Method for fastening a turbulator insert within a conduit

The present invention proposes a method for fastening a turbulator insert (10) within a conduit (20), in particular in a blast furnace cooling system. The method comprises the steps of providing a conduit (20); providing a turbulator insert (10) suitable for insertion into the conduit (20); and inserting the turbulator insert (10) into a region of the conduit to form a work assembly comprising the conduit (20) and the turbulator insert (10). According to an important aspect of the invention, the method comprises the further step of fastening the turbulator insert (10) within the conduit (20) by bending the work assembly at the region containing the turbulator insert (10).
Description

Introduction

[0001] The present invention relates to a method for fastening a turbulator insert within a conduit. The turbulator can be used in particular for swirling a cooling medium in a blast furnace cooling system and especially in cooling staves of such a cooling system.

[0002] Heat exchange applications employ at least one flowing medium, liquid or gaseous or a mixture of both flowing through a conduit. Efficiency of thermal transfer depends partly on relative velocity of the medium. One way of improving efficiency is to increase axial velocity of the medium. In order to increase axial velocity, the discharge rate of the medium must be increased, which is generally not desired. Another way of improving efficiency is to add a transversal velocity component to the medium. Due to such a transversal velocity component the flow velocity of the medium is increased near the walls of the conduit, whereby the heat transfer is improved. By optimizing the transversal velocity, considering the required heat transfer, the total discharge rate of the medium can be reduced considerably. Turbulator inserts are commonly used as passive elements in such heat exchange applications to add or increase a transversal velocity component of a medium, or in other words to curl or swirl the medium so as to benefit from aforementioned increase in efficiency.

[0003] Different embodiments of such turbulator inserts are known. EP-B-0 181 711 discloses a turbulator insert for waste gases made from a single flat sheet, loosely inserted into a flue and maintained by the biasing effect of an end section. FR-A-2 320 520 discloses a turbulator insert made from a single flat sheet, maintained by an end section which is out of the straight and engages a cavity. US-B-6 530 422 discloses a heat exchanger tube, for petrochemical applications, with a turbulator directly cast with the tube, or at least part of it.

[0004] In applications where density of the flowing medium combined with high axial flow velocity impart considerable tractive forces onto the turbulator insert, secure fastening is required.

[0005] A common solution to securely fastening a turbulator insert within a conduit, such as a tube or a pipe, is to provide at least one opening in, or a cut through, the conduit at a convenient location. The turbulator insert can then be securely fastened inside the conduit by soldering or welding before restoring the conduit. Another solution is to produce at least one recess onto the conduit wall such as to deform the inner wall of the conduit. The turbulator insert can then engage this deformation by means of a retainer ring or similar support structure having little radial clearance from the inner conduit wall.

[0006] While such known embodiments present the advantage of increasing efficiency of thermal transfer and are suitable for insertion into heat exchanger conduits they also present a disadvantage related to their fixation method inside heat exchanger conduits. Known fastening or fixation methods for turbulators are either relatively straightforward but do not provide sufficient firmness or they provide sufficient firmness but require relatively elaborate measures.

Object of the invention

[0007] The object of the present invention is to provide a simplified method for securely fastening a turbulator insert within a conduit. This object is achieved by a method as claimed in claim 1.

General description of the invention

[0008] In order to overcome the abovementioned problems, the present invention proposes a method for fastening a turbulator insert within a conduit, in particular in a blast furnace cooling system. The method comprises the steps of providing a conduit; providing a turbulator insert suitable for insertion into the conduit; and inserting the turbulator insert into a region of the conduit to form a work assembly comprising the conduit and the turbulator insert. According to an important aspect of the invention, the method comprises the further step of fastening the turbulator insert within the conduit by bending the work assembly at the region containing the turbulator insert.

[0009] The turbulator insert is simply inserted in the conduit and fastened therein by bending. Once the conduit is bent, the turbulator insert is trapped therein. The bending of the conduit is an easy and effective method for fixing the turbulator insert in the conduit, in particular if compared to other methods, such as e.g. welding. More importantly, through the bending of both the turbulator insert and the conduit, the turbulator insert is securely fixed in the conduit. The turbulator insert is prevented from moving in the conduit, even if quite considerable forces are exerted on the turbulator insert by the cooling medium. A particularity easy, fast and secure method for fixing a turbulator insert in a conduit is thereby provided by the above method.

[0010] Preferably an essentially straight portion of the turbulator insert is inserted into an essentially straight portion of the conduit, so as to allow for an easy insertion of the turbulator insert into the conduit.

[0011] The region of the conduit is advantageously predetermined to be bent. By inserting the turbulator insert in a region of the conduit that is e.g. to be transformed into a pipe elbow or knee bend, the turbulator insert can be fixed at the same time. A separate step for fixing the turbulator insert in the conduit is no longer necessary. By thereby saving a manufacturing step, manufacturing time and costs can be reduced.

[0012] Preferably, the turbulator insert comprises a turbulating part and an extension part. By providing the turbulator insert with a turbulating part and an extension
part, only the extension part of the turbulator needs to be suitable for bending in the conduit. The turbulating part, on the other hand, can be located in an unbent part of the conduit, thereby not compromising the turbulating effect of the turbulator insert on the cooling medium. Furthermore, depending on where, with respect to the bend, the turbulating effect is to be achieved, the turbulating part can be either upstream or downstream of the extension part in a flow direction of the cooling medium.

According to an embodiment of the invention, the step of providing a turbulator insert comprises the steps of:

- providing a flat sheet having an upper surface and an opposite lower surface, a downstream edge and an opposite upstream edge, a first side edge and an opposite second side edge;
- making at least one incision in the sheet;
- transforming part of the sheet at the incision so as to form a vane on the upper surface of the sheet; and
- transforming the sheet into an essentially cylindrical body by bringing the first side edge in proximity to the second side edge, wherein the vane is formed in the turbulating part of the turbulator insert.

This method provides a simple, fast and cheap way of producing turbulator inserts, wherein the vanes can be arranged so as to impart a swirling motion to the medium, without having an excessive flow restriction or resistance.

According to another embodiment of the invention, the turbulator insert is provided by connecting an extension part to a turbulating part. The turbulating part of the turbulator insert can e.g. be a turbulator readily available on the market. By complementing such a turbulator with an extension part, such a turbulator can also be fixed in the conduit according to the present invention.

The extension part is preferably essentially cylindrical. An essentially cylindrical extension part is particularly well suited for providing a good fixing means when being bent within a conduit. Such an essentially cylindrical extension part also minimises flow restriction.

The method can comprise bending the work assembly at a region containing only the extension part of the turbulator insert. As long as the extension part of the turbulator insert is suitable for bending, it does not matter whether the turbulating part is.

The conduit and the turbulator insert can each be made of metal or plastic material. It will be understood that the material should be chosen depending on the intended use. The material can e.g. be steel, preferably stainless steel, or copper. Any other suitable material which has the properties of being resistant to thermal fatigue, corrosion resistant, machineable, thermally conductive and of sufficient strength can also be used.

After bending of the conduit at the region containing the turbulator insert, the conduit can be installed in a cooling stave for a blast furnace cooling system.

Detailed description with respect to the figures

The present invention will be more apparent from the following description of not limiting embodiments with reference to the attached drawings, wherein

Fig.1: is a longitudinal sectional view of a turbulator insert according to a first embodiment suitable for fastening within a conduit according to the present invention;

Fig.2: is a longitudinal sectional view of the turbulator insert of Fig.1 coaxially inserted into a conduit;

Fig.3: is a longitudinal sectional view of the turbulator insert of Fig.1 fastened within the conduit by means of a bend according to the present invention;

Fig.4A: is a perspective view of a first step for manufacturing the turbulator insert of Fig.1;

Fig.4B: is a perspective view of a second step for manufacturing the turbulator insert of Fig.1;

Fig.4C: is a perspective view of a third step for manufacturing the turbulator insert of Fig.1;

Fig.5: is a longitudinal sectional view of a cooling stave for blast furnace cooling system comprising the fastened turbulator insert of Fig.1;

Fig.6: is a longitudinal sectional view of an alternative turbulator insert suitable for fastening within a conduit according to the present invention;

Fig.7: is a longitudinal sectional view of the turbulator insert of Fig.6 coaxially inserted into a conduit;

Fig.8: is a longitudinal sectional view of the turbulator insert of Fig.6 fastened within the conduit by means of a bend according to the present invention;

Description of preferred embodiments

Fig.1 shows a turbulator insert 10 of essentially cylindrical shape suitable for insertion into a conduit according to a first embodiment of the invention. The tur-
The sheet 30 is made from steel, preferably stainless steel, or copper. Any other suitable material, such as e. g. plastic material, which has the properties of being resistant to thermal fatigue, corrosion resistant, machineable, thermally conductive and of sufficient strength can be used.

[0026] In FIG.4B, the flat sheet 30 is provided with incisions 44, 44', 44'', e.g. by means of cutting or punching. These incisions 44, 44', 44'' are essentially straight, perpendicular to and starting at the downstream edge 36 of the sheet 30.

[0027] The incisions 44, 44', 44'' are such as to describe open contours on the sheet 30, which are complemented by base lines 46, 46', 46'', 46''' so as to form vane areas 48, 48', 48'', 48'''. The thickness of the sheet 30 is chosen such that the vanes 50, 50', 50'', 50''' resist operational stress of the turbulator insert without being deformed.

[0028] In FIG.4C, the flat sheet 30 is shown with all of the vane areas 48, 48', 48'', 48''' transformed into vanes 50, 50', 50'', 50'''. The sheet 30 is then transformed, e. g. by bending or coiling, as shown by arrow 52, into a generally cylindrical body, wherein the first side edge 40 and the second side edge 42 meet. In order to maintain the shape of the turbulator insert, first side edge 40 can be welded to the second side edge 42.

[0029] FIG.5 shows a cooling stave 60 of a blast furnace cooling system containing a cooling plate 62 and a conduit 20" with a turbulator insert 10 therein. The cooling stave 60 has been manufactured while taking advantage of the method for fastening the turbulator insert 10 according to the present invention.

[0030] It will be understood that the fastening method is, although preferred, not limited to a turbulator insert 10 manufactured according to the method described above.

[0031] FIG.6 shows an alternative turbulator insert 10' suitable for fastening according to the method of the present invention. The turbulator insert 10' comprises a downstream turbulating part 12' comprising turbulating means and an upstream extension part 14' of tubular shape. The turbulating means comprises a helical shape attached to a support structure, which in turn is firmly attached to the upstream extension part 14'.

[0032] FIG.7 shows the alternative turbulator insert 10' inserted into a straight region of conduit 20. The turbulator insert 10' and the region of conduit containing the turbulator insert 10' form a work assembly, which is subsequently transformed.

[0033] FIG.8 shows the alternative turbulator insert 10' fastened within the conduit 20' by transformation of the work assembly into a permanent bend according to the present invention.

[0034] It will be appreciated that the above method al-
lows fastening of turbulator elements unsuitable for bending if connected to an extension part, which is suitable for bending.

Claims

1. A method for fastening a turbulator insert within a conduit, in particular in a blast furnace cooling system, said method comprising the steps of:
   - providing a conduit;
   - providing a turbulator insert suitable for insertion into said conduit;
   - inserting said turbulator insert into a region of said conduit to form a work assembly comprising said conduit and said turbulator insert;
   characterized in that the method comprises the further step of:
   - fastening said turbulator insert within said conduit by bending said work assembly at said region containing said turbulator insert.

2. The method according to claim 1, wherein a straight portion of said turbulator insert is inserted into a straight portion of said conduit.

3. The method according to claim 1 or 2, wherein said region of said conduit is predetermined to be bent.

4. The method according to any of the preceding claims, wherein said turbulator insert comprises a turbulating part and an extension part.

5. The method according to claim 4, wherein said step of providing a turbulator insert comprises the steps of:
   - providing a flat sheet having an upper surface and an opposite lower surface, a downstream edge and an opposite upstream edge, a first side edge and an opposite second side edge;
   - making at least one incision in said sheet;
   - transforming part of said sheet at said incision so as to form a vane on said upper surface of said sheet; and
   - transforming said sheet into an essentially cylindrical body by bringing said first side edge in proximity to said second side edge, wherein said vane is formed in said turbulating part of said turbulator insert.

6. The method according to claim 4, wherein said turbulator insert is provided by connecting an extension part to a turbulating part.

7. The method according to any of claims 4 to 6, wherein said extension part is essentially cylindrical.

8. The method according to any of claims 4 to 7, wherein said method comprises bending said work assembly at a region containing only said extension part of said turbulator insert.

9. The method according to any of the preceding claims, wherein said conduit and said turbulator insert are each made of metal or plastic material.

10. The method according to any of the preceding claims, wherein said conduit is installed in a cooling stave of a blast furnace cooling system.
## DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
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The present search report has been drawn up for all claims

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**CATEGORY OF CITED DOCUMENTS**

- **T**: theory or principle underlying the invention
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**TECHNICAL FIELDS SEARCHED (Int.Cl.)**

- C21B
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- F27D
- F28F
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For more details about this annex: see Official Journal of the European Patent Office, No. 12/82

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