PROPOSAL (R&D)

INUSULATION METHODS

DESIGN – PROCEDURES - GUIDELINES

THE IMPACT OF INSULATION

Heat Losses through conduction

T1

T2

T3

Less heat loss due to insulation

Insulation protection

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1. Introduction

Insulation systems are considered to be complex systems with respect to the operational adaptability and expected outcomes. The diverse circumstances encountered on various processes can cause serious accidents. In case of doubt on the selection of insulation system, guidance must be obtained from a local material specialist, engineering companies and/or from research publications published in the recent past.

The appropriate functional sections of engineering departments and of construction groups are usually in touch with such situation. This research report has been proposed to be prepared to provide support in such instance, therefore extensive research which includes primary as well as secondary data collection will be completed.

Understanding the reason for insulations and the factors that can affect the insulation under different circumstances is an essential for the selection of insulation. The relevant design conditions, operating temperature and any other constraints that may exist must be taken into account, if a successful insulation system is to be achieved (Hall, 2010).

Aspects of design

Insurance of adequate communication between the designer, operating staff, contractor and/or construction and maintenance organisation holds primary importance in any process. Any proposed design should be as such to facilitate insulation system.

The Insulation can have an Impact on design of equipment in many ways and so it is important to make sure that the selected insulation system is compatible with the duty. Insulation can Impact on:

- Atmospheric contamination, mechanical damage, severity of fire hazard
- Thermal expansion
- Life expected and/or minimum life
Aims, Objectives and Research Questions

Following are the **Aims** of this research paper;

- Develop Understanding of the importance of insulations
- Outline the key methods of insulations currently in practice in the UK
- Find out methods of improvements through detailed literature review
- Complete methodological designs on Insulations
- Conduct experimentations to analyze insulation techniques
- Propose recommendations for future works

Following are the **Objectives** of this Research Paper;

- Discuss and present the theoretical and practical framework of insulation methods
- Discuss the adaptability of insulation
- Present data of the previous completed research papers on the subject and critically analyze the contents through practical experimentations
- Complete the design guidelines on the insulation methods

Below are the **Research Questions** that drives the research to be completed;

- What are possible factors that can affect the insulation?
- How does the water proofing and sealing of protective finishes work?
- What are the associated hazards? How can these be eliminated?

2. Literature Review

Much research has been completed in the last few decades in the field of insulation and associated engineering (AIRAH, 2007). Abdou and Budaiui (2005) compared thermal conductivity measurements of building insulation materials under various operating temperatures, which highlighted the fact the insulation material selection is the primary
step in insulation techniques. The research work completed by Anderlind and Johansson in 1983 presented a theoretical analysis of thermal insulation through which a gas or fluid flows. However, in this research paper, research will be conducted on the impacts of insulation on design equipment.

The essential criterion in this research is the external temperature of the insulation system for personal protection. The primary material types used to achieve this objective is Calcium silicate, details of which are given as follows in the Table-1;

<table>
<thead>
<tr>
<th>Pipe Nominal Size (in)</th>
<th>Operating Temperature range °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 250</td>
<td>251 to 350</td>
</tr>
<tr>
<td>0.5 ---1.0</td>
<td>25</td>
</tr>
<tr>
<td>1.0 ---1.5</td>
<td>25</td>
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<tr>
<td>2</td>
<td>25</td>
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<td>3</td>
<td>25</td>
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<tr>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>6 to 8</td>
<td>25</td>
</tr>
</tbody>
</table>

*Table 1: Calcium silicate insulation thickness for personal protection (source: Hall, 2010)*

**Temperature range:** Recommended for high temperature range i.e. 200 to 600 °C.

**Comments:** The operating upper limit should be 100 °C below the BS limit, for longer exposure.

**Supports:** Stainless steel bands, support rings on vertical surfaces

**Protective finish:** Metal cladding, asbestos free cement, fire resistant mastic.

When using asbestos-free magnesia, it must be noted that it has a much lower temperature range (320 °C max.) and it tends to be more affected by spillage (ASTM, 2010; ASHRAE, 2009; ISO 6946, 2005)

Mineral wood is another popular material used for the subject purpose;

<table>
<thead>
<tr>
<th>Pipe Nominal size (in)</th>
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<tbody>
<tr>
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<tr>
<td>0.5 to 1.5</td>
<td>25</td>
</tr>
<tr>
<td>1.5 to 8.0</td>
<td>25</td>
</tr>
</tbody>
</table>

*Table 2: Mineral Wool insulation thickness for personal protection (source: Hall, 2010)*

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**Temperature range:** The recommended temperature range for the use of mineral wool (glass, slab, rock) is 0 to 350 °C.

**Comments:** Mineral wool mattresses must not be applied to horizontal surfaces

**Supports:** stainless steel bands, support rings, cleats.

**Protective finish:** Metal cladding. (Fire resistant mastic on canvas covered slabs for resin-bonded mineral wool)

The following aspects of design will be investigated in this research paper:

![Figure 1; Aspects of Design (source: self created using MS word)](http://www.researchprospect.com/)
3. Methodology

The possible factors that can affect the insulation are to be analyzed through primary as well as secondary research. Various factors are considered in addition to the reason for insulation. Experiments will be conducted to obtain the results through the methodology defined in the following diagram;

Figure 2; Defining the Methodology (source: self created using MS word)
4. Considerations and Intended Outcomes

Requirements of design and experimentations:

1. Selecting appropriate insulation types
2. Preventing warm/hot insulation from becoming wet and hence ineffective and damaged.
3. Protection against spillage.
4. Water vapor barrier technique utilization for sub ambient system

These requirements will be applied for instances where waterproofing is the primary precaution against stress corrosion of austenitic steel. Good practice is to leave some gaps in sheltered regions to allow any water that enters the insulation to escape. Expert’s advice will be sought before insulation is applied to flanged joints where the process temperature is above 350°C (Yarbrough and Graves, 1997).

The condition of the equipment will be checked if there is a reason to suspect that insulation has become saturated, or if the standard of waterproofing appears inadequate. This can cause corrosion under insulation.

The protective system will be developed with the ability to withstand rain, sun and extremes of ambient temperature and care will be taken to seal gaps where the external cladding overlaps (e.g. hangers, braches on vessels). This aspect is less important as long as spillage is unlikely.

NOTE: Stainless steel is much more resistant to weakening in a fire situation as compared to alternatives of carbon steel or galvanized steel.

Precautions will be taken whenever insulated austenitic steel equipment is exposed to Temperature range of 70°C to 500°C (can keep the equipment wet in the temperature range of 70°C to 250°C)
When using aluminum foil as an interlayer (a preferred precaution), the temperatures of the equipment will not be allowed to exceed 500°C. Above this temperature the aluminum foil can melt and damage the equipment, a more serious hazard (ASTM, 2010). For use over steam tracing the foil shall not be less than 0.06mm (46smg) thickness.3.5.1, (M5017C).

**Expected Outcomes**

- To avoid austenitic steel from corrosion cracking, the aluminum foil shall be held in place with stainless steel wire with all laps 50mm (2 in) minimum and formed so as to shed water. Experimentations will be conducted to confirm this expected outcome. The durability of different materials types to be used in the experimentations will also be tabulated in the form conclusive results.

- Galvanized metal such as cladding or mesh will be allowed to come into contact with austenitic steel surfaces. The experimentation will provide the impacts of this practice.

- The aluminum foil will be applied such that it completely encases the austenitic steel, isolating it from the steam tracing.

- Where it is impracticable to apply aluminum foil or where there is a possibility of temperature rise up to 500C, optimized methods of insulations will be used. These methods will be outlined through the results obtained from practical applications of insulation.

- Finally, design guidelines will be prepared / issued based on practical implementation to support the activity of insulation; which will provide support to the engineers, researchers and developers around the globe.
5. References


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Appendices

APPENDIX A:
APPENDIX B:
APPENDIX C: