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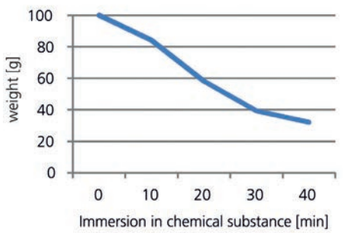
Recyclabilty

Another unique feature of polycyanurate-ester foams is the recyclability. The material can be chemically decomposed. After reconditioning of the dissolved compound the basic components can be re-used.

6 *Partly decomposed foam after immersion in chemical substance for 60 min*

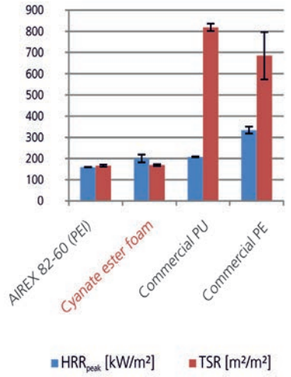


7 *Development of specimen weight immersed in chemical substance*

Flame Retardance

To obtain information about the fire characteristics of different foam materials a cone calorimeter was used. The foam samples were exposed to a 50 kW/m² radiant heat flux. Heat Release Rate Peak (HRR_{peak}) and Total Smoke Release (TSR) were determined and compared. The diagram illustrates the results and points out the very good flame retardance in contrast to PU-or-PE Foams.

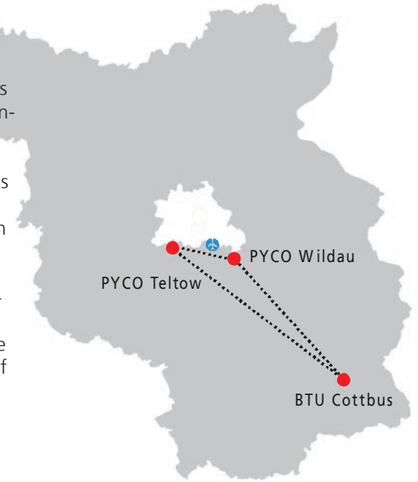
HRR_{peak} and TSR are comparable to Airex which is presently used in aerospace applications but has to be shaped for complex geometries.



8 *Comparison of HRR_{peak} and TSR between selected rigid foams tested by cone calorimeter*

Location Berlin-Brandenburg

New solutions require new approaches: The locations of the research institute in Teltow and Wildau, where the metropolis of Berlin and the federal state of Brandenburg meet, offer optimal conditions for innovative scientific research. Here, the products of tomorrow emerge from ideas and visions. Therefore, the institute's scientists have formed a creative research network with renowned universities, well-known large-scale enterprises, and various innovative medium-sized companies.
Additionally, new synergy arises from the integration in the third largest location of aerospace industry in Germany.



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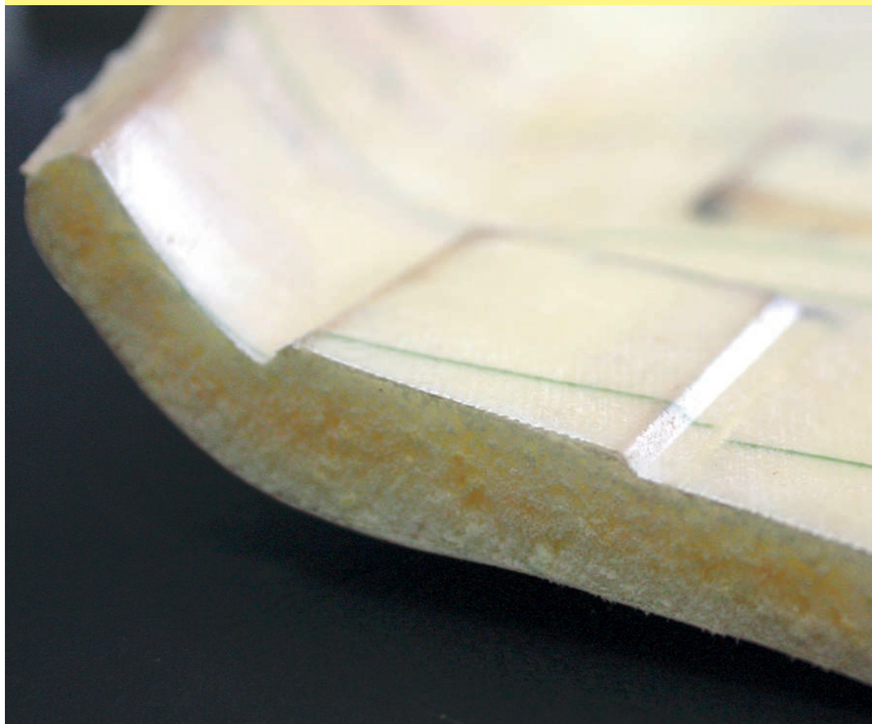
9 *Main building*

Rigid Foams from Reactive Polycyanurates



RIGID FOAMS FROM REACTIVE POLYCYANURATES

Motivation

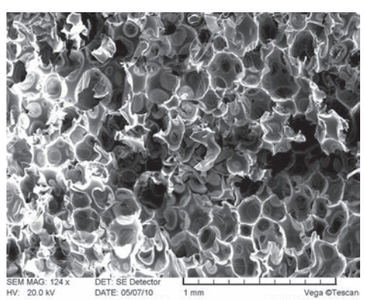
Due to a rising environmental awareness and economic efficiency lightweight structures gain more and more importance in many sectors. Especially in the transport sector a reduction of weight goes along with economic benefit.
Sandwich structures are state-of-the-art to fulfill the high requirements of stability in combination with light weight.
Presently the production process of complex 3D-sandwich parts is not possible in one step and usually the core is produced in a separate step. Generally, the core material gets thermoformed or milled to the final contour before the covering layers are applied. This workflow is expensive and slows down the production process.
The aim of this work was the development of a reactive rigid foam based on polycyanurate ester resin which can be used as core material and meets the requirements of low density combined with high mechanical strength. Presently there is no product with these characteristics commercially available.

Applications at a Glance

- Naval architecture
- Aerospace applications
- Railway transportation
- Automotive
- Complex 3D-sandwich parts

Properties at a Glance

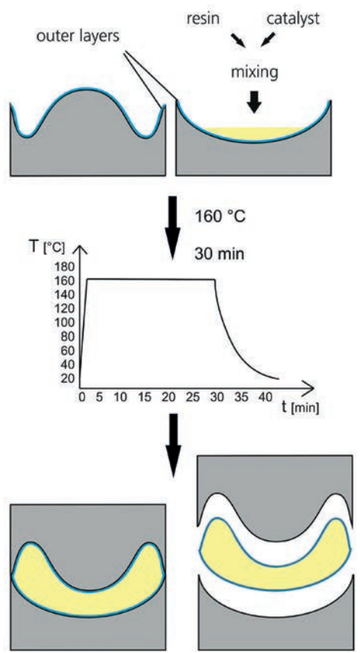
- Low heat release
- Low smoke emission
- High mechanical strength
- Repairable
- Recyclable
- Can be foamed in-mold
- Adjustable viscosity of resin
- Adjustable density (90-400 kg/m²)
- Variable pore size
- Open or closed cells
- High storage stability
- Mechanical properties are not influenced by water uptake
- Good bonding to outer layers
- Acoustic insulation
- Thermal insulation



1 *SEM-Exposure: Foamstructure (124x magnification)*

In-Mold Foaming

The resin can be foamed in mold and offers the possibility to reduce the workload for sandwich production.

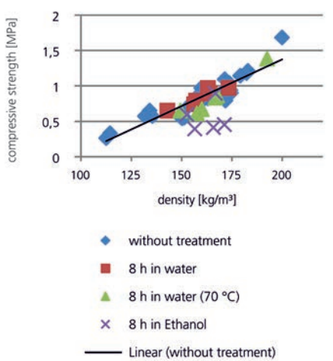


2 *Workflow for in-mold production of sandwich parts*

Compressive Strength

The compressive strength depends almost linearly on the density of the foam and is adjustable in a wide range.

As shown in the diagram the foam is unaffected by exposition to water. An 8h immersion in water (at 20 °C and 70 °C) has no influence on the compressive strength. This mechanical characteristic is still maintained after an immersion for 7 days. An exposition to solvents like ethanol weakens the foam.



3 *Compressive strength of foams with different densities and treatments*

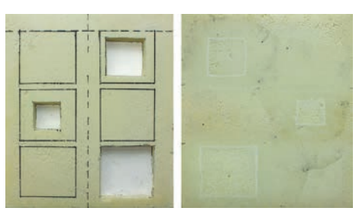
Repairability

An outstandig feature is the possibility to repair parts of the core by refoaming the damaged area. The resin is given into the section in need of repair and then heated to 160 °C to expand and fill out the area.

The image shows a plate which is separated in 6 fields. 3 fields serve as reference for compression tests. The other 3 fields have a refoamed area with 25%, 50% and 100% of the surface. All fields have been positioned randomly.

Due to the pores in the material which offer a grand surface to bond the connection between old and new material is excellent.

This feature also provides the possibility to combine two or more foamed components without creating weak spots.

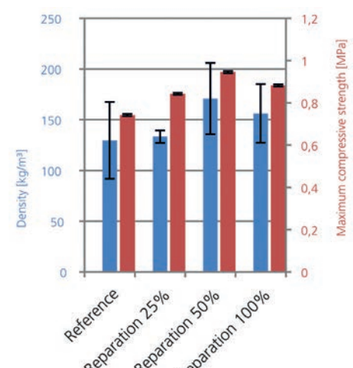


4 *Left: Foamplate with 6 fields and 3 cutouts in different sizes (25%, 50%, 100% of field size) Right: Repaired foamplate with refoamed cutouts*

To assure a complete fill-out it is necessary to add some extra resin to the theoretically required amount to fill the volume.

As a result the repaired areas become heavier than the pristine zones. The higher density of the repaired fields involves a slightly higher compressive strength as can be seen in the following diagram.

Therefore every reparation heightens the weight of the component but guarantees to fully restore the mechanical properties of the part.



5 *Density and compressive strength of pristine and repaired foam*