the relationship between the surface pressure (= estimated surface pressure) applied to the gasket and the surface pressure (= actual surface pressure) to which the gasket is actually subjected under the influence of the state in which the bolt and the flange are tightened is as follows:

estimated surface pressure ≠ actual surface pressure.

Even if the measurement accuracy of the torque value and the axial force value is increased, the estimated surface pressure and the actual surface pressure on the gasket do not match. The surface pressure to which the gasket is subjected cannot be perceived.

[0011] Regarding such issues, the inventor has obtained findings that a change in the shape of a gasket depends on a load applied from between flanges and it is beneficial to observe the shape change in order to control the gasket tightening. Patent Literatures 1 to 3 do not disclose or suggest such issues. The configuration disclosed in Patent Literatures 1 to 3 cannot solve such issues.

[0012] Therefore, an object of the present disclosure is to directly observe a change in the shape of a gasket that is subjected to a load between flanges and to use the observation result for the gasket tightening control to improve the gasket and a technique for controlling the gasket based on the issues and findings described above.

Solution to Problem

Summary

[0013] In order to achieve the above object, a gasket according to one aspect of the present disclosure includes an inner cut formed in a non-restrained portion adjacent to a restrained portion restrained between flanges, in which a shape of the inner cut changes due to a load applied to the restrained portion.

[0014] In the gasket, minimum point information is acquired based on a shape change of the inner cut.

outer ring 701. In Example 5, for example, by observing a shape change Qa of the outer edge portion along the position at which the inner cut 4 is formed, the shape of the inner cut 4 is measured, and the surface pressure state of the gasket 70 is controlled. For example, the strain sensor 28 of the gasket control system 26 may be used to observe the shape change Qa. The gasket control system 26 calculates the shape of the inner cut 4 based on the measured shape change Qa. Processing for controlling the state in which the gasket 70 is tightened may be performed in a manner similar to that in the above embodiment.

[0104] <Configuration of gasket 70>

The outer ring 701 and the inner ring 703 are made of, for example, a metal material such as stainless steel, carbon steel, or titanium, and are formed in an annular shape having a predetermined thickness or a shape close thereto. The gasket body 702 is configured by winding a laminate of a thin plate-like member made of, for example, a metal material and a buffer material (filler) such as graphite or fluororesin in a spiral shape between an inner wall surface of the outer ring 701 and an outer wall surface of the inner ring 703. The laminate constituting the gasket body 702 is formed to have, for example, a "V" shape in cross section, or a waveform shape close thereto. The laminate has end surfaces, for example, adhered to the outer ring 701 and the inner ring 703 by spot welding.

[0105] As illustrated in B of Fig. 12, for example, in the outer ring 701, an inner cut 4a is opened with a predetermined width before the load F from the flanges 16-1 and 16-2 is applied to the gasket body 702. When the load F acts through the gasket body 702, for example, as illustrated in C of Fig. 12, a part or the whole of the opening of the outer ring 701 is deformed to form a closed inner cut 4b.

[0106] In Fig. 13, the horizontal axis shows the load [kN]

and the vertical axis shows the strain (shape change), and the shape change Qa (Fig. 12) in the circumferential direction occurring in the outer edge of the outer ring 701 is shown as a measurement value measured by the strain sensor 28.

[0107] In the measurement result, in a case where the load on the gasket increases, for example, there is no large change from the start of application of the load to a predetermined value, and thereafter, when the load exceeds a predetermined value, a negative value is measured in the strain sensor. This shows, for example, a shape change showing that the outer edge portion of the outer ring 701 is compressed in the circumferential direction. The value of the strain in the circumferential direction increases in the positive direction after a minimum point appears around 220 kN of the load, for example.

[0108] <Effects of Example 5>

(1) The shape change of the outer ring 701 of the spiral wound gasket 70 sandwiched between the flanges 16-1 and 16-2 is measured, so that the surface pressure on the gasket 70 due to the load F can be perceived.

[0109] (2) In a case where the spiral wound gasket 70 is used, a change representing the load F can be acquired from the gasket 70 by measuring the shape change of the inner cut 4 based on the shape change Qa occurring in the outer ring 701, unlike the torque control and the measurement of bolt axial force in monitoring and measuring the shape change. Therefore, the load F applied to the flanges 16-1 and 16-2 can be estimated from the shape change of the gasket 70 without the influence of the bolt 18 and the flanges 16-1 and 16-2.

[0110] <Appendices>

With regard to the embodiments and examples described above, the following appendices are disclosed.

[0111] (Appendix 1) A gasket placed between flanges of a flange tightening portion, the gasket including: