global insulation
CONFERENCE & EXHIBITION

Sustainable high temperature insulation material SUHITEMPIN using waste silica fibre

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Agenda

1. ISE
2. INNODAEM network
3. R&D project SUHITEMPIN
4. First results of material development
5. First results of application development
6. Conclusion

ISE - applied research and development

Background:

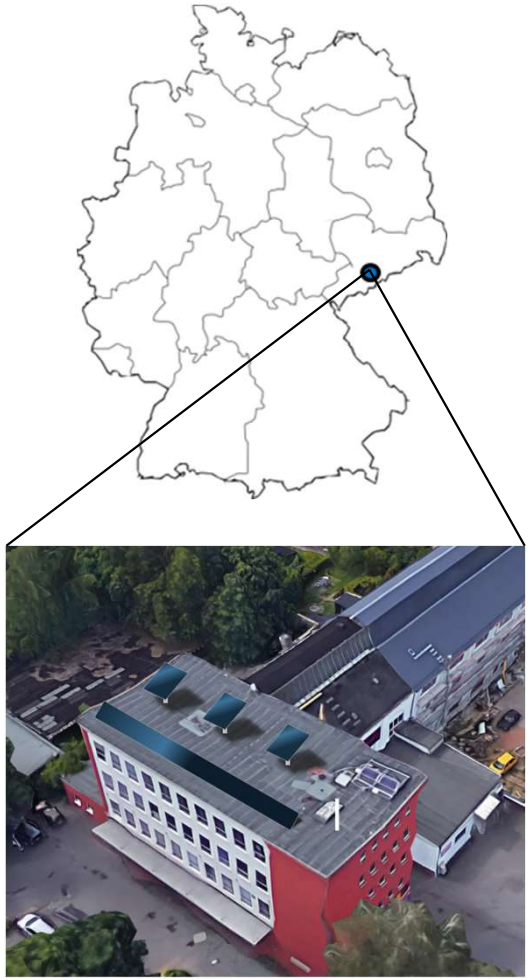
- Founded in 2015
- More then 20 regional, national and international projects
- 20 employees, incl. 16 research associates

Research focus:

- Lightweight constructions
- Energy efficiency
  - Reducing energy consumption
  - Using renewable energy sources

Partner structure:

- Small to medium-sized companies
- Research institutions (universities, Fraunhofer, etc.)



INNODAEMM network

INNODAEMM = innovative thermal insulation materials

- Granted network of different stakeholders:
  - Producers of high-performance thermal insulation materials (TIM), e.g. VIP
  - Producers of external thermal insulation composite systems
  - Users of TIM, e.g. in building construction, transportation, plant engineering
  - Research institutions
- Main goal:
  - Merging competences from research and industry in the field of innovative TIM and their applications
- 8 research projects successfully completed or still under work, e.g.

Gefördert durch:
Bundesministerium für Wirtschaft und Energie
aufgrund eines Beschlusses des Deutschen Bundestages

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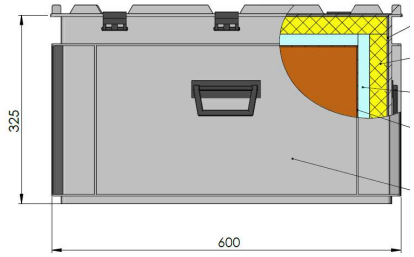
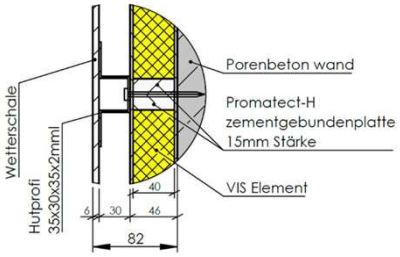
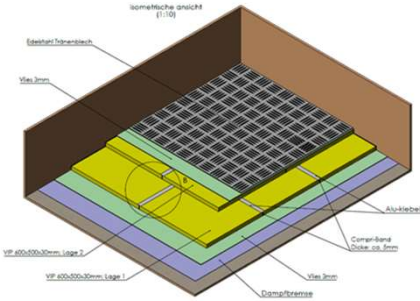
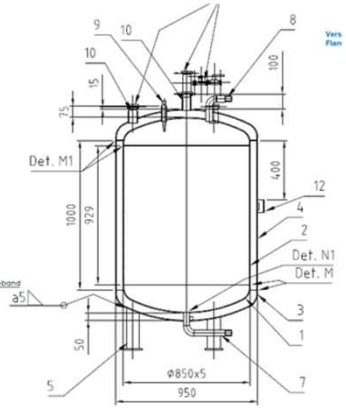




FA-VIP





R&D project SUHITEMPIN

SUHITEMPIN

= sustainable high-temperature insulation

Gefördert durch:

Bundesministerium für Wirtschaft und Energie

aufgrund eines Beschlusses des Deutschen Bundestages

- Main goal:
  - Development of resource-efficient HT TIM by using waste silica fibres and its application
- Key parameters:
  - Operation temperature: up to 1200 C
  - Density: approx. 250 kg/m3
  - Heat conductivity: approx. 0.2 W/(m K) @ 1000-1200 C
  - Lightweight and cheap
- Partners:
  - ASGLAWO technofibre → producer of fibre-based TIM
  - Buckau-Wolf → producer of mixing technologies
  - TU Bergakademie Freiberg → research institute (materials)
  - ISE → research institute (applications)

R&D project SUHITEMPIN

SUHITEMPIN

= sustainable high-temperature insulation

ASGLAWO technofibre

Buckau-Wolf

TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG
The University of Resources. Since 1765.

Material & Process development
- Processing technology fibres (cutting, separating, milling)
- Mixing technology / slurry (mixing tools, mixing parameters)
- Controlled porosity (composition of mixture, pore-producing agents, etc.)

ISE

Application development – HT insulation furnace
- Joining, assembling, mounting
- Demonstration objects and show cases

ISE

Application development – fire protecting (buildings)
- Joining, assembling, mounting
- Demonstration objects and show cases

First results of material development

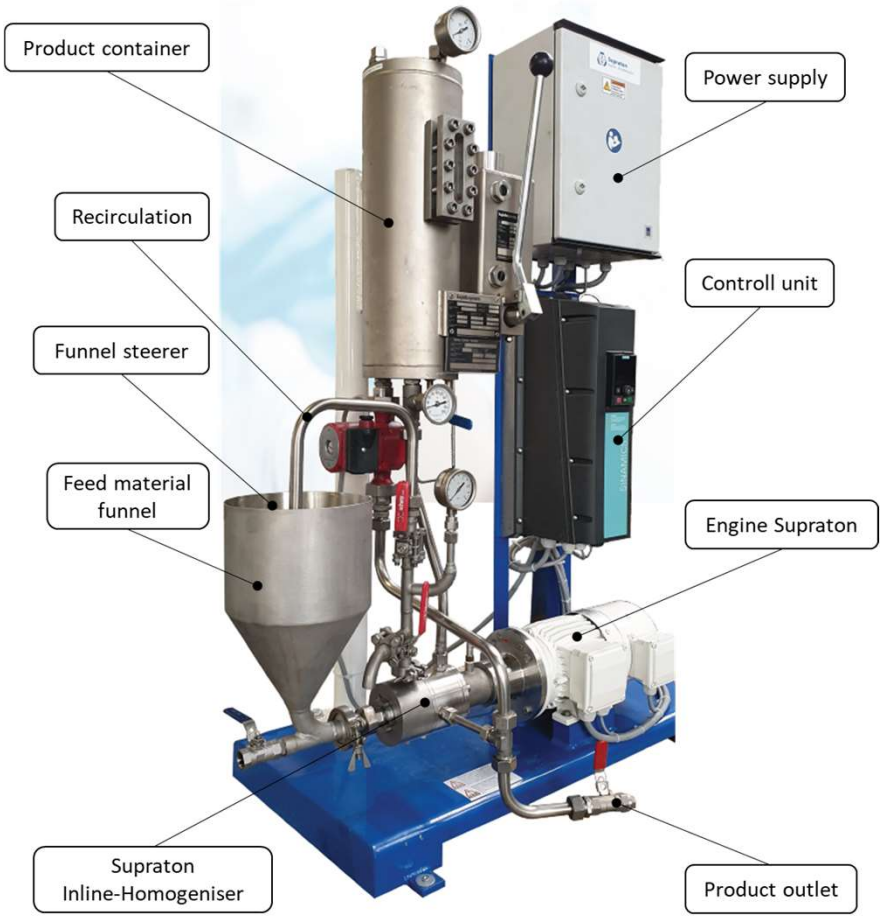
Step-wise approach

Hand mixing
- Getting things started
- Finding a “good” composition/mixture
- Show that it can work

Laboratory scale → Supraton S100
- Refining mixture (different variations)
- Produce samples for analyses
- Analysing key parameters

Technical scale → Supraton S200
- Optimising mixing process to achieve key parameters
- Produce bigger samples for demonstration
- Final SUHITEMPIN to transfer to industry

BW Supraton S100 Homogeniser



First results of material development

Finding / optimizing mixing technology

Mixing of: water + dispersant + flow agent

↓ Steering

Adding of: silica fibre + cement + chalk + Porosity agent

↓ Casting into mould

Swelling at room temperature

↓

Setting + mould removing

↓

Cutting in slices / blocks

↓

Drying at 110 C for 48 h

Aiming for fibre content of 67.5 wt.%

Mould sizes:
20 x 20 x 50 cm
35 x 20 x 24 cm

Mould removing after 12 h

Hand saw → later industrial saw

For determining key parameters

First results of material development

Optimizing mixture/composition

- Components:
  - Calcinated waste Silica fibres
  - Cement
  - Chalk
  - Porosity agent (aluminium powder)
  - Water
  - Dispersant (SDS = soap)
  - (Flow agent)
- Exemplary mixture (67.5 wt.% fibre content):

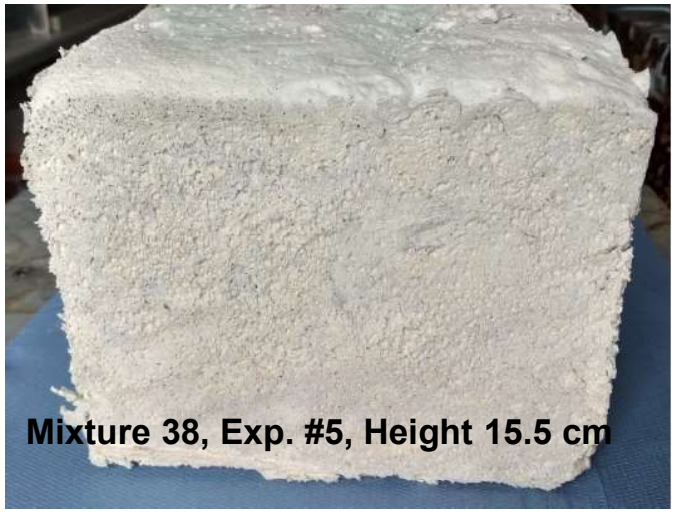
Component	Weight [g]
Silica fibre	5129
Cement	1520
Chalk	798
Alumina powder	27
Water	10559

First results of material development

Getting things stable and comparable

- Process control:
  - Temperature increase/control
  - Point of component addition
  - Number of re-circulations
  - Place of re-circulation inlet
  - Revolutions per minute
  - Choice of tool type for Supraton
  - Many more


Mixture 38, Exp. #3, Height 13 cm


Mixture 38, Exp. #5, Height 15.5 cm

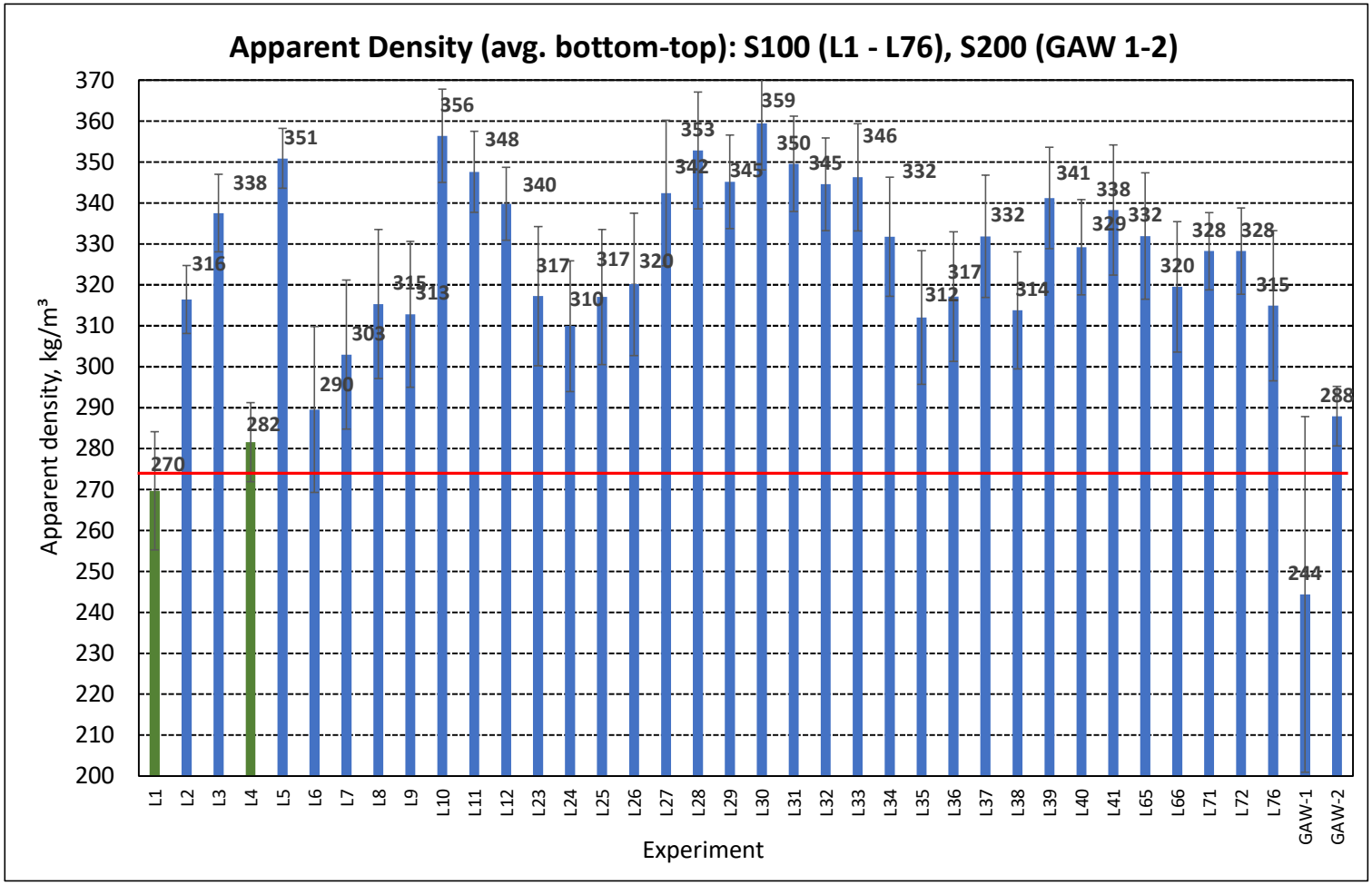
First results of material development

Optimizing fibre cutting/milling

- Starting material:
  - Calcinated (800 C) silica matts/fleece
  - Off-cuts / production residuals
- First SUHITEMPIN mixtures:
  - Fine powders (100-200 µm)
  - Ball milled
    → high energy input
    → high dust level
- Further SUHITEMPIN mixtures:
  - 1 x Rotary shear (RS)
  - 2 x RS
  - 1 x RS + 1 x cutting mill (CM)
    → was “feedable” into the Supraton S100

First results of material development

Variation of apparent density



First results of material development

Wear of Supraton tools

- After 100+ experiments recognizable wear at body and teeth of tools
- Sealing issues with original graphite/graphite sealing (changed to graphite/SiC sealing)

First results of material development

Next steps in material development (with Supraton S200)

- Enables high flexibility in processing
  - Bigger feeding inlet
  - Bigger tools (diameter)
  - More options in tool geometry
  - Wider gap between stator and rotor
  - Better temperature control
- Using coarse ground fibres
  - Fine milling takes place inside Supraton
- Further optimizing mixture to reach key parameters
  - Longer fibres
  - Infra-red blockers, e.g. Fe3O4
- Producing bigger samples for applications

First results of application development

Fields of application

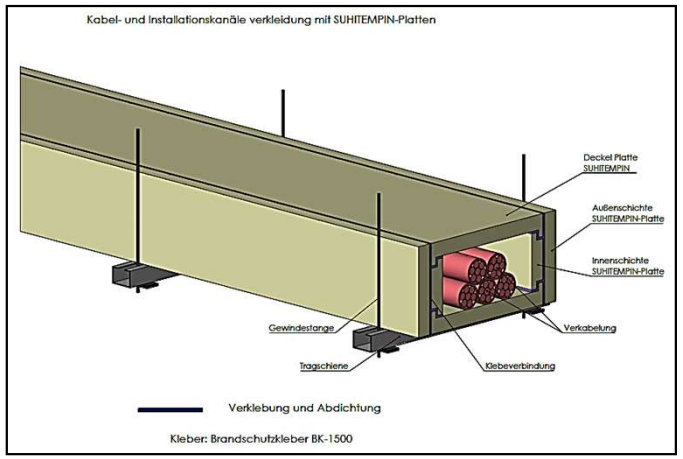
- Fire protection in building applications:
  - Cable / supply line ducts
  - Wall / ceiling facings
  - Column claddings

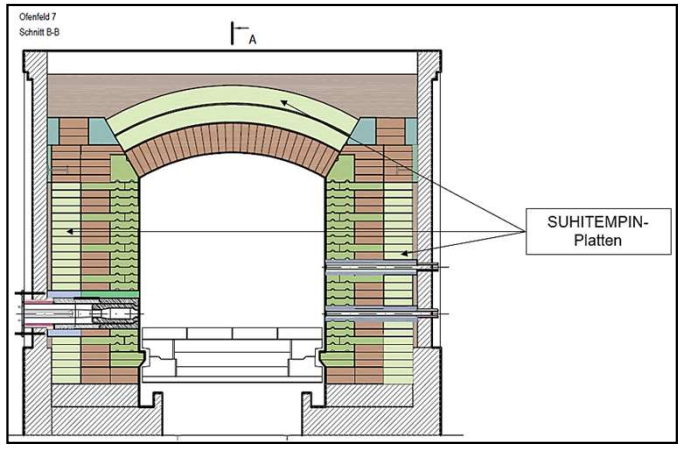
- TIM in industrial furnaces:
  → outer layers
  → no exposure to aggressive atmospheres / slag
  - Tunnel furnace
  - Bogie hearth furnace
  - Roller passage furnace

✓ Lightweight

✓ High insulation

✓ Low cost



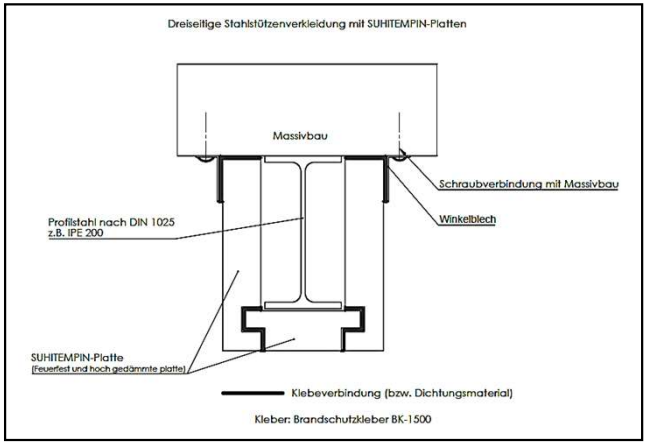


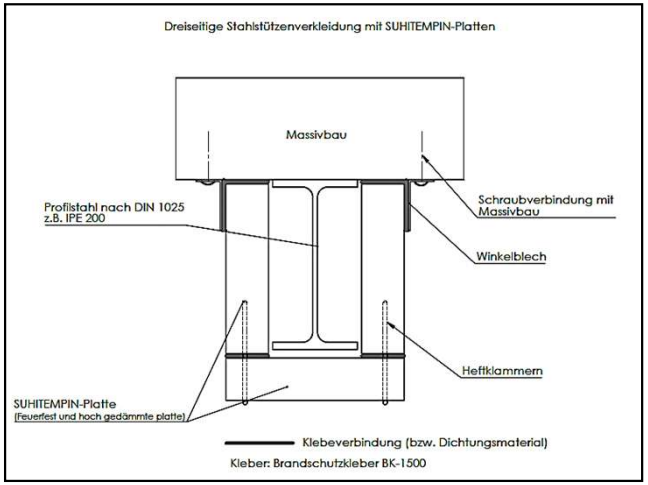
First results of application development

Fire protection in building applications

- 3- and 4-face cladding of T-beams (or other columns)
  → bonding + cramping
  - Protection of construction element against over-temperature
  - Benefit of SUHTEMPIN material:
    → increased thermal insulation
    → lightweight (lower density)

- Research focus
  - New material (new properties) → adapted joining / assembling
  - Bonding with HT-glue (1-component, non-combustible)
  - Increasing contact area
  - Optional: additional metal cramps



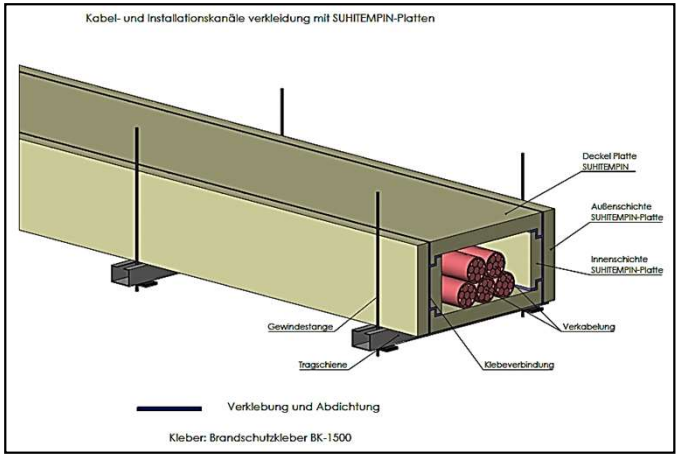


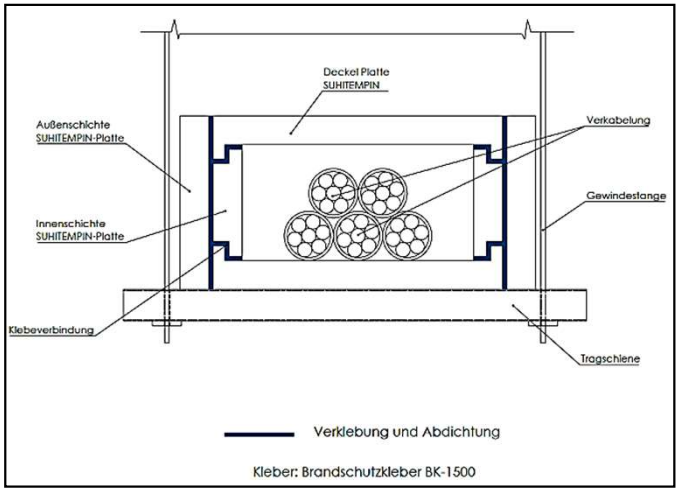
First results of application development

Fire protection in building applications

- Cable / supply line ducts
  → bonding
  - Protection of cables and supply lines against over-temperature and direct contact to fire and flue gas
  - Benefit of SUHTEMPIN material:
    → increased thermal insulation
    → lightweight (lower density)
    → construction can be slimmer

- Research focus
  - New material (new properties) → adapted joining / assembling
  - Need for gas-tight bond
  - Bonding with HT-glue (1-component, non-combustible)
  - Increasing contact area via nut-profile



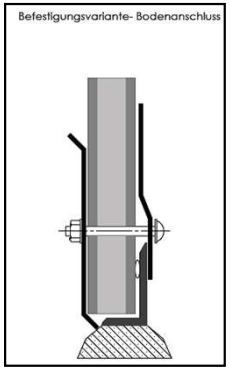


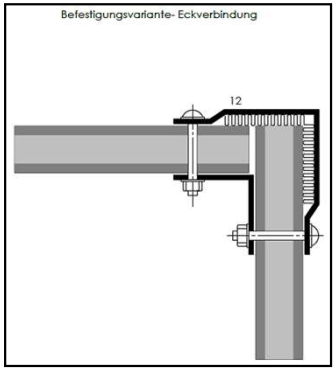
First results of application development

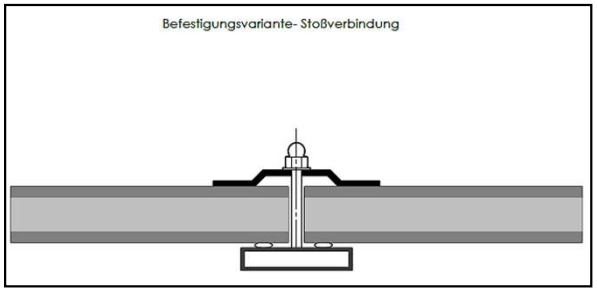
Thermal insulation in industrial furnaces

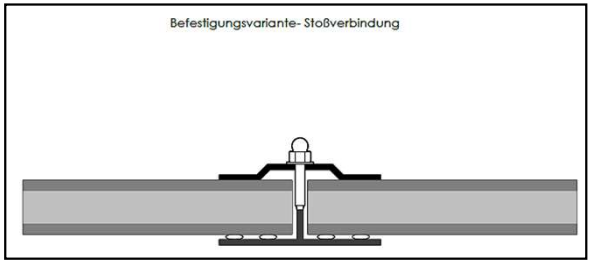
- SUHITEMPIN as boards in steel frame
  - Outer shell of furnace
  - Benefits of SUHITEMPIN material:
    → low weight
    → slim steel frame, less thermal bridges
    → lower costs

- Research focus
  - Joining and mounting points
  - Constructive solutions bolted and clamping connections
  - Consideration of mechanical properties (porous, brittle)





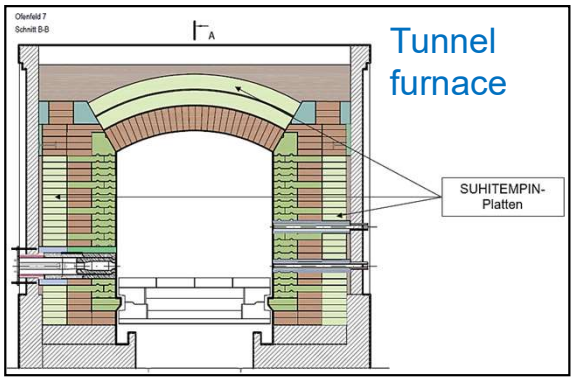


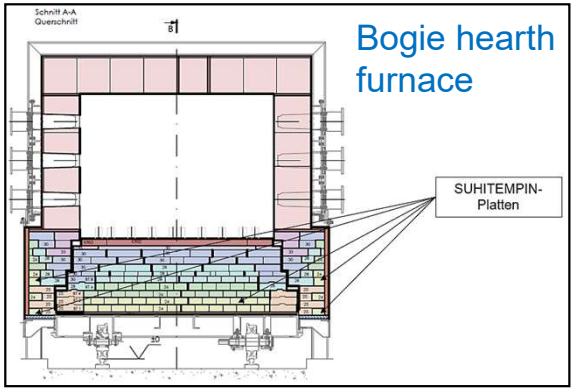


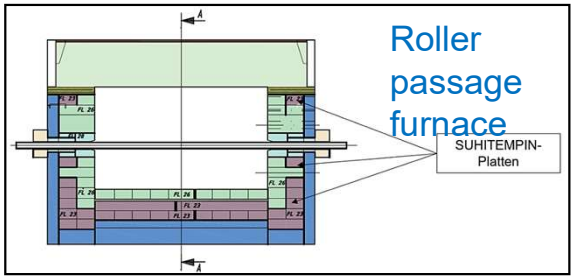
First results of application development

Thermal insulation in industrial furnaces

- SUHITEMPIN as brick in furnace wall
  - Outer layers with no corrosive conditions
  - Position according to temperature profile and max. operation temperature
  - Benefits of SUHITEMPIN material:
    → high thermal insulation
    → lower costs
- Research focus
  - Bonding and mortar technologies
  - Temperature profiles inside wall
  - Energy savings





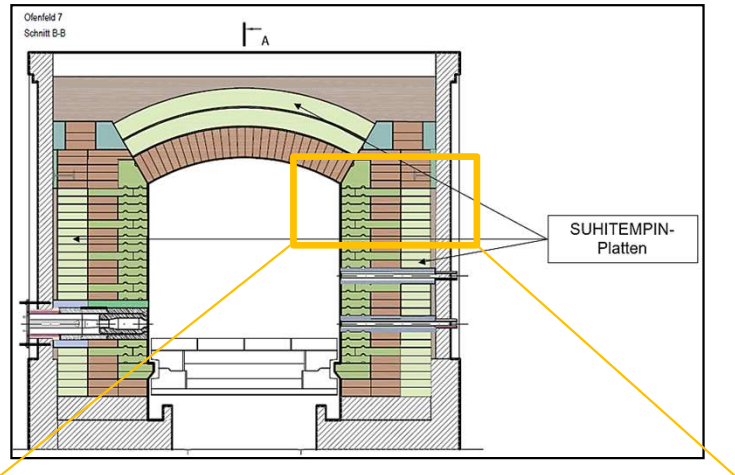


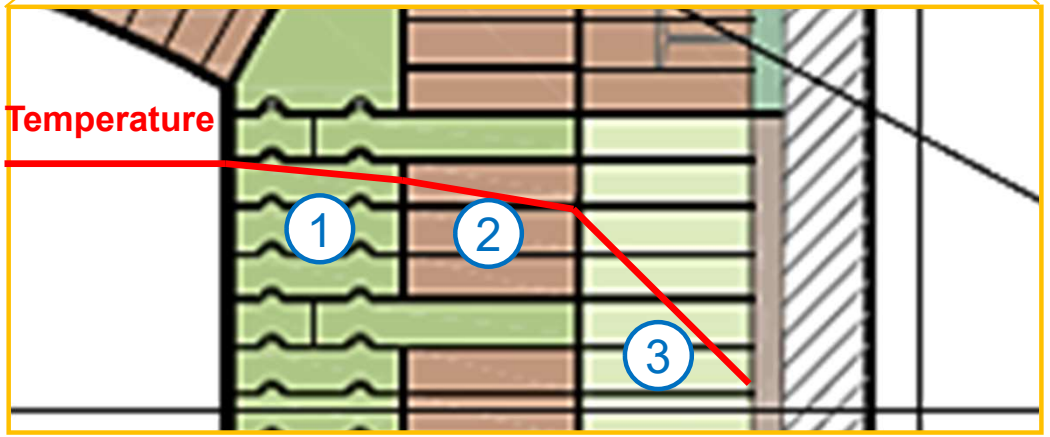
First results of application development

Thermal insulation in industrial furnaces

- SUHITEMPIN as brick in furnace wall

	Conventional structure	SUHITEMPIN
T innen (° C)	1450 C	1450 C
Layer 1	**SUPRATH 403-t** ρ: 2300 kg/m³ λ @1200: 1,8 W/(m K) Tmax: 1480 C	**SUPRATH 403-t** ρ: 640 kg/m³ λ @1200: 1,8 W/(m K)
Layer 2	**SUPRATH A40-442** ρ: 2250 kg/m³ λ @1200: 1,8 W/(m K) Tmax: 1460 C	**SUPRATH A40-442** ρ: 2250 kg/m³ λ @1200: 1,8 W/(m K) Tmax: 1460 C
Layer 3	**PORRATH FL 24-06** ρ: 640 kg/m³ λ @1200: 0,38 W/(m K) Tmax: 1350 C **PORRATH FL 24-10** ρ: 1000 kg/m³ λ @1200: 0,50 W/(m K) Tmax: 1350 C	**SUHITEMPIN** ρ: 640 kg/m³ λ @1200: 0,38 W/(m K) Tmax: 1200 C
U-Value, tot.	**1.55 W/(m² K)**	**0.79 W/(m² K)** (51 %)





Conclusions

SUHITEMPIN = Sustainable high-temperate insulation

Material development

- Good composition found, with high fibre content (≈ 68 wt.%)
- Mixing technology with Supraton approved
- SUHITEMPIN properties not yet in optimal range
  - Density is close to target value
  - Porosity is homogenously distributed
  - Thermal conductivity still to high (0.4 W/(m K) @ 1200 C)

Application development

- Material with new properties (porous, brittle) needs adapted assembling technologies
- SUHTEMPIN properties beneficial for
  - Fire protection in building applications
  - HT thermal insulation material for industrial furnaces

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