(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 July 2002 (11.07.2002)

PCT

(10) International Publication Number
WO 02/053960 A2

(51) International Patent Classification[7]: F16L

(21) International Application Number: PCT/GB02/00038

(22) International Filing Date: 4 January 2002 (04.01.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0100262.5 5 January 2001 (05.01.2001) GB
0116136.3 29 June 2001 (29.06.2001) GB

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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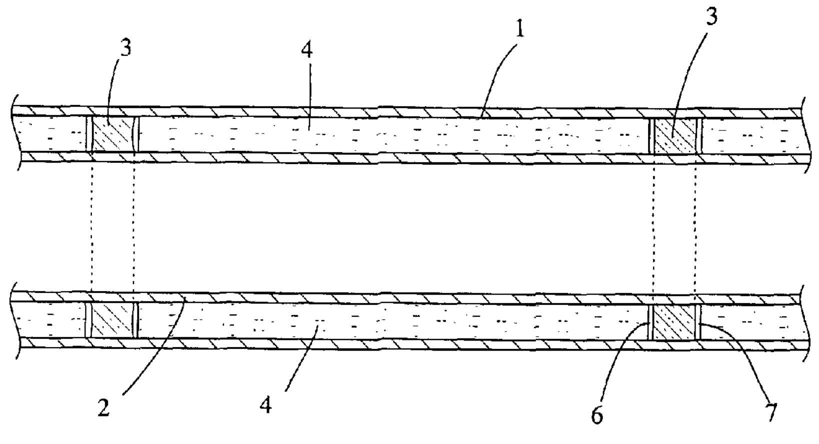
(54) Title: BULKHEADS FOR DOUBLE-WALLED PIPE STRUCTURES



(57) Abstract: An insulation material for a double-walled pipe structure comprises a composite of a resin and an insulating particulate material. The particulate material can be glass or a suitable polymer such as polyelthylene. It is preferably provided with a particle size of less than 1mm, more preferably less than 0.1mm. A suitable resin is epoxy or a phenolic resin, in particular a syntactic foams. It preferably fills between 25% and 100% of the interstices between the particulate material. A solid insulating material is also described formed of a composite of a resin and an insulating particulate material in a half-annular shape. This is especially useful in joining sections of double-walled pipe structures since it can be fitted in place without difficulty. It is preferred that the half-annular shell is bonded on at least one cylindrical face to a steel structure. This can be the steel half-shell which is to be welded in place at the join. An assembly of a double-walled pipe structure is also described in which there is at least one join, the join including at least one half-annular block of insulation material around the join between the inner pipes, the insulation material being as defined above. The half-annular shell can be bonded in position after welding, or the bonding completed after welding. Thus, the block of insulation material is preferably bonded to at least one and preferably both pipes of the double-walled pipe structure.

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

— *of inventorship (Rule 4.17(iv)) for US only*

Published:

— *without international search report and to be republished upon receipt of that report*

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BULKHEADS FOR DOUBLE-WALLED PIPE STRUCTURES

FIELD OF THE INVENTION

The present invention relates to bulkheads for double-walled pipe structures.

BACKGROUND ART

Double-walled pipe structures are well-known for use in the sub-sea transportation of fluids at elevated temperatures. An inner flow pipes carries the fluid and is surrounded by an outer sleeve pipe. The annular space between the two can be filled with thermally insulating material, thereby preventing the fluid from cooling excessively. This is important in, for example, the transport of crude oil which leaves the well at temperatures above 80°C and contains a range of hydrocarbon fractions. If it is allowed to cool then higher molecular weight fractions may solidify and block the pipeline.

SUMMARY OF THE INVENTION

The present invention is intended to address difficulties encountered in the such pipelines. One problem is the water-tightness of the volume containing the insulation material. If water is allowed to penetrate into this volume, then it will act as a convective heat transfer medium and destroy the insulative effect. Accordingly, it is usual to include a "waterstop" bulkhead at intervals. Previously these have consisted of annular rings of an elastomeric material that are compressed longitudinally by mechanical means to seal them against the inner and outer pipes. It is desired to improve further on this arrangement.

Another problem is that of thermal insulation at the joins between pipe sections. It is necessary to have access to the flow pipe in order to join adjacent sections, and therefore the sleeve pipe is usually formed short of the end of the flow pipe. This allows installation engineers to join a new section of pipeline by first welding the flow pipes and then either sliding the sleeve pipe into place or by welding a pair of short "half-shells" in place around the gap.

However the join is covered, it is necessary to provide insulation in the annulus around the join. Previously, this has been done by packing a fibrous material such as mineral wool. However, fibrous materials are not preferred since (as noted above) they lose all thermal insulation if they become wet. The material used between joins are generally difficult to handle in the field and not suitable for use at the join.

The present invention therefore provides an insulation material for a double-walled pipe structure comprising a composite of a resin and an insulating particulate material.

The particulate material can be glass or a suitable polymer such as polyelthylene, or a particulate insulation material such as alumino-silicate microspheres. It is preferably provided with a particle size of less than 1mm, more preferably less than 0.1mm.

A suitable resin is epoxy. It preferably fills between 25% and 100% of the interstices between the particulate material.

An alternative resin is a phenolic resin, in particular syntactic foams.

The present invention also provides a double-walled pipe structure with at least one annular bulkhead in the space between the inner and outer pipes, the bulkhead being of any of the insulation materials defined above. This can seal a further insulation material into the annular space behind the bulkhead. If desired, a layer can be provided between the bulkhead and the further insulation material. Suitable layers include polymeric films such as polyethylene and polypropylene, and glass reinforced polymers.

A bulkhead of this type can be formed by casting the insulation material to a suitable shape, placing the cast item into the space between the pipes, and sealing around the extremities of the cast item to the pipes. An adhesive composition will provide suitable sealing. Alternatively, it can be poured into the annular space over the further insulation material and allowed to cure in place. This removes the need for sealing. It may be useful to include a layer between the curing bulkhead and the further insulation material in order to hinder mixing.

The present invention also provides a solid insulating material formed of a composite of a resin and an insulating particulate material in a half-annular shape. This is especially useful in joining sections of double-walled pipe structures since it can be fitted in place without difficulty. The composite is sufficiently robust to withstand normal handling and can therefore be treated as a solid item.

The half-annulus can be formed with cylindrical recesses. These will then accommodate a weld bead.

It is preferred that the half-annular shell is bonded on at least one cylindrical face to a steel structure. This can be the steel half-shell which is to be welded in place at the join. The bonding can be by way of an adhesive.

The present invention also provides an assembly of a double-walled pipe structure in which there is at least one join, the join including at least one half-annular block of insulation material around the join between the inner pipes, the insulation material being as defined above.

The half-annular shell can be bonded in position after welding, or the bonding completed after welding. Thus, the block of insulation material is preferably bonded to at least one and preferably both pipes of the double-walled pipe structure. Again, the bonding can be by way of an adhesive.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described by way of example, with reference to the accompanying figures, in which;

Figure 1 is a longitudinal section through a double-walled pipe structure incorporating a bulkhead according to the present invention;

Figure 2 is a longitudinal section through a double-walled pipe structure incorporating an alternative bulkhead according to the present invention;

Figure 3 is a perspective view of the joint region of a double-walled pipe structure; and

Figure 4 is a transverse section through the joint region.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In Figure 1, a pipeline is shown that comprises an outer sleeve 1 and an inner flow pipe 2, with bulkheads 3 dividing the inter-pipe space into sections containing an insulation material 4.

Suitable materials the bulkheads are set out above. Once cured, both epoxy resins and syntactic foams are suitable for operation at temperatures in excess of 150°C and offer good thermal insulation. The thermal properties are improved still further by including a second phase within the composition such as glasses, polymeric materials and alumino-silicate microspheres, a known particulate insulation material. The second phase can also act as a filler/extender and improve mechanical properties such as toughness. A suitable syntactic foam is a phenolic composition manufactured by Alderley Materials under the brand name of 'Contratherm'. The foam is mouldable and cures at ambient temperatures or just above to form a rigid structure. A preferred epoxy resin is Permabond™ DE244. When used with a microsphere filler, the resin occupies the interstitial voids between the spherical microspheres which hence exhibit a packing density of around 65%.

The bulkheads 3 are typically formed by casting to shape outside the pipe structure and placing them within the annulus. They can then be sealed by adhesive layers 5 which secure them to the inner and outer pipes 1, 2.

Figure 2 shows an alternative form. The bulkheads 3 are cast in place within the annulus. Prior to casting, the insulation material 4 is inserted. This is then covered with a protective layer 6 and the still flowable material of the bulkhead 3 is poured in and allowed to set in place. A further protective layer 7 can optionally be inserted and the next section of insulation material 4 inserted.

The protective layers 6, 7 prevent the flowable material of the bulkhead from impregnating the insulation material 4. Whilst this is not problematic of itself, it may prevent sufficient material from remaining in place. This could be overcome by adding further material, or by adding when the viscosity has risen due to partial curing, or by use of protective layers as shown. The protective layers should be impermeable, but can be flexible such as a polymeric film of (for example) polyethylene or polypropylene or rigid such as glass reinforced polymer (GRP), or of an intermediate stiffness. It can extend to the edges of the annulus but this will probably not be necessary in most instances.

Referring to Figure 3, the outer sleeve pipe 10 surrounds an inner sleeve pipe 12 which carries the fluid to be transported. In the annular space 14 there is an insulation material, except at the region of the join 16 where access needs to be provided to the inner flow pipe 12 in order to allow adjacent sections to be joined.

The weld 16 consists of a direct butt weld between the inner flow pipes 12. The outer sleeve pipes 10 are each formed short of the inner flow pipes 12 so that access is possible to form the butt weld, and therefore they adjoined via 2 half-shells 18-20 which are formed by longitudinally dividing a short cylindrical section into two halves. Other methods adjoining the outer sleeve pipes 10 are known, but these also require access to be provided to the inner sleeve pipes and therefore the same difficulty will arise.

Figure 4 shows how insulation can be provided around the join 16. The two half shells 18-20 can be seen, together with the weld beads 22, 24 adjoining them. The pair of half-annular insulation blocks 26, 28 between them substantially fill the annular volume between the inner flow pipe 12 and the outer half shells 18-20. Each half-annular insulation block is bonded to the outer half open shell 18 or 20 via an adhesive layer 30 and to the inner flow pipe via an adhesive layer 32.

The insulation blocks are a composite of a resin and a particulate insulation material such as microspheres. The microspheres can be glass or polythene with a particulate size which is preferably below 0.1mm but can be up to 1mm in particular applications.

The resin can be either an epoxy or a phenolic resin. Epoxy resins such as DE244 have been found to be particular suitable, and preferably filled between 30 and 100% of the intestacies between the particulate material. Of phenolic resins, syntactic foam resins such as Contratherm™ exhibit suitable properties.

The particulate block is typically formed to shape and can then either be positioned prior to welding or bonded to the outer half shell with a suitable adhesive. It can be provided with cylindrical recesses to accommodate the weld bead if desired. Once in place in the annular space, additional adhesive can be introduced to bond it on the remaining or both sides, such as to the inner flow pipe if it has already been bonded to the outer sleeves.

Through the present invention, a stable and rigid insulation block is provided which can be fitted in place easily in a field if necessary. Nevertheless, the insulation offered by the composite material is sufficient to allow the double walled pipe structure to operate satisfactorily. It is also superior to known insulation materials which are capable of being applied in the fields since it is more resistant to water ingress

CLAIMS

1. An insulation material for a double-walled pipe structure comprising a composite of a resin and an insulating particulate material.

2. An insulation material according to claim 1 in which the particulate material is glass.

3. An insulation material according to claim 1 in which the particulate material is a polymeric material.

4. An insulation material according to claim 1 in which the particulate material is polyelthylene.

5. An insulation material according to claim 1 in which the particulate material is alumino-silicate microspheres.

6. An insulation material according to any one of the preceding claims in which the particulate material has a particle size of less than 1mm.

7. An insulation material according to any one of the preceding claims in which the particulate material has a particle size of less than 0.1mm.

8. An insulation material according to any one of the preceding claims in which the resin is epoxy.

9. An insulation material according to any one of claims 1 to 7 in which the resin is phenolic.

10. An insulation material according to claim 9 in which the resin is a syntactic foam.

11. An insulation material according to any one of the preceding claims in which the resin fills between 25% and 100% of the interstices between the particulate material.

12. A double-walled pipe structure with at least one annular bulkhead in the space between the inner and outer pipes, the bulkhead being an insulation materials according to any one of the preceding claims.

13. A double-walled pipe structure according to claim 12 in which there is a further insulation material in the annular space between the pipes of the double-walled structure, behind the bulkhead.

14. A double-walled pipe structure according to claim 13 in which a layer is provided between the bulkhead and the further insulation material.

15. A double-walled pipe structure according to claim 14 in which the layer is one of a polymeric films, a polyethylene sheet, a polypropylene sheet, and a glass reinforced polymers sheet.

16. A method of manufacturing an insulated double-walled pipe structure comprising the steps of forming the double-walled pipe structure, casting an insulation material according to any one of claims 1 to 11 to a suitable shape, placing the cast item into the space between the pipes, and sealing around the extremities of the cast item to the pipes.

17. A method of manufacturing an insulated double-walled pipe structure comprising the steps of forming the double-walled pipe structure, inserting

a bulk material into the space between the pipes thereof, pouring an curable insulation material into the annular space over the bulk insulation material and allowing it to cure in place, the curable insulation material being according to any one of claims 1 to 11.

18. A method according to claim 17 in which a layer is provided between the curable material and the bulk insulation material.

19. A double-walled pipe structure according to claim 18 in which the layer is one of a polymeric films, a polyethylene sheet, a polypropylene sheet, and a glass reinforced polymers sheet.

20. A solid insulating material formed of a composite of a resin and an insulating particulate material in a half-annular shape.

21. A solid insulating material for joining sections of double-walled pipe structures, formed of a composite of a resin and an insulating particulate material in a half-annular shape.

22. A solid insulating material according to claim 20 or claim 21 in which the half-annulus is formed with cylindrical recesses.

23. A solid insulating material according to any one of claims 20 to 22 in which the half-annular shell is bonded on at least one cylindrical face to a steel structure.

24. A solid insulating material according to claim 23 in which the steel structure is a steel half-shell.

25. A solid insulating material according to claim 23 or claim 24 in which the bonding is by way of an adhesive.

26. An assembly of a double-walled pipe structures in which there is at least one join, the join including at least one half-annular block of insulation material around the join between the inner pipes, the insulation material being according to any one of the preceding claims.

27. An assembly of a double-walled pipe structures according to claim 26 in which the block of insulation material is bonded to at least one pipe of the double-walled pipe structure.

28. An assembly of a double-walled pipe structures according to claim 27 in which the bonding is by way of an adhesive.

29. An insulation material for a double-walled pipe structure substantially as any one described herein with reference to and/or as illustrated in the accompanying figures.

30. An double-walled pipe structure substantially as any one described herein with reference to and/or as illustrated in the accompanying figures.

Fig 1

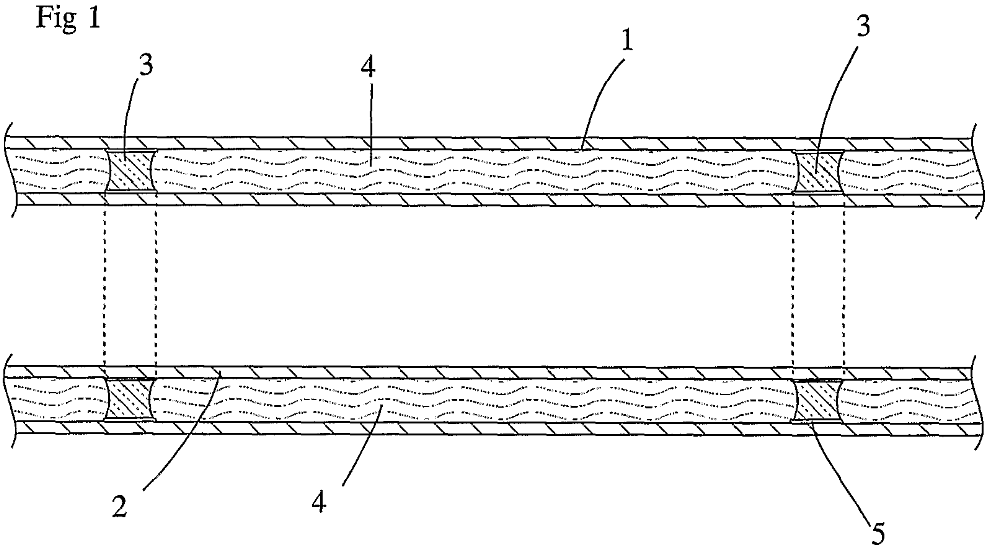
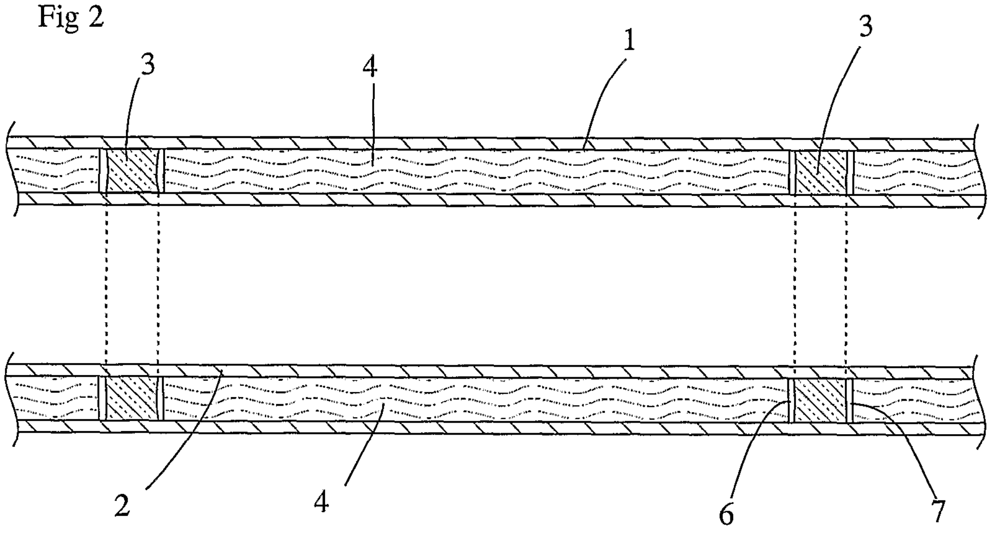


Fig 2



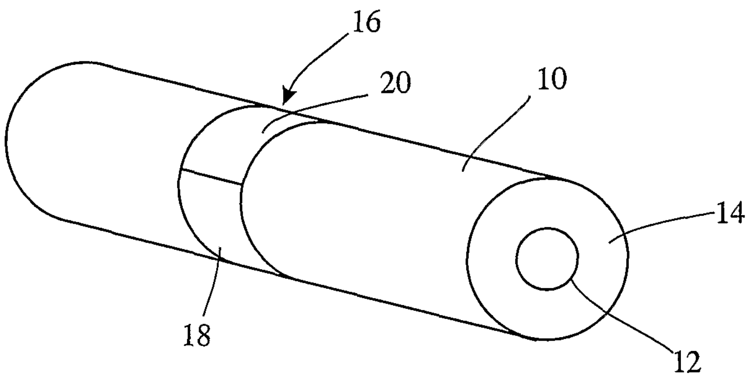


Fig 3

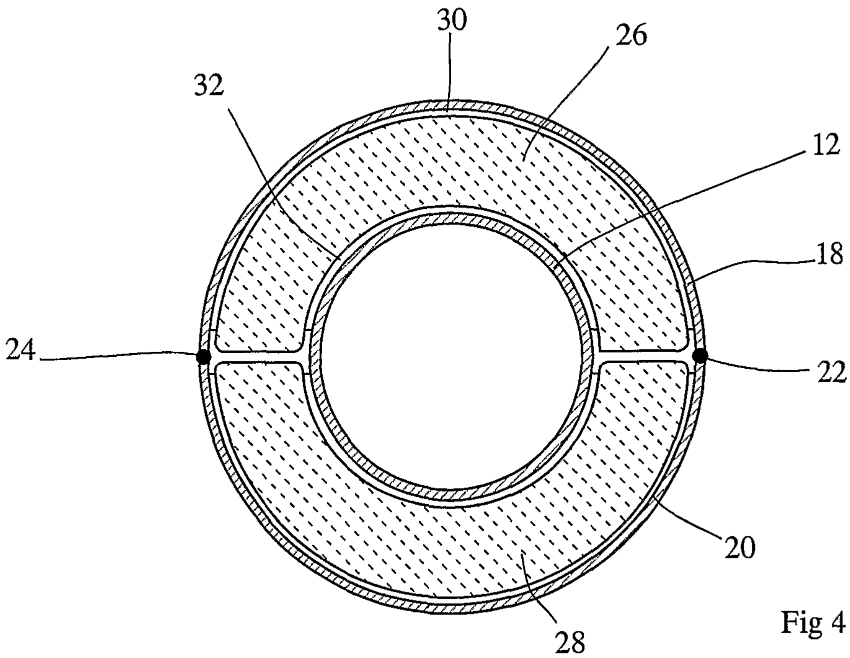


Fig 4