A cellular glass system for an outer surface of a pipe. An insulation layer surrounds the outer surface of the pipe. The insulation layer has an outer surface and an inner surface and comprises cellular glass. A foam fills an annular space between the outer surface of the pipe and the inner surface of the insulation layer and is configured to limit water intrusion into the annular space and attenuate sound. The system may also include another insulation layer and another foam layer between the two insulation layers.

[Continued on next page]
(84) Designated States (unless otherwise indicated, for every

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— with international search report (Art. 21(3))
Cellular Glass Corrosion Under Insulation System

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of the earlier filing date of United States Provisional Patent Application No. 62/189,442 filed on July 7, 2015, the disclosure of which is incorporated by reference herein.

BACKGROUND

[0002] This application discloses an invention which is related, generally and in various embodiments, to cellular glass insulation systems.

[0003] Cellular glass may be fabricated into sections for various applications such as insulating industrial and commercial pipes as well as insulating vessels. While insulating these applications provides the necessary purpose of energy conservation or process control, other problems may arise. For instance, corrosion under insulation (CUI) may occur under cellular glass insulation where moisture has been allowed to migrate between the cellular glass insulation and the pipes or vessels which are typically comprised of metal. The temperature range for CUI generally occurs between 32°F and 400°F. This includes liquid water that is trapped under the cellular glass insulation and has not been allowed to evaporate or be removed from the system.

SUMMARY OF THE INVENTION

[0004] According to embodiments of the invention, a foam is utilized to fill an annular spacer between the cellular glass insulation and the pipe or vessel being insulated. The foam, when compressed in the annular space, limits the intrusion of moisture under the surface of the cellular glass insulation, thereby eliminating or greatly reducing the risk of CUI. The preferred foam composition utilized will not degrade over the CUI temperature range. In addition, the
foam and cellular glass insulation system has several other key attributes including the attenuation of sound. In particular, the foam can be placed either at the annular space of the metal and cellular glass insulation, between an inner and outer layer of the cellular glass insulation, or both at the annular space as well as between the layers of the cellular glass insulation. In addition, the densities of the products can be modified to produce the desired sound attenuation properties.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For the invention to be clearly understood and readily practiced, the invention will be described in conjunction with the following figures, wherein like reference characters designate the same or similar elements, which figures are incorporated into and constitute a part of the specification, wherein:

[0006] FIG. 1a is a perspective view of a single layer system.

[0007] FIG. 1b is an end view of a single layer system having a single cellular glass insulation layer with curved quarter segments.

[0008] FIG. 1c is an end view of a single layer system having a single cellular glass insulation layer with curved half segments.

[0009] FIG. 2a is a perspective view of a double layer system.

[0010] FIG. 2b is an end view of a double layer system having two cellular glass insulation layers with curved quarter segments.

[0011] FIG. 2c is an end view of a double layer system having two cellular glass insulation layers with curved half segments.
DETAILED DESCRIPTION

[0012] Referring to FIGS. 1a to lc, there is illustrated a single layer cellular glass insulation system generally designated by reference numeral 10 for a pipe 12 having a cellular glass insulation layer 14. A pipe and cellular glass insulation annular space or interface 16 is between an outer surface 18 of pipe 12 and an inner surface 20 of cellular glass insulation layer 14. A foam 22 fills the pipe and cellular glass insulation interface 16. Foam 22 limits water intrusion into pipe and cellular glass insulation interface 16 and attenuates sound. The preferred foam material does not degrade over the application temperature range. Example foam materials include silicone sponges, silicone foams, polyimide foams, nitrile foams, and melamine foams. A primary consideration when choosing the foam is the compressibility of the foam. The foam material should have a compression force of less than 2 psi at 25% compression utilizing ASTM D 1056 test procedure. Ideally, the foam material will have a 25% compression force rating per this test at less than 1 psi. This property is significant in that it defines the compressibility of the foam between the rigid metal of the pipe and cellular glass insulation layer. A foam material that is difficult to compress will not perform as desired. The foam 22 may be open or closed celled. If the foam is open-celled, it must compress to a level that significantly limits moisture migration under the cellular glass insulation layer or it must include another CUI mitigating property such as a hydrophobe, corrosion inhibitor, or water resistant coating/finish. The foam 22 may contain a water resistant layer 23 (FIG. 1b) such as aluminum foil, stainless steel foil, or other spray applied product. An example of the spray applied product is a urethane or silicone coating. In addition, the foam may contain a hydrophobe to limit moisture migration through the foam and/or a corrosion inhibitor. The corrosion inhibitor will be either impregnated into the foam or sprayed on the surface in contact with metal.
[0013] Foam 22 may also be placed to attenuate sound. The sound attenuation properties must be tested for the chosen foam material but testing has shown that a foam placed between the rigid cellular glass insulation layer and the metal of the pipe will lower and attenuate sound levels. Utilizing multiple layers of foams with the cellular glass insulation layer will give improved performance. In addition, the utilization of a higher density cellular glass insulation layer (8-15 pcf) with the foam will provide improved performance for low frequency sounds. The cellular glass insulation layer 14 and foam 22 may either be applied in the field or applied prior to installation at the project site.

[0014] First cellular glass insulation layer 14 may either be curved segments, such as quarter segments 24 as shown FIG. 1b or two half clam shells, such as half segments 26 as shown in FIG. lc. Joints 28 between edges of the segments 24, 26 may be sealed with a sealant 30 such as silicone.

[0015] Referring to FIGS. 2a to 2c, there is illustrated a double layer cellular glass insulation system generally designated by reference numeral 100 for a pipe 120 having a first cellular glass insulation layer 140 and a second cellular glass insulation layer 141. A pipe and cellular glass insulation interface 160 is between an outer surface 180 of pipe 120 and an inner surface 200 of first cellular glass insulation layer 140. A first foam 220 fills pipe and cellular glass insulation interface 160. A cellular glass insulation layer interface 161 is between an outer surface 181 of first cellular glass insulation layer 140 and an inner surface 201 of second cellular glass insulation layer 141. A second foam 221 fills cellular glass insulation layer interface 161. Like the embodiment of FIGS. 1b and 1c, cellular glass insulation layers 140 and 141 may either either have curved segments, such as quarter segments 240 as shown FIG. 2b or two half clam shells, such as half segments 260 as shown in FIG. 2c. Joints 280 are rotated such that the joints
280 on the cellular glass insulation layers 140 and 141 are not in the same radial position, but are offset to one another. Like the embodiment of FIGS. 1b and 1c, the embodiments of FIGS. 2a and 2b may include sealant 300 in joint 280 and a water resistant layer 230 on foam 220.

[0016] Although the present invention has been described in detail for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those in the art without departing from the spirit and scope of the invention.
Claims

What is claimed is:

1. A cellular glass corrosion under insulation system for an outer surface of a pipe comprising:

   a first insulation layer surrounding the outer surface of the pipe, wherein the first insulation layer has an outer surface and an inner surface, wherein the first insulation layer comprises cellular glass;

   a first annular space between the outer surface of the pipe and the inner surface of the first insulation layer; and

   a first foam filling the first annular space configured to limit water intrusion into the annular space and attenuate sound.

2. The cellular glass corrosion under insulation system of claim 1, further comprising:

   a second insulation layer surrounding the outer surface of the first insulation layer, wherein the second insulation layer has an outer surface and an inner surface, wherein the second insulation layer comprises cellular glass;

   a second annular space between the outer surface of the first insulation layer and the inner surface of the second insulation layer;

   a second foam filling the second annular space configured to limit water intrusion into the annular space and attenuate sound.
3. The cellular glass corrosion under insulation system of claim 1, wherein the first insulation layer comprises curved segments.

4. The cellular glass corrosion under insulation system of claim 3, wherein the curved segments are quarter segments.

5. The cellular glass corrosion under insulation system of claim 3, wherein the curved segments are half segments.

6. The cellular glass corrosion under insulation system of claim 3, further comprising joints between the curved segments, wherein the joints are closed with a sealant.

7. The cellular glass corrosion under insulation system of claim 2, wherein the first and second insulation layers comprise curved segments.

8. The cellular glass corrosion under insulation system of claim 6, wherein the curved segments are quarter segments.

9. The cellular glass corrosion under insulation system of claim 6, wherein the curved segments are half segments.

10. The cellular glass corrosion under insulation system of claim 6, further comprising joints between the curved segments, wherein the joints are closed with a sealant.

11. The cellular glass corrosion under insulation system of claim 1, wherein the foam is closed cell.

12. The cellular glass corrosion under insulation system of claim 1, wherein the foam is open cell.
13. The cellular glass corrosion under insulation system of claim 1, further comprising a water resistant layer on the foam.

14. The cellular glass corrosion under insulation system of claim 1, wherein the foam comprises a material selected from silicone sponges, silicone foams, polyimide foams, nitrile foams, and melamine foams.
INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 16/41290

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B32B 5/18; C03C 11/00; F16L 58/14; F16L 59/14 (2016.01)

CPC - B32B 5/18; C03C 11/007; F16L 58/14; F16L 59/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8): B32B 5/18; C03C 11/00; F16L 58/14; F16L 59/14 (2016.01)

CPC: B32B 5/18; C03C 11/007; F16L 58/14; F16L 59/14

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC: 428/316.6; 428/319.1

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Google Scholar, Google Patents, PatBase

Keywords used:

Cellular glass, foam glass, insulatation, foam, layer, pipe, corrosion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US 6,403,180 B1 (Barrall) 11 June 2002 (11.06.2002); entire document, but especially: col 1 line 8, col 2 lines 21-24, col 2 lines 34-35, col 2 lines 48-51</td>
<td>1-10; 13</td>
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<td>11-12; 14</td>
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<tr>
<td>Y</td>
<td>US 2003/0213525 A1 (Patel et al.) 20 November 2003 (20.11.2003); entire document, but especially: para [0007], para [0009], para [0025], para [0026], para [0029], fig. 1</td>
<td>11-12; 14</td>
</tr>
<tr>
<td>A</td>
<td>&quot;Foamglas Insulations Systems&quot; (Pittsburgh Corning USA) February 2009; entire document, but especially: page 2 col 3 para 1, page 6 col 6 para 1, page 6 col 6 para 2</td>
<td>1</td>
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<tr>
<td>A</td>
<td>US 4,623,585 A (Linton et al.) 18 November 1986 (18.11.1986); entire document</td>
<td>1-14</td>
</tr>
<tr>
<td>A</td>
<td>US 3,959,541 A (King et al.) 25 May 1976 (25.05.1976); entire document</td>
<td>1-14</td>
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</tbody>
</table>

Further documents are listed in the continuation of Box C.

"A" Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Z" document member of the same patent family

Date of the actual completion of the international search
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Date of mailing of the international search report
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