Innovative material – Innovative solutions

Svenska Aerogel AB
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Overview

➢ Svenska Aerogel AB
➢ Aerogels
➢ The Innovation
➢ Quartzene®
➢ Application areas
Svenska Aerogel AB – R&D journey

2017
• Increasing sales on coating and filtration
• Boosting the company for international sales

2016
• Listed on Nasdaq 1st North
• 12 MSEK funded EU projects SME and Aerofilter
• 3:rd up-ramped pilot production
• 13 employees

2015
• 2:nd up-ramped pilot production
• 10 employees

2014
• 1:st pilot production starts
• First commercial product on the market

2013
• EU 7:th framework projects: SESBE & H-House
• Partnership in Turkey

2012
• Paying customers
• Strategic industrial partnerships
• Rated 1 of 11 globally leading aerogel companies

2011
• 10 MSEK funding
• WWF Climate Solver & finalists in Nordic Cleantech Open
• 7 employees

2010
• Cleantech company of the year award
• 3 employees

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Svenska Aerogel AB - Today

- Head Quarter and factory in Gävle
- Office in Stockholm
- 13 Employees
- Present production capacity 35 – 50 ton/year
- 12 MSEK funded EU projects SME and Aerofilter
- EU 7:th framework projects: SESBE & H-House
- Listed on Nasdaq First North in Stockholm
Aerogels

- Invented in 1931
- Samuel Kistler
- Sol gel process
- Supercritical drying

- Complicated and energy demanding production process
- Use of expensive chemicals

Too expensive for the mass-market
The Innovation: Cost effective production process

Svenska Aerogel Process
Ambient pressure drying technique
Low cost silica source

Conventional Process
Supercritical drying technique
Expensive silica source
50-60% price reduction

The low manufacturing cost gives us:
✓ New markets
✓ High volume applications
Quartzene®

- Silica based
- Extremely porous
- Large inner specific surface
- Excellent insulation properties
- Low density
- Fire proof
- Environmentally harmless
Main Quartzene® application areas

- Insulation
- Filtration
  - Liquids
  - Gases
- Paint and Coatings
Cooperation partners
Svenska Aerogel is a development partner and material supplier that in close cooperation with its customers develops cutting-edge applications of Quartzene®.
Thermal Insulation

Quartzene® a high performance insulation material
Quartzene® - high performance and low cost insulation

Insulating products:
• Paper & Food Container
• Textils
• Paints & coatings
• Foam concrete
• High & low temperatur blankets

• Adding Quartzene to cellulose matrix
• Food containers to keep the food warm/cold.
Quartzene® - high performance and low cost insulation

Insulating products:
• Paper & Food Container
• **Textiles**
• Paints & coatings
• Foam concrete
• High & low temperature blankets

Fire resistance textile
Quartzene® - high performance and low cost insulation

Insulating products:
• Paper & Food Container
• Textils
• Paints & coatings
• Foam concrete
• High & low temperature blankets

• Insulating coating
• Insulating paint

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Quartzene® - high performance and low cost insulation

Insulating products:
• Paper & Food Container
• Textils
• Paints & coatings
• **Foam concrete**
• High & low temperature blankets

• Light weight concrete
• Decreased thermal conductivity
• Increased compressive strength
Quartzene® - high performance and low cost insulation

Insulating products:
• Paper & Food Container
• Textils
• Paints & coatings
• Foam concrete
• High & low temperature blankets

• Automotive industry

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Air Filtration

Quartzene® can be tailored to capture any type of air contaminants
Quartzene® - tailored filter medias for clean air solutions

Tailored molecular air filters absorbents for removing:
• SO₂ and NO₂
• VOCs
• Ethylene
• H₂S

• Cleaning of air for process industry
• Indoor air quality (IAQ)
• Paper and food packages

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Quartzene® - tailored filter medias for clean air solutions

- **Purple** = evaluated and successfully removed
- **Green** = proposed to be tested

<table>
<thead>
<tr>
<th>Optimize sorbents for:</th>
<th>Purple sorbents for:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene</td>
<td>α-Pinene</td>
</tr>
<tr>
<td>α-, m-, p-Xylene</td>
<td>+/-R/d-Limonene</td>
</tr>
<tr>
<td>Naphtalene</td>
<td></td>
</tr>
<tr>
<td>Styrene</td>
<td>Propionic acid</td>
</tr>
<tr>
<td>Toluene</td>
<td>Butyric acid</td>
</tr>
<tr>
<td>PAHs</td>
<td>Isovaleric acid</td>
</tr>
<tr>
<td>Valeric acid</td>
<td></td>
</tr>
<tr>
<td>2-Butanon</td>
<td></td>
</tr>
<tr>
<td>Methyl isobutyl ketone</td>
<td>Formaldehyde</td>
</tr>
<tr>
<td>Butyl acetate</td>
<td>Acetaldehyde</td>
</tr>
<tr>
<td>Propionaldehyde</td>
<td></td>
</tr>
<tr>
<td>1-Butyl alcohol</td>
<td>Butyraldehyde</td>
</tr>
<tr>
<td>Isobutyl alcohol</td>
<td>Isovaleraldehyde</td>
</tr>
<tr>
<td>2-Ethyl hexanol</td>
<td>Valeraldehyde</td>
</tr>
<tr>
<td>Benzyl alcohol</td>
<td>Decane</td>
</tr>
</tbody>
</table>

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Liquid Filtration

Quartzene® can be tailored to capture any type of liquids contaminants
Quartzene® - a highly efficient liquid filter material

Tailored filter media removing contaminants from:
- Drinking water
- Food liquids
- Edible oils

Promising results for cleaning water in oil platforms
Quartzene®, a promising family of sorbent materials for application in the final stages of produced water treatment.

Experiment results:

Adsorption of aqueous phase organics at concentrations below their solubility limits has been tested:

<table>
<thead>
<tr>
<th>Sorbent</th>
<th>Adsorbate</th>
<th>Max uptake / mg g⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartzene®</td>
<td>benzene</td>
<td>264.03</td>
</tr>
<tr>
<td></td>
<td>toluene</td>
<td>78.82</td>
</tr>
</tbody>
</table>

✓ Kinetic tests reveal up to 90% of benzene and toluene is adsorbed in the first 6 h of treatment, and up to 50% in the first 2 h.

Quartzene® - a highly efficient liquid filter material

Tailored filter media removing contaminants from:
- Drinking water
- **Food liquids**
- Edible oils

- Successful results on Beer Filtration
Quartzene® - a highly efficient liquid filter material

Tailored filter media removing contaminants from:
- Drinking water
- Food liquids
- Edible oils

• Promising results on sunflower oil filtration

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Edible oil refining steps

- Long time process.
- Chemicals used in the oil refining process can damage the edible oil and human health.

Degumming: Phospholipids, sugars, resins, protein compounds, trace metals and others.

Neutralization: Fatty acids, pigments, phospholipids, Sulfur compounds, Soapstock (soap).

Bleaching: Pigments, oxidation products, trace metals, trace soaps.

Deodorization: Fatty acids, mono and diglycerides, aldehydes, ketones, alcohols.

Dewaxing: Stearins + waxes
Analyzing the performance of the Quartzene® as an adsorbent in removal of the contaminants from edible oil

Studying the possibilities for:
• Better performance in oil refining.
• Reducing the crude oil refining steps.
• Replacing the chemical process with an environmentally friendly process.
• Reducing the process time and temperature.
• Reducing the process costs

☑ Free fatty acids Decreased by 30%
☑ Pigments Removed
☑ Phospholipids Removed

All the analysis has been conducted according to the American Oil Chemist’s Society Official Methods (AOCS).
Quartzene® is a lightweight, nano-porous material that can enhance a number of surface properties.
Quartzene® - a performance additive for paint and coatings

Potential areas
• Thermal insulation paint
• Acoustic insulation paints
• Hygroscopic paints for humidity control
• Improved printability on paper
• Anti-corrosion paint
• Anti-fouling paint
• Anti-bacterial paint
• Fire protection paint
Quartzene® properties
Silica based, amorphous gel, powder or beads

- Particle size (powder): 1-24 μm
- Pore size: 2-100 nm
- Porosity: 96 – 98 %
- Specific Surface Area: 100-750 m²/g
- Tapped Density: 0.06 – 0.12 g/ml @ 20 ºC
- Temperature : ~ 1000 ºC
- Thermal Conductivity @20 ºC 0.025-0.035 W/m K
- Surface Chemistry hydrophilic or hydrophobic
- Surface can be functionalized
- Environmentally friendly material

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Different shapes of Quartzene®

**Paste**  
Intermediate product with a dry content of 6-12%  
Thixotropic nature

**Powder**  
Initially hydrophilic, but can be made hydrophobic

**Granules**  
Sizes from 0.1 mm to 5-6 mm

**Pellets**  
Sizes from diameter 2-10 mm and length 2-10 mm
Material Analysis Techniques - Objectives and Challenges

- Electron Microscopy Methods (SEM, TEM, FIB)
- Nitrogen adsorption method
- Laser diffraction method

Objectives:
Establish a methodology for material analysis which:

1) Allows analysis of the porous system on 3 different length scales
2) Enables correlation between pore and material structure, chemical composition, and resulting material properties.
3) Technologies to be developed are multi-scale and correlative microscopy.
Analysis Results

Scanning Electron Microscopy (SEM)

Application related SEM images: (a) reference fiber mat sample and (b) Quartzene® coating in fiber mat.
Quartzene®, worlds first low-cost aerogel-like material
SME-2 project (May 2016 – April 2018) H.2020

Project Objectives:

• Objective 1: Validating Quartzene® in thermal insulation applications by 4 potential customers setting performance requirements and testing

• Objective 2: Validating the patented Master Pilot Plant process, and finalizing design of 24/7 fully automated 2000 ton/year production units

• Objective 3: Validating the business plan, including developed licensing concepts of 24/7 production units
The company in 2017

• Strengthening R&D for increased customer service
• Increasing sales on coating and filtration
• Boosting the company for international affair
Thank you for listening!

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