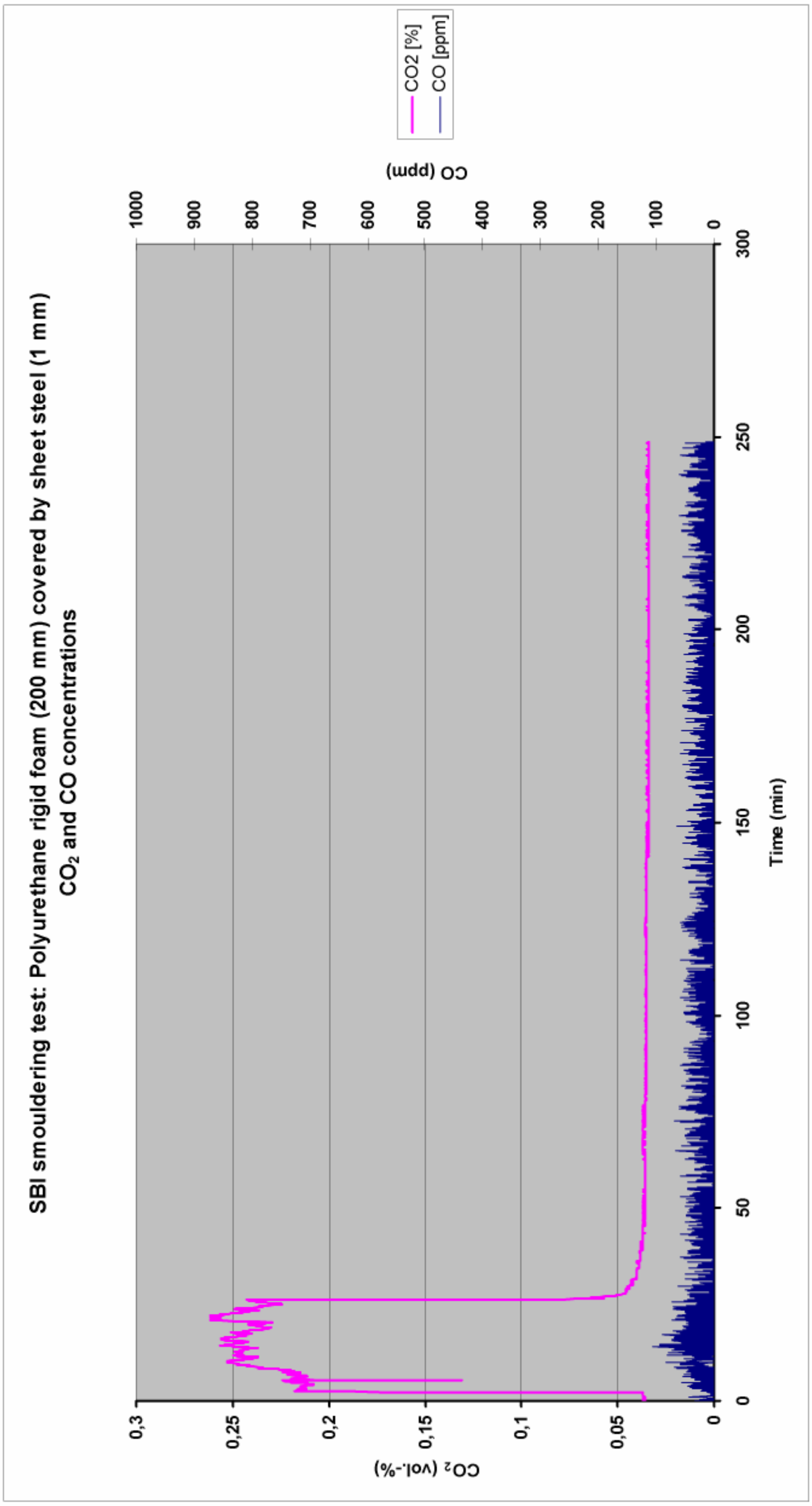
<u>CO_2 and CO concentrations</u>



Institut für **Brandtechnologie GmbH**

SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

BIS-SUA-SPA/Brandtechnologie

Customer: **IBW**

PUR rigid foam 200 mm

Substrate: CaSi 12mm; Mounting: Sheet steel covering 1 mm

Filename	Test no.	Operator	Test Date:	Print Date:
T40201V1	1	Pelzer	23. Jun 04	17. Aug 04

Test condition

Ambient Temp. $_{(t=30-90)}$ [°K]	293,27
Ambient pressure. [Pa]	101300
Humidity [%]	48,0
K(t)	0,9
K(p)	1,0800
E [KJ/m³]	17200
Duct Diameter: [m]	0,315
Conditioning:	fixed period
Conditioning time [days]	>3
Cond. start weight [g]	0
Cond. end weight [g]	0
Baseline O_2^a $_{(t=30-90)}$ [%]	20,7190
Baseline O_2 $_{(t=30-90)}$ [%]	20,9548
Baseline CO_2 $_{(t=30-90)}$ [%]	0,0368
Baseline Light sig. $_{(t=30-90)}$	99,9376

Check points

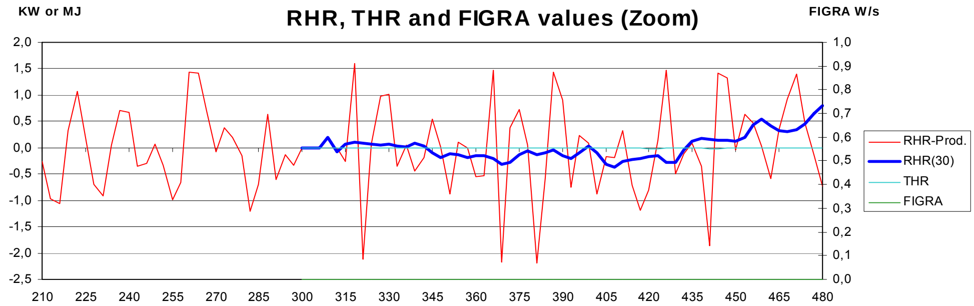
$RHR_{av,burner}$ [KW]	30,916
$RHR_{std\ burner}$ [KW]	0,775
CO_2/O_2 $Ratio_{burner}$	0,635
$RSP_{av,burner}$ [m²/s]	0,034
$RSP_{std\ burner}$ [m²/s]	0,006
Baseline Duct temp. $_{(t=30-90)}$ [°K]	293,36
Min. no. of accep. Thermocouples	3
Minimum for flow [m³/s]	0,56
Maximum for flow [m³/s]	0,65
Burner response time [s]	9
Conditioning cond. [%/day]	#DIV/0!
End data O_2 [%]	20,95
End data CO_2 [%]	0,04
End data Light signal	99,9

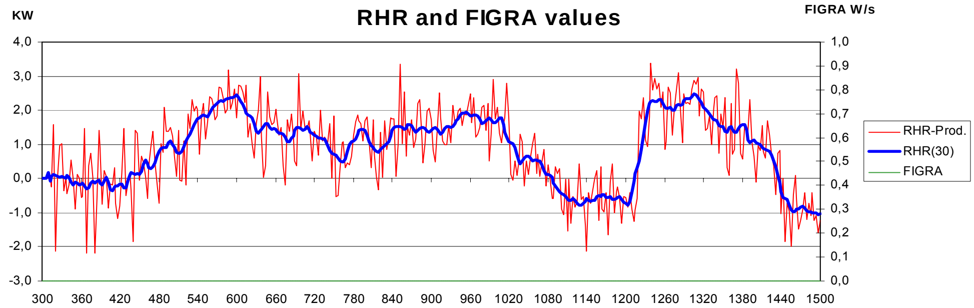
Results

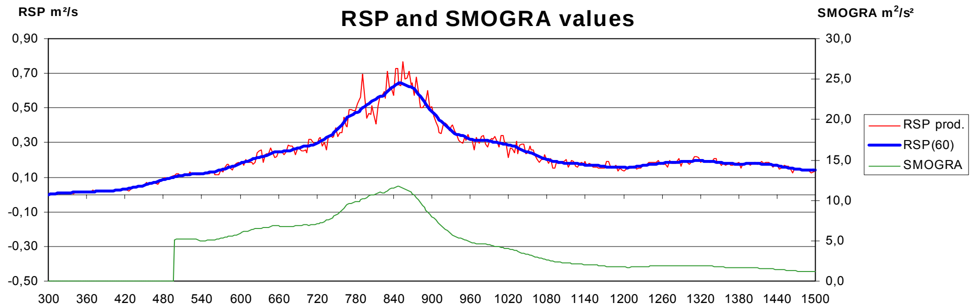
FIGRA Threshold: 0.2 MJ [W/s]	**0**
FIGRA Threshold:0.4 MJ [W/s]	**0**
THR_{600} [MJ] *	**0,6**
Latheral flame spread (LFS) reach the edge?	**no**
SMOGRA [m²/s²]	**12**
TSP_{600} [m²] *	**142**
Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Time to max Figra [s] *	0
Tig (2*6KW) [s] *	Not reach
RHR(30) max.	2,5

* After ignition of main burner

Synchronisation information	Baseline	Last point
T-Duct (2.5 °K drop from baseline)	318,73	315
O2 (0.05% rise from baseline)	20,6793	309
CO2 (0.02% drop from baseline)	0,2115	309







Recorded events	
Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

Classification (1 Test):

(if the material fulfil the standarts EN ISO 11925-2; exposure 30s)

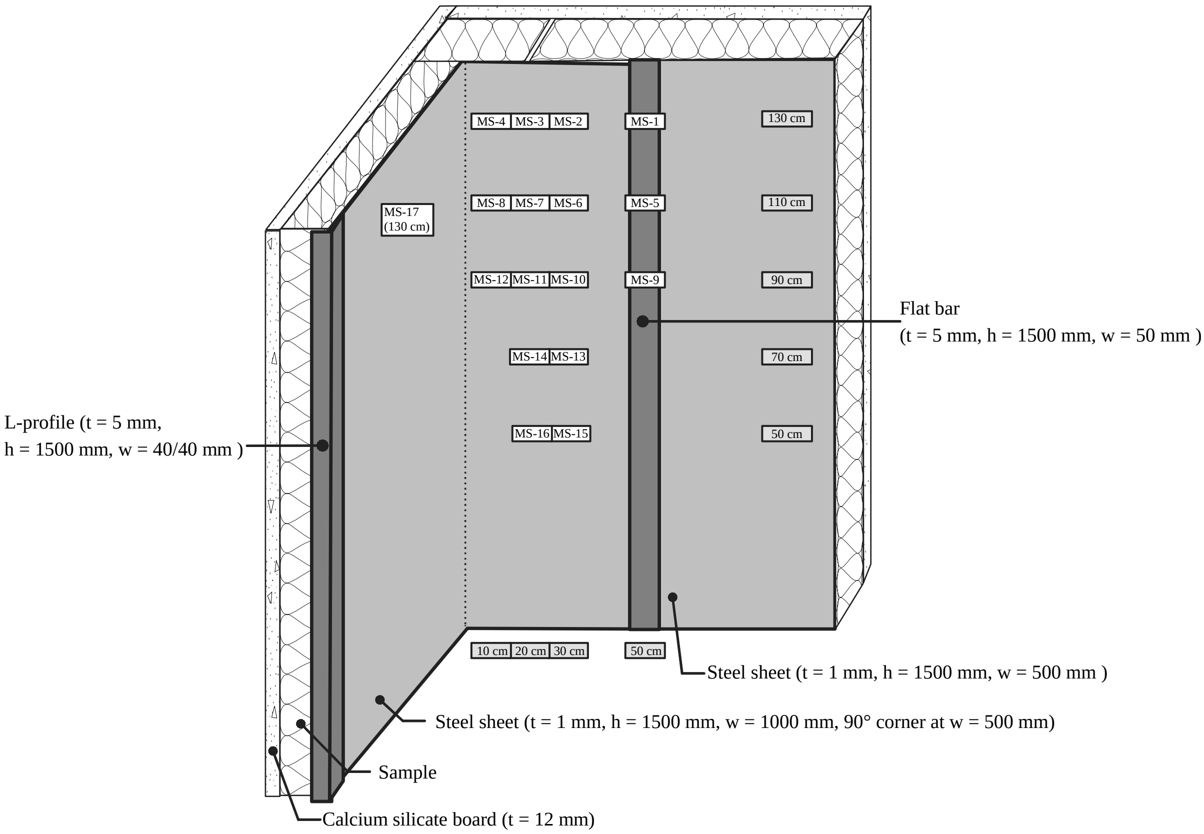
A2/B	Burn (A2/B; C; D; no SBI-class)
S2	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

Photograph

Sample after test

A.6 Rock wool insulation panel (Korff)

Test setup and temperature measuring points



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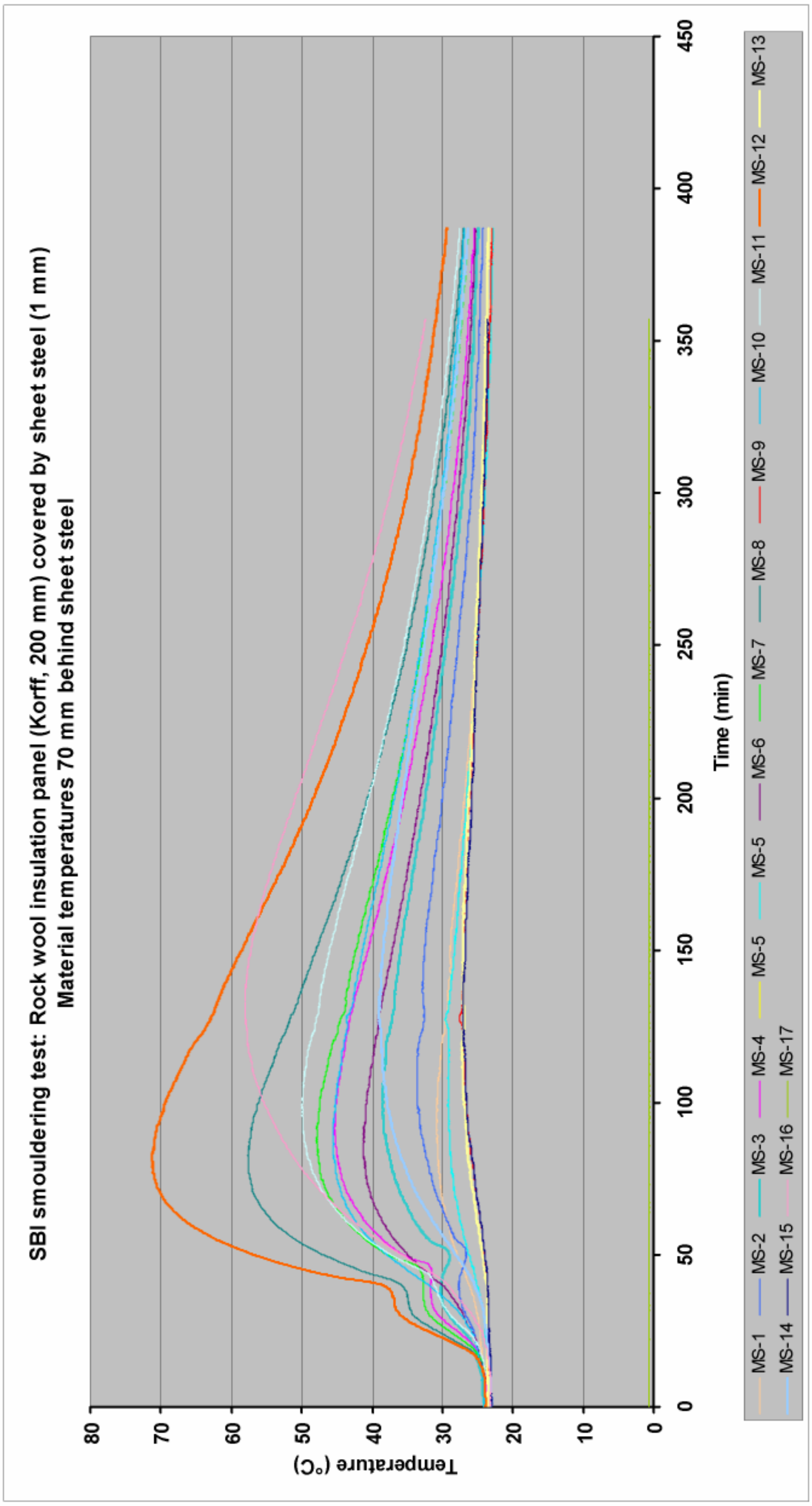
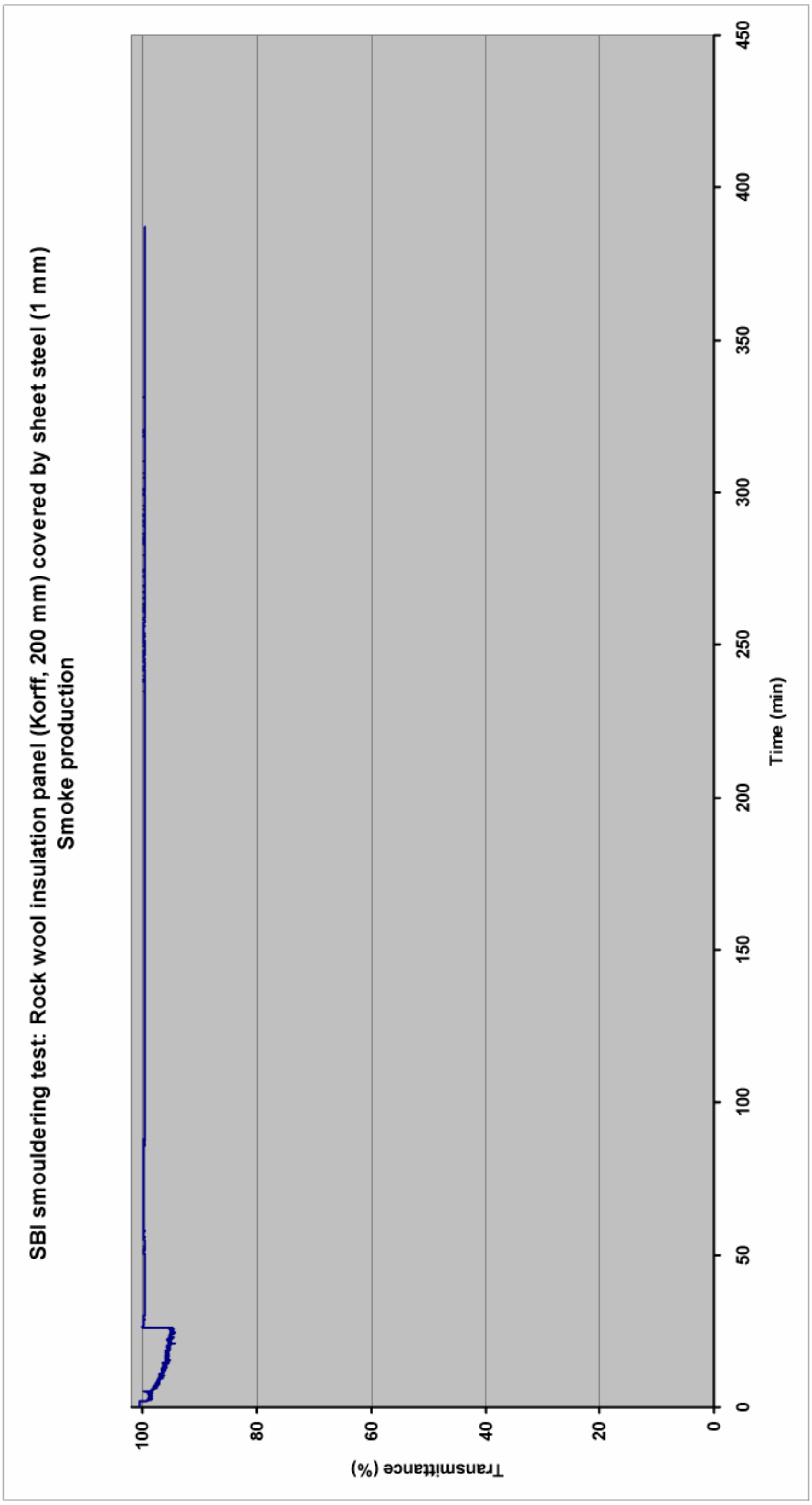
Temperatures



Institut für **Brandtechnologie GmbH**

Smoke production



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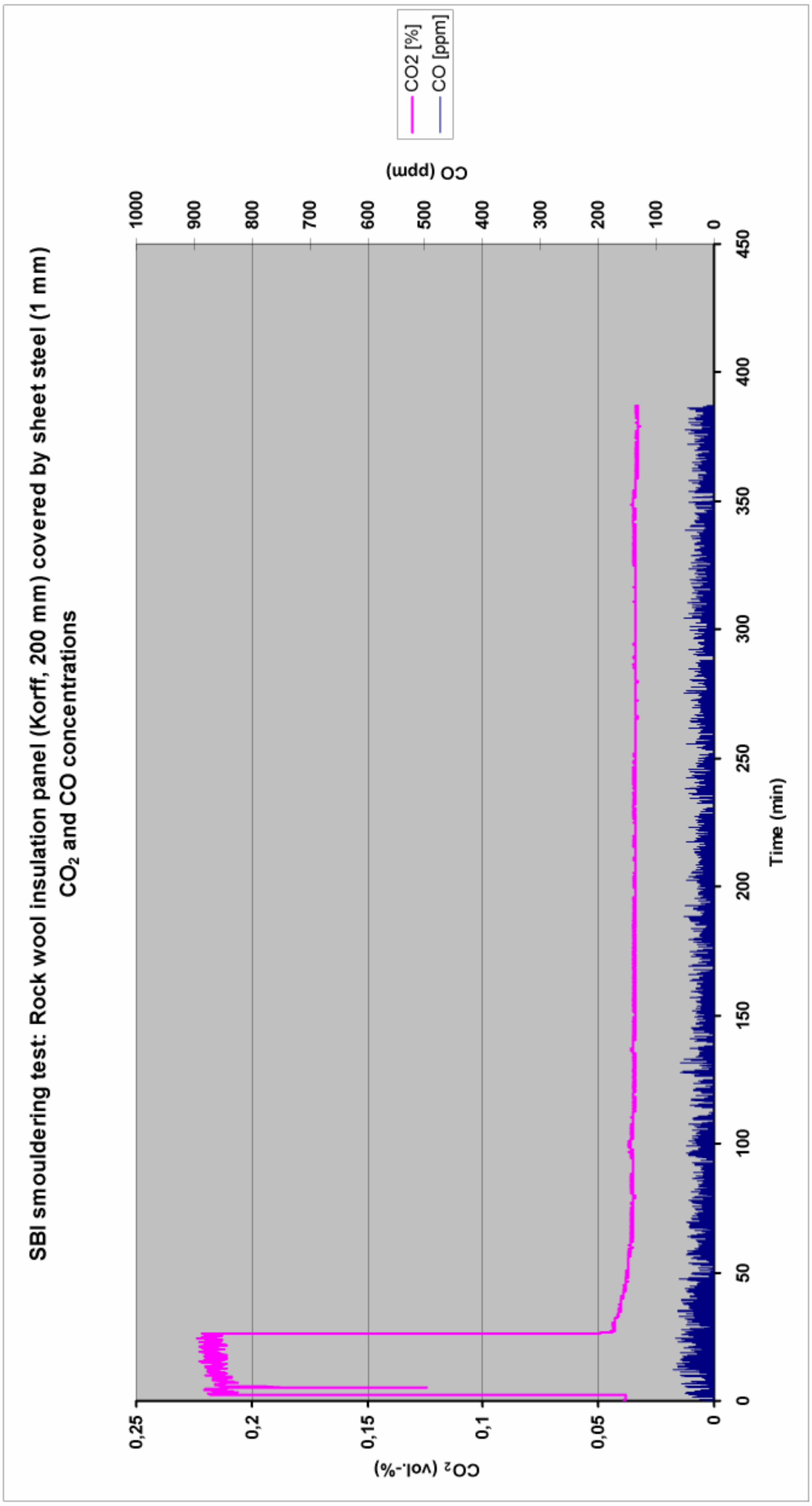
CO_2 and CO concentrations



Institut für Brandtechnologie GmbH

SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

BIS-SUA-SPA/Brandtechnologie

Customer: **IBW**

Rock wool insulation panel (Korff) 200 mm

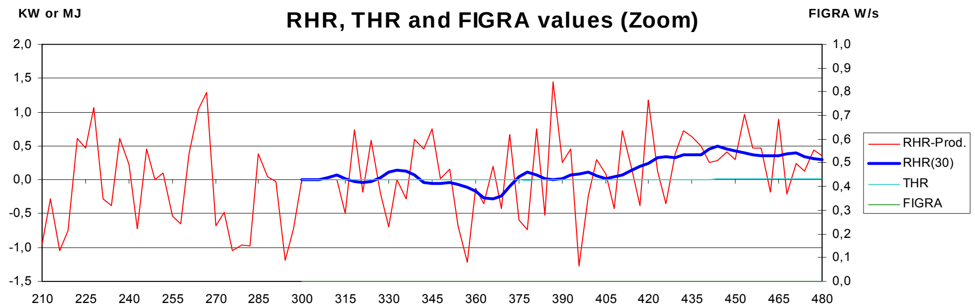
Substrate: CaSi 12mm; Mounting: Sheet steel covering 1 mm

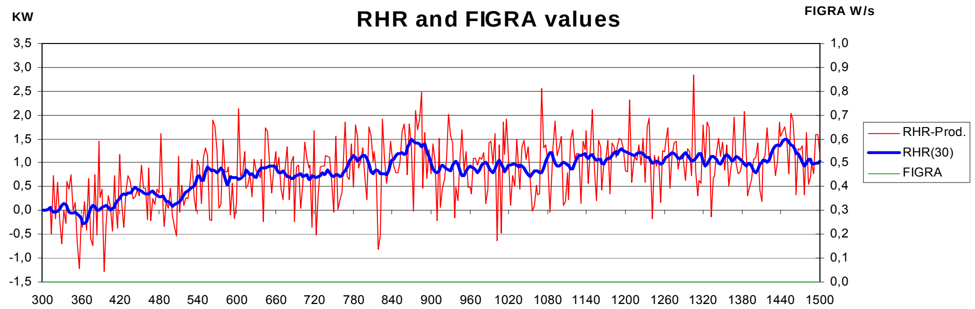
Filename	Test no.	Operator	Test Date:	Print Date:
T40201V3	1	Pelzer	01. Jul 04	17. Aug 04

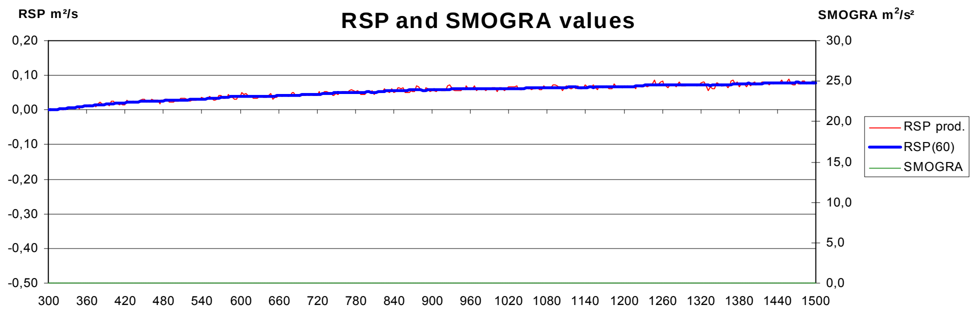
Test condition		Check points	
Ambient Temp. $_{(t=30\text{-}90)}$ [°K]	295,32	$RHR_{av,burner}$ [KW]	29,859
Ambient pressure. [Pa]	101200	$RHR_{std\ burner}$ [KW]	0,702
Humidity [%]	46,0	CO_2/O_2 $Ratio_{burner}$	0,644
		$RSP_{av,burner}$ [m²/s]	0,037
K(t)	0,9	$RSP_{std\ burner}$ [m²/s]	0,004
K(p)	1,0800		
E [KJ/m³]	17200	Baseline Duct temp. $_{(t=30\text{-}90)}$ [°K]	295,54
Duct Diameter: [m]	0,315	Min. no. of accep. Thermocouples	3
Conditioning:	fixed period	Minimum for flow [m³/s]	0,56
Conditioning time [days]	>3	Maximum for flow [m³/s]	0,63
Cond. start weight [g]	0	Burner response time [s]	9
Cond. end weight [g]	0	Conditioning cond. [%/day]	#DIV/0!
Baseline $O_2{}^{a}$ $_{(t=30\text{-}90)}$ [%]	20,6955		
Baseline O_2 $_{(t=30\text{-}90)}$ [%]	20,9545	End data O_2 [%]	20,96
Baseline CO_2 $_{(t=30\text{-}90)}$ [%]	0,0380	End data CO_2 [%]	0,04
Baseline Light sig. $_{(t=30\text{-}90)}$	100,5243	End data Light signal	99,2

Results	
FIGRA Threshold: 0.2 MJ [W/s]	**0**
FIGRA Threshold:0.4 MJ [W/s]	**0**
THR_{600} [MJ] *	**0,4**
Latheral flame spread (LFS) reach the edge?	**no**
SMOGRA [m²/s²]	**0**
TSP_{600} [m²] *	**21**
Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Time to max Figra [s] *	0
Tig (2*6KW) [s] *	Not reach
RHR(30) max.	1,5
* After ignition of main burner	

Synchronisation information	Baseline	Last point
T-Duct (2.5 °K drop from baseline)	322,21	312
O2 (0.05% rise from baseline)	20,6790	312
CO2 (0.02% drop from baseline)	0,2156	312







Recorded events	
Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

Classification (1 Test):

(if the material fulfil the standards EN ISO 11925-2; exposure 30s)

A2/B	Burn (A2/B; C; D; no SBI-class)
S1	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

Photograph

Sample after test

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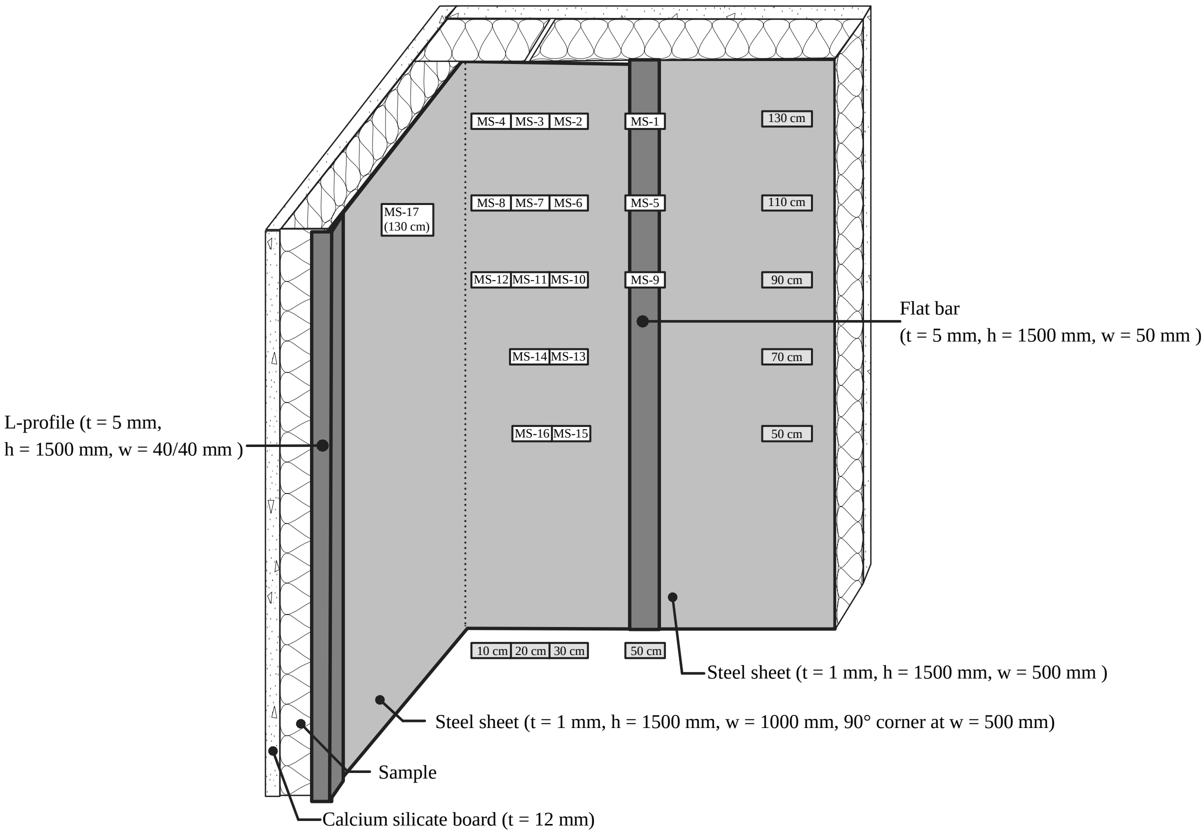
A.7 Glass wool insulation panel (Korff)

<u>Test setup and temperature measuring points</u>



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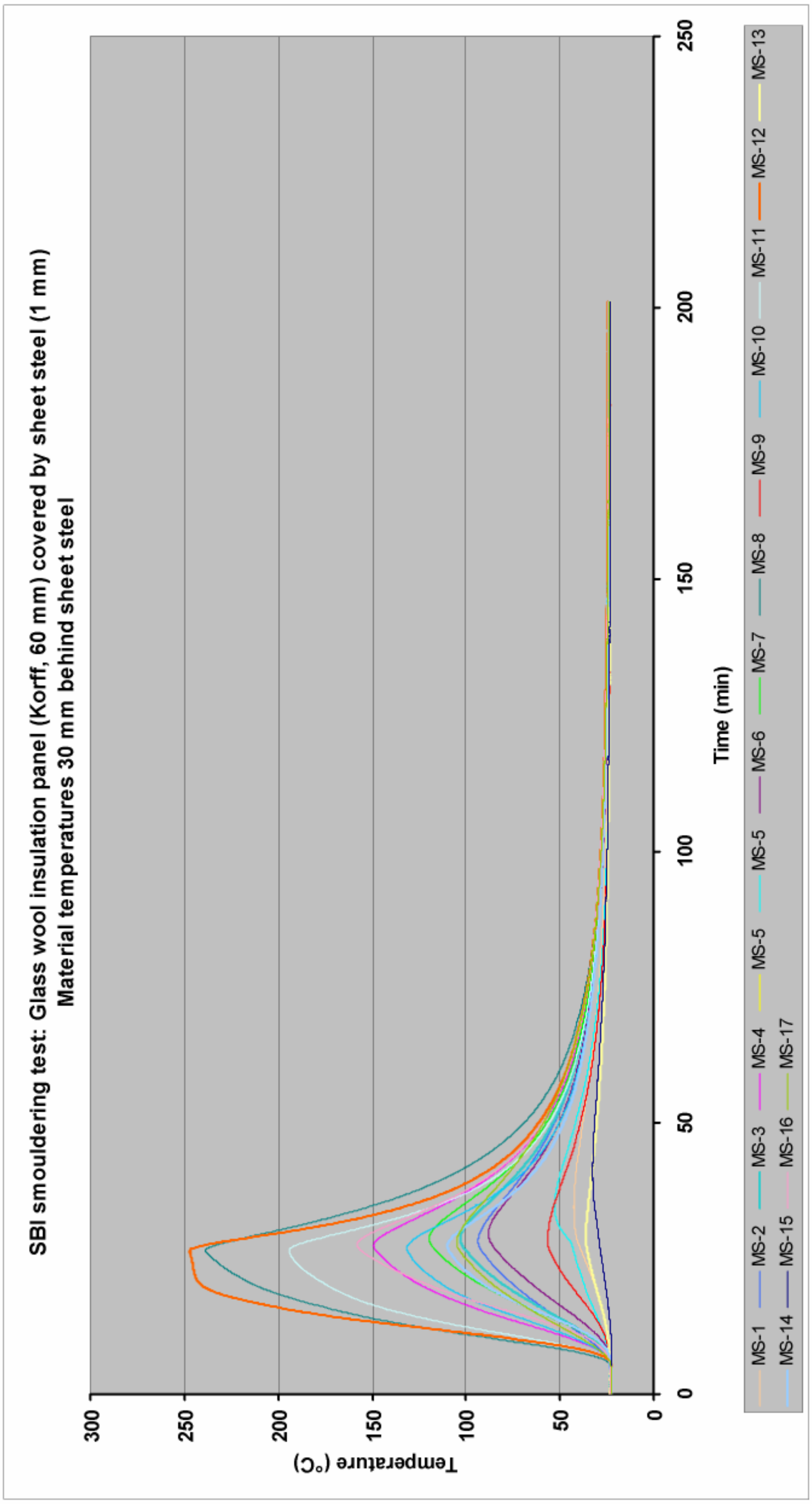
Temperatures



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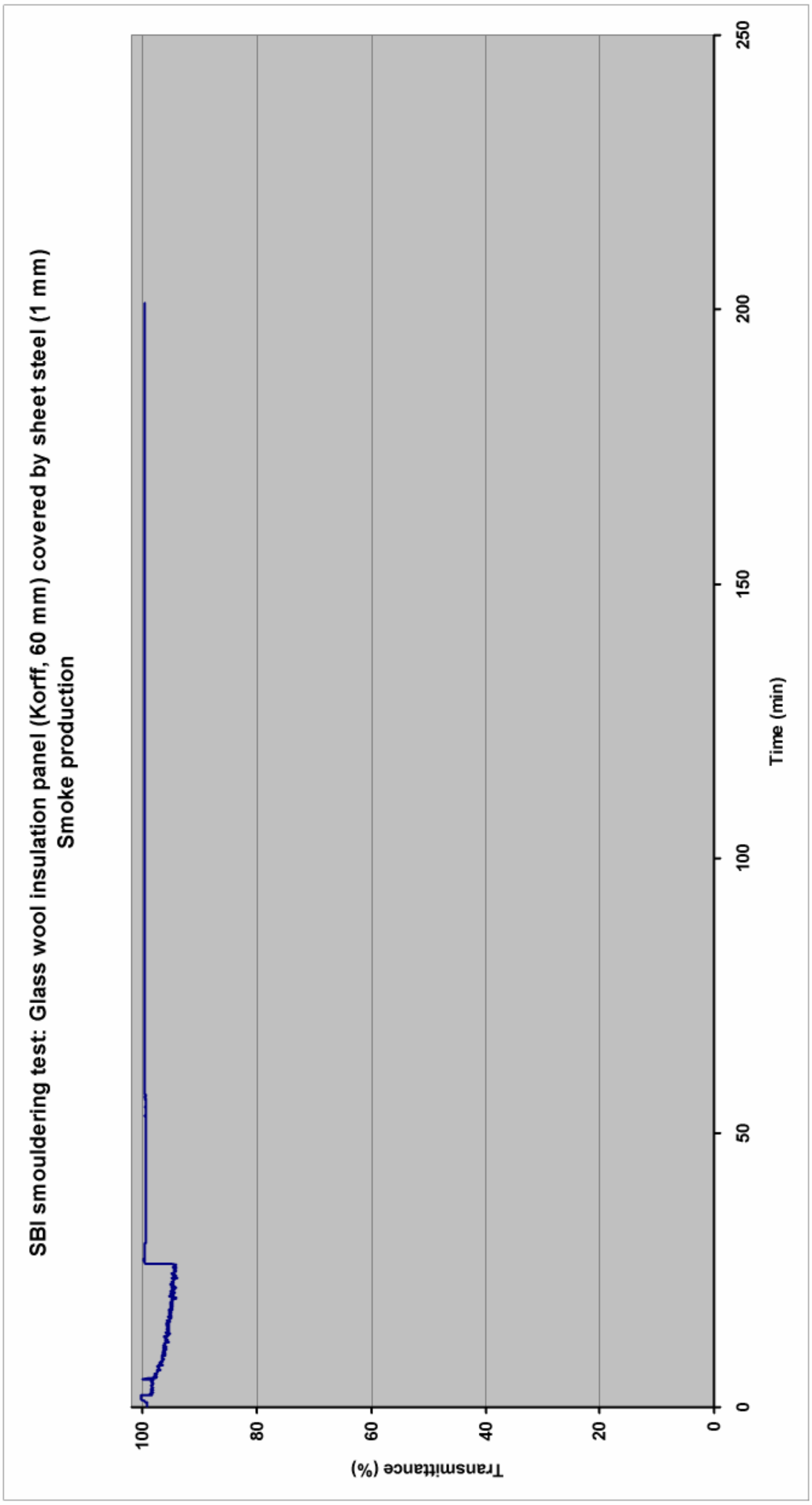
Smoke production



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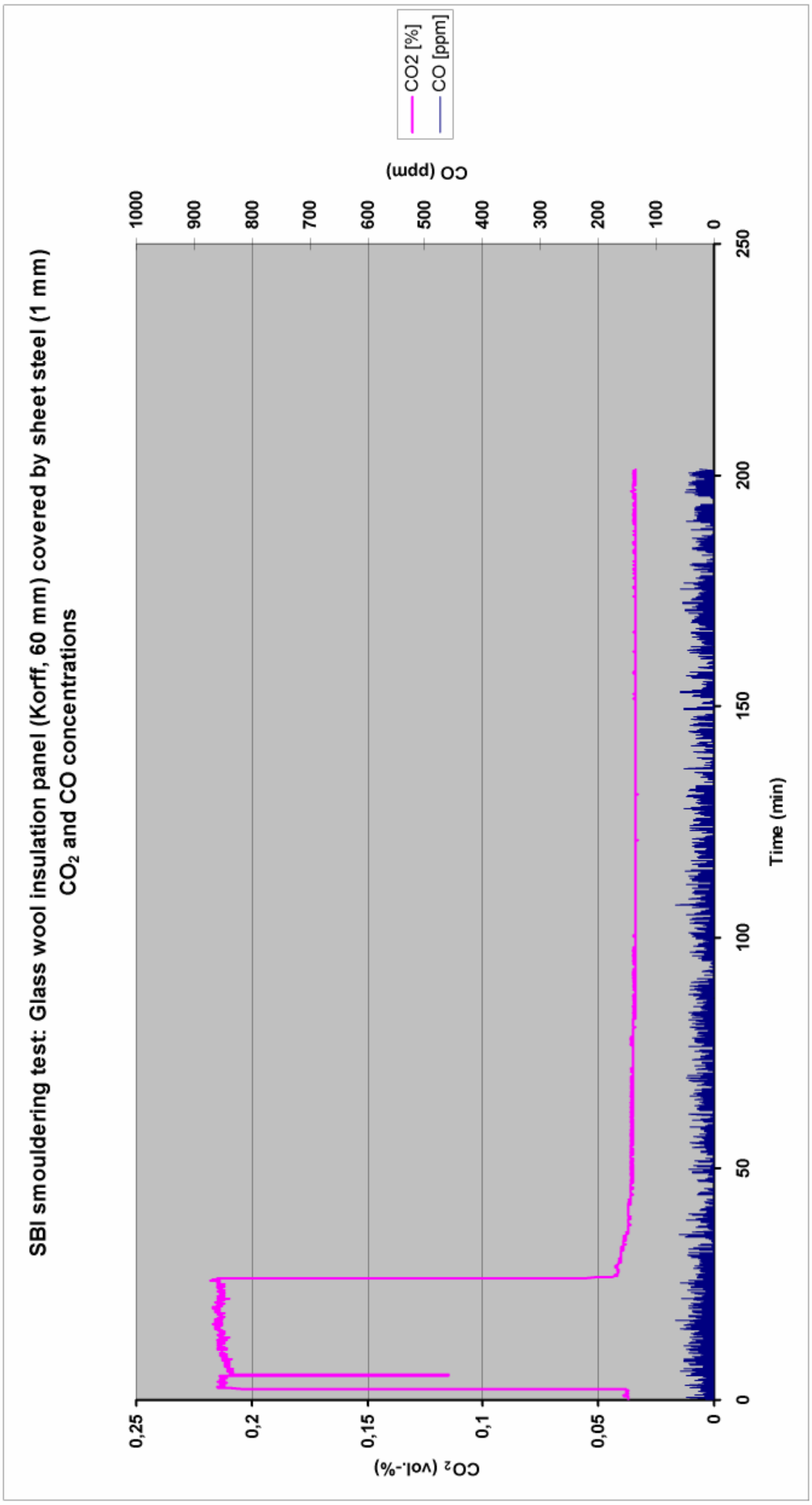
<u>CO_2 and CO concentrations</u>



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SBI test report

SBI Test DIN EN 13823

Bayer Industry Services

Customer: IBW

BIS-SUA-SPA/Brandtechnologie

Glass wool insulation panel (Korff) 60 mm

Substrate: CaSi 12mm; Mounting: Sheet steel covering 1 mm

Filename	Test no.	Operator	Test Date:	Print Date:
T40201V2	1	Pelzer	30. Jun 04	17. Aug 04

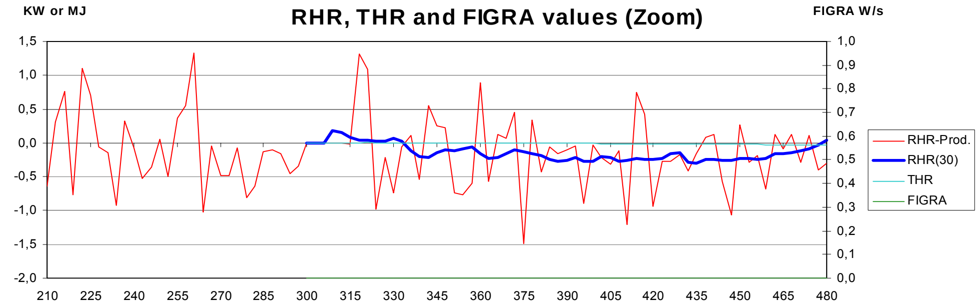
Test condition	
Ambient Temp. $_{(t=30\text{-}90)}$ [°K]	293,90
Ambient pressure. [Pa]	101500
Humidity [%]	46,0
K(t)	0,9
K(p)	1,0800
E [KJ/m³]	17200
Duct Diameter: [m]	0,315
Conditioning:	fixed period
Conditioning time [days]	>3
Cond. start weight [g]	0
Cond. end weight [g]	0
Baseline O_2^a $_{(t=30\text{-}90)}$ [%]	20,7120
Baseline O_2 $_{(t=30\text{-}90)}$ [%]	20,9561
Baseline CO_2 $_{(t=30\text{-}90)}$ [%]	0,0380
Baseline Light sig. $_{(t=30\text{-}90)}$	99,7910

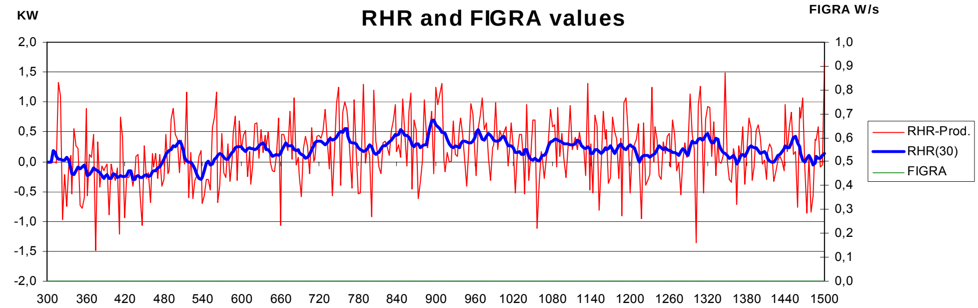
Check points	
$RHR_{av,burner}$ [KW]	30,297
$RHR_{std\ burner}$ [KW]	0,653
CO_2/O_2 $Ratio_{burner}$	0,625
$RSP_{av,burner}$ [m²/s]	0,027
$RSP_{std\ burner}$ [m²/s]	0,002
Baseline Duct temp. $_{(t=30\text{-}90)}$ [°K]	294,63
Min. no. of accep. Thermocouples	3
Minimum for flow [m³/s]	0,57
Maximum for flow [m³/s]	0,61
Burner response time [s]	12
Conditioning cond. [%/day]	#DIV/0!
End data O_2 [%]	20,96
End data CO_2 [%]	0,04
End data Light signal	99,2

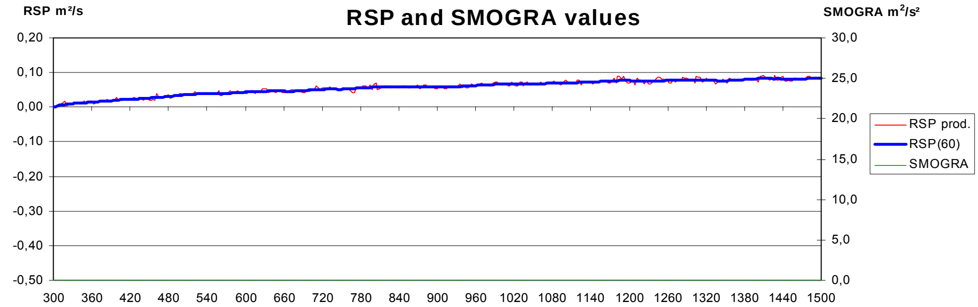
Results	
FIGRA Threshold: 0.2 MJ [W/s]	**0**
FIGRA Threshold:0.4 MJ [W/s]	**0**
THR_{600} [MJ] *	**0,1**
Latheral flame spread (LFS) reach the edge?	**no**
SMOGRA [m²/s²]	**0**
TSP_{600} [m²] *	**24**
Flaming droplets/particles (FDP) (flaming <= 10 s)?	**no**
Flaming droplets/particles (FDP) (flaming > 10 s)?	**no**
Time to max Figra [s] *	0
Tig (2*6KW) [s] *	Not reach
RHR(30) max.	0,7

* After ignition of main burner

Synchronisation information	Baseline	Last point
T-Duct (2.5 °K drop from baseline)	321,57	315
O2 (0.05% rise from baseline)	20,6757	312
CO2 (0.02% drop from baseline)	0,2131	312







Recorded events	
Surface flash:	no
Falling of specimen parts:	no
Smoke not entering hood:	no
Mutual fixing of backing board fails:	no
Conditions justify early stop of test:	no
Tendency distortion/collapse:	no

Any other additional event:

Classification (1 Test)**:**

(if the material fulfil the standarts EN ISO 11925-2; exposure 30s)

A2/B	Burn (A2/B; C; D; no SBI-class)
S1	Smoke (S1; S2; S3)
D0	Droplets (D0; D1; D2)

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Photograph

Sample after test

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Annex B

Mass loss test results

B.1 Test conditions (for all products)

Test method: Non-combustibility test apparatus according to DIN 4102-1

Temperature: 760 °C

Test duration: 30 min

Conditioning: dehumidified 6 h at 105 °C, bedded over anhydrous $CaCl_2$ until testing

B.2 Rock wool products

B.2.1 Rhinox (Rockwool, Benelux)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	18.024	17.2	0.824	**4.57**

B.2.2 Rock wool product (unknown manufacturer, supplied by Korff & Co. KG)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	8.883	8.580	0.303	**3.41**
2	9.075	8.712	0.363	**4.00**

Test 1

Test 2

B.2.3 Tervol PTP (Termo d.d., Slovenja)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	15.684	15.180	0.504	**3.21**

B.2.4 Rock wool product (unknown manufacturer, supplied by Korff & Co. KG)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	7.029	6.807	0.222	**3.158**
2	8.719	8.465	0.254	**2.913**


Test 1


Test 2

B.2.5 Tervol TPT (Termo d.d., Slovenja)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	15.042	14.589	0.453	**3.01**

B.2.6 Termotoit (Termo d.d., Slovenja)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	20.474	19.884	0.590	**2.88**

B.3 Glass wool products

B.3.1 Ventilam Alu (Saint-Gobain Isover, Poland)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	2.335	2.115	0.220	**9.42**
2	1.908	1.652	0.256	**13.42**

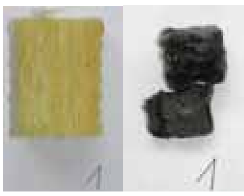
Test 1

Test 2

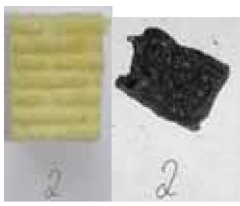
Note: insufficient amount of material available for an SBI test

B.3.2 Glass wool product (unknown manufacturer, supplied by Korff & Co. KG)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	6.158	5.683	0.475	**7.71**
2	6.203	5.698	0.505	**8.14**



test 1



test 2

B.3.3 Glass wool product (unknown manufacturer, supplied by Korff & Co. KG)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	3.115	2.889	0.226	**7.26**
2	2.240	2.060	0.180	**8.04**


test 1


test 2

B.3.4 Ventilux (Saint-Gobain Isover, Poland)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	3.293	3.043	0,250	**7.59**
2	3.296	3.053	0.243	**7.37**


test 1


test 2

B.3.5 Glass wool product (unknown manufacturer, supplied by Korff & Co. KG)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	3.512	3.293	0.219	**6.24**
2	3.467	3.236	0.231	**6.66**


test 1


test 2

B.3.6 FDP 14 (Saint-Gobain Isover)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	8.940	8.411	0.529	**5.92**

B.3.7 TDPT 60/60 (Saint-Gobain Isover)

Test no.	Before test (g)	After test (g)	Mass loss (g)	**Mass loss (%)**
1	13.181	12.414	0.767	**5.82**