

Specification of Invention

Title of Invention

Corrosion inspection device

Field of the Invention

5 The present invention relates to engineering of corrosion inspection devices.

Background of the Invention

Many industries, in particular the petrochemical industry, use a large number of metal parts, for example, in pipework, most of which are made of metal. After a certain period of use, these metal parts usually corrode as a result, for examples, of water and humidity. In the case of general
10 iron pipes, corrosion can be visually observed, and maintenance can be planned accordingly. However, because some parts of the pipework are insulated, corrosion of pipes within the insulation is not visible.

The inventor has conducted a search for prior arts related to corrosion inspection devices and found prior arts, such as the followings:

15 The US Patent No. 4,271,120 discloses a device to detect and indicate corrosive fluids in insulation for pipes of heavy water plants. The device is composed of a housing, the inside of which is equipped with a primary indicator, a secondary indicator, a corrodible link, and a compression spring. One end of the corrodible link is anchored to the secondary indicator, and the other end of the corrodible link is anchored to the wall at the end of the housing in order to pull the spring in a
20 compressed condition. When there is corrosive fluid in the pipe insulation, the corrodible link will be corroded and break, which results in the spring losing its tension and pushing the secondary indicator. After that, the secondary indicator will push the primary indicator, which is characterized by a reel of thread wrapped in cloth, out of the housing. Nevertheless, the aforementioned detecting device has certain disadvantages. That is, the corrodible link is not placed near and/or in the same
25 condition as the metal pipe, because the said device cannot be installed in such a way that the corrodible link is near the metal pipe. In addition, the corrosive fluid may remain inside the said device, which leads the corrodible link and spring to be immersed in the corrosive fluid. The fact

that the spring is in the same condition as the corrodible link may allow the spring to break and be corroded, which can lead to errors of the device's functioning.

5 The US Patent No. 8,810, 264 B2 discloses a device for sensing corrosion under insulation, which comprises a base, at least one corrosion-test circuit mounted to the base and comprising a first conductor; a second conductor and a testing element extending between the first conductor and the second conductor, and a reference circuit mounted to the base. The said patent also discloses a method for sensing corrosion under insulation, which comprises positioning the device for sensing corrosion under insulation radially adjacent an outer surface of the pipe, exposing the testing element to the same environment as the outer surface of the pipe, and determining whether the testing element has been corroded by measuring and comparing the resistance across the testing element with a reference element. 10 If the measured value is high, this indicates that the test element suffers from corrosion, which in turn also indicates that the pipe experiences corrosion. Nonetheless, this device and its method have some disadvantages, for examples, complexity of the device, difficulty in operating, and a high cost.

15 The prior arts described above are intended to provide devices for detecting corrosion with different characteristics. However, there is no prior art disclosure of a solution to the aforementioned problems.

Summary of the Invention

20 According to an aspect of the present invention, there is provided a corrosion inspection device, which comprises a housing, a display arranged at one end of the housing, and a spring arranged in compression within the housing and having one end pressed on the display, and a sensor arranged within the housing. The corrosion inspection device is provided with a compartment that allows a part of the sensor to be near and/or in the same condition as metal parts and allows the spring not to be near and/or in the same condition as the metal parts, in such a way that, when the sensor is corroded and breaks in relation to the degree of corrosion of the metal parts, the display continues to function and indicates the 25 metal parts having experienced corrosion.

Embodiments of the present invention to provide a corrosion inspection device with specific features and several advantages, such as:

- Providing results of corrosion inspection of the metal parts, which are visually observable;

- Allowing the installation of the device at the site, so that the results of corrosion inspection of metal parts can be observed by staff at all time;

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- Simple function;

- Providing a precise and accurate inspection, as the sensor is placed near and/or in the same condition as the metal parts, is not immersed in corrosive substances and is not directly in contact with the metal parts;

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- Possessing durability, without errors or malfunctions caused by spring deterioration as a result of corrosion by corrosive substances;

- Compact and appropriate in size;

- Allowing easy, convenient and quick installation of the device;

- Providing a cost-saving for corrosion inspection of metal parts; and

- Affordable price.

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Brief Description of Drawings

Fig. 1 is a representation of the corrosion inspection device according to the present invention.

Fig. 2 is a longitudinal section of the corrosion inspection device according to the present invention, in the condition of which the metal parts are not corroded, the display of non-corrosion of the metal parts extending from the housing, and the display of corrosion of the metal parts remaining inside the housing;

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Fig. 3 is a longitudinal section of the corrosion inspection device according to the present invention, in the condition of which the metal parts are corroded and the display of corrosion of the metal parts extending from the housing; and

25 Fig. 4 is a representation of an inspection of corrosion of an insulated metal pipe by inserting part of the sensor of the corrosion inspection device according to the present invention into the pipe insulation.

Detailed Description of the Invention

The characteristics and additional advantages of the present invention will become more obvious from the following details in reference to the accompanying drawings.

Figures 1 – 3 show the corrosion inspection device according to the present invention.

5 Figure 4 shows inspection of the corrosion of metal parts of an insulated metal pipe, by inserting part of the sensor into the pipe insulation.

As shown in Figures 1 – 4, this corrosion inspection device according to the present invention comprises a housing (1), a display (2), arranged at one end of the housing (1), a spring (3) arranged in compression within the housing (1) and having one end of the spring (3) pressed on the display (2), and a sensor (4) arranged within the housing (1). According to the present invention, the corrosion inspection device is provided with a compartment (5) that allows a part of the sensor (4) to be near and/or in the same condition as metal parts and allows the spring (3) not to be near and/or in the same condition as the metal parts, in such a way that, when the sensor (4) is corroded and breaks related to the degree of corrosion of the metal parts, the display (2) continues function and indicates the metal parts having experienced corrosion.

According to the present invention, the housing (1) is characterized by a long hollow rod with a notch (1.1) arranged at one end of the housing (1). The notch (1.1) is provided for allowing a part of the sensor (4) to be near and/or in the same condition as the metal parts. The notch (1.1) can be of various shapes, for example, two-dimensional shapes, e.g. a circle, oval, square, triangle, and other geometric shapes, or three-dimensional shapes, e.g. a half-sphere, wedge or triangular cross-section with a cut or rounded apex (from the side view of the device, as seen in Figures 2 and 3). The material used to make the housing (1) should be heat-resistant and non-corrodible and have a low friction coefficient, such as plastic, suitable types of which are polyvinyl chloride and polytetrafluoroethylene (PTFE). Polytetrafluoroethylene (PTFE) is the most preferred.

25 According to the present invention, the display (2) comprises a display indicating non-corrosion of the metal parts (2.1) and a display indicating corrosion of the metal parts (2.2), both of which have different characteristics, in term of color, pattern or shape, and so on. For example, the color of the display indicating non-corrosion of the metal parts (2.1) is green, and the color of the

display indicating corrosion of the metal parts (2.2) is red. The display indicating non-corrosion of the metal parts (2.1) and the display indicating corrosion of the metal parts (2.2) can be the same piece or different pieces. Preferably, they are the same piece. The material used to make the display (2) should be heat-resistant and non-corrodible and have a low friction coefficient, such as plastic, suitable types of which are polyvinyl chloride and polytetrafluoroethylene (PTFE). Polytetrafluoroethylene (PTFE) is the most preferred.

According to the present invention, in the condition of which the metal parts have no corrosion, or the degree of corrosion is within an acceptable range, the sensor (4) will not be corroded or it will be corroded but will not break, resulting in the display indicating non-corrosion of the metal parts (2.1), which has a particular characteristic, for example, green in color, extending from the housing (1), to indicate that the metal parts have no corrosion. The display indicating corrosion of the metal parts (2.2), which has a different characteristic, for example, red in color, will remain inside the housing (1) (see Figures 1 and 2).

According to the present invention, in the condition of which the metal parts experience corrosion beyond an acceptable range, the sensor (4) will be corroded and break, resulting in the display indicating corrosion of the metal parts (2.2) extending from the housing (1) by the pushing of the spring (3), to indicate that the metal parts have experienced corrosion beyond an acceptable range (see Figure 3).

According to the present invention, the compartment (5) is a solid rod or close-ended hollow rod tightly arranged within the housing (1), with or without a seal. This will prevent leakage or seepage of vapor and/or liquids into the spring (3). The compartment (5) comprises a notch (5.1) and an insertion slot (5.2), in such a way that the notch (5.1) of the compartment (5) is located so that it exactly aligns with the position of the notch (1.1) of the housing (1), and the sensor (4) is exposed, and/or a part of the sensor (4) is near and/or in the same condition as the metal parts. The insertion slot (5.2) is provided for inserting the sensor (4) to pass through it. The compartment (5) is mounted to the housing (1), preferably with a screw (6). The material used to make the compartment (5) should be heat-resistant and non-corrodible and have a low friction coefficient, such as plastic, suitable types of which are polyvinyl chloride and polytetrafluoroethylene (PTFE). Polytetrafluoroethylene (PTFE) is the most preferred.

The aforementioned embodiment has an advantage. That is, the compartment (5) will prevent the spring (3) from being in the same condition as the metal parts in order to prevent the spring (3) from corroding and breaking so that the corrosion inspection device experiences a malfunction. Therefore, the corrosion inspection device is durable, without errors or malfunctions
5 due to spring deterioration as a result of corrosion by corrosive substances.

According to the present invention, the notch (5.1) can be of various shapes, for example, two-dimensional shapes, e.g. a circle, oval, square, triangle, and other geometric shapes, or three-dimensional shapes, e.g. a half-sphere, wedge or triangular section with a cut or rounded apex (from the side view of the device, as seen in Figures 2 and 3).

10 According to the present invention, the most appropriate shape of the notch (1.1) of the housing (1) and the notch (5.1) of the compartment (5) is a triangular cross-section with a cut or rounded apex (from the side view of the device, as seen in Figures 2 and 3). The notch (1.1) and the notch (5.1) have corresponding shapes. This embodiment has an advantage. That is, the sensor (4) is protected from immersion in corrosive substances. The corrosive substances will drain laterally and
15 towards the end of the notch (1.1) and the notch (5.1), so immersion at the sensor (4) will not occur. In addition, this will allow the sensor (4) to be in the same condition as the metal parts, thus providing an improved accuracy and reliability of inspection by the corrosion inspection device of the present invention. In addition, it also prevents leakage or seepage of the corrosive substances into the interior of the corrosion inspection device.

20 However, the corrosion inspection device may be modified to allow the compartment (5) to be the same piece as the housing (1) instead of using the compartment (5) to block the spring (3) from being in the same condition as the metal parts.

According to the present invention, the sensor (4) is a long rod or a string or may have diverse patterns and characteristics, such as a flat plate, bent plate, straight rod, straight string, bent
25 string or coil. The sensor (4) in the housing (1) can be arranged in different ways. For example, as for the first pattern, one end of the sensor (4) is hooked to the compartment (5), and the other end of the sensor (4) is hooked to the display (2) in a way so that the end of the sensor (4) bends to be mounted with the end of the compartment (5) and the end of the display indicating non-corrosion of

the metal parts (2.1) of the display 2. As for the second pattern, one end of the sensor (4) is mounted to the compartment (5) in a way so that one end of the sensor (4) bends to be tied to the compartment (5) or connects the sensor (4) to the compartment (5) with adhesive, and the other end of the sensor (4) is mounted to the display indicating corrosion of the metal parts (2.2) of the display (2) by, for examples, connecting it with adhesive or tying it to a groove, hole or a hook provided at the display indicating corrosion of the metal parts (2.2).

According to the present invention, the corrosion inspection device further comprises a spacer (7), which is movably arranged inside the housing (1), partly covering the sensor (4) in such a way that one end of the spacer (7) is pressed on the compartment (5), and the other end of the spacer (7) is pressed on one end of the spring (3).

The spacer (7) also prevents the spring (3) from being in the same condition as the metal parts. However, the corrosion inspection device may operate without the spacer (7). It may be modified by pressing one end of the spring (3) directly against one end of the compartment (5). As such, when the sensor (4) is corroded and breaks related to the degree of corrosion of the metal parts, the spring (3) will push the display indicating corrosion of the metal parts (2.2) of the display (2) to extend from the housing (1) to indicate that the metal parts have corrosion.

According to the present invention, the corrosion inspection device further comprises a plug (8), which mounts the end of the housing (1) on the side with the compartment (5), and is arranged within the housing (1). The plug (8) helps to prevent the end of the sensor (4) from making contact with corrosive substances, which may be in a gas/liquid state. This will also reinforce the strength and stability of hooking of the sensor (4) with the compartment (5) in the case where the sensor (4) is arranged by hooking one end of the sensor (4) to the end of the compartment (5) in such the way that the end of the sensor (4) bends to be mounted to the end of the compartment (5), for example.

According to the present invention, the metal parts are a metal pipe (P) wrapped with the insulation (I) (as seen in Figure 4). However, the metal parts are not limited to insulated pipes. They can be any non-insulated metal parts, which may be corrodible.

In the case when the metal parts are the metal pipe (P) wrapped with the insulation (I), the insulation may have a different thickness. Therefore, it is necessary to adjust the length of the

corrosion inspection device properly so that part of the sensor (4) is placed near and/or in the same condition as the metal parts, while changes in the display (2) remain clearly visible. In the present invention, the length of the corrosion inspection device can be easily adjusted by changing the lengths of the spacer (7), the sensor (4), and the housing (1) in line with the thickness of the insulation, without adjusting the lengths of the spring (3) and the display (2).

According to the present invention, the sensor (4) is a metal or alloy wire, although carbon steel wire is most suitable. However, the sensor (4) is not limited to the carbon steel wire; it can be of any metal, preferably the same as the metal parts, so that when metal parts are corroded, the metal wire will be corroded at a similar or same rate as the metal parts, for example. In addition, the length and size of the sensor (4) in the notch (1.1) of the housing (1) and notch (5.1) of the compartment (5) must be designed in such a way that any corrosion will be related to the corrosion of the metal parts that will be inspected.

According to the present invention, the corrosion inspection device is installed by inserting a part of the corrosion inspection device into the insulation (I), which wraps around the metal pipe (P) in such a way that part of the sensor (4) in the notch (1.1) of the housing (1) and the notch (5.1) of the compartment (5) is arranged near and/or in the same condition as the metal pipe (P) (as seen in Figure 4).

Figure 4 shows the inspection of corrosion of metal parts, which shows an example of inspection of corrosion of the metal pipe (P) wrapped with the insulation (I), through the following steps:

- Install the corrosion inspection device by inserting part of the sensor (4) into the insulation (I), which wraps around the metal pipe (P). The corrosion inspection device is horizontally placed near the external surface of the metal pipe (P). A part of the sensor (4) is placed near and/or in the same condition as the metal pipe (P) without coming into direct contact with the metal pipe (P). The display indicating non-corrosion of the metal parts (2.1) of the display (2), which has a color, e.g. green, extends from the housing (1) to indicate that the metal pipe (P) has no corrosion (as seen in Figures 1 and 2).

Thus, when the inspection staff observes the green color, he or she will learn that the metal pipe (P) has no corrosion.

- In the case when the metal pipe (P) is corroded, the sensor (4) will also be corroded until reaching a point when it breaks. When the sensor (4) breaks, the spring (3) will expand and push the display indicating corrosion of the metal parts (2.2) of the display (2), which has another color, e.g. red, to extend from the housing (1) to indicate that the metal pipe (P) has corrosion (as seen in Figure 3).

Thus, when the inspection staff observes the red color, he or she will learn that the metal pipe (P) has been corroded and is able to plan for maintenance or replacement of the metal pipe (P).

Based on the aforementioned details, the corrosion inspection device of the present invention provides advantages as indicated above. That is, it can provide visual inspection of metal part corrosion without the use of aid equipment, can be installed at the site and can provide corrosion inspection at all times by inspection staffs, is accurate because the sensor (4) has a comparable or same corrosion rate as the metal used to make the pipe and is not immersed in corrosive substances. In addition, the sensor (4) is not directly in contact with the metal pipe, thus preventing galvanic reactions. Moreover, the corrosion inspection device is compact, so it can be installed in close proximity to the metal pipe, thus allowing the sensor to be in the same condition as the metal parts. Therefore, it provides significant accuracy for corrosion inspection. It saves the costs for inspecting metal part corrosion, and its price is affordable, and so on.

The corrosion inspection device according to the present invention is not limited to the embodiments described above or in the drawings. The present invention is capable of other embodiments and being modified or changed in different ways to provide the same results of the invention. Such modifications or changes are considered to be within the concept and scope of the present invention.

The Most Preferred Embodiment of the Invention

As disclosed in the detailed description.

Claims

1. A corrosion inspection device, comprising:

- a housing;
- a display arranged at one end of the housing;
- 5 - a spring arranged in compression within the housing and having one end of the spring pressed on the display; and
- a sensor arranged within the housing,

wherein the corrosion inspection device is provided with a compartment that allows a part of the sensor to be near and/or in the same condition as the metal parts and allows the spring not
10 to be near and/or in the same condition as the metal parts, in such a way that, when the sensor is corroded and breaks in relation to the degree of corrosion of the metal parts, the display continues to function and indicates the metal parts having experienced corrosion.

2. The corrosion inspection device according to claim 1, wherein the housing is characterized by a long hollow rod with a notch at one end of the housing to allow a part of the
15 sensor to be near and/or in the same condition as the metal parts.

3. The corrosion inspection device according to claim 1, wherein the display comprises a display indicating non-corrosion of the metal parts and a display indicating corrosion of the metal parts, both of which have different characteristics, and are the same piece or different pieces.

4. The corrosion inspection device according to claim 1 or 3, wherein

20 - In the condition where the metal parts have no corrosion, or their corrosion is within an acceptable range, the sensor is not corroded, or corroded but does not break, resulting in the display indicating non-corrosion of the metal parts, which has a particular characteristic, to extend from the housing to indicate that the metal parts have no corrosion, and the display indicating corrosion of the metal parts, which has a different characteristic, remains inside the housing; and

- In conditions where the metal parts experience corrosion beyond an acceptable range, the sensor is corroded and breaks, resulting in the display indicating corrosion of the metal parts of the display to extend from the housing by the pushing of the spring.

5 5. The corrosion inspection device according to claim 2, wherein the compartment is characterized by a rod with a notch, which is arranged within the housing, in such a way that causes the notch of the compartment to be located so that it exactly aligns with the position of the notch of the housing in order to allow that part of the sensor to be near and/or in the same condition as the metal parts and the compartment to be mounted to the housing, preferably with a screw.

10 6. The corrosion inspection device according to claim 1, wherein the sensor is a long rod or string and one end of the sensor is hooked to the compartment, with the other end of the sensor hooked to the display in such a way that the end of the sensor bends to be mounted with the end of the compartment and the end of the display.

15 7. The corrosion inspection device according to any one of the preceding claims, further comprising a spacer, which is movably arranged inside the housing, partly covering the sensor in such a way that one end of the spacer is pressed on the compartment, and the other end of the spacer is pressed on one end of the spring.

 8. The corrosion inspection device according to any one of the preceding claims, further comprising a plug, which mounts an end on the side with the compartment and is arranged within the housing.

20 9. The corrosion inspection device according to any one of the preceding claims, wherein the metal parts are a metal pipe wrapped with the insulation, and the sensor is a metal wire, preferably a carbon steel wire.

25 10. The corrosion inspection device according to claim 5, wherein the corrosion inspection device is installed by inserting a part of the corrosion inspection device into the insulation, which wraps around the metal pipe in such a way that part of the sensor in the notch of the housing and the notch of the compartment is arranged near and/or in the same condition as the metal pipe.