Thermal Insulation

- Technical Requirements
- Definitions
- Condensation
- Q/A
HVAC Insulation

Thermal Insulation
HVAC Insulation

**Thermal Insulation**, in principal,
is the resistance to reduce the heat transfer in a considerable amount.

- *cold lines* prevents heat loss
- *heating lines* prevents heat gains
The Resistance

In Buildings; in Winter time → Heat Losses
in Summer time → Heat Gains

In HVAC; in Heating Lines → Heat Losses
in Cooling lines → Heat Gains

is “Thermal Insulation”
Cold – Warm and Heating Lines

- **HVAC Lines**
  - **Cold Lines**: +6 °C
  - **Warm Lines**: +100 °C
  - **Heating Lines**: +100 °C
Where?

- Building
- HVAC
- Technical insulation

→ Circular Surfaces (Pipes)
→ Rectangular Surfaces (Air ducts)
→ Valves and Accessories
What is a Thermal Insulation Material?

According to ISO and EN Standards:

- If $\lambda > 0.065$ W/mK, Building Material
- If $\lambda < 0.065$ W/mK, Thermal Insulation Material
Thermal Insulation Materials

- Glasswool (EN 13162)
- Stonewool (EN 13162)
- Extruded Polistren (XPS) (EN 13164)
- Expanded Polistren (EPS) (EN 13163)
- Polyurathane (PUR) (EN 13165)
- Phenolic Foam (EN 13166)
- Cellular Glass (EN 13167)
Technical Requirements

1) Thermal Conductivity Coefficient (λ)
2) Water Vapor Diffusion Resistance Coefficient (μ)
3) Fire Classification (DIN 4102, BS 476, EN 13501)
4) Corrosion Risk
5) Temperature Range (°C)
6) Cell Structure
7) Acoustic Performance
8) Density (kg/m³)
9) Weathering Resistance
10) Dimensional Stability
11) Easy Application
12) Economics

NOT: Temperature range is not a selection criteria, it defines the usage area.
1. Thermal Conductivity ($\lambda$)

It is the quantity of the energy which passes through a m$^3$ of insulating material where there is 1C difference in temperature between opposite surfaces.
Thermal Conductivity ($\lambda$)

$\lambda_{TM} = \lambda$ at mean temperature

$t_m = \frac{t_{\text{medium}} + t_{\text{ambient}}}{2}$
### Thermal Conductivity Coefficient (\( \lambda \))

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<tr>
<th>Mean Temperature</th>
<th>Thermal Conductivity (W/mK)</th>
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<td>75</td>
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<td>100</td>
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</table>
It is the ratio of the resistance to the water vapour diffusion of an insulation material to the resistance of air
Water Vapour Diffusion Resistance Coefficient ($\mu$)

\[ \mu = 1 \] (no resistance to diffusion)

\[ \mu = \infty \] (no diffusion)

Diffusion tight materials

\[ \mu = 10.000 - 100.000 \]

For e.g.; Aluminium ($\mu = \infty$)
3. Fire Classification

- DIN 4102
- BS 476
- EN 13501
A  Incombustible materials
   A1  That does not contain combustible materials
   A2  That contains combustible materials

B  Combustible materials
   B1  Hardly combustible materials
   B2  Normal combustible materials
   B3  Easily combustible materials
DIN 4102 Standard

**Class A** (Incombustible)
- A1
  - Sand
  - Concrete
  - Brick
  - Glasswool
  - Stonewool
- A2
  - Glasswool
  - Stonewool

**Class B** (Combustible)
- B1
  - XPS
  - PE
- B2
  - PUR
  - EPS
  - Wood
- B3
  - Paper
  - Wood
  - Glasswool
  - Stonewool
  - XPS
  - PE
  - PUR
  - EPS
  - Wood
  - Glasswool
  - Stonewool
CLASSIFICATION OF REACTION TO FIRE IN ACCORDANCE WITH EN 13501-1:2007

Applicant: ODE Yatirim Bank A.Ş.

Prepared by: Centrum stavebního inženýrství a.s.

Product name: ODE STARFLEX - ALUMINIUM FOIL FACED HVAC BOARD

Classification report No.: FK-06-055

Issue number: 2/2

Date of issue: 22nd November 2008

This classification report consists of 4 pages and may only be used or reproduced in its entirety.

Test results:

<table>
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<th>Test Method</th>
<th>Parameter</th>
<th>Mean Value</th>
<th>Critical Value</th>
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</table>

3. CLASSIFICATION AND DIRECT FIELD OF APPLICATION

Reference and direct field of application

This classification has been carried out in accordance with the clauses 11.5.1 of EN 13501-1:2007.

Classification

The product ODE STARFLEX - HVAC BOARD, in relation to its reaction to the behavior of combustion:

A1

The additional classification in relation to smoke production is:

not classified

The additional classification in relation to smoke toxicity is:

not classified

The additional classification in relation to fire propagation is:

not classified

Field of application

Reaction to fire classification: A1
CLASSIFICATION OF REACTION TO FIRE
IN ACCORDANCE WITH EN 13501-1

4.1 References of classification
The classification has been carried out in accordance with clause 11 of EN 13501-1:2007.

4.2 Classification
The following classes concerning the behaviour in case of fire are assigned to the product:

ODE R-Flex sheet: B-s3,d0
4. Corrosion Risk

According to DIN 1988 Part 7 Section 5:3 Limit Values

Steel Pipes;

Chlor (%0,05)

Copper Pipes;

Nitrate ve Ammonia (%0,2)
## 5. Temperature Range

<table>
<thead>
<tr>
<th>Thermal Insulation Material</th>
<th>Max. Operating Temperature (°C)</th>
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<tbody>
<tr>
<td>Ceramic wool</td>
<td>1800</td>
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<td>Stonewool</td>
<td>750</td>
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<tr>
<td>Cellular Glass</td>
<td>430</td>
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<tr>
<td>Glasswool</td>
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</tr>
<tr>
<td>FEF *</td>
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<tr>
<td>Melamine Foam</td>
<td>150</td>
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<td>Phenolic Foam</td>
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<td>Polyurathane</td>
<td>110</td>
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<td>Polyethylene</td>
<td>105</td>
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</tbody>
</table>
6. Cell Structure

$\mu = 1$ open cell

$\mu = 3.000$ closed cell

$\mu = 7.000$ closed cell
The Other Requirements

8- Density

*is the only specification that can be measured in the site.*

9- Mechanical Resistance

*is the compressive strength at % 10 deflection.*

10- Dimensional Stability

11- Easy Application

12- Economics
Question-1

Which Thermal Insulation Materials are used in HVAC Applications?
Thermal Insulation Materials in HVAC Applications

- Glasswool (GW)
- Stonewool (SW)
- Flexible Elastomeric Rubber Foam (NBR)
- Extruded Polyethylene Foam (XPE)
- Polyurathane Foam (PUF)
- Phenolic Foam (PF)
- Cellular Glass (CG)
Question-2

Which thickness should be used?
Which thickness should be used?

**OdeCalc Program**

**For Pipes**
- → Heat loss
- → Temperature drop
- → Surface temperature
- → Freezing time
- → Minimum insulation thickness preventing condensation

**For Flat Surfaces**
- → Heat loss
- → Surface temperature
- → Minimum insulation thickness preventing condensation
To Prevent Condensation

- Minimum insulation thickness preventing condensation for Pipes -

PARAMETERS

<table>
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<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Ambient temperature (T_a °C)</td>
<td>30</td>
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<tr>
<td>Medium temperature (T_m °C)</td>
<td>6</td>
</tr>
<tr>
<td>Tube diameter (mm)</td>
<td>114</td>
</tr>
<tr>
<td>Insulation material</td>
<td>R-Flex-ST</td>
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<tr>
<td>Relative Humidity (%)</td>
<td>70</td>
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</tbody>
</table>

RESULTS

<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Thermal Conductivity (W/mK)</td>
<td>0.0375</td>
</tr>
<tr>
<td>Dew point temperature (T_d °C)</td>
<td>23.9</td>
</tr>
<tr>
<td><strong>Minimum insulation thickness (mm)</strong></td>
<td><strong>11.4</strong></td>
</tr>
<tr>
<td>K-Flex dimension</td>
<td>13 x 114</td>
</tr>
</tbody>
</table>
**E.g.**

Ambient Temperature (T<sub>a</sub>) : 35°C  
Medium Temperature (T<sub>m</sub>) : 6 °C  
Pipe Diameter (inch) : 2”  
Relative Humidity (%) : 60

**RESULT**

Min. insulation thickness to prevent condensation: 7.8 !

<table>
<thead>
<tr>
<th>Insulation Thickness</th>
<th>9 mm.</th>
<th>13 mm</th>
<th>25 mm</th>
<th>32 mm</th>
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</thead>
<tbody>
<tr>
<td>Energy saving due to thickness</td>
<td>62%</td>
<td>69%</td>
<td>78%</td>
<td>80%</td>
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</tbody>
</table>
How is possible to prevent condensation?
Definition of the Condensation

\[ T_s = 24.1^\circ C \]

\[ T_m = 6^\circ C \]

\[ \phi = % 65 \]

\[ T_d = 22.8^\circ C \]

\[ T_a = 30^\circ C \]

R-Flex ST

Tube diameter = 25.4 mm

Minimum insulation thickness = 7.6 mm

Thickness = 9 mm

\[ T_s = 24.1^\circ C > T_d = 22.8^\circ C \]

Surface temperature > Dew point temperature

No Condensation!
Factors Affecting the Dew Point

- Ambient Temperature \( (T_a = ^\circ \text{C}) \)
- Relative Humidity \( (\varphi = \%) \)
- Medium Temperature \( (T_m = ^\circ \text{C}) \)
What is Relative Humidity?

<table>
<thead>
<tr>
<th>t°C</th>
<th>f [g/m³]</th>
<th>t°C</th>
<th>f [g/m³]</th>
<th>t°C</th>
<th>f [g/m³]</th>
<th>t°C</th>
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<td>597,7</td>
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</tbody>
</table>
Parameters of Condensation

- Ambient Temperature \( T_a = ^\circ C \)
- Relative Humidity \( \varphi = \% \)
- medium temperature \( T_m = ^\circ C \)
- Air flow
- The heat transfer coefficient \( \alpha \)
- Thermal Conductivity \( \lambda \)
- Water vapour diffusion resistance coefficient \( \mu \)
Factors Affecting the Dew Point

- Ambient temperature \( (T_a = \degree C) \)
- Relative Humidity \( (\varphi = \% ) \)
Parameters of Condensation.

\[ \alpha = \text{Heat Transfer Coefficient of the Surface} \]

It is being changed according to the material structure.
How does condensation happen?

1) If no thermal insulation is applied,

2) If an insufficient thermal insulation thickness is applied, **Condensation on the Surface**!

3) Sufficient thermal insulation thickness

   3.1 Thermal insulation material with a low $\mu$ value  
   **Condensation within the Insulation Material**!

   3.2 Thermal insulation material with a high $\mu$ value  
   **No Condensation**!
1- If no thermal insulation is applied

\[ T_s = 6.1^\circ C \]
\[ T_m = 6^\circ C \]

\[ \varphi = \% 65 \]
\[ T_d = 22.8^\circ C \]
\[ T_a = 30^\circ C \]

Tube diameter = 25.4 mm

Minimum insulation thickness = 7.6 mm

\[ T_s = 6.1^\circ C < T_d = 22.8^\circ C \]

Condensation on the SURFACE!
2- If an insufficient thermal insulation thickness is applied

\[ T_s = 21.3^\circ C \]
\[ T_m = 6^\circ C \]

\[ \varphi = \% 65 \]
\[ T_d = 22.8^\circ C \]
\[ T_a = 30^\circ C \]
\[ R\text{-}Flex\ ST \]
\[ \text{Thickness} = 6\ mm \]
\[ \text{Tube diameter} = 25.4\ mm \]

Minimum insulation thickness = 7.6 mm

\[ T_s = 21.3^\circ C < T_d = 22.8^\circ C \]

Condensation on the SURFACE!
2.1 If an insufficient thermal insulation thickness is applied
3.1- Sufficient thermal insulation thickness

\[ T_s = 23.6^\circ C \]
\[ T_m = 6^\circ C \]

Thermal insulation material with a low \( \mu \) value

Condensation within the Insulation Material!
3.2- Sufficient thermal insulation thickness

$T_s = 23.6^\circ\text{C}$

$T_m = 6^\circ\text{C}$

kalınlık = 9 mm

Minimum insulation thickness = 7.6 mm

$\varphi = \% 65$

$T_d = 22.8^\circ\text{C}$

$T_a = 30^\circ\text{C}$

R-Flex ST

Tube diameter = 25.4 mm

$T_s = 23.6^\circ\text{C} > T_d = 22.8^\circ\text{C}$

Thermal insulation material with a high $\mu$ value

No Condensation! (a diffusion tight application is a must!)
To prevent condensation; We should

1) choose the right thermal insulation material,
2) calculate the right insulation thickness,
3) have a sufficient μ value,
4) apply a diffusion tight application.
Precautions against Condensation

To prevent condensation; We should

1) choose the right thermal insulation material,
2) calculate the right insulation thickness,
3) have a sufficient μ value,
4) apply a diffusion tight application.
Precautions against Condensation

To prevent condensation; We should

1) choose the right thermal insulation material,
2) calculate the right insulation thickness,
3) have a sufficient $\mu$ value,
4) apply a diffusion tight application.
Precautions against Condensation

To prevent condensation; We should

1) choose the right thermal insulation material,
2) calculate the right insulation thickness,
3) have a sufficient μ value,
4) apply a diffusion tight application.
# Recommendation in HVAC Applications

<table>
<thead>
<tr>
<th>Cold Lines</th>
<th>Warm Lines</th>
<th>Heating Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Wool</td>
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</tr>
<tr>
<td>FEF</td>
<td>Polyethylene</td>
<td>Stonewool</td>
</tr>
<tr>
<td></td>
<td>FEF</td>
<td>FEF</td>
</tr>
</tbody>
</table>

- **Cold Lines** (Below 6°C)
- **Heating Lines** (Above 100°C)
GLASSWOOL
GLASSWOOL

Produced with the transformation of silica sand into fiber by melting in high temperature.

Thermal insulation, acoustic insulation, fire safety purposes.
GLASSWOOL Production Plant
The Range of Product

- Board,
- Blanket,
- Prefabricated Pipe
The Lamination Types of Glasswool

*YGT1-YGT2
yellow glasswool faced

*BGT1-BGT2
black glasswool faced
The Lamination Types of Glasswool

* FS  
aluminium foil faced

* AGC  
alu glass faced
Quality Certificates

EN 13162
Quality Certificates

- European Certificate

[Image of European Certificate]

[Text of European Certificate]

Centrum stavebního inženýrství a.s., Praha,
Centrum stavebního inženýrství a.s., Praha,
Laboratoř v Praze
Laboratoř v Praze
Quality Management System
Quality Management System

EC-CERTIFICATE OF CONFORMITY

EN 13 162: 2001
EN 13 162: 2001
and Annex B and C of the standard EN 13 172: 2001/ A1
and Annex B and C of the standard EN 13 172: 2001/ A1
Technical Requirements

**Thermal Conductivity Coefficient:** 0.040 W/mK

**Water vapour Diffusion Resistance Coefficient (µ):** 1.1

**Fire Classification:** TS EN 13501-1 → A1

**Temperature range:** -50°C — +250°C

**Density:** 12-100 kg/m³
HVAC Ins.

HVAC Blanket

- one side is covered with alu foil

- **Density**: 24 kg/m³

- **Usage area**:
  - Insulation of ventilation ducts from outside
  - Insulation of air conditioning ducts from outside
HVAC Board

- one side is covered with alu foil
- **Density**: 50 kg/m³
- **Usage area**:
  - air ducts insulation
  - boiler rooms and generator rooms
Radiator Panel

Used as thermal insulator and reflector behind sources of heat such as radiators, stoves and ovens
Prefabricated Pipe

- none or alu foil covered
- **Density**: 60-100 kg/m³
- **Usage area**:  
  - Radiator and central heating systems  
  - Solar energy systems
FEF- Elastomeric Rubber Foam
FEF- Product Range
Technical Requirements

Thermal Conductivity Coefficient: 0.036 W/mK (0°C)

Water vapour Diffusion Resistance Coefficient: $\mu \geq 7000$

Fire Classification: EN 13501 (B-s3-d0)

Temperature range: -200°C — +116°C

Water Absorption: %0.4
4.3 Diffusion Tight Applications
4.4 Diffusion Tight Applications
Valves and Accessories

Insulation
No command
No command
Solution : Valve Jackets
Applications
Applications
Applications
Applications
Thanks For
Your Attention!
Q & A