SVENSKA AEROGEL

# Quartzene®

**Sustainable aerogel for high performance coating solutions**

**An introduction to aerogels, the Quartzene platform and functionality**

Quartzene®
Next Generation Aerogel

## What are Aerogels

- The worlds lightest solids – usually 95-99% air by volume
- Silica aerogels most common
- Super insulators – low thermal conductivity
- Low density – usually > 0,02 g/cm3 (0,001-0,5 g/cm3)
- Large internal surface
- Predominantly nano & mesoporous – pores <100 nm (meso: 2-50 nm)
- Amorphous
- Inert
- Non-combustible
- Non-hazardous

SVENSKA AEROGEL

# Quartzene – a performance additive

- Quartzene is a precipitated amorphous aerogel-like silicate material which is used to bring or enhance special functionality to various materials and products.
- Quartzene is manufactured in a patented waterborne process using commodity type of silica source thus opening up to a broader market than classic aerogels due to its better cost performance.

Quartzene®

Next Generation Aerogel

# Quartzene: A green and cost-efficient product & process

The challenge for the traditional Aerogel Industry:

Expensive starting materials + Energy demanding production process → Too expensive for mass market

Quartzene is the solution: silica + water + district heating from nearby industries

Scalable manufacturing process & modular production

**The Svenska Aerogel Process**

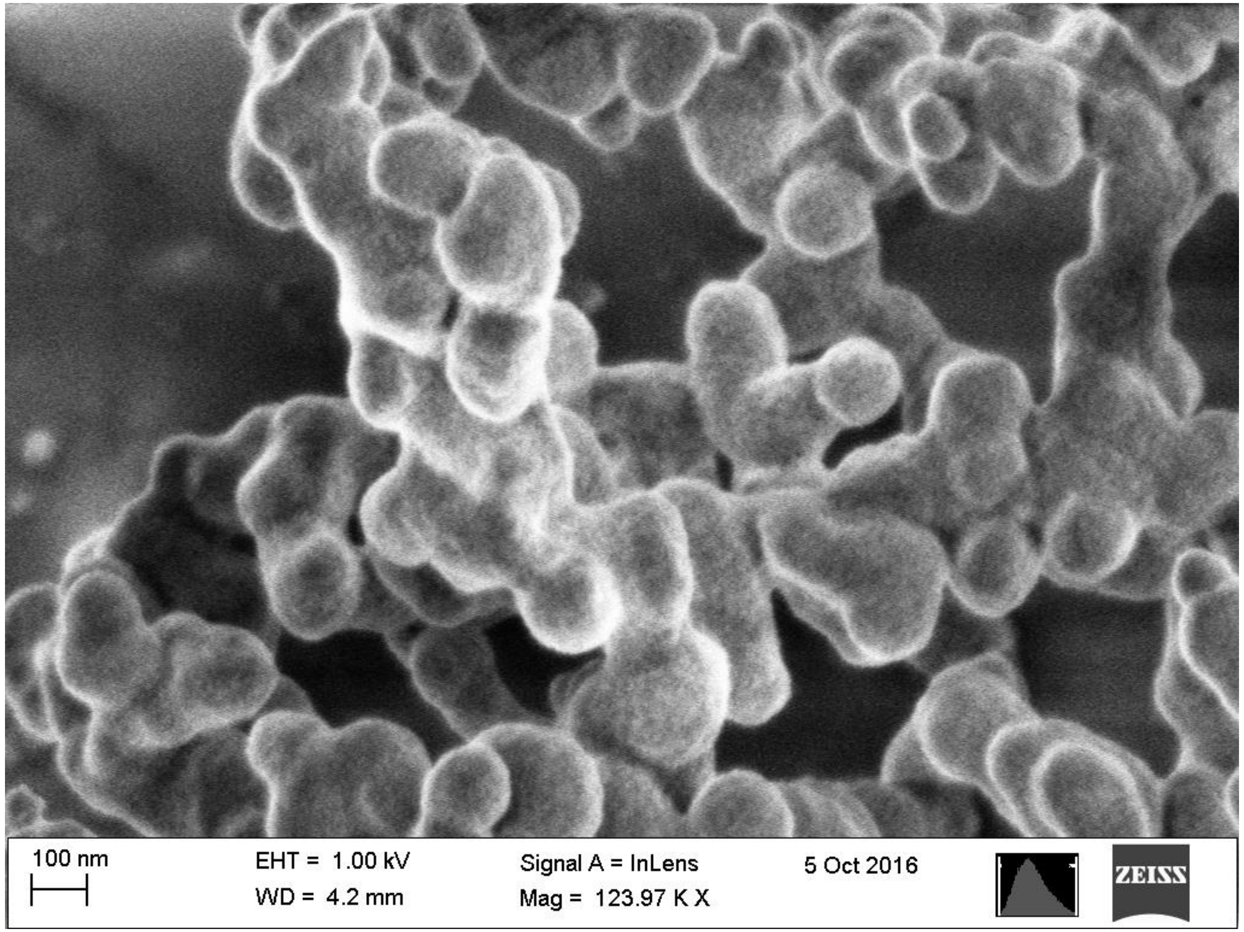
- Ambient pressure drying technique
- Earth abundant silica source
- Water based

**The Conventional Process**

- Supercritical drying technique
- Expensive silica source
- Solvent based

## Quartzene: 124k magnification by SEM (Scanning Electron Microscopy)

- A dendritic microstructure in which spherical particles are fused together into clusters.
- These clusters form a three-dimensional highly porous structure of almost fractal chains or “agglomerate” with pores under 100 nm. The average size and density of the pores can be controlled during the manufacturing process.

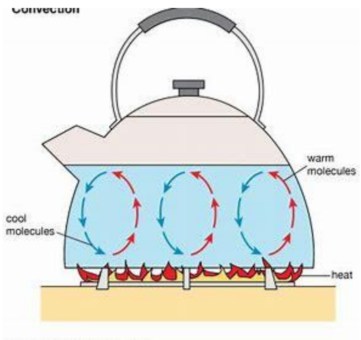


Quartzene®
Next Generation Aerogel

# Thermal conductivity: The theory behind heat transfer

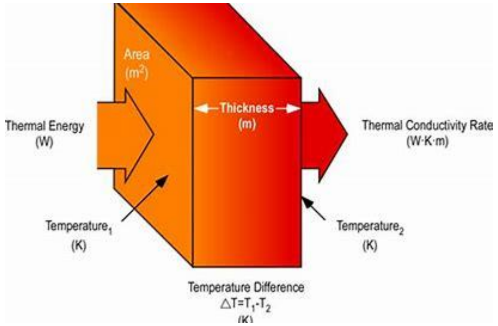
**Convection:** heat is transferred by mass movement of a fluid (gas or liquid)

+ Quartzene prevents net gas movement through the lattice



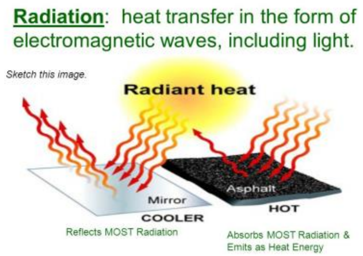

**Conductivity:** heat is directly transferred by the material without mass movement

+ Quartzene is mostly composed of insulating gas, silica aerogels are especially good since silica is a poor heat conductor




**Radiation**: Energy transmitted by means of electromagnetic waves

+ Quartzene absorbs IR radiation and slows down the heat transfer in the material matrix



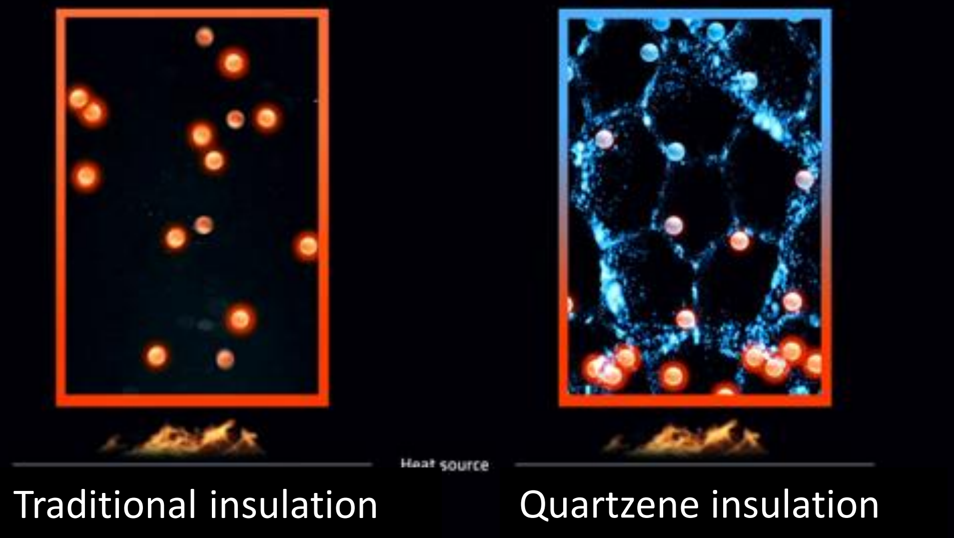

SVENSKA AEROGEL

Quartzene®

Next Generation Aerogel

# Nano-sized pores – the key to the aerogel properties: The Knudsen Effect

Quartzene has a pore-size less than 70 nm, restricting the air molecules to move and collide. This limits heat transfer to a minimum




The **mean free path** of air is the average distance travelled before collision with another air molecule.

When the pore size is less than 70 nm, the air molecules, at atmospheric pressure, are more likely to collide with the pore walls rather than with one another which reduces the thermal conductivity,

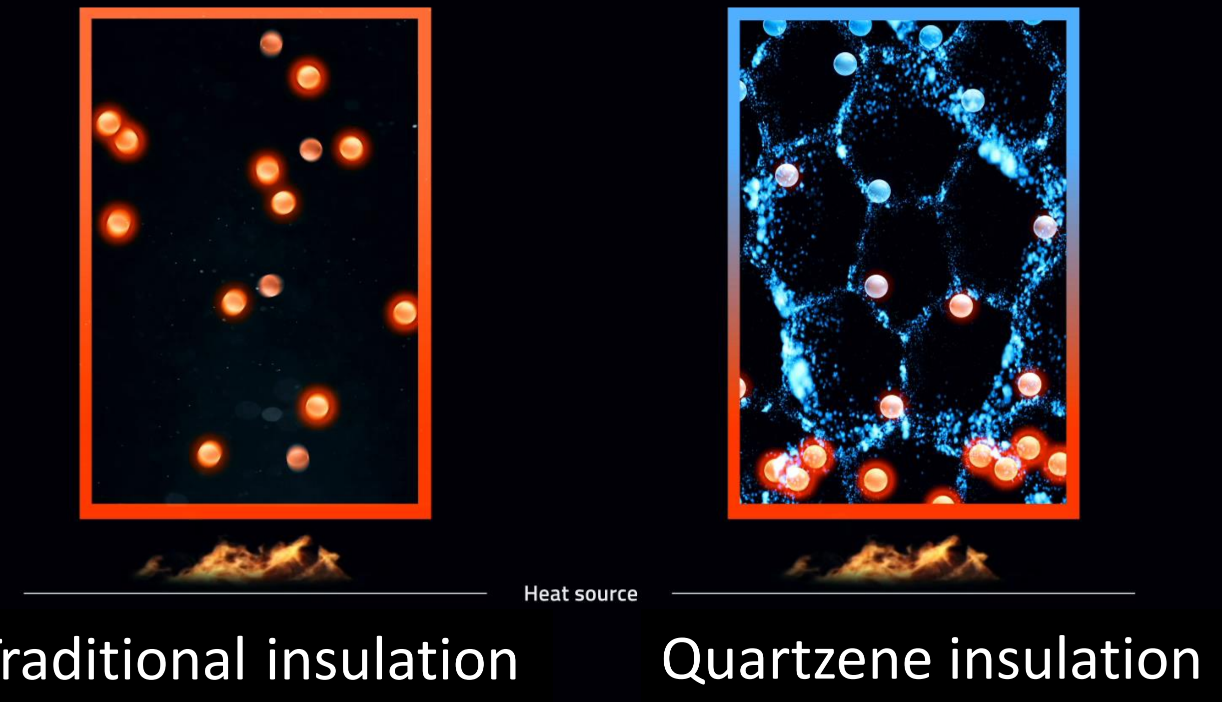
For good insulation: the pore size should be smaller than the free mean path for the air molecules.

SVENSKA AEROGEL

Quartzene®
Next Generation Aerogel

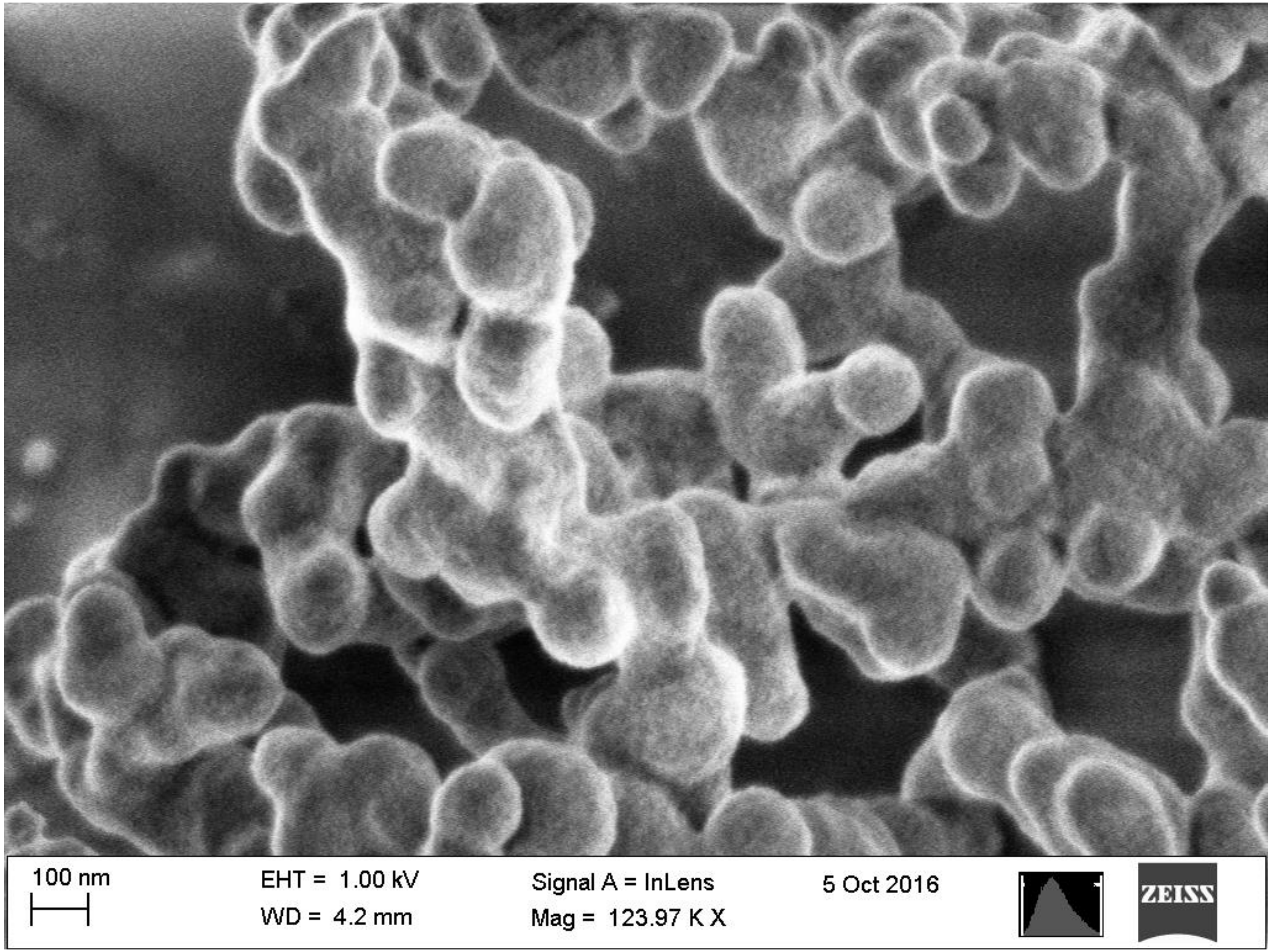
## Nano-sized pores – the key to the aerogel properties: The Knudsen Effect

Quartzene has a pore-size less than 70 nm, restricting the air molecules to move and collide. This limits heat transfer to a minimum




SVENSKA AEROGEL

Quartzene®
Next Generation Aerogel




## To summarize:

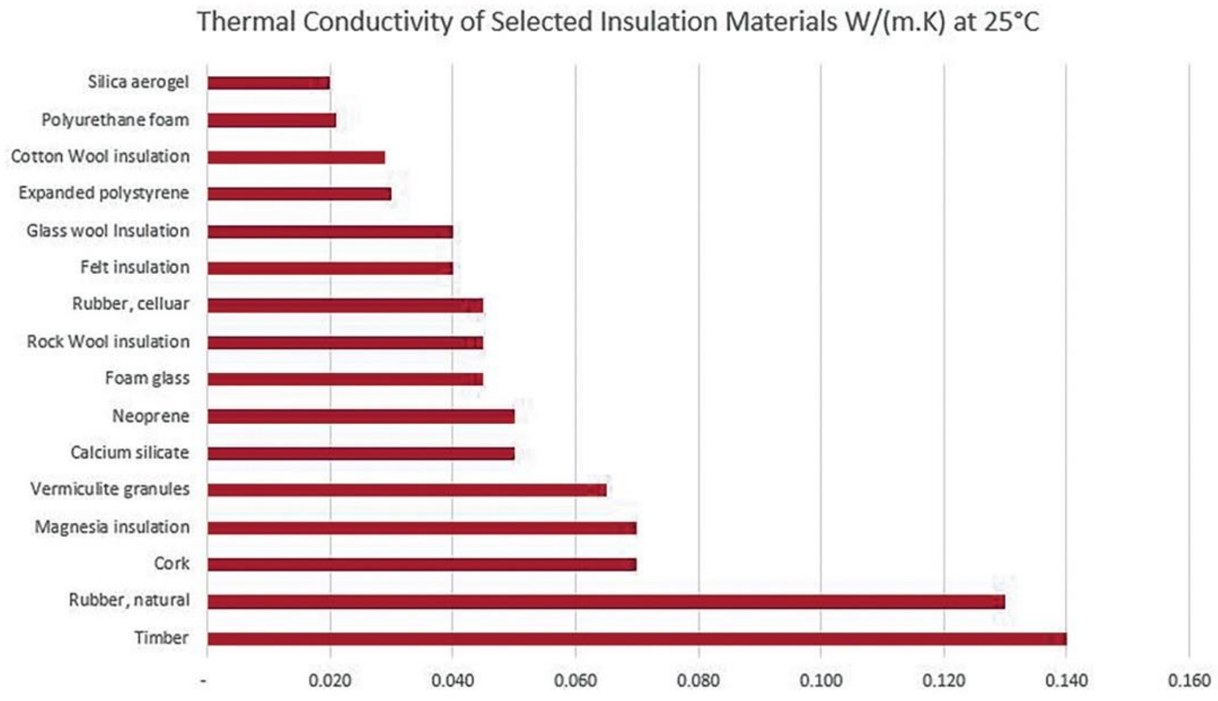
The nano and mesoporous aerogel structure with very little solid material together with the intrinsic low heat transfer of silicate is the key to the thermal insulating properties.

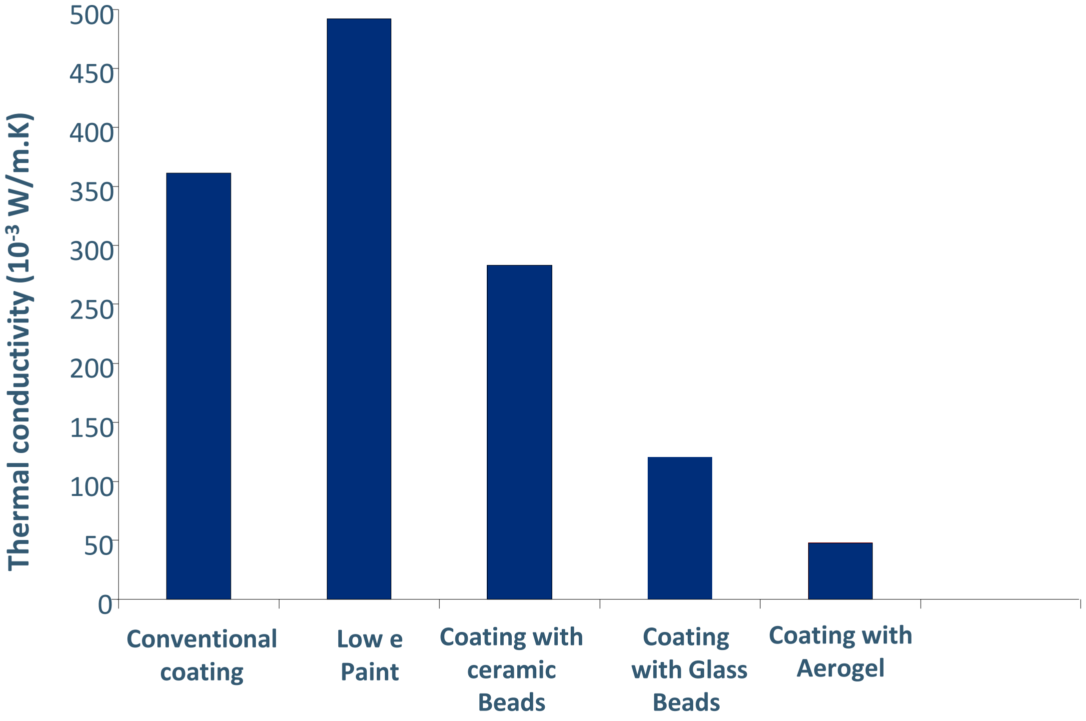
SVENSKA AEROGEL

# Key specifications of the different Quartzene products

| Quartzene | Z1 | Z2TP | Z1H1 | Z2H1TP |
|---|---|---|---|---|
| Chemistry | Silicon dioxide | Silicon dioxide | Silicon dioxide, methylated | Silicon dioxide, methylated |
| Polarity | Hydrophilic | Hydrophilic | Hydrophobic | Hydrophobic |
| Tapped Density ($kg/dm^3$) | 0.05-0.10 | 0.08-0.11 | 0.12-0.16 | 0.16 |
| Surface area, $S_{BET}$ ($m^2/g$) | 400-550 | >300 | 400-550 | >200 |
| Particle size (µm) | 1-20 | 1-70 | 1-20 | 1-70 |
| Pore size (nm) | 1-50 | 7 (average) | 5 (average) | 5 (average) |
| Thermal conductivity λ (W/m·K) | 0,025-0,030 | 0,026-0,030 | 0,025-0,030 | 0,026-0,030 |

# Thermal conductivity of materials and coatings



Quartzene®
Next Generation Aerogel

# Sustainable chemistry

## Nano-porosity + surface area + surface character

=


**Property of Quartzene:**

- Low thermal conductivity
- Porous
- Fire resistant
- Low density
- Hydrophilic/hydrophobic
- Large surface area

**Functionality:**

- High thermal insulation
- Acoustic insulation
- Fire resistance
- Reduced weight
- Absorbs gases and liquids
- Changes rheology

**Benefit:**

- Improved performance
- Material & energy efficiency
- Comfort
- Safety
- Reduced fuel consumption
- Replace petroleum products
- Clean air & water
- Shorter drying time etc.

SVENSKA AEROGEL

# Target Markets

Building & construction

- lightweight cement/concrete
- thermal insulating concrete
- fire resistant concrete
- fire resistant coating
- thermal insulating paints and plasters
- cool roof
- thermal insulation sealants
- thermal insulation PUR/PIR

Process Industries

- safe touch
- corrosion under insulation
- anti-condensation
- district heating/cooling insulation
- molecular absorption
- thermal blankets

Transportation

- thermal and acoustic insulation coatings
- panels and composites
- protection against thermal runway
- thermal blankets

Pulp & Paper

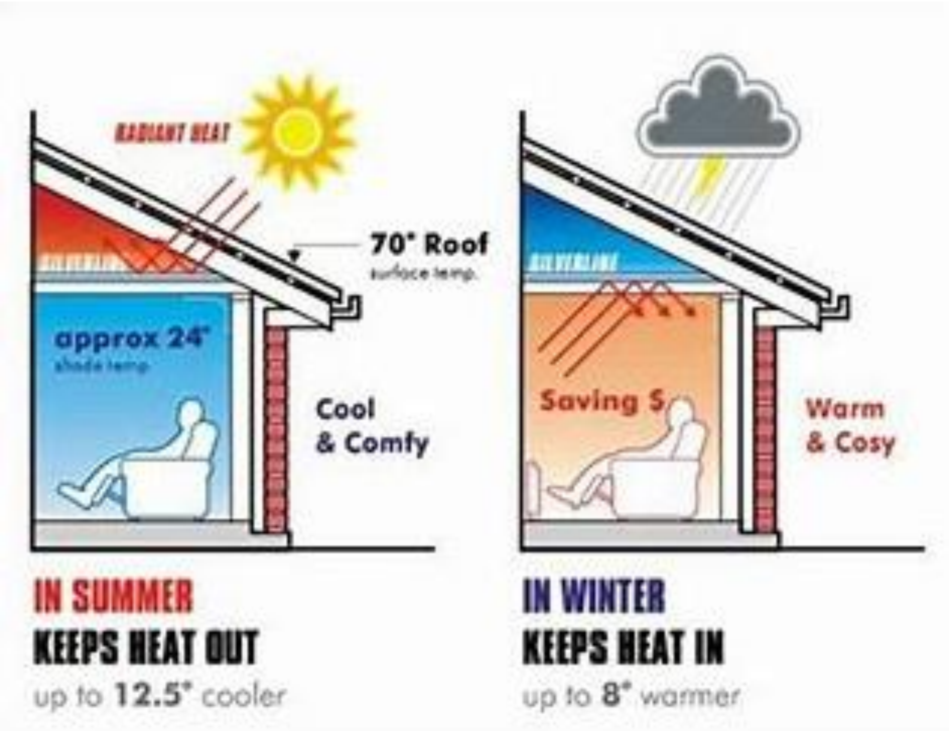
- thermal and acoustic insulation coatings
- barrier coating for paper
- lightweight paperboard and carton
- high resolution printing

Technical textiles

- thermal insulation - through impregnation or coating of woven & non-woven fabrics

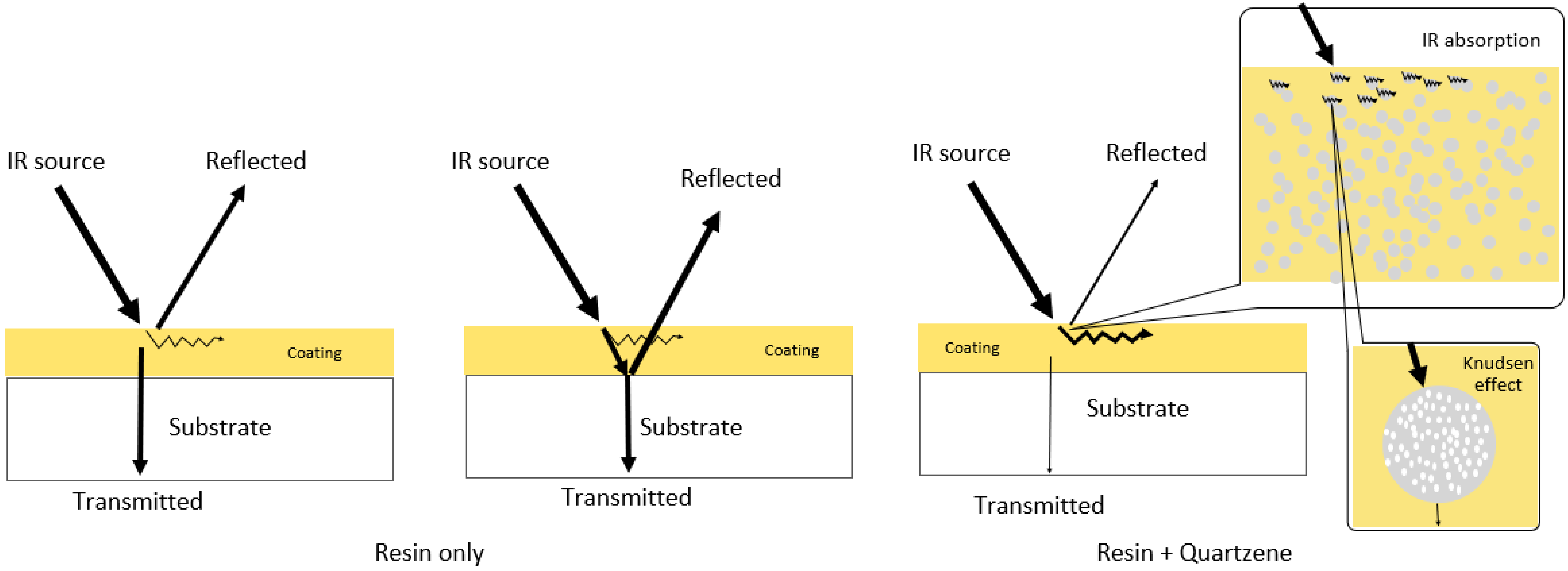
# Cool Roof Coatings

- Expensive IR reflective pigments are commonly used for cool roof coatings
- These types of system only provide protection from heat from the direct sunlight
- Replacing part (or all) of these pigments with Quartzene improves the overall insulation property of the coatings
- Additionally, the low heat conductivity of Quartzene will help to keep the cold or heat inside the building - saving cost on central heating or air conditioning
- Furthermore, Quartzene brings opacity and tinting strength to the system, improving the brightness and hiding power of the coating as well as reducing delamination



Quartzene®
Next Generation Aerogel

# Cool Roof Coating – acrylic co-polymer with Quartzene and/or TiO2




Quartzene limits the heat transfer through the binder to the substrate by two mechanisms: low thermal conductivity and the Knudsen effect (low convection).

SVENSKA AEROGEL

Quartzene®
Next Generation Aerogel

# Cool Roof Coating – acrylic co-polymer with Quartzene and/or TiO2

## Back temperature of metal substrate after IR heating


| | Pure resin | Resin + 11,2 %-wt (0,4 mm) | Resin + 11,2 %-wt (2,8 mm) | Resin + 10 %-wt Qz | Resin + 10 %-wt Qz + 5%-wt TiO2 | Resin + 10 %-wt TiO2 | Resin + 20 %-wt TiO2 |
|---|---|---|---|---|---|---|---|
| ▲ Back temperature 5 min (°C) | 63 | 45 | 38 | 47 | 41 | 44 | 44 |
| ■ Back temperature 10 min (°C) | 65 | 49 | 41 | 49 | 43 | 47 | 46 |

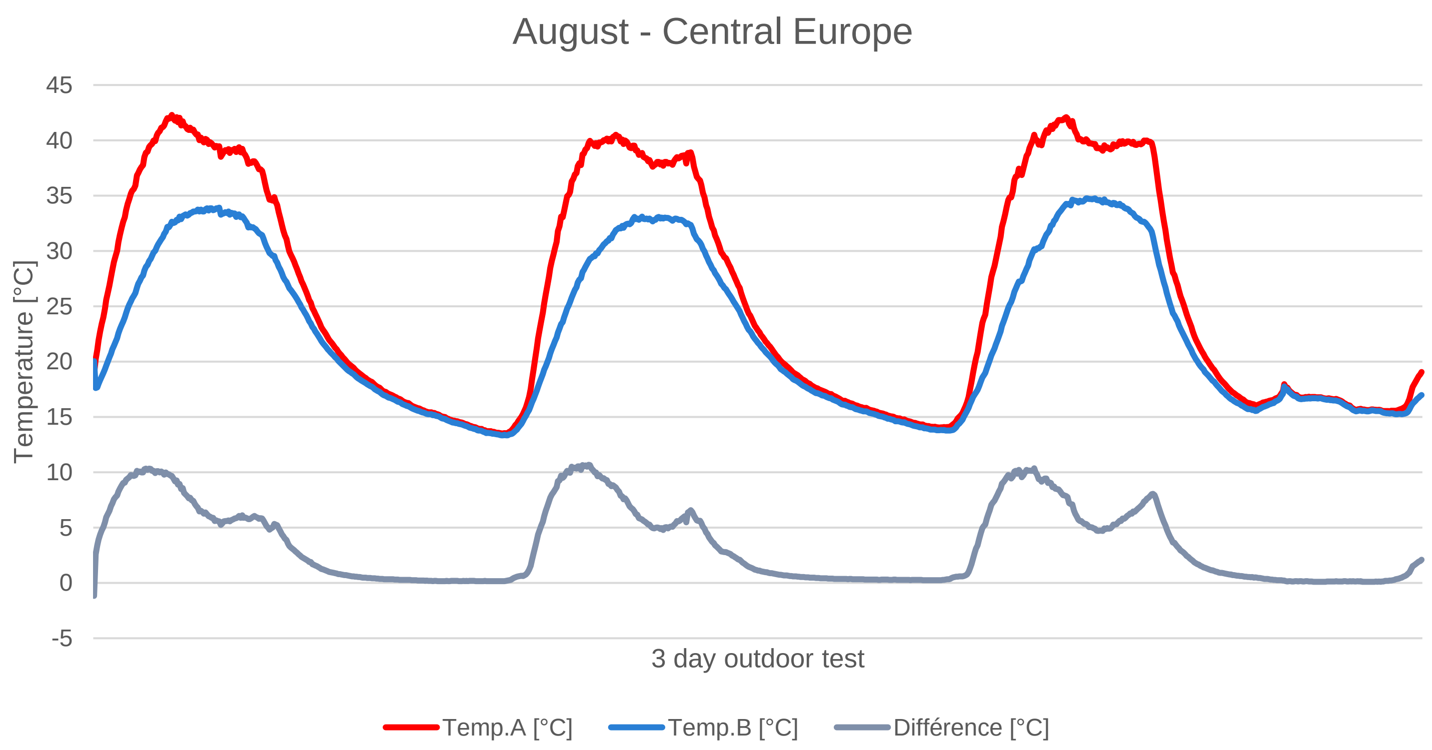
Titolo asse

▲ Back temperature 5 min (°C) ■ Back temperature 10 min (°C)

SVENSKA AEROGEL

Quartzene®
Next Generation Aerogel

# Insulating Coating – acrylic with and without Quartzene and TiO2



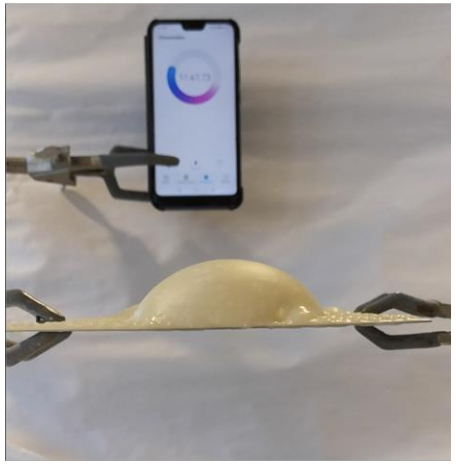

1 mm acrylic coating coating on metal surface with TiO2 + Quartzene (blue) and without (red)

10°C reduction in surface temperature during peak temperature

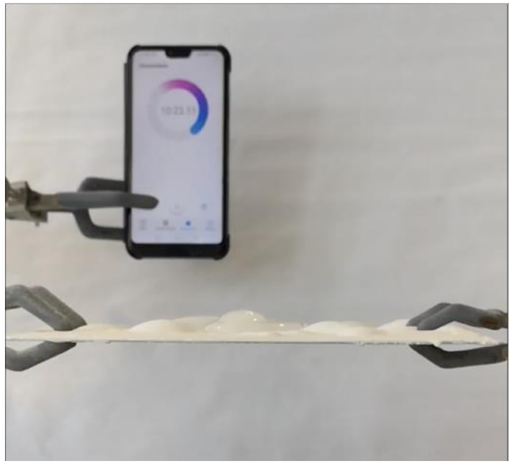
Time shift in heating visible

SVENSKA AEROGEL

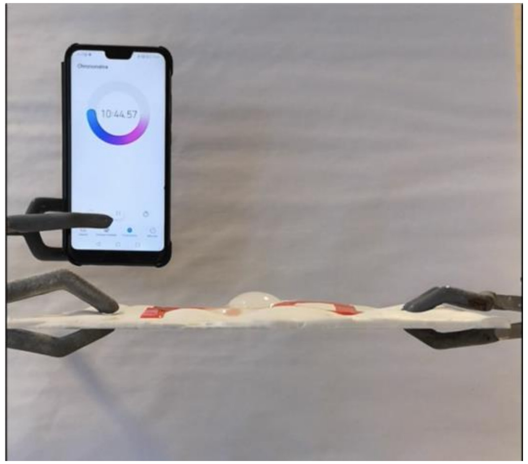
# Delamination test at 500° - acrylic co-polymer on metal substrate



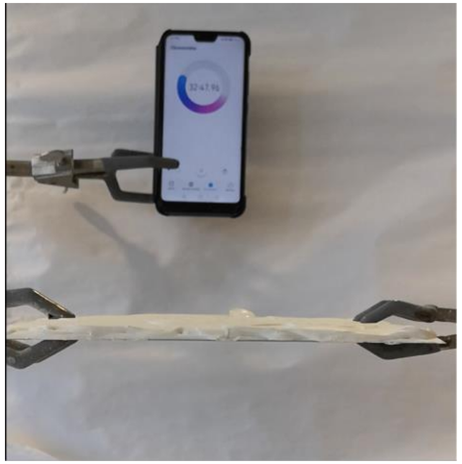
Pure resin
2,0mm
~10 min



Resin + 11,2 %-wt Qz
2,0mm
~10 min



Resin + 11,2 %-wt Qz
2,8mm
~10 min



Resin + 11,2 %-wt Qz
6,0mm
>30 min

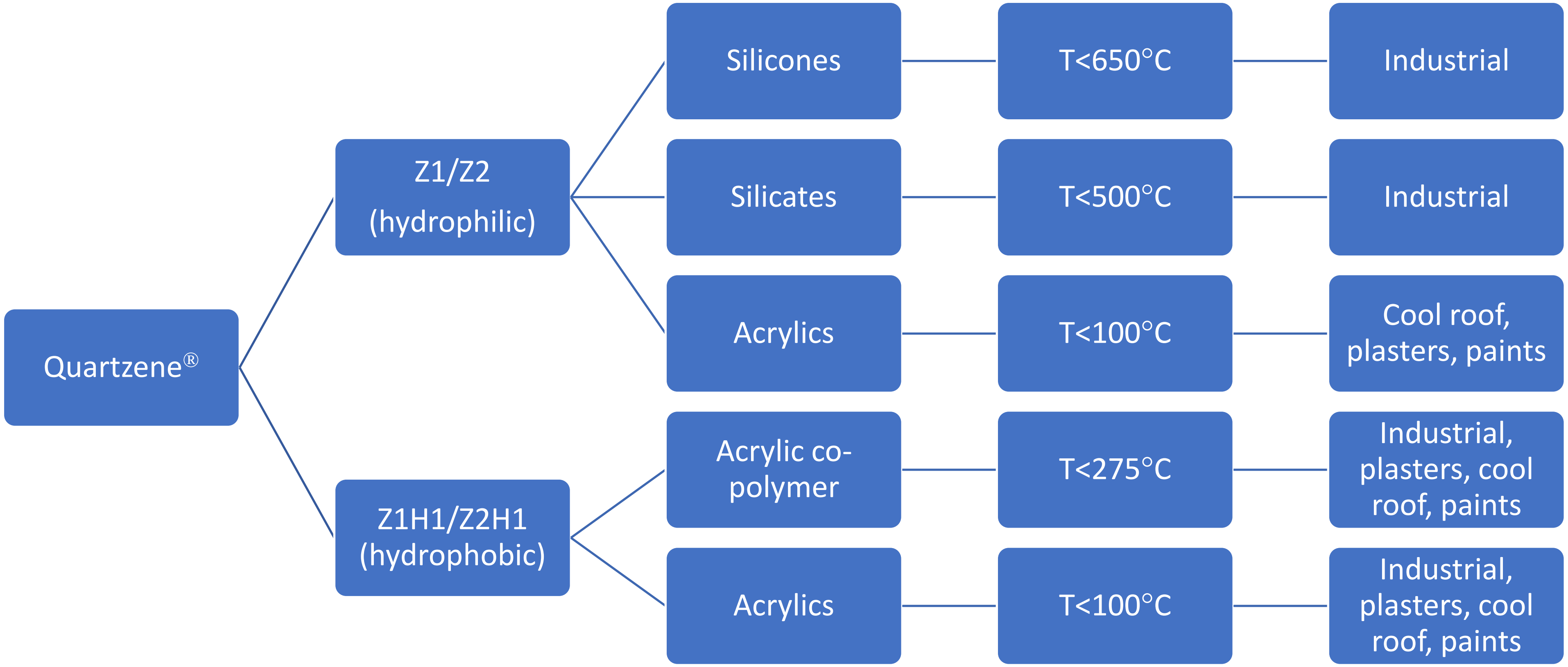
Resin + 10%-wt TiO2
2,7mm
~10 min

# In conclusion:

- A cool roof resin typically absorbs part of the IR radiation, and either reflects or transmits the other part
- Quartzene absorbs IR light but due to its excellent thermal performance it acts insulating in a cool roof coating
- $TiO_2$ reflects IR light to a certain degree, which is complementary to the Quartzene properties
- $TiO_2$ alone is not sufficient to have an insulating coating, its thermal conductivity is ~4,8 W/mK, compared to that of Quartzene at 0,025-0,030 W/mK
- An increased coating thickness will perform better but there is a synergy when adding Quartzene and $TiO_2$ together and therefore a thinner coating can be applied with the same effect or better!
- Delamination processes is decelerated  by the presence of Quartzene, thanks to its heat absorption properties

Quartzene®
Next Generation Aerogel

# Quartzene in resins, working temperatures and applications




SVENSKA AEROGEL

Quartzene®

Next Generation Aerogel

# Quartzene Example starting formula – wb acrylic for cool roof

**STARTING FORMULA WATERBORNE COATING FOR THERMAL INSULATION**

| Raw material | Function | Weight % | Weight % | Component | Density g/ml | Volume | Solids weight | Solids volume | Supplier | Procedure |
|---|---|---|---|---|---|---|---|---|---|---|
| Water | Diluent | 39,26 | 39,26 | Water | 1 | 39,26 | | | Tap or deionized | |
| NaOH 10%/water | To increase pH:9 | 0,55 | 0,05 | NaOH | 2,1 | 0,02 | 0,05 | 0,02 | | |
| | | | 0,5 | Water | 1 | 0,50 | | | | |
| VISCOATEX 46 | Thickener | 0,68 | 0,22 | (1) | 1,19 | 0,18 | 0,22 | 0,18 | COATEX | Simple agitation by hand for mixture |
| | | | 0,46 | Water | 1 | 0,46 | | | | |
| HMPNa | Chelating & dispersing agent | 0,11 | 0,11 | HMPNa | 2,484 | 0,04 | 0,11 | 0,04 | | |
| ACTICIDE MBS | Biocide | 0,22 | 0,22 | Water | 1,03 | 0,21 | | | THOR | |
| TEGO FOAMEX 30 | Anti-foam | 0,98 | 0,2 | (2) | 1 | 0,20 | 0,2 | 0,20 | EVONIK | |
| | | | 0,78 | Water | 1 | 0,78 | | | | |
| TiO2 KRONOS 2190 | Pigment | 3,27 | 3,27 | TiO2 | 4,1 | 0,80 | 3,27 | 0,80 | KRONOS | High shear @4000 rpm for dispersion |
| CHP 517 | Binder | 42,42 | 25,46 | (3) | 1,1 | 23,15 | 25,46 | 23,15 | CH POLYMER | Correct agitation @ 500 rpm for mixture |
| | | | 16,96 | Water | 1 | 16,96 | | | | |
| QZ1H1 | Thermo insulating filler | 12,51 | 12,51 | QZ1H1 | 0,1 | 125,10 | 12,51 | 125,10 | SVENSKA AEROGEL AB | (4) |
| TOTAL | | 100,00 | 100 | | | 207,67 | 41,82 | 149,50 | | |

| | | |
|---|---|---|
| Density g/cm3 | | 0,50 |
| Solid content weight g | | 41,82 |
| Solid content volume cm3 | | 149,50 |
| QZ1H1 volume in dry film % | | 83,68 |

(1) Anionic acrylic copolymer emulsion @32% d:1,06

(2) Organo-modified polysiloxane & fumed silica @20%

(3) Styrene acrylic copolymer dispersion/anionic emulsifier @60% d:1,06

(4) First low shear agitation @500-600 rpm to start dispersion without loss of powder.
When all powder is added, increase shear rate up to 1000-1500 rpm. If needed, improve proper wetting of all powder by moving stirrer blade up and down.

SVENSKA AEROGEL

Thank you for listening!

Please visit our website:
[https://www.aerogel.se/](https://www.aerogel.se/)


Sara Wengström, M.Sc.Eng.
Account Manager – Distribution
Business Development
sara.wengstrom@aerogel.se
+46(0)733370095

SVENSKA AEROGEL